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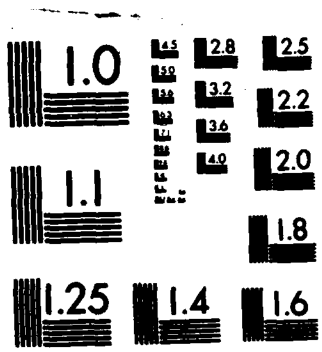

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THESIS

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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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. (cont)

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

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Submitted in partial fulfillment of the
requirements for the degree of

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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.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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 backround 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

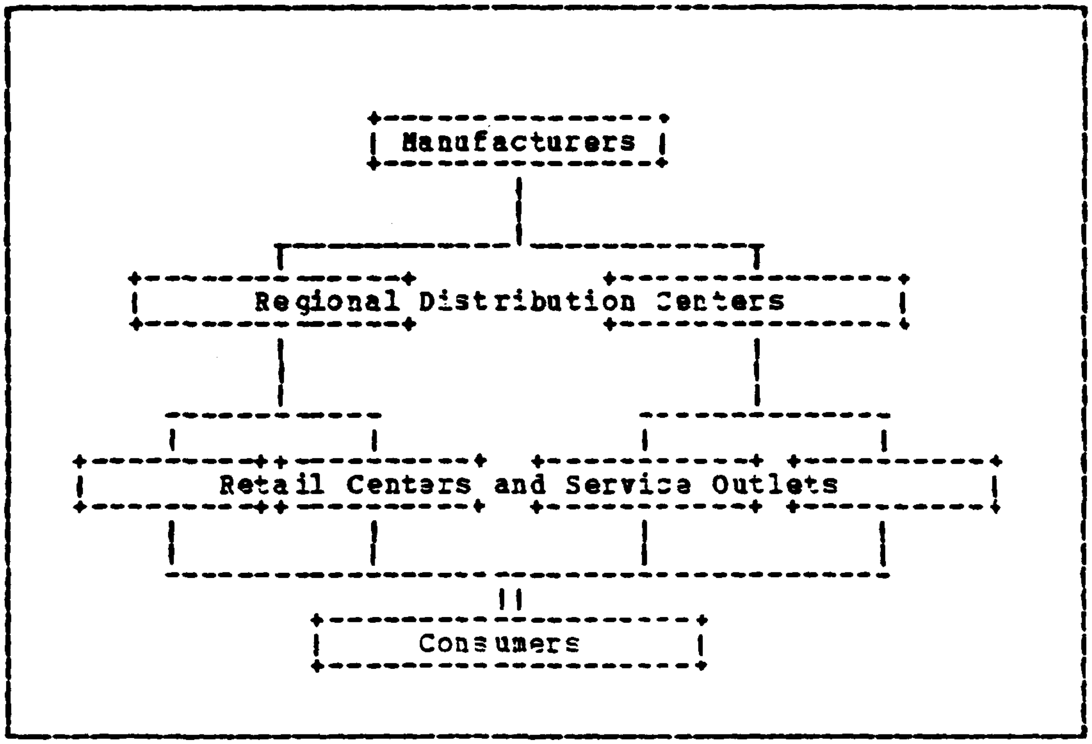

Figure 2.1 Typical Supply Echelon Structure.

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 practice. 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_o). Operational availability has been defined by the following equation:

$$A_o = \frac{MTBF}{MTBF + MTTR + MLDT} \qquad (2.1)$$

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.

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*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_o. 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_o is as shown in equation 2.1, and may be calculated with the following equations:

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

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:

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

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_o calculated by the two methods. However, inspection of the two formulas reveals the potential for significant differences.

The preceding 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_o 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_o 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_o, 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 intractible.

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 ingermediate 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 activites (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 reliabiltiy 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, MTTR, 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.

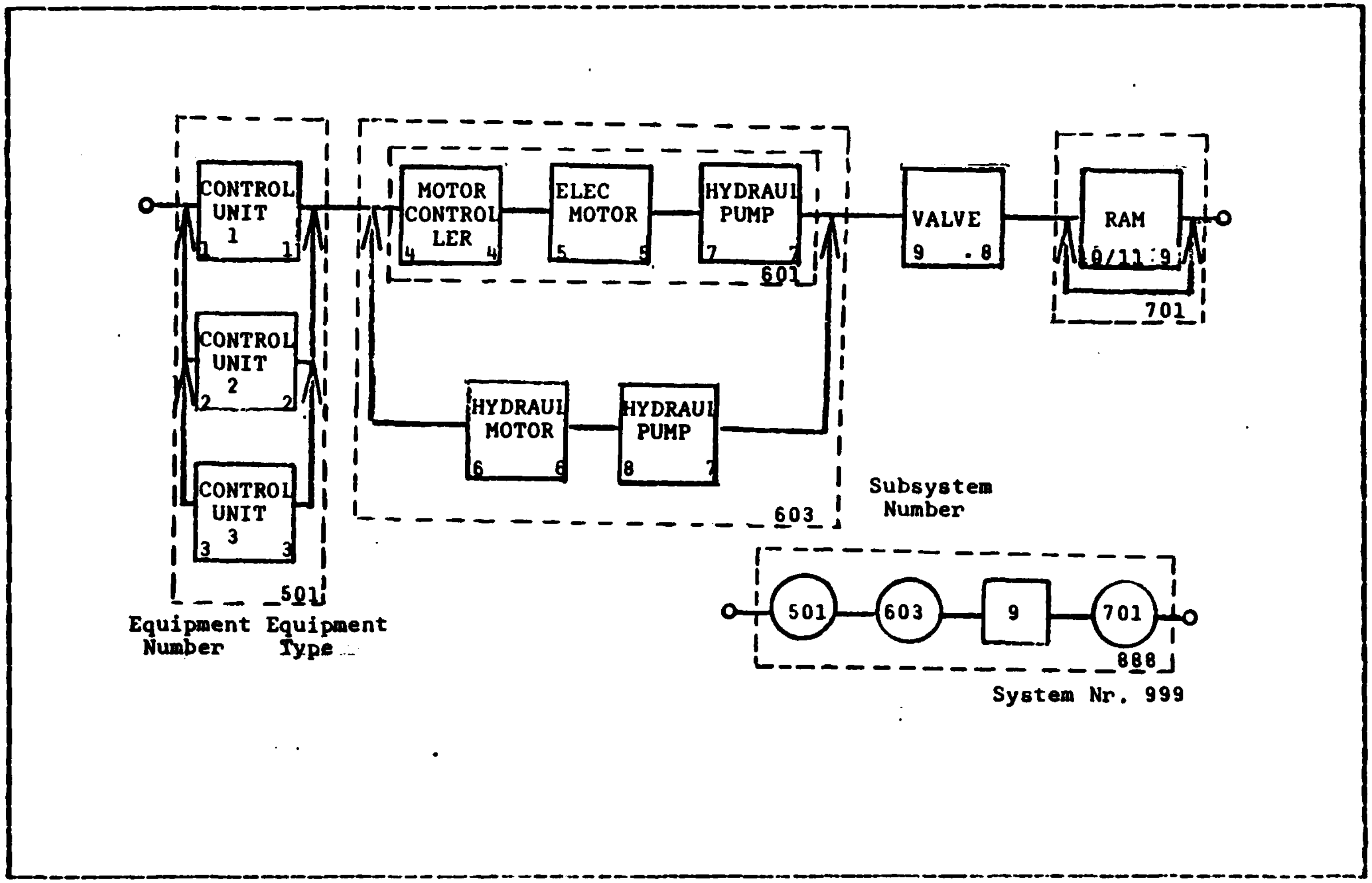

Figure 4.1 Sample Reliability Block Diagram.

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.

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

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.*

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

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.

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

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. Satifactory operating

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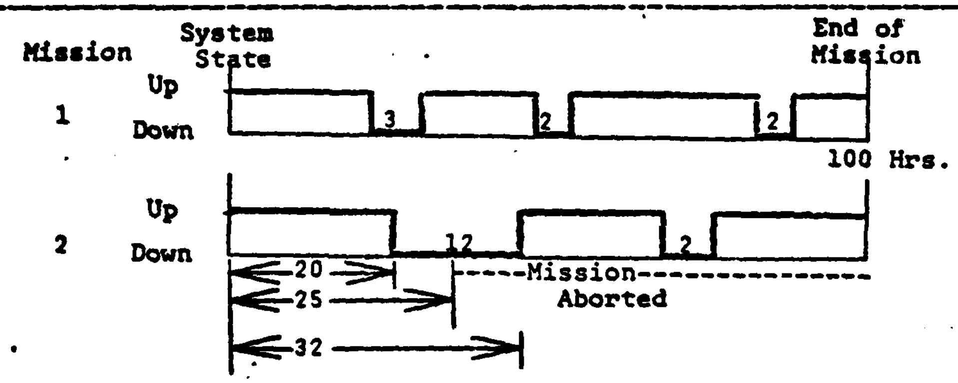
*Although one phase begins where a previous ends, the instantaneous availability value may be different if the system states are different in the two phase types.

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 reliabilty, availability, and readiness performance measures.



	Mission 1	Mission 2	Simulation Total
Calendar time	100	100	200
Downtime (AVA)	7	14	21
Uptime (AVA)	93	86	179
Availability	.93	.86	.895
Downtime (RED)	7	80	87
Uptime (RED)	93	20	113
Readiness	.93	.20	.565
Nr. Missions	1	1	2
Nr. Successful Missions	1	0	1
Reliability	1.0	0.0	0.5

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 if 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

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*Note the assumption that an equipment failure assumes that a replacement part is necessay 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.

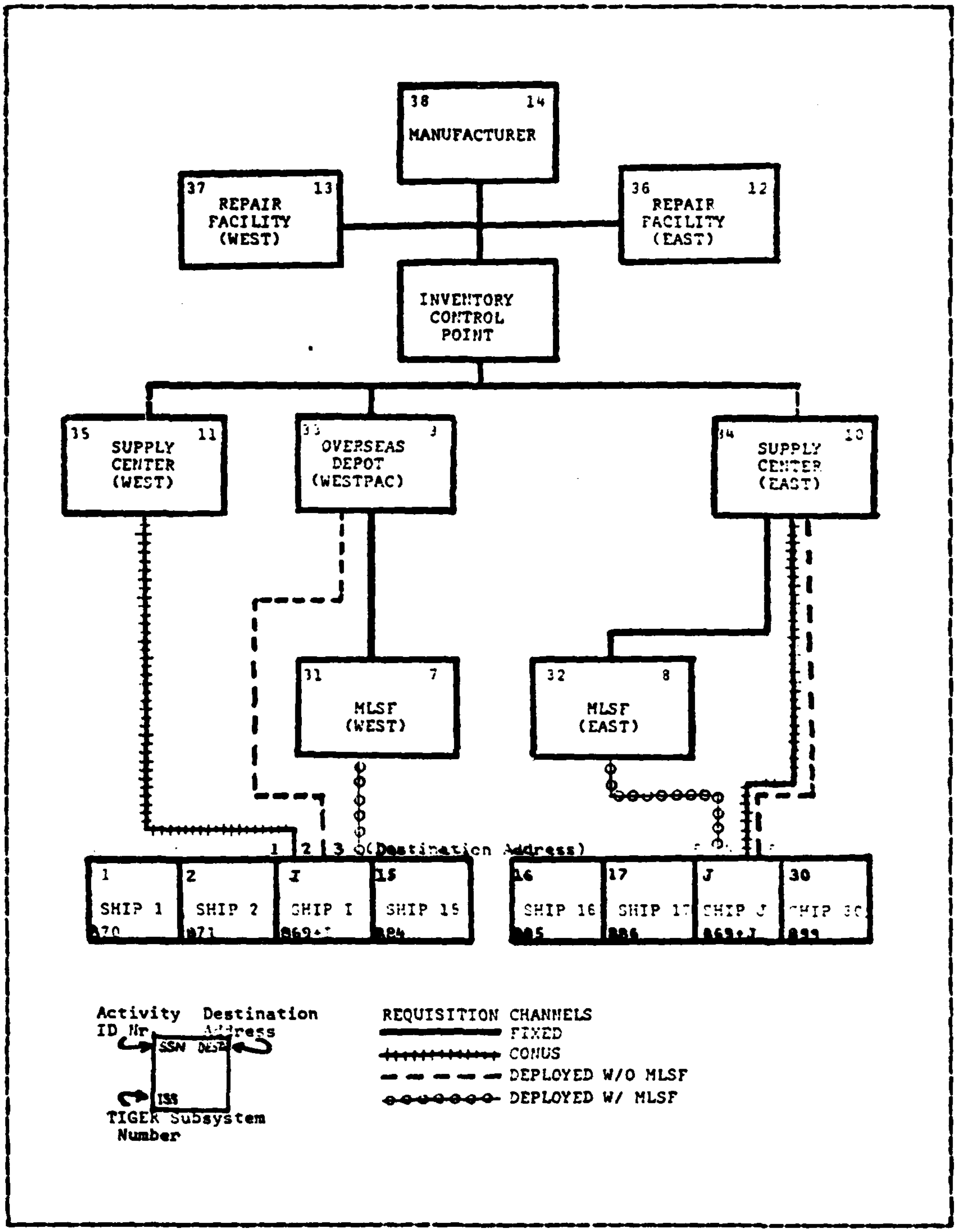

Figure 5.1 METEOR Requisition Channels.

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. <u>Requisitioning, Issue, and Reorder Procedures</u>

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 shipboard 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 Chaper 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

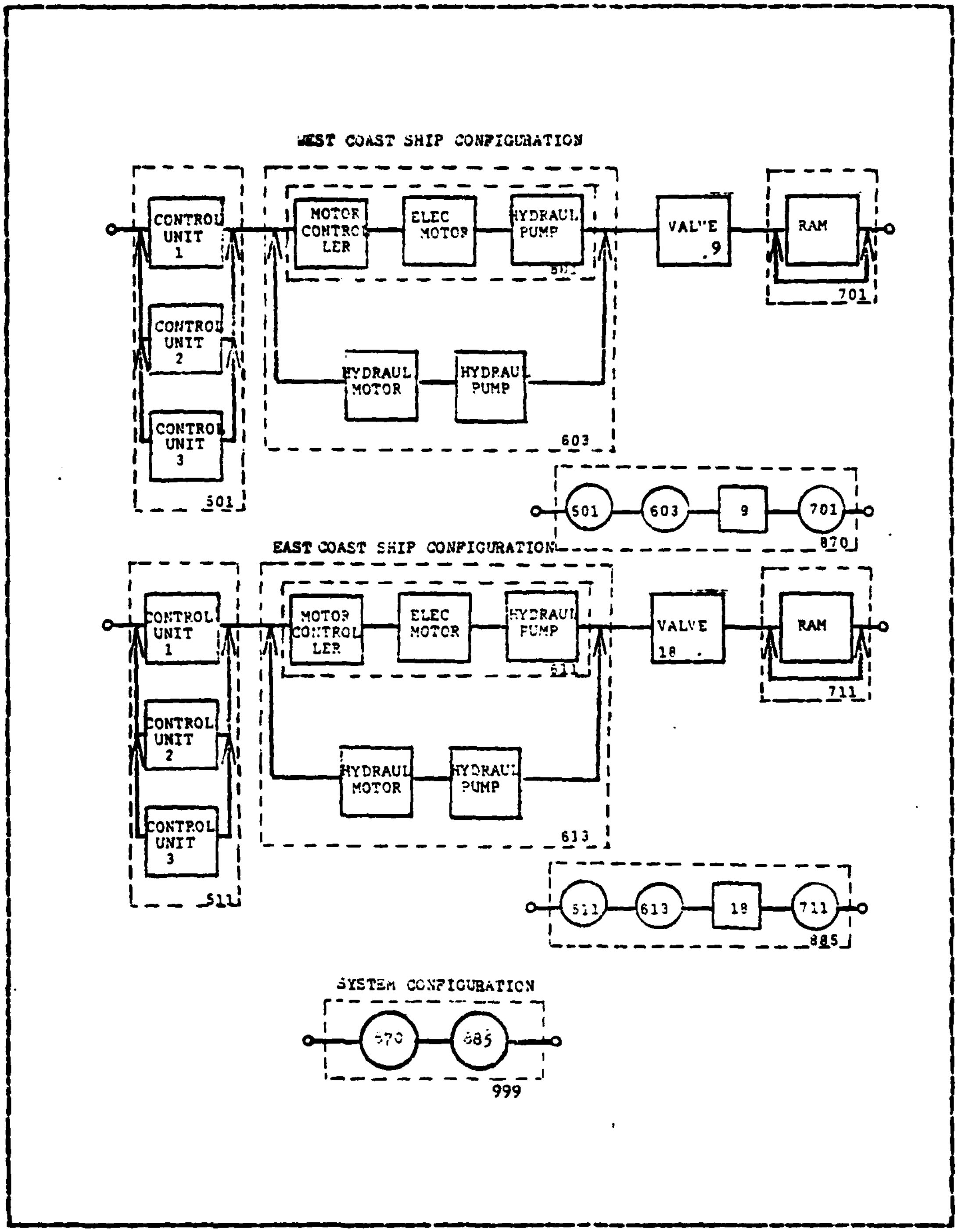

Figure 5.2 Sample Configuration Scheme.

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 likihood 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.*

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*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 likihood 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 inidvidual 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

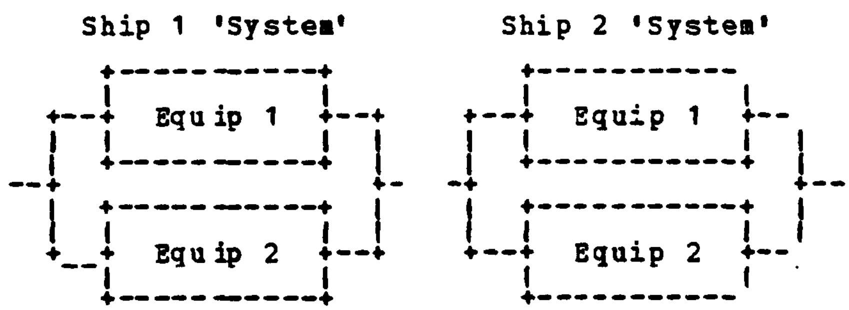
Destination Addresses

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

- 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 effectivenss 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



Scenario	1		2	
	MTBF	MTTR	MTBF	MTTR
Equip 1	100	12	100	9999
Equip 2	50	8	50	9999
Duration	5000		100	

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],

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

From the system reliability diagram,

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

Where,

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

The limiting results for average availability are:

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

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

For the system under study,

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

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

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

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

$$R(t) = EXP(-\lambda t) \qquad (6.8)$$

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

Run	Seed	Availability	Reliability
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 MLSF. 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 reprentative 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:

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

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 Tehnique for Recoverable Item Control; Modified (Mod-METRIC) [Ref. 12].

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

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.

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

where,

c_e = Cost of equipment

c_j = Unit cost or module j

N = Number of modules

s_o = Number of spare modules at depot, o

C = Total allowable budget

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

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

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 the 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	IOPTP	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	IOPTP1	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.

IOPTP1 -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 IOPTM is 0.

Column	Format	Variable Name	Description
1-4 5-8 9-12 Etc.	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.

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 540. 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 para- meters 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 type (up to six).
5-8	I4	IFLAG(2)	= 0 if on-board repair allowed.
			= 1 if no on-board repair allowed.
9-12	I4	IFLAG(3)	= 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	Varaiable 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 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.

Column	Format	Variable Name	Description
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 0 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.

Column	Format	Variable Name	Description
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. Their 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.

Column	Format	Variable Name	Description
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 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 the 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.

Column	Format	Variable Name	Description
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 "FLT ") 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 invidual 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.

Column	Format	Variable Name	Description
1-4	A4	ID	Any alphanumeric (e.g., the "SHP 1").
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 870 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
13-16	I4	IB(3)	groups which make up the group de-
17-20	I4	IB(4)	fined on this card. The maximum
21-24	I4	IB(5)	number of members in a group is
25-28	I4	IB(6)	unlimited; however, if there are more
29-32	I4	IB(7)	than 7, a continuation card is
33-36	I4	IB(8)	required, which is of the same format. The number required and master group number must be identical on all continuation cards.

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 of 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.
5-8	I4	ISTB(2)	The other equipment or equipment group numbers.
9-12	I4	ISTB(3)	
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	Place any non-zero integer in this field (to distinguish Equipment Operating Cards from Configuration Cards.

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.

Column	Format	Variable Name	Description
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	MLSF screening delay time. Enter the time required to process a NIS requisition through the MLSF, and refer the requisition to the next echelon.
26-35	F10.0	SSPT	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.

Column	Format	Variable Name	Description
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.

Column	Format	Variable Name	Description
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 proceding 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.

Column	Format	Variable Name	Description
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)	W.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 refering 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., MLSF to supply center). In these cases, no entry is required. Cards must be input in the following order:

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

Column	Format	Variable Name	Description
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 METEOR Input File

```
   1   3   1   3   2  22   1  0.0          -METEOR Option Card
 870 885                                   -Ship Identification Card
   1 2-SHIP:  STEERING SYSTEM.  TEST 1/1   -Timeline Iteration Card
 100 100 1.0 1.08672   1                   -Statistical Parameter Card

1. 5000.                                   -Phase Type and Duration Card
   5   1                                   -Printout Option Card
   0                                       -Phase Repair Card
 1.0100000.  1.0 1.0                       -Repair Policy Card
   1BRIDGE CONTROL      450.0 4.0  1.
   2ELECTRIC CONTROL    550.0 3.0  1.
   3LOCAL CONTROL       900.0 8.5  1.      -Equipment
   4MOTOR CONTROLLER   1750.0 5.0  1.         Type Cards
   5ELECTRIC MOTOR      500.0 8.0  1.
   6HYDRAULIC MOTOR     300.0 8.0  1.
   7HYDRAULIC PUMP      300.019.5  1.
   8VALVE              4500.024.0  1.
   9RAM                1000.050.0  1.

   1   1   2
   2   3   4
   3   5   6
   4   7   8                               -Equipment Cards
   5   9  10
   6  11  12
   7  13  14  15  16
   8  17  18
   9  19  20  21  22

FLT    1   2 999100000.                    -System Card
SHP1   1     870100000.                    -Subsystem Cards
SHP2   1     885100000.
   1   2   1   2   1   2   1   2   1   2   1   2   1   1   2   2   1   2
   1   1   2   2                           -Equipment/Subsystem
                                              Crossreference Card
```

Sample Input File (con't)

```
  1 501   1   3   5                                 
 -5   1   3                                        1
  3 601   7   9  13                                 
  7   9  13                                        1
  9   7  13                                        1
 13   7   9                                        1
  2 602  11  14                                     
 11  14                                            1
 14  11                                            1
  1 603 601 602                                     
 -6 601                                            1
 -8 601                                            1
  1 701  19  20                                     
  4 870 501 603  17 701                             
  9 603                                            1
 10 603                                            1
 11 603                                            1
  1 511   2   4   6                                   -Configuration Matrix and
 -6   4   2                                        1   Equipment Operating Rule
  3 611   8  10  15                                      Cards
  8  10  15                                        1
 10   8  15                                        1
 15   8  10                                        1
  2 612  12  16                                     
 12  16                                            1
 16  12                                            1
  1 613 611 612                                     
-17 611                                            1
-19 611                                            1
  1 711  21  22                                     
  4 885 511 613  18 711                             
 20 613                                            1
 21 613                                            1
 22 613                                            1
  2 999 870 885                                     
```

Sample Input File (con't)

```
  1    .05           24.        12.         1.0          1.0  -METEOR Parameter
         0   2400.       500.                                            Card
  1      1     1     0     1     1     0     0     2
  0      0     0     0     0     0     0     0     1
         0     72.         50.
  2      1     1     0     1     1     0     0     2
  1      0     0     0     0     0     0     0     0
         0    500.       350.
  1      0     0     0     1     1     0     0     2
  0      0     0     0     0     0     0     0     0
         1    400.      2000.                             -Supply Information Card
 180.                2                                    -Repair Information Card
  0      0     0     1     1     0     0     0     2      -High LimitCard
  0      0     0     0     0     0     0     0     0      -Reorder Point Card
         0    240.       750.
  1      1     1     1     2     1     0     0     4
  0      0     0     0     0     0     0     0     2
         0    300.      1250.
  1      0     0     2     1     1     0     0     4
  0      0     0     0     0     0     0     0     1
         0    500.       999.
  0      0     0     0     0     1     0     0     1
  0      0     0     0     0     0     0     0     0
         1   2400.      2000.
 300.                2
  1      0     0     1     1     1     0     0     3
  0      0     0     0     0     0     0     0     1
         1   4800.      9999.
800.                 1
  1      0     0     0     0     1     0     0     1
  0      0     0     0     0     0     0     0     0
24.    24.    24.    24.      24.     24.             -OST Manufacturer Card
24.   500.   660.   -Card 31        450.   400.    24.     24.
0.0    0.0   150.                   0.0    0.0     0.0     0.0
0.0   240.   200.   Order and       0.0    0.0     0.0     0.0
24.   480.   600.   Shipping        500.   350.    48.     0.0
24.   480.   600.   Time.           500.   350.    48.     24.
0.0    0.0    0.0                   0.0    0.0     0.0     0.0
0.0    0.0    0.0  -Cards 33-40     0.0    0.0     0.0     0.0
48.   548.   800.                   350.   400.    0.0     48.
48.   548.   800.                   350.   400.    24.     48.
```

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.
AATDV(i)	R	Average dollar value of inventory at echelon i.
ACT	I	Activity number designatior.
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.
IOPTM	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 sybsystems.
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 MULTE.
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.
NMPR(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
NMPE(i,k)*	I	Nr. of equipments, i, procured from mfr. K as above.
NMPL(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.
NRF(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 repari facilities for level j. K as above.
NRFL(I,K)*	I	Nr. equipments, i, inducted by repair facilities. K as above.
NFRT(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 baolw).
SRT	R	Supply response time.
SRT1	R	Temp holding variable for SRT.
SSADT	R	Ship's continuous allowable downtime.
SSN	I	Activity identification nmuber (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.
TOTREL	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 preceeded 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.

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

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

TABLE IV

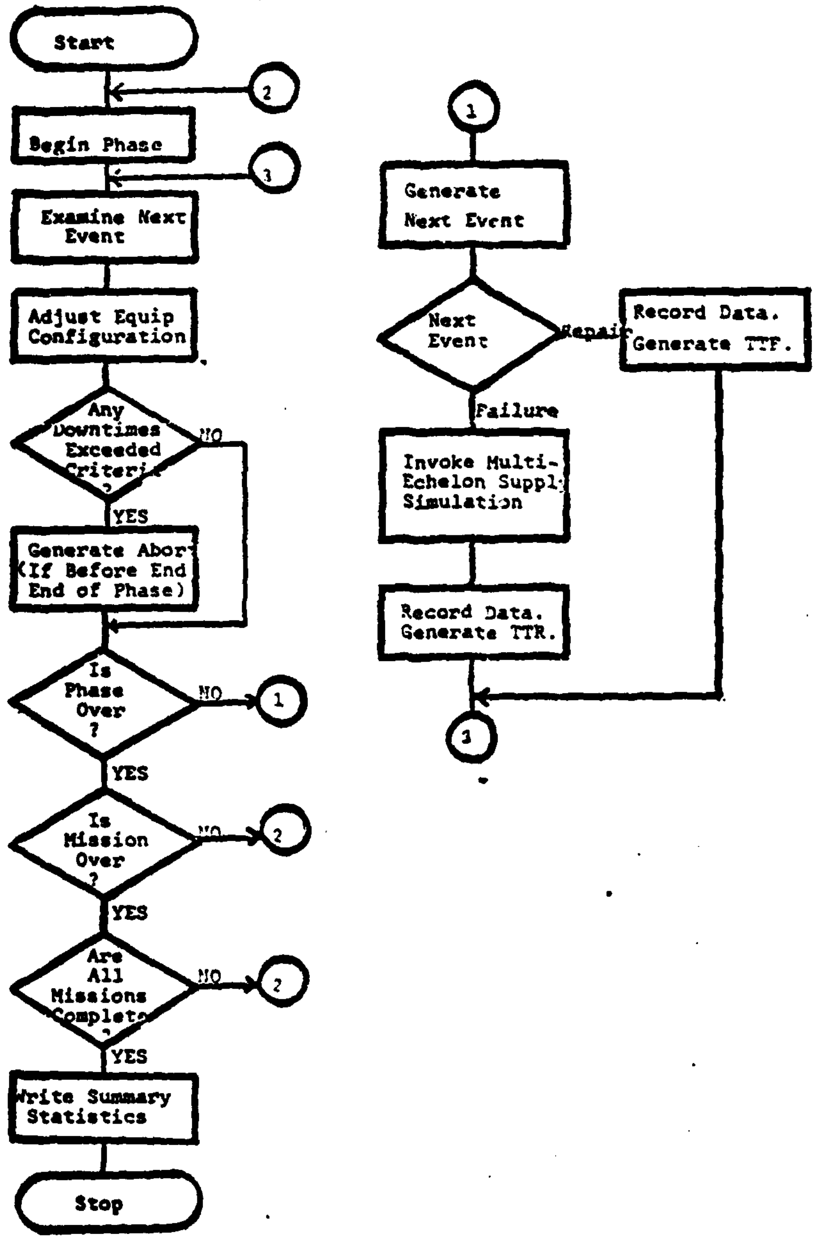
Activity Designators

Activity	Designator ISHIP	SSN	DESTN	LEVEL	ECHELON
West coast ships	870-884	1-15	1-3	1	-
East coast ships	885-899	16-30	4-6	1	-
MLSF:					
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	-	-

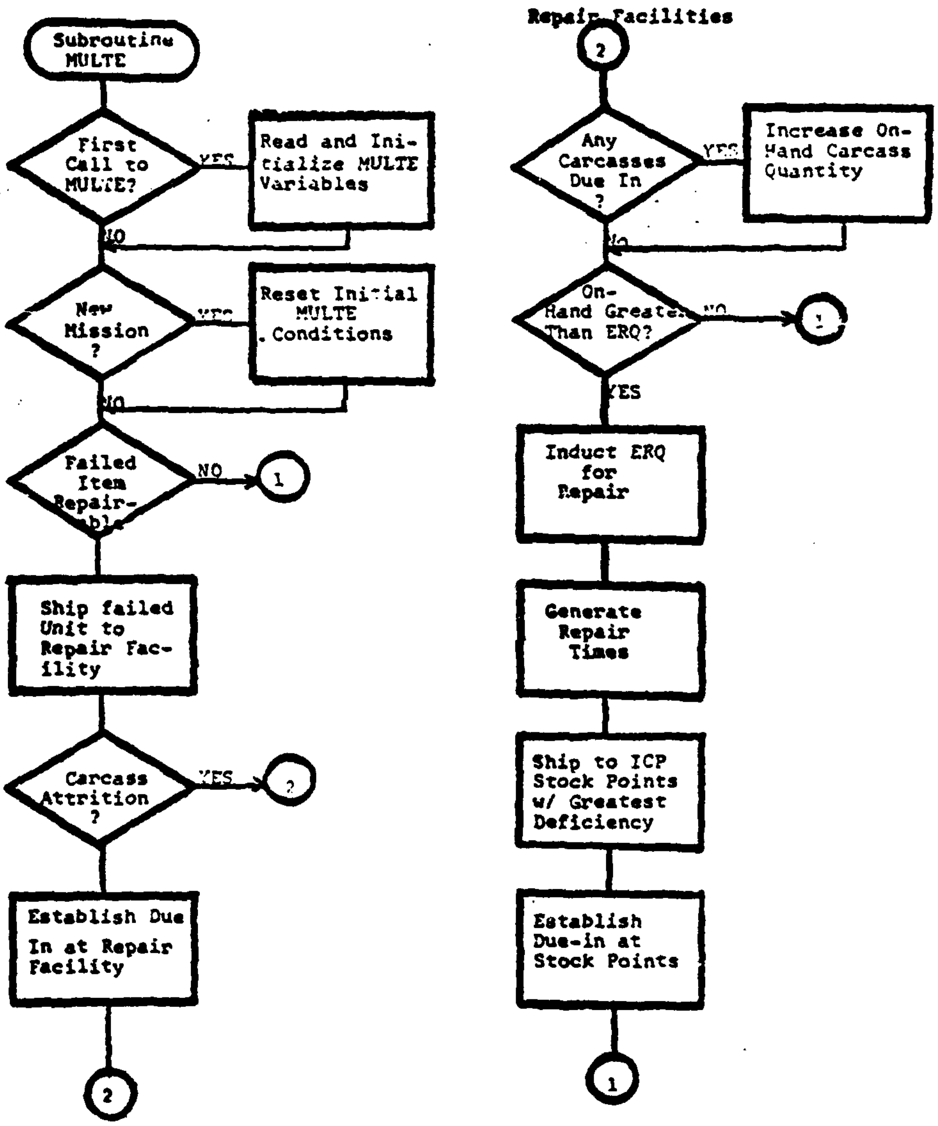
APPENDIX D
METEOR/MULTE PROCESS FLOW CHART

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



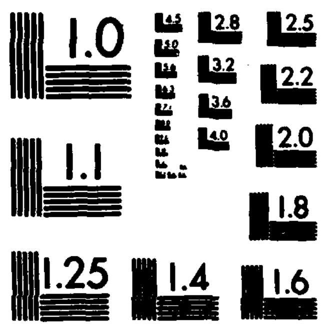
Flowchart: MULTE Initialization



AD-A127 898 METEOR: A TOOL FOR EVALUATING MULTI-ECHELON INVENTORY MODELS AND MATERIAL READINESS(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA T A BUNKER MAR 83 2/2

UNCLASSIFIED F/G 15/5 NL

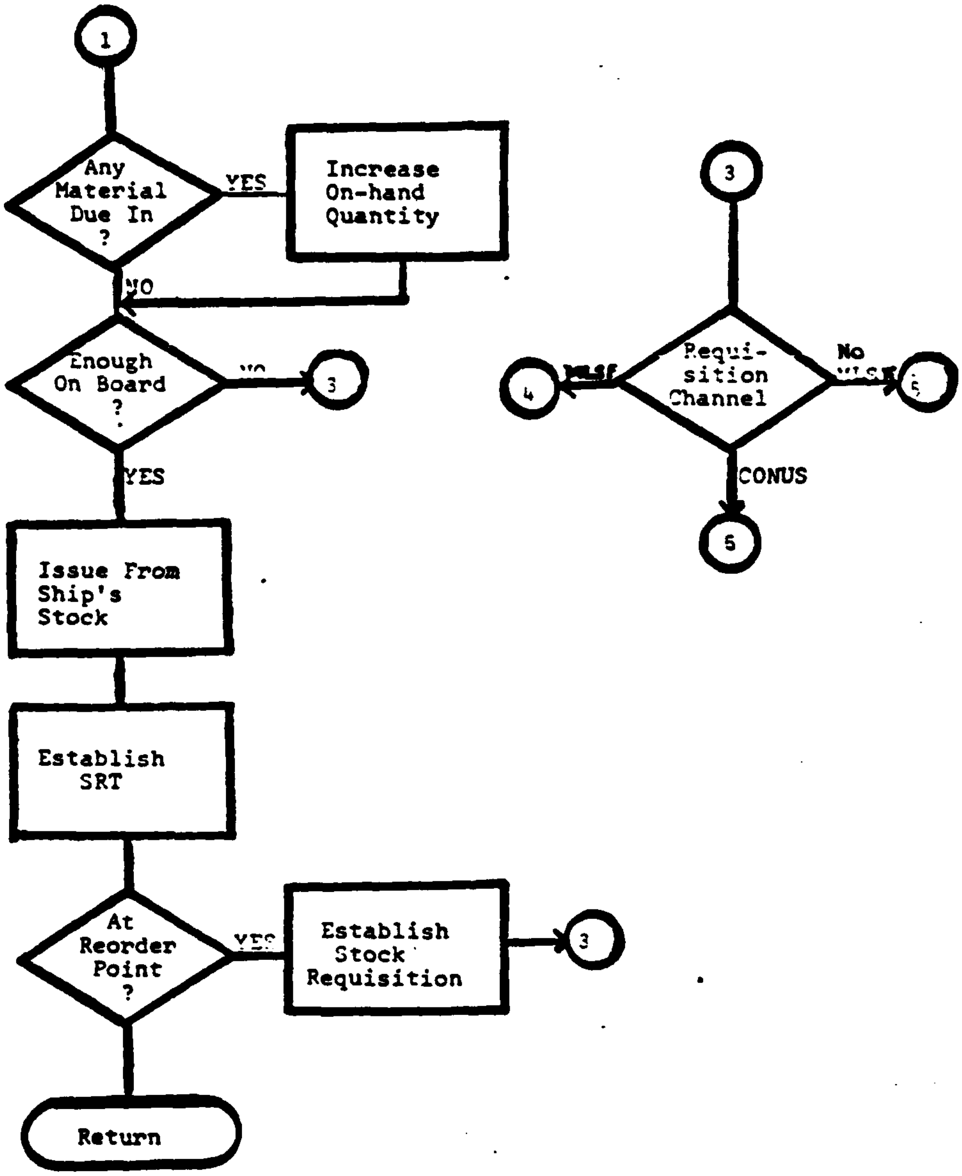
END
DATE
FILMED
6-83
DTIC



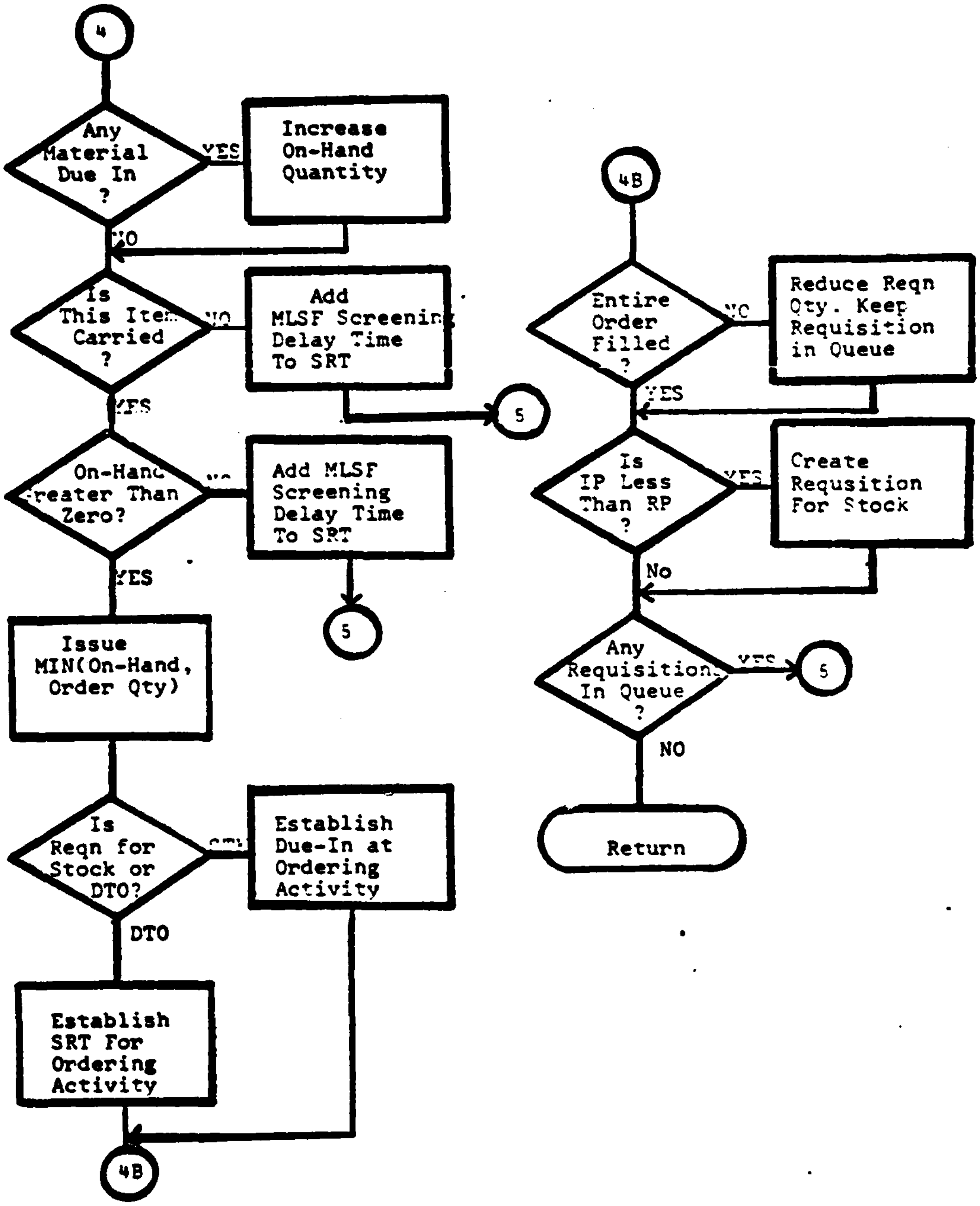
MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

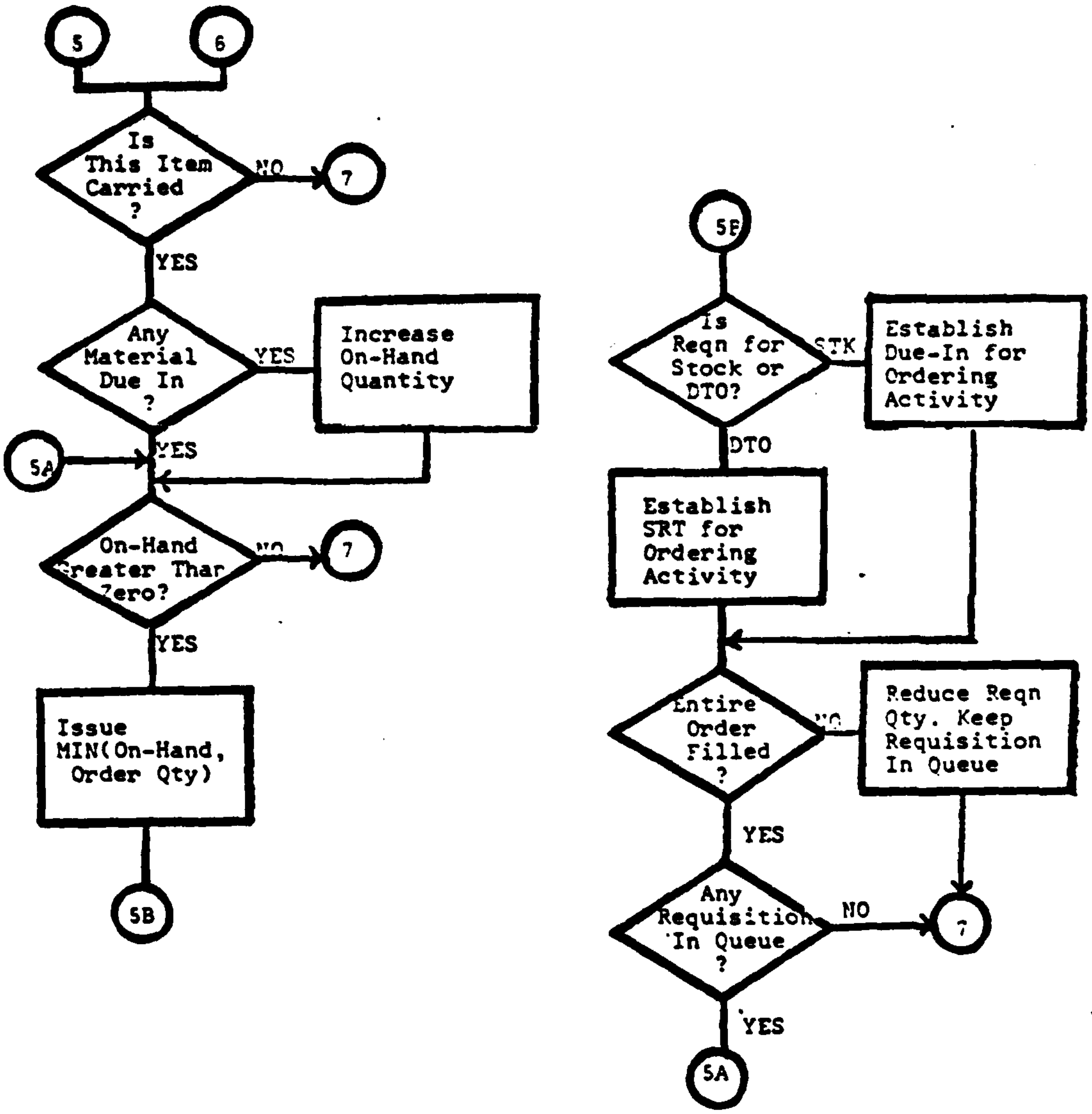
Flowchart: Ship Issue and Reorder Process



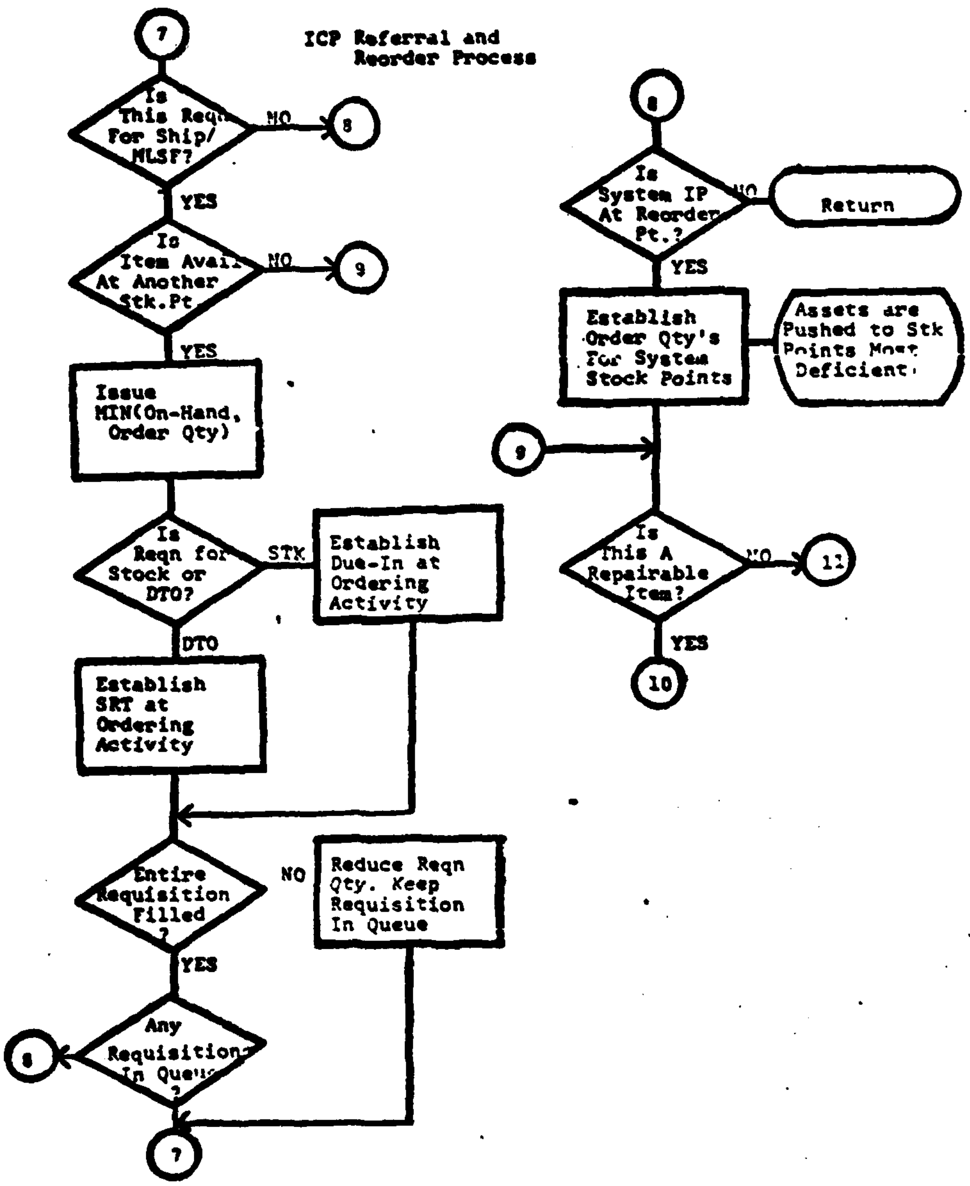
Flowchart: MLSF Issue and Reorder Process



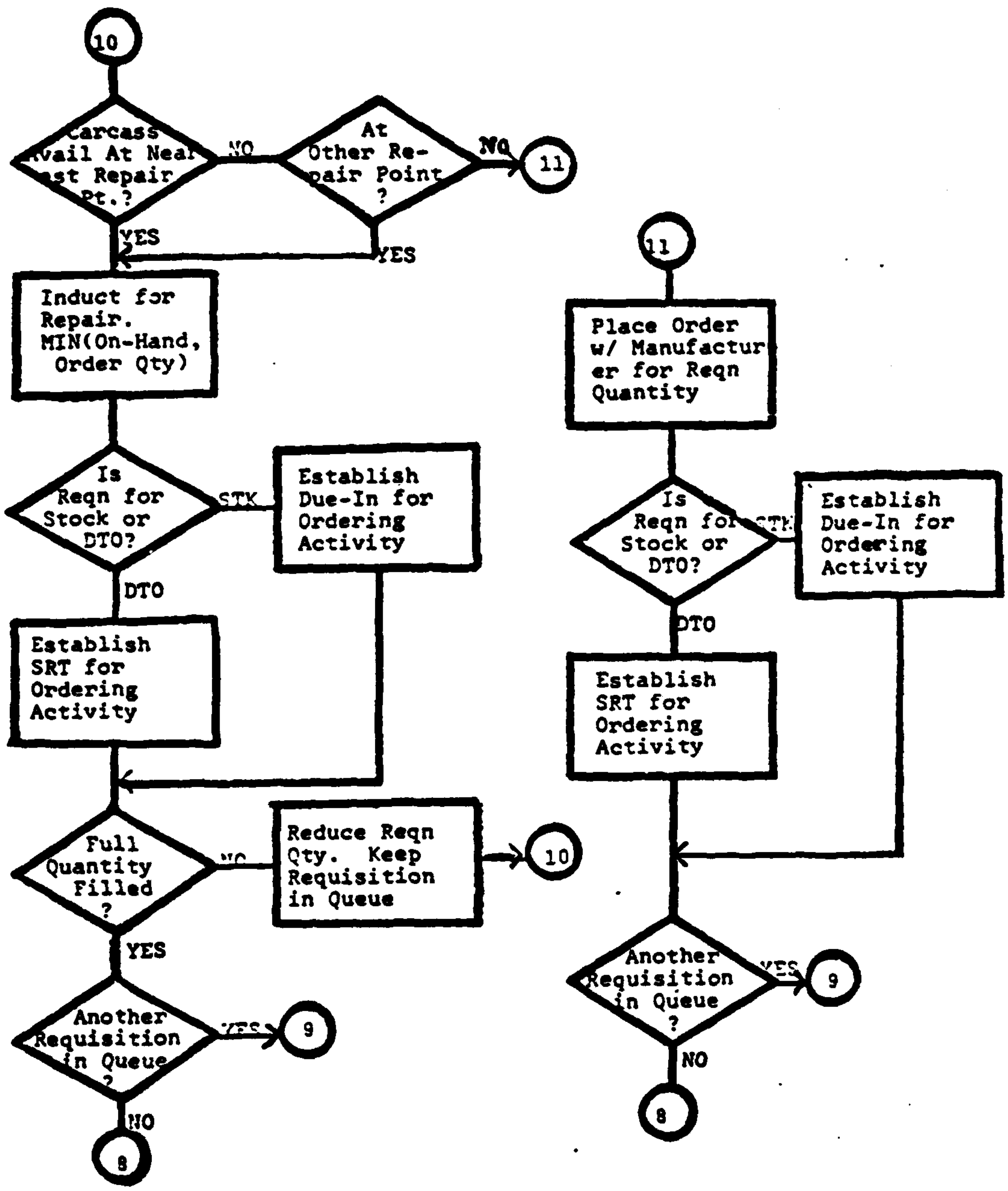
Flowchart: Depot and Supply Center Issue Process



Flowchart: ICP Redistribution and Reorder Process



Flowchart: ICP Repair and Procurement Process



APPENDIX E

SAMPLE METEOR OUTPUT

```
MISSION:   2
```

(Event Driven Output)

```
------------------------------------------------------------------------
     FAILURE CF EQUIPMENT TYPE  6 CN SHIP 16 AT TIME   74.
     RESULTEC IN THE FCLLCWING SUPPLY ACTICNS:
ENC USE REQUIREMENT FILLEC BY SSN 16.    SUPPLY RESPONSE TIME IS:     12.
ORDERS FOR STCCK WERE GENERATEC AS FCLLCWS:
     REQUISITICNOR(SSN)     DUE-IN AT TIME     ISSUED FRCM(SSN)
          16                     71C                34
------------------------------------------------------------------------
     FAILURE OF EQUIPMENT TYPE  7 CN SHIP  1 AT TIME  1C7.
     RESULTEC IN THE FCLLCWING SUPPLY ACTIONS:
ENC USE REQUIREMENT FILLEC BY SSN 35.    SUPPLY RESPONSE TIME IS:    624.
ORDERS FOR STCCK WERE GENERATEC AS FCLLOWS:
     REQUISITICNOR(SSN)     DUE-IN AT TIME     ISSUED FRCM(SSN)
          35                     458                38
------------------------------------------------------------------------
     FAILURE CF EQUIPMENT TYPE  6 CN SHIP 16 AT TIME  141.
     RESULTEC IN THE FCLLCWING SUPPLY ACTICNS:
END USE REQUIREMENT FILLEC BY SSN 34.    SUPPLY RESPONSE TIME IS:    624.
NO ORDERS FCR STOCK RESULTED FRCM THIS ISSUE.
------------------------------------------------------------------------
     FAILURE CF EQUIPMENT TYPE  7 CN SHIP 16 AT TIME  311.
     RESULTEC IN THE FCLLCWING SUPPLY ACTIGNS:
ENC USE REQUIREMENT FILLED BY SSN 35.    SUPPLY RESPONSE TIME IS:    523.
NO ORDERS FCR STOCK RESULTED FRCM THIS ISSUE.
------------------------------------------------------------------------
     FAILURE CF EQUIPMENT TYPE  2 CN SHIP 16 AT TIME  314.
     RESULTEC IN THE FOLLCWING SUPPLY ACTICNS:
END USE REQUIREMENT FILLEC BY SSN 16.    SUPPLY RESPONSE TIME IS:     12.
ORDERS FOR STCCK WERE GENERATEC AS FCLLCWS:
     REQUISITIONOR(SSN)     DUE-IN AT TIME     ISSUED FROM(SSN)
          16                     476                32
          32                     676                34
------------------------------------------------------------------------
     FAILURE OF EQUIPMENT TYPE  1 CN SHIP  1 AT TIME  370.
     RESULTED IN THE FCLLCWING SUPPLY ACTIONS:
ENC USE REQUIREMENT FILLED BY SSN  1.    SUPPLY RESPONSE TIME IS:     12.
ORCERS FOR STCCK WERE GENERATED AS FCLLCWS:
     REQUISITICNOR(SSN)     DUE-IN AT TIME     ISSUED FROM(SSN)
           1                     533                31
          31                     733                33
          35                    5386                38
------------------------------------------------------------------------
     FAILURE CF EQUIPMENT TYPE  6 CN SHIP  1 AT TIME  397.
     RESULTEC IN THE FCLLCWING SUPPLY ACTIONS:
END USE REQUIREMENT FILLED BY SSN  1.    SUPPLY RESPONSE TIME IS:     12.
ORDERS FOR STCCK WERE GENERATEC AS FCLLCWS:
     REQUISITIONOR(SSN)     DUE-IN AT TIME     ISSUED FROM(SSN)
           1                     633                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	MLSF	DEPOT	SUPPLY CENTERS
NR. PROCUREMENTS	4.3	1.6	1.2	5.9
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	0.4	0.0	1.2	1.4	3.4	0.0	0.5	0.0	0.0
NR. ITEMS PROCURED	3.4	3.7	0.4	0.0	1.2	1.8	3.4	0.0	0.5	0.0	0.0

II. REPAIR COSTS

ECHELON SUMMARY

SHIPPED FR REPAIR FACILITY TO:	SHIPS	MLSF	DEPOT	SUPPLY CENTERS
NR. INDUCTIONS	0.7	0.0	0.1	0.0
NR. ITEMS INDUCTED	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	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0
NR. ITEMS INDUCTED	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.8	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

(DESINATIONS 1-6 REFER TO SHIP LOCATIONS)

SHIPPER		1	2	3	4	5	6	7	8	9	0	0
MLSF-W	(7)	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0
-E	(8)	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
DEPOT	(9)	0.0	0.0	1.9	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
CENTER-E	(10)	0.0	0.0	0.9	0.0	0.0	1.7	0.0	2.1	0.0	0.0	0.0
-W	(11)	0.0	0.0	1.5	0.0	0.0	1.7	1.8	0.2	0.0	0.0	0.0
REPAIR-E	(12)	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
-W	(13)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
MFR	(14)	0.0	0.0	2.0	0.0	0.0	1.2	0.9	0.7	1.2	3.8	3.7

TOTAL NR. OF ISSUES FROM SHIP STOCK: 11.9

Sample Summary Output

IV. INVENTORY COSTS

INITIAL INVENTORY INVESTMENT

ECHELON: EQUIPMENT	SHIPS	MLSF	DEPOT	CENTERS
1	1300.00	1000.00	0.0	1000.00
2	200.00	100.00	0.0	100.00
3	700.00	0.0	0.0	700.00
4	0.0	0.0	2000.00	2000.00
5	1500.00	1500.00	750.00	2250.00
6	2500.00	0.0	2500.00	2500.00
7	0.0	0.0	0.0	999.00
8	4000.00	0.0	2000.00	4000.00
9	19998.00	0.0	0.0	9999.00
TOTALS:	29898.00	2600.00	7250.00	23548.00

TOTAL INVESTMENT: 43296.00

AVERAGE ON-HAND INVENTORY DOLLAR VALUE

ECHELON: EQUIPMENT	SHIPS	MLSF	DEPOT	CENTERS
1	467.73	443.05	0.0	366.89
2	113.16	39.32	0.0	23.25
3	576.29	0.0	0.0	575.60
4	0.0	0.0	1880.76	1541.97
5	697.47	697.47	269.33	1684.30
6	828.11	0.0	707.82	1558.52
7	0.0	0.0	0.0	47.85
8	3573.15	0.0	1842.38	3557.18
9	9851.71	0.0	0.0	3829.34
TOTALS:	16167.41	1179.85	4700.29	13184.89

TOTAL INVESTMENT: 35172.64

V. DEMAND HISTORY (TOTAL/MIS/NC)

ECHELON: EQUIPMENT	SHIPS	MLSF	DEPOT	CENTERS	TOTAL
1	3.4/0.8/0.0	3.4/1.3/0.0	1.6/0.0/1.6	1.8/1.0/0.0	10.2/3.1/1.6
2	4.0/0.3/0.0	4.0/1.2/0.0	2.1/0.0/2.1	1.9/0.5/0.0	12.0/2.4/2.1
3	0.6/0.1/0.0	0.6/0.0/0.6	0.2/0.0/0.2	0.4/0.1/0.0	1.8/0.2/0.8
4	0.2/0.0/0.2	0.2/0.0/0.2	0.0/0.0/0.0	0.2/0.0/0.0	0.6/0.0/0.4
5	1.6/0.2/0.0	1.6/0.1/0.0	1.1/0.4/0.0	0.5/0.0/0.0	4.8/0.7/0.0
6	3.2/1.2/0.0	3.0/0.0/3.0	1.8/0.0/0.0	1.2/0.4/0.0	9.3/1.6/3.0
7	3.4/0.0/3.4	3.4/0.0/3.4	2.6/0.0/2.6	0.8/0.0/0.8	10.2/0.0/***
8	0.4/0.1/0.0	0.4/0.0/0.4	0.1/0.0/0.0	0.3/0.1/0.0	1.2/0.2/0.4
9	1.9/0.6/0.0	1.9/0.0/1.9	0.9/0.0/0.9	1.0/0.0/1.0	5.7/0.6/3.8
TOTAL	18.8/ 3.3/ 3.6	18.5/ 2.6/ 9.5	10.4/ 0.4/ 7.4	8.1/ 2.5/ 1.8	

GRAND TOTAL: 55.8/ 8.8/ 22.3

HARDWARE SYSTEM PERFORMANCE SUMMARY

2 END USE ACTIVITES WERE SIMULATED IN A MISSION OF DURATION 1000.
10 SIMULATED MISSIONS WERE RUN

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

1. SYSTEM RELIABILITY (PROB OF SUCCESSFUL MISSION)
   = 0.0

2. SYSTEM AVAILABILITY (PROB SYSTEM OPERATIONAL AT AN ARBITRARY TIME)
   = 0.4589

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 paramenters 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     MAIN PROGRAM
C
      COMMON /ALPHA/DNT2,ENDPHA,ICRI,IFF,IFR,INUM,IOPT,JBB,KEQ,KKK,KZZ
     1,KK1,KS1,LL,LLLAST,NEQ,NPH,NTYPE,NUM,REDAD2,REDAD1(100),RELP,RED2
     2,RELPY,REPOL,STPHAS,TP,T1,XCUM,TT3,UP3,IFFEOP,T3,TIME,T3SUM
      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/INDABT(100),INMI(100),IAUP1(100),TT2(100),UP2(100)
     1,IAUP2(100)
      COMMON /TYP/EX(2,200),ISPARE(3,200),IUSED(3,200),IIUSED(3,200)
      COMMON /MAX/MAXNEQ,MAXTYP,MAXIB,MAXSTD
      COMMON /GAMMAA/XMTBA,VAR,RELGA(100),TIMA(100),XXT(200),ITT,ISEED
      COMMON /TABCRT/ XTABT(1000),RDT
      COMMON /TIGAP/ UP4,XNUM,BAPRIN,AVA,XPCAP,RUNID(19),TYCOON(500)
     +,COUNTB(500),XTCUM
      COMMON /DONE/DONE(3)
C  **  BUNKER ADDS
      COMMON/NS/NUMSS(30),NRSHPS,ITOTEQ,NSSEQ(500),NRWCS
      COMMON/STAT/XD(200,4),XT(4),XG,SUMC(200,4),SUMXD(200,4)
      COMMON/ISTAT/NIST,NMFR(200,4,2),NNK(200,4,3),NRA,NRRT,
     1NRF(200,4,2),NSHIP(14,14),IXD(200,4),IXT(4),IXG
      COMMON/MP/CFAR,ALFA1,ALFA2,SSRT,ECCST(200),OSTSR(6),OSTM(11),
     1OST(2,11,4)
      COMMON/ESTAT/UP4SS(30),DTSS1(30),DTSS2(30),XCUMSS(30),RELSS(30),
     1AVASS(30),ITEMSS(30)
      COMMON/MULTI/MAXD,MULTC,MFLAG,IOPTM,IRC,IOPTP1
      COMMON/DT/SSADT
C  **  BUNKER STOPS
      DATA  BLNK/4H    /
C
    5 MAXRUN=1000
      MAXNPH=6
      MAXSTD=50
      MAXNEQ=500
      MAXTYP=200
      MAXIB=300
      MAXSS=31
      MAXSEC=100
C  **  BUNKER ADDS
      MAXD = 1000
      READ(5,10)ICPTM,IOPTP,IOPTP1,IRC,NRSHPS,ITOTEQ,NRWCS,SSADT
      IF(ICPTM.EQ.0)GO TO 18
      READ(5,11)(NUMSS(I),I=1,20)
      IF(NRSHPS.GT.20) READ(5,11)(NUMSS(I),I=21,30)
   10 FORMAT(7I4,F7.0)
   11 FORMAT(20I4)
```

```
C   **   BUNKER STOPS                                                         MUL00490
    18 READ (5,19) JCC,(RUNID(I),I=1,19)                                      MUL00500
    19 FORMAT(I4,19A4)                                                        MUL00510
       WRITE (6,220) JCC                                                      MUL00520
       DO 1230 JC=1,JCC                                                       MUL00530
    20 WRITE (6,30) (RUNID(I),I=1,19)                                         MUL00540
    30 FORMAT(1H1,30X,19A4//)                                                 MUL00550
       WRITE (6,40)                                                           MUL00560
       WRITE (6,50)                                                           MUL00570
       WRITE (6,55)                                                           MUL00580
       WRITE (6,56)                                                           MUL00590
    40 FORMAT(1X,50H ++++++++++++++++++   TIGER   ++++++++++++++++++++ )      MUL00600
    50 FORMAT(/1X,50H++ NAVSEC 6112 LUETJEN+MANDEL+VAIL+ALLEY+BROWN ++ )      MUL00610
    55 FORMAT(/1X,50H++NPS IBM/360 VERSION LT. J. LEATHER THESIS 9/80++)      MUL00620
    56 FORMAT(/1X,48H++AS AMENDED BY LCDR. T. A. BUNKER THESIS 3/83++)        MUL00630
       BAPRIN=0.0                                                             MUL00640
C   **   BUNKER ADDS                                                          MUL00650
       MULTC = 0                                                              MUL00660
C   **   BUNKER STOPS                                                         MUL00670
       DO 70 I=1,MAXNEC                                                       MUL00680
    60 COUNTB(I)=0.0                                                          MUL00690
       TYCOON(I)=0.C                                                          MUL00700
       KEQU(I)=0                                                              MUL00710
    70 ETIME(I)=100000.                                                       MUL00720
       NUM=0                                                                  MUL00730
       IFF=0                                                                  MUL00740
       IFR=0                                                                  MUL00750
       UP4=0.0                                                                MUL00760
C **   BUNKER ADDS                                                            MUL00770
       DO 71 I=1,30                                                           MUL00780
    71 UP4SS(I)=0.0                                                           MUL00790
C **   BUNKER STOPS                                                           MUL00800
       T3=0.C                                                                 MUL00810
       T3SUM=0.0                                                              MUL00820
       SUMX=0.0                                                               MUL00830
       SUMX2=0.0                                                              MUL00840
       DO 80 I=1,100                                                          MUL00850
    80 TIMA(I)=0.                                                             MUL00860
       DO 90 I=1,3                                                            MUL00870
       DO 90 J=1,MAXTYP                                                       MUL00880
    90 IIUSEC(I,J)=0                                                          MUL00890
       DO 100 I=1,MAXSEC                                                      MUL00900
       TT2(I)=0.0                                                             MUL00910
       UP2(I)=0.0                                                             MUL00920
       IAUP1(I)=0                                                             MUL00930
       IAUP2(I)=0                                                             MUL00940
       REDAD1(I)=0.0                                                          MUL00950
       INMI(I)=0                                                              MUL00960
```

```
  100 INOABT(I)=0
      IAUP=0
      XTCUM=0
C  **  BUNKER ADDS
      DO 101 I=1,30
  101 XCUMSS(I)=0.0
C  **  BUNKER STOPS
      IF (JC-1) 110,110,140
  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)=100000.
      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=1,191,10
      READ (5,240) XXT(I),(XXT(I+J),J=1,9)
      IF (XXT(I)) 260,260,250
  240 FORMAT (5(F2.0,F8.0))
  250 CONTINUE
  260 WRITE (6,270)
  270 FORMAT (1H1,10X40HPHASE SEQUENCE  TYPE  DURATION  CUM TIME)
      IK=1
      IK2=2*IK
      IK3=IK2-1
      IXXT=XXT(IK3)
      TIMA(1)=XXT(2)
C  **  BUNKER ADDS
      TPM = TIMA(1)
C  **  BUNKER STOPS
      WRITE (6,280) IK,IXXT,XXT(IK2),TIMA(IK)
  280 FORMAT (19XI4,2XI4,2XF8.2,2XF8.2)
      DO 300 IK=2,100
      IK2=2*IK
      IK3=IK2-1
      IF (XXT(IK2)) 290,310,290
  290 TIMA(IK)=TIMA(IK-1)+XXT(IK2)
      IXXT=XXT(IK3)
      WRITE (6,280) IK,IXXT,XXT(IK2),TIMA(IK)
C  **  BUNKER ADDS
```

```
      TPM = TIMA(IK)
C  **  BUNKER STOPS
  300 CONTINUE
  310 CONTINUE
      IF (JC-1) 320,320,330
  320 CALL PACK
C
  330 CONTINUE
      JBB=1
      RELPY=1.0
      RELP=1.
      UP3=0.0
      TT3=0.0
      REDAC2=0.0
      DO 340 I=1,MAXSS
  340 ISW(I)=1
      ICRI=0
      DNT2=0.0
C  **  BUNKER ADDS
      DO 345 I=1,30
      DTSS2(I)=0.0
  345 ITEMSS(I)=0
C  **  BUNKER STOPS
  350 STPHAS=0
      T1=0.0
C
C     RDT IS RUNNING DOWNTIME
C
      RDT=0.0
      IF (KS(8)) 380,380,360
  360 KAB=NUM+1
      WRITE (6,370) KAB
  370 FORMAT(1X,16HSTART OF MISSION,I5,20H********************)
  380 KKK=0
  390 I=1
C  **  BUNKER ADDS
      MFLAG = 0
C  **  BUNKER STOPS
  400 LL=XXT(I)
      IF (LL) 450,450,410
  410 ENDPHA=STPHAS+XXT(I+1)
      I=I+2
      CALL RUN
      IX=NUM+1
      IF (XTABT(IX)) 420,420,440
  420 WRITE (6,430)
  430 FORMAT (1X44HTHE ABORT TIME IS ZERO,CHECK THE INPUT DATA.)
      GO TO 1260
```

```
  440 STPHAS=ENDPHA
      N=NSS(LL)+1
      GO TO 400
C
  450 NUM=NUM+1
      IF (IFFEOP) 460,460,480
  460 IFF=IFF+1
      IF (T3) 470,480,470
  470 CONTINUE
      T3SUM=T3SUM+T3
      T3=0.C
  480 XTCUM=XTCUM+XCUM
C  **  BUNKER ADDS
      DO 485 I=1,NRSHPS
      IF(ITEMSS(I).EQ.0) XCUMSS(I)=XCUMSS(I)+1
  485 UP4SS(I)=UP4SS(I)+ENDPHA-DTSS2(I)
C  **  BUNKER STOPS
      UP4=UP4+ENDPHA-DNT2
      IF (XTABT(NUM)-100000.) 500,49C,500
  490 X=ENDPHA
      GO TO 510
  50C 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) 33C,540,540
  540 INUM=INUM+10
  550 WRITE(6,2017)
      WRITE (6,560) NUM
  560 FORMAT (/1X16HA GRAND TOTAL OF,I6,24H MISSIONS HAVE BEEN RUN.)
  57C XNUM=NUM
  58C XPCAP=XTCUM/XNUM
  590 WRITE (6,600) XPCAP
  60C FORMAT (1X24HTHE RELIABILITY IS      ,F8.4)
  610 XPLCL=XPCAP-XK*SQRT(XPCAP*(1.-XPCAP)/XNUM)
      IF (XPLCL) 620,630,63C
  620 XPLCL=C.0
  630 WRITE (6,640) XPLCL
  64C FORMAT (1X24HTHE LOWER CONF LIMIT IS ,F8.4)
      WRITE (6,650) PL
  65C FORMAT (1X24HTHE SPEC REQUIREMENT IS ,F8.4)
      WRITE (6,66C) RED2
  66C FORMAT (1X17HTHE READINESS IS ,7XF8.4)
      AVA=UP4/TT3
      WRITE (6,67C) AVA
  670 FORMAT (1X28HTHE AVERAGE AVAILABILITY IS ,F8.4)
```

```
      XIAUP=IAUP                                                        MUL02410
      AVAINS=XIAUP/XNUM                                                 MUL02420
      WRITE (6,680) AVAINS                                              MUL02430
  680 FORMAT (1X28HTHE INSTANT AVAILABILITY IS ,F8.4)                   MUL02440
      XDWN=XNUM-XTCUM                                                   MUL02450
      IF (XDWN) 690,690,700                                             MUL02460
  690 XMTBA=2.0*SUMX                                                    MUL02470
      XLCLA=0.434*SUMX                                                  MUL02480
      VAR=(0.5*SUMX)**2                                                 MUL02490
      GO TO 710                                                         MUL02500
  700 XMTBA=SUMX/XDWN                                                   MUL02510
      VAR=(SUMX2/XNUM)-(SUMX/XNUM)**2                                   MUL02520
      CORR=(SUMX*(1/XDWN-1/XNUM))**2                                    MUL02530
      VAR=VAR+CORR                                                      MUL02540
      XLCLA=XMTBA-(1.28*SQRT(VAR))                                      MUL02550
  710 WRITE (6,720) XMTBA                                               MUL02560
  720 FORMAT (/1X41HTHE MEAN TIME BETWEEN MISSION FAILURES IS,F20.1)    MUL02570
      WRITE (6,730) XLCLA                                               MUL02580
  730 FORMAT (1X21HTHE LCL,90, MTBMF IS ,F20.1)                         MUL02590
      WRITE (6,740) VAR                                                 MUL02600
  740 FORMAT (1X27HTHE MTBMF VARIANCE IS       ,F20.1)                  MUL02610
      XIFF=IFF                                                          MUL02620
      XIFR=IFR                                                          MUL02630
      IF (IFF) 760,750,760                                              MUL02640
  750 XMUT=2.0*UP4                                                      MUL02650
      XMDT=0.0                                                          MUL02660
      GO TO 790                                                         MUL02670
  760 XMUT=UP4/XIFF                                                     MUL02680
      IF (IFR) 780,770,780                                              MUL02690
  770 XMDT=(TT3-UP4-T3SUM)/XIFF                                         MUL02700
      GO TO 790                                                         MUL02710
  780 XMDT=(TT3-UP4-T3SUM)/XIFR                                         MUL02720
  790 WRITE (6,810) XMUT                                                MUL02730
  800 WRITE (6,820) XMDT                                                MUL02740
  810 FORMAT (/1X18HTHE SYSTEM MUT IS ,F20.1)                           MUL02750
  820 FORMAT (1X18HTHE SYSTEM MDT IS ,F20.3)                            MUL02760
  830 IF (XPCAP-PL) 840,840,920                                         MUL02770
  840 IF (NOPT-NUM) 870,870,850                                         MUL02780
  850 WRITE (6,860)                                                     MUL02790
  860 FORMAT (1X14HANOTHER SET OF,3H 50,20HMISSIONS WILL BE RUN,43H TO OMUL02800
     1BTAIN REQUIRED STATISTICAL CONFIDENCE.)                           MUL02810
      GO TO 330                                                         MUL02820
  870 WRITE (6,880)                                                     MUL02830
  880 FORMAT (1X52HSIMULATION COMPLETE-OPTIMUM NUMBER MISSIONS WERE RUN)MUL02840
      IF(PL.EQ.1.) GO TO 910                                            MUL02850
  890 WRITE (6,900)                                                     MUL02860
  900 FORMAT (1X33HWEAPON SYSTEM FAILS REQUIREMENTS.)                   MUL02870
  910 GO TO 1010                                                        MUL02880
```

```
  920 IF (NMAX-NUM) 930,930,960                                               MUL02890
  930 WRITE (6,940)                                                           MUL02900
  940 FORMAT (1X52HSIM COMPLETE-PREDEFINED MAX NUMBER MISSIONS WERE RUN)      MUL02910
  950 IF (XPLCL-PL) 890,990,990                                               MUL02920
  960 IF (XPLCL-PL) 850,970,970                                               MUL02930
  970 WRITE (6,980)                                                           MUL02940
  980 FORMAT (2X22HSIMULATION COMPLETE - )                                    MUL02950
      IF(PL.EQ.1.) GO TO 1010                                                 MUL02960
  990 WRITE (6,1000)                                                          MUL02970
 1000 FORMAT (1X33HWEAPON SYSTEM MEETS REQUIREMENTS.)                         MUL02980
 1010 CONTINUE                                                                MUL02990
 1019 IF (JC-1) 1020,1020,1230                                                MUL03000
 1020 READ (5,1030) SPRS,APPL,GMMA,DMNO                                       MUL03010
 1030 FORMAT (4A4)                                                            MUL03020
C  **  BUNKER ADDS                                                            MUL03030
 1040 IF(IOPTM .EQ. 1) GO TO 1190                                             MUL03040
C1040 IF (SPRS.EQ.BLNK) GO TO 1190                                            MUL03050
      IF (SPRS.EQ.BLNK) GO TO 1190                                            MUL03060
C  **  BUNKER STOPS                                                           MUL03070
 1050 IDIFF=0                                                                 MUL03080
      TAFM=0.0                                                                MUL03090
      TACMMH=0.0                                                              MUL03100
      WRITE (6,1060)                                                          MUL03110
 1060 FORMAT (1H1,4X53HEQUIP FAILURES AND CORRECTIVE MAINTENANCE(CM) SUMMUL03120
     1MARY/8X71HEQUIP. NO.   TYPE NO.   TOTAL EQUIP.   AVG. NO. FAILURES   AMUL03130
     2VG. CM MANHOURS/32X8HFAILURES,7X11HPER MISSION,5X11HPER MISSION/)       MUL03140
      DO 1090 I=1,NEQ                                                         MUL03150
      IF(XMTTR(IEQU(I)).EQ.9999.) GO TO 1090                                  MUL03160
      IF (KEQU(I)) 1090,1090,1070                                             MUL03170
 1070 AFM=KEQU(I)/XNUM                                                        MUL03180
      IEQ=IABS(IEQU(I))                                                       MUL03190
      ACMMH=AFM*ABS(XMTTR(IEQ))                                               MUL03200
      WRITE(6,1080) I,IEQ,KEQU(I),AFM,ACMMH                                   MUL03210
 1080 FORMAT (10XI4,6XI4,6XI10,6XF10.3,6XF10.3)                               MUL03220
      IDIFF=IDIFF+KEQU(I)                                                     MUL03230
      TAFM=TAFM+AFM                                                           MUL03240
      TACMMH=TACMMH+ACMMH                                                     MUL03250
 1090 CONTINUE                                                                MUL03260
      WRITE (6,1100) IDIFF,TAFM,TACMMH                                        MUL03270
 1100 FORMAT (31X10H----------,6X10H----------,6X10H----------/31XI10,6XMUL03280
     1F10.3,6XF10.3)                                                          MUL03290
 1110 CONTINUE                                                                MUL03300
      WRITE (6,1120)                                                          MUL03310
 1120 FORMAT (1H1,3X41HAVERAGE NUMBER OF SPARES USED PER MISSION)             MUL03320
      WRITE (6,1130)                                                          MUL03330
 1130 FORMAT (/4X6HSPARES,7X4HSHIP,18X6HTENDER,16X4HBASE)                     MUL03340
      WRITE (6,1140)                                                          MUL03350
 1140 FORMAT (8X4HTYPE,4X3(5HSTOCK,3X4HUSED,10X))                             MUL03360
```

```
      DO 1170 J=1,NTYPE
      ALDONE=0.0
      DO 1150 I=1,3
      DONE(I)=IUSED(I,J)/XNUM
      ALDONE=ALDONE+DONE(I)
 1150 CONTINUE
      IF(ALDONE) 1155,1170,1155
 1155 WRITE(6,1160)J,(ISPARE(I,J),DONE(I),I=1,3)
 1160 FORMAT (8XI4,4X3(I5,F7.2,10X))
 1170 CONTINUE
 1180 CONTINUE
 1190 IF (APPL.EQ.BLNK) GO TO 1210
 1200 BAPRIN=-1.0
      CALL APPLE
 1210 CONTINUE
 1220 CONTINUE
 1230 CONTINUE
C  **  BUNKER ADDS
      TOTREL=0.0
      TOTAVA=0.0
      DO 1241 I=1,30
      AVASS(I)=0.
 1241 RELSS(I)=0.
      XNRSHP=FLOAT(NRSHPS)
      DO 1242 I=1,NRSHPS
      RELSS(I)=XCUMSS(I)/XNUM
      TOTREL=TOTREL + RELSS(I)
      AVASS(I)=UPASS(I)/TT3
 1242 TOTAVA=TOTAVA+AVASS(I)
      ASREL=TOTREL/XNRSHP
      ASAVA=TOTAVA/XNRSHP
      IF (IOPTM .EQ. 0) GO TO 1260
      CALL MSTAT(NUM,NTYPE,TPM,IOPTP)
      WRITE(6,2017)
      WRITE(6,1011)
      WRITE(6,1012)NRSHPS,ENDPHA
      WRITE(6,1013)NUM
      WRITE(6,1014)
      WRITE(6,1015)
      WRITE(6,1016)ASREL
      WRITE(6,1017)
      WRITE(6,1016)ASAVA
      WRITE(6,2017)
 2017 FORMAT('0',80('-')/)
 1011 FORMAT('0',15X,'HARDWARE SYSTEM PERFORMANCE SUMMARY')
 1012 FORMAT('0',5X,I2,' END USE ACTIVITES WERE SIMULATED IN A MISSION O
     XF DURATION',F7.0)
 1013 FORMAT(6X,I4,' SIMULATED MISSICNS WERE RUN')
```

```
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',5X,'2.  SYSTEM AVAILABILITY (PROB SYSTEM OPERATIONAL AT
    X AN ARBITRARY TIME)')
C  **  BUNKER STOPS
1260 STOP
     END
C
C
C
C
     SUBROUTINE RUN
     COMMON /MAX/MAXNEQ,MAXTYP,MAXIB,MAXSTD
     COMMON /ALPHA/DNT2,ENDPHA,ICRI,IFF,IFR,INUM,IOPT,JBB,KEQ,KKK,KZZ
    1,KK1,KS1,LL,LLLAST,NEC,NPH,NTYPE,NUM,REDAD2,REDAD1(100),RELP,RED2
    2,RELPY,REPOL,STPHAS,TP,T1,XCUM,TT3,UP3,IFFEOP,T3,TIME,T3SUM
     COMMON/BETA/NRO(6,300),IB(6,300,8),NLINE(6)
     COMMON/EXTRA/ KS(20),ISW(31)
     COMMCN /N/IECU(500),KEQU(500),ETIME(1000),XMTBF(200),XMTTR(200)
     COMMCN/NPH/ NSS(6),IFLAG(6),TITLE(6,31),SSTIME(6,31,2),ISS(6,31)
     COMMON /SEQ/INOABT(100),INMI(100),IAUP1(100),TT2(100),UP2(100)
    1,IAUP2(100)
     COMMON /TYP/EX(2,200),ISPARE(3,200),IUSED(3,200),IIUSED(3,200)
     COMMON /GAMMAA/XMTBA,VAR,RELGA(100),TIMA(100),XXT(200),ITT,ISEED
     COMMCN /TABCRT/ XTABT(1000),RDT
     COMMON /CELTA/KKK2
     COMMON /XXX/XXX
     COMMON/VDC/VCC(50,6),IUI(200),VMTTR(200,6),TAD2
     COMMON/STAN/ISTB(60,10,6)
     COMMON/RUNAP/ITEMP2,DELT,ISSA(31),ISSC
     CCMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1
     COMMON/NS/NUMSS(30),NRSHPS,ITOTEQ,NSSEQ(500),NRWCS
     COMMON/ESTAT/UP4SS(30),DTSS1(30),DTSS2(30),XCUMSS(30),RELSS(30),
    1AVASS(30),ITEMSS(30)
     COMMON/DT/SSADT
C
     TDEOP=0.0
     TP=STPHAS
     KAA=NUM+1
     XKAA=KAA
     NX=NSS(LL)
     N=NX+1
     ITEMP=0
     ITEMP2=0
     IF (KKK) 40,10,40
```

```
   10 DO 20 I=1,3
      DO 20 J=1,NTYPE
      IUSED(I,J)=0
   20 CONTINUE
      DO 30 I=1,NEQ
   30 ETIME(I)=100000.
   40 CONTINUE
C
   50 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-9999.) 120,90,120
   90 ETIME(KEQ)=-99999.
      GO TO 120
  100 XXX=XMTTR(IABC)
  110 CALL TTE
  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=2,8
      KEQ=IABS(IB(LL,I,J))
      IF (KEQ-MAXNEQ) 151,151,250
  151 IF(KEQ)250,250,155
  155 IF(ETIME(KEQ)+100001.001)160,250,160
  160 IEQU(KEQ)=IABS(IEQU(KEQ))
      IABC=IEQU(KEQ)
      IF (XMTTR(IABC)) 170,170,180
  170 IF (VMTTR(IABC,LL)-9999.) 180,190,180
  180 CONTINUE
      IF (IFLAG(LL)-1) 210,190,210
  190 IF (ETIME(KEQ)) 200,210,210
```

```
  200 ETIME(KEQ)=ETIME(KEQ)-(ENDPHA-STPHAS)                  MUL04810
  210 IF (ETIME(KEQ)-100000.) 220,240,220                    MUL04820
  220 IF (ABS(ETIME(KEQ))-STPHAS) 240,230,230                MUL04830
  230 IF (STPHAS) 250,240,250                                MUL04840
  240 ETIME(KEQ)=-STPHAS                                     MUL04850
      IABC=IABS(IEQU(KEQ))                                   MUL04860
      XXX=XMTBF(IABC)                                        MUL04870
      CALL TTE                                               MUL04880
  250 CONTINUE                                               MUL04890
      KKK2=1                                                 MUL04900
C                                                            MUL04910
      DO 330 ILB=1,NEQ                                       MUL04920
      KEQ=ILB                                                MUL04930
      IF(ETIME(KEQ)+100001.001)255,330,255                   MUL04940
  255 IF(IEQU(KEQ))260,260,330                               MUL04950
  260 IEQU(KEQ)=IABS(IEQU(KEQ))                              MUL04960
      IABC=IEQU(KEQ)                                         MUL04970
      IF (XMTTR(IABC)) 270,270,280                           MUL04980
  270 IF (YMTTR(IABC,LL)-9999.) 280,290,280                  MUL04990
  280 CONTINUE                                               MUL05000
      IF (IFLAG(LL)-1) 310,290,310                           MUL05010
  290 IF (ETIME(KEQ)) 300,320,320                            MUL05020
  300 ETIME(KEQ)=ETIME(KEQ)-(ENDPHA-STPHAS)                  MUL05030
      GO TO 330                                              MUL05040
C                                                            MUL05050
  310 IF(ETIME(KEQ)) 331,320,320                             MUL05060
  320 ETIME(KEQ)=100000.                                     MUL05070
      IEQU(KEQ)=IABS(IEQU(KEQ))                              MUL05080
      GO TO 330                                              MUL05090
  331 IEQU(KEQ)=-IABS(IEQU(KEQ))                             MUL05100
  330 CONTINUE                                               MUL05110
C                                                            MUL05120
      CALL STATUS                                            MUL05130
      CALL STNDBY                                            MUL05140
C                                                            MUL05150
      CALL STATUS                                            MUL05160
      IF (ISW(N)) 350,350,340                                MUL05170
  340 IAUP1(JBB)=IAUP1(JBB)+1                                MUL05180
  350 XIAUPI=IAUP1(JBB)                                      MUL05190
      XAVI=XIAUPI/XKAA                                       MUL05200
C                                                            MUL05210
      TIME=STPHAS                                            MUL05220
      DNT1=0.0                                               MUL05230
C  **  BUNKER ADDS                                           MUL05240
      DO 351 I=1,30                                          MUL05250
  351 DTSS1(I)=0.0                                           MUL05260
C  **  BUNKER STOPS                                          MUL05270
      DO 360 KSS=1,N                                         MUL05280
```

```
  360 SSTIME(LL,KSS,1)=0.0                                               MUL05290
C                                                                        MUL05300
  370 TP=TIME                                                            MUL05310
      CALL STNDBY                                                        MUL05320
  380 IF (KS(6)) 390,440,390                                             MUL05330
  390 WRITE (6,430) TP                                                   MUL05340
      DO 410 J=1,NEQ                                                     MUL05350
      IF (ETIME(J)-100000.) 400,410,400                                  MUL05360
  400 IEQ=IABS(IECU(J))                                                  MUL05370
      WRITE(6,420) J,IEQ,ETIME(J)                                        MUL05380
  410 CONTINUE                                                           MUL05390
  420 FORMAT (1XI5,1XI5,5XF22.4)                                         MUL05400
  430 FORMAT (1XF12.4)                                                   MUL05410
  440 CALL EVENT                                                         MUL05420
      TIME=ABS(ETIME(KEQ))                                               MUL05430
  446 IF (KS(5)) 450,470,450                                             MUL05440
  450 WRITE (6,460) KEC,ETIME(KEQ),KAA                                   MUL05450
  460 FORMAT (10X5HEQUIP,I5,F12.4,5X7HMISSION,I10)                       MUL05460
  470 DELT=TIME-TP                                                       MUL05470
      CALL STATUS                                                        MUL05480
C                                                                        MUL05490
  480 DO 510 KSS=1,NX                                                    MUL05500
      IF (ISW(KSS)) 490,490,500                                          MUL05510
  490 SSTIME(LL,KSS,1)=SSTIME(LL,KSS,1)+DELT                             MUL05520
      GO TO 510                                                          MUL05530
  500 SSTIME(LL,KSS,1)=0.0                                               MUL05540
  510 CONTINUE                                                           MUL05550
      IF (ISW(N)) 520,520,530                                            MUL05560
  520 SSTIME(LL,N,1)=SSTIME(LL,N,1)+DELT                                 MUL05570
      T3=T3+DELT                                                         MUL05580
      IF (TIME-ENDPHA) 522,522,521                                       MUL05590
  521 T3=T3+ENDPHA-TP-DELT                                               MUL05600
  522 RDT=RDT+DELT                                                       MUL05610
      GO TO 550                                                          MUL05620
  530 T3=0.0                                                             MUL05630
      RDT=0.0                                                            MUL05640
      IF (SSTIME(LL,N,1)) 1140,550,540                                   MUL05650
  540 T1=SSTIME(LL,N,1)                                                  MUL05660
      SSTIME(LL,N,1)=0.0                                                 MUL05670
  550 CONTINUE                                                           MUL05680
C                                                                        MUL05690
      IF (SSTIME(LL,N,1)) 570,560,570                                    MUL05700
  560 IF (T1) 620,620,580                                                MUL05710
  570 IF (T1) 620,610,620                                                MUL05720
  580 IFF=IFF+1                                                          MUL05730
  590 IFR=IFR+1                                                          MUL05740
  600 T1=0.0                                                             MUL05750
      GO TO 620                                                          MUL05760
```

```
  610 T1=SSTIME(LL,N,1)
  620 CONTINUE
C  **  BUNKER ADDS
      DO 628 I=1,NRSHPS
      DIFFT=SSTIME(LL,I,1)-SSADT
      IF(DIFFT)628,628,622
  622 IF(TIME-DIFFT-ENDPHA)624,628,628
  624 ITEMSS(I)=1
  628 CONTINUE
C  **  BUNKER STOPS
C
      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
      DO 655 KSS=1,NX
      IF(SSTIME(LL,KSS,1)-SSTIME(LL,KSS,2))655,655,652
  652 ISSC=ISSC+1
      ISSA(ISSC)=KSS
  655 CONTINUE
      IF(ISSC)660,660,962
  660 CONTINUE
C
      IF (TIME-ENDPHA) 670,670,1140
  670 IF (ISW(N)) 680,680,730
  680 CALL APPLE
  730 IF (ETIME(KEQ)) 810,810,740
  740 IABC=IABS(IEQU(KEQ))
      IF (IFLAG(LL)-1) 750,760,750
  750 CALL LRND(ISEED,RN,1,16807,0)
      IF (RN-REPOL) 770,770,800
  760 ETIME(KEQ)=-99999.
      GO TO 830
  770 IF (XMTTR(IABC)) 780,780,790
  780 XXX=VMTTR(IABC,LL)
      IF (XXX-9999.) 820,760,820
  790 XXX=XMTTR(IABC)
      GO TO 820
  800 ETIME(KEQ)=-10000.001
      GO TO 830
  810 IABC=IABS(IEQU(KEQ))
      XXX=XMTBF(IABC)
  820 IF(IEQU(KEQ))811,821,821
```

```
  811 IEQU(KEQ)=IABS(IEQU(KEQ))
C
      ETIME(KEQ)=100000.
      GO TO 830
  821 CALL TTE
C  **  BUNKER ADDS
      INDIC=0
C  **  BUNKER STOPS
  830 IF (ETIME(KEQ)) 840,831,870
C
C  **  BUNKER ADDS
C NOTE: LABEL 830 CHANGED FROM 840,1150,870
  831 INDIC = -1
      GO TO 1140
C  **  BUNKER STOPS
  840 KEQU(KEQ)=KEQU(KEQ)+1
C  **  BUNKER ADDS
      DO 842 I=1,NRSHPS
      IF(ISW(I))841,841,842
  841 DTSS1(I)=DTSS1(I)+DELT
  842 CONTINUE
C  **  BUNKER STOPS
  849 IF (ISW(N)) 850,850,370
  850 DNT1=CNT1+DELT
      IF (ICRI) 860,370,860
  860 REDAD1(JBB)=REDAD1(JBB)+DELT
      GO TO 370
C
  870 CONTINUE
C  **  BUNKER ADDS
      DO 873 I=1,NRSHPS
      IF(ISW(I)) 871,871,873
  871 DTSS1(I)=DTSS1(I) + DELT
  873 CONTINUE
C  **  BUNKER STOPS
  879 IF (ISW(N)) 880,880,370
  880 DNT1=CNT1+DELT
      IF (ICRI) 890,900,890
  890 REDAD1(JBB)=REDAD1(JBB)+DELT
  900 TDOWN=TIME-SSTIME(LL,K,1)
      TTEMP=SSTIME(LL,K,1)
      IF (KS(13)) 370,370,910
  910 WRITE (6,920) LL,TDOWN,TTEMP,KAA
  920 FORMAT (13H DURING PHASE,I6,20HSYSTEM WENT DOWN AT ,F14.4,13H DOWN
     1TIME IS ,F14.4,3X7HMISSION,I6)
      GO TO 370
C
  930 ICRI=5
```

```
      TABORT=TIME-(RDT-TAD2)
      IF(TABORT-ENCPHA)940,645,645
  940 IF (XTABT(KAA)-100000.) 660,95C,66C
  950 ITEMP=1
      ITEMP2=1
C  **  BUNKER ADDS
      IF(IOPTM.EQ.1) GO TO 955
C  **  BUNKER STOPS
      WRITE(6,1010)LL,JBB,KAA,TABORT,TITLE(LL,N)
      WRITE(6,1011)TAD2
  955 CONTINUE
      GO TO 1020
  960 ICRI=4
      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,985,65C
  985 ICRI=0
      GO TO 660
C
  990 IF (XTABT(KAA)-100000.) 660,1000,660
 100C ITEMP=1
      ITEMP2=1
C  **  BUNKER ADDS
      IF(IOPTM .EC. 1)GO TO 1006
C  **  BUNKER STOPS
      DO 1005 I=1,ISSC
      WRITE(6,1009)LL,JBB,KAA,TABORT,TITLE(LL,ISSA(I))
 1005 WRITE(6,1008)SSTIME(LL,ISSA(I),2)
 1006 CONTINUE
 1009 FORMAT(1X9HIN PHASE ,I2,1X3HSEQ,I3,4X7HMISSION,I6,4X15HABORTED AT
     1TIME,F10.4,10H  BECAUSE ,A4)
 1008 FORMAT(1X34HEXCEEDED PHASE ALLOWABLE DOWNTIME,2XF10.3,5H HRS.)
 1010 FORMAT (1X9HIN PHASE ,I2,1X3HSEQ,I3,4X7HMISSION,I6,4X15HABORTED AT
     1 TIME,F10.4,10H  BECAUSE ,A4)
 1011 FORMAT(1X36HEXCEEDED MISSION ALLOWABLE DOWNTIME,2XF10.3,5H HRS.)
 1020 XTABT(KAA)=TABORT
      IF (TABORT) 1590,1590,1040
 1040 DO 1110 I=1,NEQ
      IF (ETIME(I)) 1050,1110,1110
 1050 IF (IECU(I)) 1080,1110,1080
 1080 IF (KS(2)) 1090,1110,1090
 1090 WRITE (6,1100) I,ETIME(I)
 1100 FORMAT (17X9HEQUIPMENT,I5,24H DOWN IT WILL CCME UP AT,F16.4)
 1110 CONTINUE
 1120 CALL APPLE
      ITEMP2=0
```

```
 1130 GO TO 660                                                          MUL07210
C                                                                        MUL07220
 1140 CONTINUE                                                           MUL07230
      IFFEOP=ISW(N)                                                      MUL07240
C  **  BUNKER ADDS                                                       MUL07250
      DO 1148 I=1,NRSHPS                                                 MUL07260
      IF(INDIC)1142,1141,1141                                            MUL07270
 1141 IF(ISW(I))1142,1142,1148                                           MUL07280
 1142 TDEOP=ENDPHA-TP                                                    MUL07290
      DTSS1(I)=DTSS1(I)+TDEOP                                            MUL07300
 1148 CONTINUE                                                           MUL07310
      IF(INDIC)1150,1149,1149                                            MUL07320
C  **  BUNKER STOPS                                                      MUL07330
 1149 IF (ISW(N)) 1160,1160,1270                                         MUL07340
 1150 CONTINUE                                                           MUL07350
 1160 TDEOP=ENDPHA-TP                                                    MUL07360
 1170 CONTINUE                                                           MUL07370
      IF (KS(3)) 1210,1210,1180                                          MUL07380
 1180 IF (TDEOP) 1190,1210,1190                                          MUL07390
 1190 WRITE (6,1200) LL,TDEOP,KAA                                        MUL07400
 1200 FORMAT (1X27HSYSTEM DOWN AT END OF PHASE,I6,13H FOR DURATION,F10.4MUL07410
     1,6X7HMISSION,I6)                                                   MUL07420
 1210 CONTINUE                                                           MUL07430
      DNT1=DNT1+TDEOP                                                    MUL07440
      RDT=RDT+TDEOP-DELT                                                 MUL07450
      DELT=TDEOP                                                         MUL07460
      CALL APPLE                                                         MUL07470
 1270 CONTINUE                                                           MUL07480
C  **  BUNKER ADDS                                                       MUL07490
      DO 1288 I=1,NRSHPS                                                 MUL07500
 1288 DTSS2(I)=DTSS2(I)+DTSS1(I)                                         MUL07510
C  **  BUNKER STOPS                                                      MUL07520
      IF (ICRI) 1280,1290,1280                                           MUL07530
 1280 REDAD1(JBB)=REDAD1(JBB)+TDEOP                                      MUL07540
 1290 DNT2=DNT2+DNT1                                                     MUL07550
 1300 IF (DNT2) 1310,1330,1310                                           MUL07560
 1310 IF(KS(6)) 1325,1330,1325                                           MUL07570
 1325 WRITE(6,1320) LL,KAA,DNT2                                          MUL07580
 1320 FORMAT (1X5HPHASE,I5,1X29HTOTAL SYS DOWNTIME IN MISSION,I5,1X3HWASMUL07590
     1,F12.4,4H HRS)                                                     MUL07600
 1330 CONTINUE                                                           MUL07610
C                                                                        MUL07620
      IF (ICRI) 1350,1350,1340                                           MUL07630
 1340 IF (ITEMP) 1360,1360,1350                                          MUL07640
 1350 XCUM=1-ITEMP                                                       MUL07650
      INOABT(JBB)=INOABT(JBB)+1-ITEMP                                    MUL07660
      INMI(JBB)=INMI(JBB)+1                                              MUL07670
 1360 CONTINUE                                                           MUL07680
```

```
      XNO=INCABT(JBB)
      TNMI=INMI(JBB)
      IF (TNMI) 1380,1380,1370
 1370 RELY=XNO/TNMI
      GO TO 1390
 1380 RELY=0.0
 1390 RELPY=RELPY*RELY
      TT1=ENDPHA-STPHAS
      TT2(JBB)=TT2(JBB)+TT1
      UP1=TT1-DNT1
      UP2(JBB)=UP2(JBB)+UP1
      IF (ISW(N)) 1410,1410,1400
 1400 IAUP2(JBB)=IAUP2(JBB)+1
 1410  XIAUPP=IAUP2(JBB)
      XAV=XIAUPP/XKAA
      IF (KAA-INUM) 1570,1420,1570
 1420 WRITE (6,1430) XAVI
 1430 FORMAT (/47X20HINSTANT AVAILABILITY,5X2X4H IS ,F6.4)
 1440 WRITE (6,1450) LL,JBB,RELY,LL,RELPY
 1450 FORMAT (9X17HRELIABILITY PHASE,I3,1H,,I3,5H, IS ,F6.4,3X25HRELIABI
     1LITY UP TO PHASE  ,I2,4H IS ,F6.4)
C
      RELGA(JBB)=RELPY
      AENDT1=0.0
      AENDT2=0.0
      DO 1520 I=1,KAA
 1460 IF (XTABT(I)-100000.) 1470,1520,1520
 1470 IF (XTABT(I)-TIMA(JBB)) 1480,1520,1520
 1480 AENDT2=AENDT2+TIMA(JBB)-XTABT(I)
      JBB1=JBB-1
      IF (JBB1) 1500,1500,1490
 1490 IF (TIMA(JBB1)-XTABT(I)) 1500,1500,1510
 1500 AENDT1=AENDT1+TIMA(JBB)-XTABT(I)
      GO TO 1520
 1510 AENDT1=AENDT1+TIMA(JBB)-TIMA(JBB1)
 1520 CONTINUE
      TT3=TT3+TT2(JBB)
      UP3=UP3+UP2(JBB)
      REDAC2=REDAC2+REDAC1(JBB)
      RED1=(UP2(JBB)-AENDT1+REDAD1(JBB))/TT2(JBB)
      RED2=(UP3-AENDT2+REDAC2)/TT3
 1530 WRITE (6,1540) RED1,RED2
 1540 FORMAT (9X16HREADINESS         ,9X4H IS ,F6.4,3X25HREADINESS
     1        ,2X4H IS ,F6.4)
      AVA1=UP2(JBB)/TT2(JBB)
      AVA2=UP3/TT3
      WRITE (6,1550) AVA1,AVA2
 1550 FORMAT (9X23HAVERAGE AVAILABILITY    ,2X4H IS ,F6.4,3X25HAVERAGE AV
```

```
     1AILABILITY      ,2X4H IS ,F6.4)
      WRITE (6,1560) XAV
 1560 FORMAT (47X20HINSTANT AVAILABILITY,5X2X4H IS ,F6.4)
 1570 CONTINUE
 1580 KKK=1
      JBB=JBB+1
      T1=SSTIME(LL,N,1)
 1590 RETURN
      END
C
C
C
      SUBROUTINE PACK
      COMMON /ALPHA/DNT2,ENCPHA,ICRI,IFF,IFR,INUM,IOPT,JBB,KEQ,KKK,KZZ
     1,KK1,KS1,LL,LLLAST,NEC,NPH,NTYPE,NUM,REDAD2,REDAD1(100),RELP,RED2
     2,RELPY,REPOL,STPHAS,TP,T1,XCUM,TT3,UP3,IFFEOP,T3,TIME,T3SUM
      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 /TYP/EX(2,200),ISPARE(3,200),IUSED(3,200),IIUSED(3,200)
      COMMON /MAX/MAXNEQ,MAXTYP,MAXIB,MAXSTD
      COMMON/VDC/VCC(50,6),IUI(200),VMTTR(200,6),TAD2
      COMMON /PACKAP/ IBNUM( 6,500),ISYS( 6),F(200,4)
      COMMON/STAN/ISTB(60,10,6)
      COMMCN /CSPARE/ SPR1,SPR2,SPR3,SPR4,SPR5,SPR6,SPR7,SPR8,SPR9
     1,SPR10,SPR11,SPR12,SPR13,SPR14,ITMPOP(200)
      COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1
      COMMON/NS/NUMSS(30),NRSHPS,ITOTEQ,NSSEQ(500),NRWCS
      DIMENSICN LCAD(19)
      DIMENSION DUM(4)
      DIMENSION IVAL(10)
      DATA IBLANK/4H    /
C
      READ (5,10) KOPT,(KS(I),I=1,13)
      WRITE (6,20) KCPT,(KS(I),I=1,13)
   10 FORMAT (20I4)
   20 FORMAT (1H1,I10,5X19I4)
C
      READ (5,10) (IFLAG(I),I=1,NPH)
      WRITE (6,30) (IFLAG(I),I=1,NPH)
   30 FORMAT (10I4)
C
      READ(5,40) REPOL,TAD2,XM,XM1
   40 FORMAT(F4.0,F8.0,2F4.C)
   50 FORMAT(20F4.C)
      IF(XM) 35,35,55
   35 XM=1.C
```

```
   55 IF(XM1) 36,36,56                                                  MUL08650
   36 XM1=1.                                                            MUL08660
   56 WRITE(6,60) REPCL,TAD2,XM,XM1                                     MUL08670
   60 FORMAT(1X,4F10.2)                                                 MUL08680
      GO TO (70,90,100,120,130),KOPT                                    MUL08690
C                                                                       MUL08700
   70 KS(1)=1                                                           MUL08710
      KS(4)=0                                                           MUL08720
   80 KS(3)=0                                                           MUL08730
      KS(2)=0                                                           MUL08740
      KS(2)=1                                                           MUL08750
      KS(5)=0                                                           MUL08760
      KS(6)=0                                                           MUL08770
      KS(7)=0                                                           MUL08780
      KS(8)=0                                                           MUL08790
      KS(9)=0                                                           MUL08800
      KS(10)=0                                                          MUL08810
      GO TO 130                                                         MUL08820
   90 KS(1)=1                                                           MUL08830
      KS(6)=0                                                           MUL08840
      KS(10)=0                                                          MUL08850
      GO TO 110                                                         MUL08860
  100 KS(1)=1                                                           MUL08870
      KS(6)=1                                                           MUL08880
      KS(7)=1                                                           MUL08890
      KS(10)=1                                                          MUL08900
      KS(12)=1                                                          MUL08910
  110 KS(2)=1                                                           MUL08920
      KS(3)=1                                                           MUL08930
      KS(4)=1                                                           MUL08940
      KS(5)=1                                                           MUL08950
      KS(7)=0                                                           MUL08960
      KS(8)=1                                                           MUL08970
      KS(9)=1                                                           MUL08980
      GO TO 130                                                         MUL08990
  120 KS(1)=0                                                           MUL09000
      KS(4)=0                                                           MUL09010
      GO TO 80                                                          MUL09020
C                                                                       MUL09030
  130 NEQ=0                                                             MUL09040
      DO 140 I=1,MAXNEC                                                 MUL09050
      ETIME(I)=100000.                                                  MUL09060
      IEQU(I)=0                                                         MUL09070
  140 CONTINUE                                                          MUL09080
      DO 155 J=1,6                                                      MUL09090
      DO 150 I=1,MAXTYP                                                 MUL09100
      XMTBF(I)=0.0                                                      MUL09110
      VMTTR(I,J)=0.0                                                    MUL09120
```

```
150 XMTTR(I)=0.C
155 CONTINUE
C
160 WRITE (6,170)
170 FORMAT (/11H TYPE  NAME,18X4HMTBF,5X4HMTTR,7X2HDC,8X4HADT1,4X4HADT
   12)
180 READ (5,190) I,(DUM(J),J=1,4),X,Y,L,V,W,IDUM
190 FORMAT (I4,4A4,F8.0,4F4.0,I4)
    IF (I) 200,490,2C0
200 IF (I-MAXTYP) 22C,220,210
21C WRITE (6,44C)
    GO TO 1000
22C DO 230 J=1,4
230 F(I,J)=DUM(J)
    IUI(I)=IDUM
    IF (IUI(I)) 240,250,240
240 READ (5,450) IU,(VDC(IU,ILL),ILL=1,NPH)
25C IF (Y) 260,280,280
260 READ (5,50) (VMTTR(I,J),J=1,NPH)
270 IF (I) 280,490,280
280 EX(1,I)=V
    EX(2,I)=W
    IF (KS(I)) 310,31C,290
290 WRITE (6,300) I,(F(I,J),J=1,4),X,Y,U,V,W
300 FORMAT (1XI4,2X4A4,2XF10.1,F10.2,F10.3,2(F8.1))
310 IF (IUI(I)) 380,380,320
320 IF (KS(I)) 340,340,330
330 WRITE (6,460) (VCC(IU,ILL),ILL=1,NPH)
340 DO 370 ILL=1,NPH
    IF (VDC(IU,ILL)) 360,360,350
35C VDC(IU,ILL)=(X/VDC(IU,ILL))*XM
    GO TO 370
360 VDC(IU,ILL)=(X/.COC1)*XM
370 CONTINUE
380 IF (KS(I)) 410,410,390
390 IF (Y) 400,410,410
400 WRITE (6,47C) (VMTTR(I,J),J=1,NPH)
410 IF (XMTBF(I)) 42C,430,420
420 WRITE (6,48C) I
    GO TO 1000
430 IF(U) 435,435,433
433 XMTBF(I)=XM*(X/U)
435 XMTTR(I)=Y*XM1
    GO TO 180
440 FORMAT (9X35HEQUIP TYPES HAVE EXCEEDED MAX ALLOWABLE)
450 FORMAT (I4,19(F4.0))
460 FORMAT (14X16HVARY DUTY CYCLE ,4F10.3)
470 FORMAT (14X16HVARIABLE MTTR    ,4F10.3)
```

```
  480 FORMAT (1X4HTYPE,I5,1X13HDEFINED TWICE)                             MUL09610
C                                                                         MUL09620
  490 WRITE (6,500)                                                       MUL09630
  500 FORMAT (/1X15HTYPE  EQUIPMENT)                                      MUL09640
  510 READ (5,10) NTYPE,(LOAD(I),I=1,19)                                  MUL09650
      IF (LOAD(1)) 520,650,520                                            MUL09660
  520 DO 620 I=1,19                                                       MUL09670
      IF (LOAD(I)) 530,620,530                                            MUL09680
  530 IBM=LOAD(I)                                                         MUL09690
      IF (IBM-500) 560,560,540                                            MUL09700
  540 WRITE (6,550)                                                       MUL09710
  550 FORMAT(1X,'EQUIPMENT NUMBER GREATER THAN 500 ******************')  MUL09720
      GO TO 1000                                                          MUL09730
  560 IF (IBM-NEQ) 580,580,570                                            MUL09740
  570 NEQ=IBM                                                             MUL09750
  580 IF (IEQU(IBM)) 590,610,590                                          MUL09760
  590 WRITE (6,600) IBM                                                   MUL09770
      GO TO 1000                                                          MUL09780
  600 FORMAT (1X9HEQUIPMENT,I5,1X34HDEFINED TWICE ******************)    MUL09790
  610 CONTINUE                                                            MUL09800
      IEQU(IBM)=NTYPE                                                     MUL09810
  620 CONTINUE                                                            MUL09820
                                                                          MUL09830
      IF (KS(1)) 640,640,630                                              MUL09840
  630 WRITE (6,10) NTYPE,(LOAD(I),I=1,19)                                 MUL09850
  640 NTY=NTYPE                                                           MUL09860
      GO TO 510                                                           MUL09870
C  **  BUNKER ADDS                                                        MUL09880
  650 NTYPE=NTY                                                           MUL09890
      IF (ICPTM .EQ. 1) GO TO 740                                         MUL09900
      WRITE(6,660)                                                        MUL09910
C 650 WRITE (6,660)                                                       MUL09920
C  **  BUNKER STOPS                                                       MUL09930
  660 FORMAT(/1X11HSPARES TYPE,6X4HSHIP,4X6HTENDER,6X4HBASE,12X6HFACTOR)MUL09940
      DO 670 I=1,3                                                        MUL09950
      DO 670 J=1,NTYPE                                                    MUL09960
  670 IUSED(I,J)=0                                                        MUL09970
      READ(5,675) IUNLIM,SX,SPR1,SPR2,SPR3,SPR4,SPR5,SPR6,SPR7,SPR8,SPR9  MUL09980
     1,SPR10,SPR11,SPR12,SPR13,SPR14                                      MUL09990
  675 FORMAT(A4,16X,15F4.0)                                               MUL10000
      IF(SX-999.) 681,676,681                                             MUL10010
  676 CALL SPARES                                                         MUL10020
      IF(KS(1)) 740,740,677                                               MUL10030
  677 DO 678 I=1,NTYPE                                                    MUL10040
  678 WRITE(6,750) I,(ISPARE(J,I),J=1,3),SX                               MUL10050
      GO TO 740                                                           MUL10060
  681 IF(SX) 684,682,684                                                  MUL10070
  682 SX=1.0                                                              MUL10080
```

```
684 IF(IUNLIM-IBLANK)690,720,690
690 WRITE (6,700)
700 FORMAT (1X41HALL EQUIPMENT TYPES HAVE UNLIMITED SPARES)
    DO 710 I=1,NTYPE
    DO 710 J=1,3
710 ISPARE(J,I)=90000
    GO TO 760
720 DO 740 I=1,NTYPE
    READ (5,10) (ISPARE(J,I),J=1,3)
    BILL=FLOAT(ISPARE(1,I))*SX
    IF(INT(BILL)-BILL) 727,725,727
725 ISPARE(1,I)=BILL
    GO TO 728
727 ISPARE(1,I)=INT(BILL)+1
728 CONTINUE
    IF (KS(1)) 740,740,730
730 WRITE(6,750)I,(ISPARE(J,I),J=1,3),SX
740 CONTINUE
750 FORMAT(5X,I4,2X,3I10,13X,F6.2)
C
760 WRITE (6,770) NPH
770 FORMAT (1H1,3X28HTHE MISSION WILL BE RUN WITH,I4,7H PHASE ,27HTYPE
   1S IN VARIABLE SEQUENCE.)
C
    DO 777 I=1,6
    DO 776 J=1,10
    DO 775 K=1,60
    ISTB(K,J,I)=0
775 CONTINUE
776 CONTINUE
777 CONTINUE
    DO 990 K=1,NPH
    READ (5,780) XID,LL,NSS(K),ISS(K,NSS(K)+1),SSTIME(K,NSS(K)+1,2)
    ISYS(K)=ISS(K,NSS(K)+1)
780 FORMAT (A4,3I4,F8.0)
    NX=NSS(K)
    N=NX+1
    IF (KS(1)) 820,820,790
790 WRITE (6,810) XID,LL,NSS(K),ISS(K,N),SSTIME(K,N,2)
800 FORMAT (1XA4,3I4,F10.2)
810 FORMAT (/1XA4,3I4,F10.2)
820 TITLE(K,N)=XID
C
    DO 840 IK=1,NX
    READ (5,780) TITLE(K,IK),KK,MM,ISS(K,IK),SSTIME(K,IK,2)
    IF (KS(1)) 840,840,830
830 WRITE (6,800) TITLE(K,IK),LL,MM,ISS(K,IK),SSTIME(K,IK,2)
840 CONTINUE
```

```
C  **  BUNKER ADDS
       IF(IOPTM.NE.1)GO TO 846
       DO 845 I=1,ITOTEC,18
  845  READ(5,847)(NSSEC(I+J-1),J=1,18)
  846  CONTINUE
  847  FORMAT(18I4)
C  **  BUNKER STOPS
       DO 850 JA=1,MAXIB
       DO 850 JB=1,8
       IB(K,JA,JB)=C
       NRO(K,JA)=0
  850  CONTINUE
       IOR=0
       I=0
  860  I=I+1
       READ(5,10) (IVAL(J),J=1,10),IRULE
       IF(IVAL(1).EQ.0) GC TC  990
       IF(IRULE.NE.0)GOTO 930
C
       IF(I.LE.MAXIB) GC TO 880
       WRITE(6,870) MAXIB
  870  FORMAT(1H1,10X,29H# CF GROUP CARDS GREATER THAN,I4)
       STOP
  880  NRO(K,I)=IVAL(1)
C
       DO 890 J=1,8
       IB(K,I,J)=IVAL(J+1)
  890  CONTINUE
       IBNUM(K,IB(K,I,1)-500)=I
       NLINE(K)=I
  900  IF(KS(1)) 86C,86C,910
  910  WRITE(6,920) NRC(K,I),(IB(K,I,J),J=1,8)
  920  FORMAT(1X,I3,8I4)
       GO TO 860
  930  CONTINUE
       I=I-1
       IOR=ICR+1
C
       IF(IOR.LE.MAXSTC) GO TC 950
       WRITE(6,940) MAXSTD
  940  FORMAT(1H1,10X,36H# OF OPERATE PULE CARCS GREATER THAN,I4)
       STOP
  95C  CONTINUE
       DO 960 J=1,10
       ISTB(IOR,J,K)=IVAL(J)
  960  CONTINUE
       IF(KS(1)) 860,86C,970
  97C  WRITE(6,980) (ISTB(IOR,J,K),J=1,10)
```

```
  98C FORMAT(30X,10I4)
      GO TO 860
  99C CONTINUE
 1000 CONTINUE
      RETURN
      END
C
C
C
C
      SUBROUTINE EVENT
      COMMON /ALPHA/DNT2,ENDPHA,ICRI,IFF,IFR,INUM,IOPT,JBB,KEQ,KKK,KZZ
     1,KK1,KS1,LL,LLLAST,NEC,NPH,NTYPE,NUM,REDAD2,REDAD1(100),RELP,RED2
     2,RELPY,REPOL,STPHAS,TP,T1,XCUM,TT3,UP3,IFFEOP,T3,TIME,T3SUM
      COMMCN /N/IECU(500),KEQU(500),ETIME(1000),XMTBF(200),XMTTR(200)
      COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1
C
      R=ABS(ETIME(1))
      KEQ=1
      DO 20 I=2,NEC
      RR=ABS(ETIME(I))
      IF (R-RR) 20,20,10
   10 R=RR
      KEQ=I
   20 CONTINUE
      RETURN
      END
C
C
C
      SUBROUTINE TTE
      COMMON /ALPHA/DNT2,ENDPHA,ICRI,IFF,IFR,INUM,IOPT,JBB,KEQ,KKK,KZZ
     1,KK1,KS1,LL,LLLAST,NEC,NPH,NTYPE,NUM,REDAD2,REDAD1(100),RELP,RED2
     2,RELPY,REPOL,STPHAS,TP,T1,XCUM,TT3,UP3,IFFEOP,T3,TIME,T3SUM
      COMMCN /N/IECU(500),KEQU(500),ETIME(1000),XMTBF(200),XMTTR(200)
      COMMON/EXTRA/ KS(20),ISW(31)
      COMMCN/NPH/ NSS(6),IFLAG(6),TITLE(6,31),SSTIME(6,31,2),ISS(6,31)
      COMMON /TYP/EX(2,200),ISPARE(3,200),IUSED(3,200),IIUSED(3,200)
      COMMON /DELTA/KKK2
      COMMON /XXX/XXX
      COMMON/VDC/VCC(5C,6),IUI(200),VMTTR(200,6),TAD2
      COMMCN /GAMMAA/XMTBA,VAR,RELGA(100),TIMA(100),XXT(200),ITT,ISEED
      COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1
      COMMON/NS/NUMSS(30),NRSHPS,ITOTEQ,NSSEQ(500),NRWCS
C
C  **  BUNKER ADDS
      ADT = 0.
C  **  BUNKER ADDS
```

```
   10 K=KEQ                                                          MUL11530
   20 J=IABS(IEQU(K))                                                MUL11540
      IF (ETIME(K)-100000.) 30,120,30                                MUL11550
C  **  BUNKER ADDS                                                   MUL11560
   30 IF (ETIME(K)) 120,120,35                                       MUL11570
C  30 IF (ETIME(K)) 120,120,40                                       MUL11580
   35 IF(IOPTM .EQ. 0) GO TO 40                                      MUL11590
      CALL MULTE(KEQ,ETIME(K),J,NTYPE,NUM,  ACT)                     MUL11600
      GO TO 120                                                      MUL11610
C  **  BUNKER STOPS                                                  MUL11620
   40 IF (ABS(XXX)-9999.) 41,120,41                                  MUL11630
   41 DO 60 I=1,2                                                    MUL11640
      IF (ISPARE(I,J)-IUSED(I,J)) 60,60,50                           MUL11650
   50 IUSED(I,J)=IUSED(I,J)+1                                        MUL11660
      IIUSED(I,J)=IIUSED(I,J)+1                                      MUL11670
      II=I                                                           MUL11680
      GO TO 120                                                      MUL11690
   60 CONTINUE                                                       MUL11700
      IF (ISPARE(3,J)-IUSED(3,J)) 70,70,110                          MUL11710
   70 IF (ETIME(K)-100000.) 80,120,80                                MUL11720
   80 ETIME(K)=-500000.                                              MUL11730
      IF (KS(12)) 340,340,90                                         MUL11740
   90 WRITE (6,100) J                                                MUL11750
  100 FORMAT (1X15HEQUIPMENT TYPE ,I4,25H HAS CONSUMED ALL SPARES.)  MUL11760
      GO TO 340                                                      MUL11770
  110 IUSED(3,J)=IUSED(3,J)+1                                        MUL11780
      IIUSED(3,J)=IIUSED(3,J)+1                                      MUL11790
      II=3                                                           MUL11800
C                                                                    MUL11810
  120 XXX=ABS(XXX)                                                   MUL11820
C                                                                    MUL11830
      IF (KKK2) 140,130,140                                          MUL11840
  130 TP=0                                                           MUL11850
      II=0                                                           MUL11860
  140 IF (ETIME(K)-100000.) 160,150,160                              MUL11870
  150 ETIME(K)=-TP                                                   MUL11880
      GO TO 170                                                      MUL11890
  160 IF (ETIME(K)) 170,170,180                                      MUL11900
  170 X=1.                                                           MUL11910
      GO TO 190                                                      MUL11920
  180 X=-1.                                                          MUL11930
  190 CALL LRND(ISEED,RN,1,16807,0)                                  MUL11940
C  **  BUNKER ADDS                                                   MUL11950
      IF (ICPTM .EQ. 1) GO TO 220                                    MUL11960
C  **  BUNKER STOPS                                                  MUL11970
      IF (II-2) 200,210,210                                          MUL11980
  200 ADT=0.                                                         MUL11990
      GO TO 220                                                      MUL12000
```

```
210 III=II-1
    ADT=EX(III,J)
220 CONTINUE
    IF (ETIME(K)) 23C,230,330
230 K1=IABS(IEQU(K))
    IF (IUI(K1)) 33C,330,240
240 IU=IUI(K1)
    ST=0.C
    SR=1.C
    RN3=RN
    DO 310 I=JBB,100
    T=XXT(2*I)
    IF (T) 250,320,250
250 IF (ST) 300,260,300
260 T=TIMA(I)+ETIME(K)
    IF (T) 270,310,3C0
27C T=0
    GO TO 310
300 LLL=XXT(2*I-1)
    XM=VDC(IU,LLL)
    IF (XM) 280,320,280
280 R=EXP(-T/XM)
    SR=SR*R
    IF (SR-RN) 320,320,290
290 ST=ST+T
    RN3=RN/SR
310 CONTINUE
320 ETIME(K)=ST-(XM*ALCG(RN3))+ABS(ETIME(K))+ADT
    GO TO 340
330 ETIME(K)=X*(-XXX*ALOG(RN)+ABS(ETIME(K))+ADT)
340 IF (IFLAG(LL)-1) 370,370,350
350 IF (ETIME(K)+500000.) 360,370,360
360 ETIME(K)=100000.
37C CONTINUE
    RETURN
    END
C
C
C
C
C
C
C
    SUBROUTINE STNDBY
    COMMON /ALPHA/CNT2,ENCPHA,ICRI,IFF,IFR,INUM,IOPT,JBB,KEQ,KKK,KZZ
   1,KK1,KS1,LL,LLLAST,NEC,NPH,NTYPE,NUM,REDAD2,REDAD1(100),RELP,RED2
   2,RELPY,REPOL,STPHAS,TP,T1,XCUM,TT3,UP3,IFFEOP,T3,TIME,T3SUM
    COMMON /N/IECU(500),KEQU(500),ETIME(1000),XMTBF(200),XMTTR(200)
```

```
      PRBSUM=PRBSUM+DUM*(EX90DD**K)/KFACT
      IF(PRBSUM-XAVAIL) 40,50,50
   50 ISPARE(1,I)=K
      GO TO 90
   60 IF(4.*EX90DC-CUT) 80,80,70
C
   70 ISPARE(1,I)=1
      GO TO 90
   80 ISPARE(1,I)=C
   90 CONTINUE
      DO 100 I=1,NTYPE
      DO 100 J=2,3
      ISPARE(J,I)=0
  100 CONTINUE
      RETURN
      END
C
C
C
C
C                            SUBROUTINE MULTE
C   ******************************************************************
C   **                                                              **
C   **  SUBROUTINE 'MULTE' SIMULATES A MULTI-ECHELON SUPPLY NETWORK **
C   **  WITH VARIABLE RESUPPLY CHANNELS.  IT RECORDS AND MOITORS ALL **
C   **  SUPPLY ACTIONS RESULTING FROM AN EQUIPMENT FAILURE IN THE   **
C   **  'TIGER' SIMULATION.  IT PROVIDES 'TIGER' WITH A SUPPLY      **
C   **  RESPONSE TIME WHICH IS RETURNED TO THE 'TTE' SUBROUTINE AND **
C   **  ADDED TO THE EQUIPMENT'S TIME-TO-REPAIR.  'MULTE' WILL ALSO **
C   **  OUTPUT VARIOUS DATA AND INFORMATIONAL SUMMARIES UPON COMPLE- **
C   **  TION OF ALL MISSIONS (SEE DOCUMENTATION FOR FURTHER DETAILS). **
C   **                                                              **
C   ******************************************************************
C
C
C
      SUBROUTINE MULTE(KEQ,CTIME,EQTYP,NTY,NUM,  SRT)
C
      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,NRRT,
     1NRF(200,4,2),NSHIP(14,14),IXD(200,4),IXT(4),IXG
      COMMON/MAX/MAXNEC,MAXTYP,MAXIB,MAXSTD
      COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1
      COMMON/MP/CRAR,ALFA1,ALFA2,SSRT,ECCST(200),OSTSR(6),OSTM(11),
     1OST(2,11,4)
      COMMON/NS/NUPSS(30),NRSHPS,ITOTEQ,NSSEQ(500),NRWCS
      INTEGER COAST,DESTN,DTOT,DUEN,DUES,ECH,EQTYP,OQICP,REQN,SHIPR,
     1SHPR,SHLOC,SSN,TC,RORD,RP,ENUSE
```

```
      INTEGER DELCH(4),DUEA(1000),DUEE(1000),DUEQ(1000),ERQ(200),
     1HILIM(38,200),IDUEJ(3,10),IP(38,200),LEVEL(35),ONHND(38,200),
     2OPMOD(6),OQREQ(3),ORACT(10),ORDER(3),ORDQT(10),REORD(38,200),
     3RESON(10),RPAIR(200)
      REAL A(100),DUET(1000),MIN,MPLT(200),MSC,MSDT,MRT(200)
C
      DATA LEVEL/30*1,2*2,3,2*4/,IX1/2954783/,
     1IX2/9483948/,IX3/785947/,IX4/294753/
      MSD = 0.0
      SRT = 0.0
      REQN = 0
      DTOT = 0
      DO 1 I = 1,4
         DELCH(I) = 0
    1 CONTINUE
      IF(MFLAG .NE. 0) GO TC 3
C
C  **  ON FIRST CALL TC 'MULTE' READ/PRINT INPUT DATA, AND CALCULATE
C  **  INITIAL INVENTORY INVESTMENT LEVELS.  AT THE BEGINNING OF EACH
C  **  MISSION RESET PARAMETERS AS APPROPRIATE. (SUBR MPACK)
C
      CALL MPACK(ERQ,HILIM,IP,ONHND,MPLT,MRT,MSDT,REORD,
     1RPAIR,OTIME,DUEA,DUEE,DUEQ,DUET,DUEN,NTY)
C
    3 MULTC = MULTC + 1
C
C  **  DETERMINE SHIP IN WHICH FAILURE OCCURED, ITS OPERATING MODE AND
C  **  LOCATION.
      IF(NSSEC(KEC).GT.NRWCS) GO TO 5
      ISHIP=NSSEQ(KEQ)+869
      GO TC 6
    5 ISHIP=NSSEQ(KEQ)+884-NRWCS
    6 COAST = 1
      IF(ISHIP .GE. 885)  CCAST = 2
      SHLOC = IRC
      IF(COAST .EC. 2) SHLOC = SHLOC + 3
C
C  **  IF EQUIPMENT IS DESIGNATED AS A REPAIRABLE, RETURN FAILED UNIT
C  **  TO APPROPRIATE REPAIR FACILITY.
C
      IF(RPAIR(EQTYP))24,24,10
C
C  **  DETERMINE IF THIS CARCASS IS LOST THROUGH ATTRITION.
C
   10 CALL LRND(IX1,A,1,1,C)
      IF(A(1) .LE. CRAR) GO TO 12
      SSN = 37
      IF(COAST .EC. 2) SSN = 36
```

```
C
C   **  ESTABLISH A DUE-IN AT REPAIR FACILITY.
C
      DTIME = CSTSR(SHLOC) + CTIME
      CALL ESDUE(SSN,EQTYP,DTIME,1,DUEN,DUEA,DUEE,DUEQ,DUET)
      NRRT = NRRT + 1
      GO TO 15
C
C   **  CARCASS LOSS DUE TO ATTRITION, REDUCE ICP INV POSITION.
C
   12 IP(38,EQTYP) = IP(38,EQTYP) - 1
      IS = ISHIP-869
      IF(IOPTP1 .EQ. 0) GO TO 14
      WRITE(6,600)EQTYP,IS
  600 FORMAT('0',5X,'REPAIRABLE EQ NR',I4,' WAS NOT RECEIVED BY REPAIR F
     1ACILITY FROM SHIP NR',I3,' DUE TO ATTRITION.')
   14 NRA = NRA + 1
   15 CONTINUE
C
C   **  IF SUFFICIENT CARCASSES ARE AVAILABLE AT REPAIR FACILITIES,
C   **  INDUCT ERQ AND DISTRIBUTE TO STOCK POINTS AS APPROPRIATE.
C
      NEED = -1
      DO 22 I=36,37
C   **  CHECK REPAIR ACTIVITIES FOR CARCASSES DUE IN.
         CALL CHKCU(I,EQTYP,CTIME,DUEN,DUEA,DUEE,DUEQ,DUET,  DUES)
         ONHND(I,EQTYP) = CNHND(I,EQTYP) + DUES
         L=1
         ST = 0.0
         IF(ONHND(I,EQTYP) .LT. ERQ(EQTYP)) GO TO 22
         SSN = 34
         IF(I .EQ.37)SSN = 33
         IF(HILIM(34,EQTYP).EQ.0 .AND. I.EQ.36) GO TO 22
         IF(HILIM(33,EQTYP).EQ.0 .AND. I.EQ.37) SSN = 35
         IF(SSN.EQ.35 .AND. HILIM(35,EQTYP).EQ.0) GO TO 22
         IF(SSN.EQ.35) GO TO 1601
         IF(I .EQ. 37) GO TO 16
 1601    RORD = ERQ(EQTYP)
         NRF(EQTYP,3,1) = NRF(EQTYP,3,1) + 1
         NRF(EQTYP,3,2) = NRF(EQTYP,3,2) + RORD
         CALL LGAMA(IX2,A,RORD,1,0,ALFA1)
         IF(I.EQ.36 .OR. SSN.EQ.35) GO TO 17
   16          NEED = HILIM(SSN,EQTYP) - CNHND(SSN,EQTYP)
               RORD = MINO(NEED,ERQ(EQTYP))
               NRF(EQTYP,2,1) = NRF(EQTYP,2,1) + 1
               NRF(EQTYP,2,2) = NRF(EQTYP,2,2) + RORD
               ST = OST(1,9,3)
   17    CONTINUE
```

```
      ICTIME=INT(CTIME)
      IF(IOPTP) .EQ. 0) GC TO 18
      WRITE(6,610)ICTIME,I,EQTYP
      WRITE(6,612)
610   FORMAT('0',2X,'AT TIME',I5,' REPAIR FACILITY',I3,' INDUCTED AN
     XERQ FOR EQUIP TYPE',I4,'.')
612   FORMAT('0',2X,'DUES ESTABLISHED FOR:',8X,'SSN',8X,'DUE TIME'/)
 18   CONTINUE
      DO 20 J=L,RORC
            RTIME = PRT(ECTYP)*A(J)
            DTIME = RTIME + CTIME + ST
            SHIPR = I - 24
            DESTN = SSN - 24
            NSHIP(SHIPR,DESTN)=NSHIP(SHIPR,DESTN) + 1
            CALL ESDUE(SSN,EQTYP,DTIME,1,DUEN,DUEA,DUEE,DUEQ,DUET)
            IF (IOPTP) .EQ. 0) GO TO 2C
            WRITE(6,614)SSN,DTIME
614         FCRMAT(32X,I3,8X,F8.0)
 20   CONTINUE
      IF(I.EC.36 .OR. SSN.EQ.35 .CR. NEED.GE.ERQ(EQTYP))GO TO 22
      SSN = 35
      IF(HILIM(SSN,EQTYP) .EQ. 0) GO TO 22
      L = NEED + 1
      RORC = ERC(EQTYP)
      NRF(EQTYF,3,1) = NRF(EQTYP,3,1) + 1
      NRF(EQTYP,3,2) = NRF(EQTYP,3,2) + ERQ(EQTYP) - NEED
      ST = 0.0
      GO TO 18
 22 CONTINUE
 24 CONTINUE
    SSN = (ISHIP-869)
C
C ** IF STOCK DUE-IN'S HAVE ARRIVEC, INCREASE ON-HAND QUANTITY.
C
    CALL CHKDU(SSN,ECTYP,CTIME,DUEN,DUEA,DUEE,DUEQ,DUET, DUES)
    ONHND(SSN,ECTYP) = ONHND(SSN,ECTYP) + DUES
    DELOH(1) = DELOH(1) + DUES
C
C ** IF NC STOCK ON-HAND, PREPARE AND SEND REQUISION TO NEXT ECHELON.
C
    NNN(EQTYP,1,1) = NNN(ECTYP,1,1) + 1
    IF (ONHND(SSN,EQTYP) .GE. 1) GC TO 30
      IF(HILIM(SSN,EQTYP) .EQ. 0) GO TC 27
            NNN(EQTYP,1,2) = NNN(ECTYP,1,2) + 1
            GC TC 28
 27   NNN(EQTYP,1,3) = NNN(EQTYP,1,3) + 1
 28   RECN = RECN + 1
      RESCN(RECN) = I
```

```
         ORACT(RECN) = SSN
         ORDQT(REQN) = 1
         IP(SSN,ECTYP) = IP(SSN,EQTYP) + 1
         GC TO 95
   30 CONTINUE
C
C  **  ISSUE ITEM FROM STOCK.  ESTABLISH SRT.
C
      ONHND(SSN,ECTYP) = ONHND(SSN,ECTYP) - 1
      DELOH(1) = CELOH(1) - 1
      IP(SSN,EQTYP) = IP(SSN,EGTYP) - 1
      NIST = NIST + 1
      SRT=SSRT
      IASRT = SSN
      CALL SWITCH(SRT,SSN,ECTYP,DUEN,DUEA,DUEE,DUEC,DUET)
C
C  **  IF IP AT RECRDER POINT, REORDER FCR STOCK FROM NEXT ECHELON
C
      IF (IP(SSN,ECTYP) .GT. REORD(SSN,ECTYP)) GO TO 35
         REQN = REQN + 1
         ORACT(RECN) = SSN
         RESON(REQN) = 2
         ORDCT(RECN) = HILIM(SSN,EQTYP) - IP(SSN,EQTYP)
         IP(SSN,EQTYP) = IP(SSN,EQTYP) + ORDQT(REQN)
         GO TO 95
   35 CONTINUE
C
C  **  IF REQUISITION FILLEC AND NO STOCK REQUIREMENT, RETURN TO 'TIGER'
C
      GO TO 495
C
C  **  IRC DETERMINES REQUISITION CHANNELS.
C
   95 IF(IRC - 2)100,200,300
C
C  **  LABEL 100 REFERS TO CCNUS SUPPLY CENTERS
C
  100 CONTINUE
      ECH = 3
      SSN = 34
      IF(COAST .EC. 1) SSN = 35
C
C  **  LABELS 105-130 ARE USED BY MLSF, CEPOT AND CENTERS FOR
C  **  GENERATING ISSUES ANC PASSING PARTIAL OR UNFILLED REQUISITIONS
C  **  TO NEXT ECHELON.
C
C  **  CHECK FOR DUE-IN'S AT ACTIVITY (SSN).
C
```

```
105     CALL CHKDU(SSN,EQTYP,CTIME,DUEN,DUEA,DUEE,DUEQ,DUET, DUES)
        ONHND(SSN,EQTYP) = ONHND(SSN,EQTYP) + DUES
        DELOH(ECH+1) = DELOH(ECH+1) + DUES
  110 CONTINUE
      NNN(EQTYP,ECH+1,1) = NNN(EQTYP,ECH+1,1) + 1
      ISSUE = MINO(ONHND(SSN,EQTYP),ORDQT(1))
      IF(ISSUE .EQ. 0) GO TO 127
      ONHND(SSN,EQTYP) = ONHND(SSN,EQTYP) - ISSUE
      DELOH(ECH+1) = DELOH(ECH+1) - ISSUE
C
C  **  IP IS DECREMENTED FOR REPAIRABLES ONLY IF ATTRITION OCCURS.
C
      IF(SSN .EQ. 31 .OR. SSN .EQ. 32) GO TO 112
        IF(RPAIR(EQTYP) .EQ. 0) IP(38,EQTYP)=IP(38,EQTYP) - ISSUE
        GO TO 113
  112 IP(SSN,EQTYP) = IP(SSN,EQTYP) - ISSUE
  113 CONTINUE
C
C  **  DETERMINE SHIPPER AND SHIPMENT DESTINATION.
C
      SHIPR = SSN - 24
      DESTN = SHLCC
      IF(ORACT(1) .GT. 30) DESTN = ORACT(1) - 24
      NSHIP(SHIPR,DESTN) = NSHIP(SHIPR,DESTN) + 1
C
C  **  IF END USE REQUIREMENT, ESTABLISH SRT.
C
      IF(RESON(1) .EQ. 2) GO TO 115
        SRT = OST(COAST,DESTN,ECH)
        IF(DESTN .LE. 6) SRT = SRT + MSD
        IASRT = SSN
        CALL SWITCH(SRT,ORACT(1),EQTYP,DUEN,DUEA,DUEE,DUEQ,DUET)
        GO TO 120
  115 CONTINUE
C
C  **  IF REQUISITION IS FOR STOCK, ESTAB DUE-IN AT ORDERING ACTIVITY.
C
        DTIME = CST(COAST,DESTN,ECH) + CTIME + SRT
        IF(DESTN .LE. 6)  CTIME = DTIME + MSD
        CALL ESDUE(ORACT(1),EQTYP,DTIME,ISSUE,DUEN,DUEA,DUEE,DUEQ,
     1  DUET)
        DTCT = DTCT + 1
        IDUEJ(1,CTOT) = ORACT(1)
        IDUEJ(2,CTOT) = INT(DTIME)
        IDUEJ(3,CTOT) = SSN
  120 CONTINUE
C
C  **  IF REQUISITION PARTIALLY FILLED, SEND REMAINING REQUIRMENT TO
```

```
C  **  NEXT ECHELON.
C
      IF(ORDQT(1) .LE. ISSUE) GO TO 122
         ORDQT(1) = ORDQT(1) - ISSUE
         GO TO 130
  122 CONTINUE
      REQN = REQN - 1
C
C  **  IF REQUISICN 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
         IF(REQN .EQ. 0) GO TO 130
         DO 125 I = 1,REQN
              ORACT(I)=ORACT(I+1)
              RESCN(I)=RESON(I+1)
              ORDCT(I)=ORDQT(I+1)
  125    CONTINUE
         GO TO 110
C
C  **  IF NOT AVAILABLE FRCM MLSF, ACD MLSF SCREENING DELAY TO SHIPMENT.
C
  127 IF(HILIM(SSN,EQTYP) .EQ. 0) GO TO 128
         NNN(EQTYP,ECH+1,2) = NNN(EQTYP,ECH+1,2) + 1
         GO TO 129
  128 NNN(EQTYP,ECH+1,3) = NNN(EQTYP,ECH+1,3) + 1
  129 IF(SSN .EQ. 31 .OR. SSN .EQ. 32) MSD = MSDT
  130 IF(SSN .EQ. 31 .CR. SSN .EQ. 32) GO TO 310
      GO TO 400
C
C
C  **  LABELS 200-210 REFER TO WEST COAST DEPCT.
C
  200 CONTINUE
      ECH = 2
      SSN = 33
      IF(COAST .EC. 1) GC TC 210
         SSN = 34
         ECH = 3
  210 CONTINUF
         GO TO 105
C
C
C  **  LABELS 300-320 REFER TO MLSF.
C
  300 CONTINUE
      ECH = 1
```

```
      SSN = 31
      IF(COAST .EC. 2) SSN = 32
      GO TO 105
C
C  **  IF IP AT RECRDER POINT, SEND REQUISITICN TC NEXT ECHELON.
C
  310 CONTINUE
      IF(HILIM(SSN,EQTYP) .EQ. 0) GO TO 320
      IF(IP(SSN,ECTYP) .GT. REORD(SSN,EQTYP)) GO TO 320
         RECN = RECN + 1
         ORACT(RECN) = SSN
         RESON(REQN) = 2
         ORDQT(RECN) = HILIM(SSN,EQTYP) - IP(SSN,EQTYP)
         IP(SSN,ECTYP) = IP(SSN,EQTYP) + ORDQT(REQN)
  320 CONTINUE
C
C  **  IF REQUISITIONS IN QUEUE, GO TO NEXT ECHELON;
C  **  ELSE RETURN TO 'TIGER'.
C
      IF(RECN .GT. 0) GO TO 200
      GO TO 495
C
C
C  **  LABELS 400-495 REFER TO ICP
C
  400 CONTINUE
C
C
C  **  LABEL 404-425 WILL REDISTRIBUTE ASSETS BETWEEN STOCK PCINTS FOR
C  **  MLSF AND SHIP REQUISITIONS.
C
  404 CONTINUE
      IF(RECN .EQ. 0) GO TC 450
      IF(ORACT(1) .GT. 32) GO TO 450
      IF(SSN .NE. 33) GO TO 406
      IF(ONHND(35,EQTYP) .GE. 1) GO TO 4C8
      IF(ONHND(34,EQTYP) .GE. 1) GO TO 4C9
C
C  **  NONE AVAILABLE FOR REDISTRIBUTION, INDUCT CR PROCURE AS
C  **  APPROPRIATE (LABEL 460).
C
      GO TO 460
  406 IF(SSN .EQ. 34) GO TO 407
      IF(ONHND(34,EQTYP) .GE. 1) GO TO 4C9
      GO TO 46C
  407 IF(ONHNC(35,EQTYP) .GE. 1) GO TO 408
      GO TO 460
  408 IA = 35
```

```
      COAST = 1
      ECH = 3
      GO TO 410
  409 IA = 34
      COAST = 2
      ECH = 3
C
C  **  LABELS 410-425 REFER TO REDISTRIBUTION ISSUE PROCESS.
C
  410 ISSUE = MINO(ONHND(IA,EQTYP),ORDQT(1))
      ONHND(IA,EQTYP)=CNHND(IA,EQTYP) - ISSUE
      DELOH(ECH+1) = DELOH(ECH+1) - ISSUE
      IF(RPAIR(EQTYP) .EQ. 0) IP(38,EQTYP)=IP(38,EQTYP) - ISSUE
      DESTN = SHLCC
      IF(ORACT(1) .GT. 30) DESTN = ORACT(1) - 24
      SHIPR = IA - 24
      NSHIP(SHIPR,DESTN) = NSHIP(SHIPR,DESTN) + 1
      IF(RESON(1) .EQ. 2) GO TO 412
         SRT = OST(COAST,DESTN,ECH)
         IF(DESTN .LE. 6) SRT = SRT + MSD
         IASRT = IA
         CALL SWITCH(SRT,ORACT(1),EQTYP,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 ESDUE(ORACT(1),EQTYP,DTIME,ISSUE,DUEN,DUEA,DUEE,DUEQ,DUET)
      DTOT = DTOT + 1
      IDUEJ(1,DTOT) = ORACT(1)
      IDUEJ(2,DTOT) = INT(DTIME)
      IDUEJ(3,DTOT) = IA
  414 CONTINUE
      IF(ORDQT(1) .LE. ISSUE) GO TO 420
         ORDQT(1) = ORDQT(1) - ISSUE
         GO TO 425
  420 CONTINUE
         REQN = REQN - 1
C
C  **  IF NO REQUISITIONS IN QUEUE, CHECK ICP INVENTORY POSITION.
C
         IF(REQN .EQ. 0) GO TO 450
         DO 422 I=1,REQN
              ORACT(I)=ORACT(I+1)
              RESON(I)=RESON(I+1)
              ORDQT(I)=ORDQT(I+1)
  422    CONTINUE
  425 CONTINUE
C
```

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

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      IF(N.LE.15 .OR. N.EQ.31 .OR. N.EQ.33 .OR. N.EQ.35) GO TO 465     MUL20170
         RP = 36                                                        MUL20180
         COAST = 2                                                      MUL20190
  465 CONTINUE                                                          MUL20200
  461 ISSUE = MINO(ONHND(RP,EQTYP),ORDQT(1))                            MUL20210
      IF(ISSUE .EQ. 0) GO TO 470                                        MUL20220
      ONHND(RP,EQTYP) = ONHND(RP,EQTYP) - ISSUE                         MUL20230
      DESTN = SHLOC                                                     MUL20240
      IF(ORACT(1) .GT. 30) DESTN = ORACT(1) - 24                        MUL20250
      SHIPR = RP - 24                                                   MUL20260
      NSHIP(SHIPR,DESTN) = NSHIP(SHIPR,DESTN) + 1                       MUL20270
      TO = LEVEL(DESTN)                                                 MUL20280
      NRF(EQTYP,TO,1) = NRF(EQTYP,TO,1) + 1                             MUL20290
      NRF(EQTYP,TO,2) = NRF(EQTYP,TO,2) + ISSUE                         MUL20300
      CALL LGAMA(IX3,A,ISSUE,1,0,ALFA1)                                 MUL20310
      DO 463 I=1,ISSUE                                                  MUL20320
      RTIME = MRT(EQTYP)*A(1)                                           MUL20330
      IF(RESON(1) .EQ. 2) GO TO 462                                     MUL20340
         SRT = RTIME + OST(COAST,DESTN,4)                               MUL20350
         IF(DESTN .LE. 6) SRT = SRT + MSC                               MUL20360
         IASRT = RP                                                     MUL20370
         CALL SWITCH(SRT,ORACT(1),EQTYP,DUEN,DUEA,DUEE,DUEQ,DUET)       MUL20380
         CALL PRICR(OST,EQTYP,DESTN,SRT,NSHIP,SHPR,DUEN,DUEA,DUEE,DUEQ, MUL20390
     1   DUET)                                                          MUL20400
         IF(SHPR .EQ. 38) GO TO 464                                     MUL20410
         IASRT = SHPR                                                   MUL20420
         NSHIP(SHIPR,DESTN) = NSHIP(SHIPR,DESTN) - 1                    MUL20430
         NSHIP(SHIPR,SHPR-24) = NSHIP(SHIPR,SHPR-24) + 1                MUL20440
         GO TO 464                                                      MUL20450
  462 CONTINUE                                                          MUL20460
         DTIME = RTIME + CTIME + OST(COAST,DESTN,4)                     MUL20470
         IF(DESTN .LE. 6) CTIME = DTIME + MSD                           MUL20480
         CALL ESDUE(ORACT(1),EQTYP,DTIME,1,DUEN,DUEA,DUEE,DUEQ,DUET)    MUL20490
         DTOT = DTOT + 1                                                MUL20500
         IDUEJ(1,DTOT) = ORACT(1)                                       MUL20510
         IDUEJ(2,DTOT) = INT(DTIME)                                     MUL20520
         IDUEJ(3,DTOT) = RP                                             MUL20530
  463 CONTINUE                                                          MUL20540
  464 IF(ORDQT(1) .LE. ISSUE) GO TO 480                                 MUL20550
  470 CONTINUE                                                          MUL20560
C                                                                       MUL20570
C  **  IF PARTIAL ORDER FILLED OR CARCASSES UNAVAILABLE FROM NEAREST    MUL20580
C  **  REPAIR FACILITY, ATTEMPT TO FILL AT THE OTHER.                   MUL20590
C                                                                       MUL20600
      IF(RP .EQ. 36) GO TO 472                                          MUL20610
         RP = 36                                                        MUL20620
         COAST = 2                                                      MUL20630
         IF(ONHND(RP,EQTYP) .GE. 1) GO TO 461                           MUL20640
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      GO TO 490
  472 CONTINUE
         RP = 37
         COAST = 1
         IF(CNHND(RP,EQTYP) .GE. 1) GO TO 461
         GO TO 490
  480 CONTINUE
      REQN = REQN - 1
C
C  **  IF NO REQUISITIONS IN QUEUE, DETERMINE IF SYSTEM IP AT REORDER PT
C
      IF(REQN .EQ. 0) GO TO 450
      DO 482 I=1,REQN
         ORACT(I)=ORACT(I+1)
         RESON(I)=RESON(I+1)
         ORDQT(I)=ORDQT(I+1)
  482 CONTINUE
      GO TO 460
C
C  **  LABELS 490-495 DETERMINE END USE AND SYSTEM REQUIREMENTS FOR
C  **  PROCUREMENT FROM MANUFACTURER.
C
  490 CONTINUE
      ISSUE=ORDQT(1)
      IF(RPAIR(EQTYP).EQ.1 .AND. ORACT(1).LE.30) IP(38,EQTYP) =
     X                                         IP(38,EQTYP) + ORDQT(1)
      COAST = 2
      N = ORACT(1)
      IF(N.LE.15 .OR. N.EQ.31 .OR. N.EQ.33 .OR. N.EQ.35) COAST = 1
      DESTN = SHLOC
      IF(ORACT(1) .GT. 30) DESTN=ORACT(1)-24
      NSHIP(14,DESTN) = NSHIP(14,DESTN) + 1
      TO = LEVEL(ORACT(1))
      NMFR(EQTYP,TO,1) = NMFR(EQTYP,TO,1) + 1
      NMFR(EQTYP,TO,2) = NMFR(EQTYP,TO,2) + ISSUE
      CALL LGAMA(IX4,A,1,1,0,ALFA2)
      PLT = MPLT(EQTYP)*A(1)
      IF(RESON(1) .EQ. 2) GO TO 492
         SRT=PLT + OSTM(DESTN)
         IF(DESTN .LE. 6) SRT = SRT + MSC
         IASRT = 38
         CALL SWITCH(SRT,ORACT(1),EQTYP,DUEN,DUEA,DUEE,DUEQ,DUET)
         CALL PRIOR(OST,EQTYP,DESTN,SRT,NSHIP,SHPR,DUEN,DUEA,DUEE,DUEQ,
     1   DUET)
         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
```

```
      GO TO 494
  492 CONTINUE
      DTIME = PLT + CTIME + OSTM(DESTN)
      IF(DESTN .LE. 6) CTIME = DTIME + MSD
      CALL ESDUE(ORACT(1),EQTYP,DTIME,ISSUE,DUEN,DUEA,DUEE,DUEQ,DUET)
      DTCT = 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 4941 I=1,REQN
      ORACT(I) = ORACT(I+1)
      ORCQT(I) = ORCQT(I+1)
      RESCN(I) = RESON(I+1)
 4941 CONTINUE
      GO TO 460
  495 CONTINUE
C
C  **  CALCULATE CHANGES IN ON-HAND INVENTORY LEVELS AT ALL ECHELONS
C  **  TO DETERMINE AVERAGE INVENTORY DOLLAR VALUE.
C
      DELTIM=CTIME-OTIME
      DO 496 I=1,4
      DO 496 J=1,NTY
  496 SUMD(J,I) = SUMXD(J,I)*DELTIM  +   SUMD(J,I)
      DO 4961 I=1,4
      SUMD(EQTYP,I) =    .5*DELTIM*FLOAT(DELOH(I)) + SUMD(EQTYP,I)
      SUMXD(EQTYP,I) = SUMXD(EQTYP,I) + DELOH(I)
 4961 CONTINUE
C
C  **  SUMMARY OF ACTION TAKEN
C
      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)
      WRITE(6,680)EQTYP,ENUSE,ICTIME
      WRITE(6,681)
      WRITE(6,683)IASRT,SRT
      IF(DTCT .EQ. 0) GO TO 498
      WRITE(6,684)
      WRITE(6,685)
      DO 497 I=1,CTOT
```

```
      WRITE(6,686)IDUEJ(1,I),IDUEJ(2,I),IDUEJ(3,I)
  497 CONTINUE
      GO TO 499
  498 WRITE(6,691)
  499 CTIME = CTIME
      RETURN
  680 FORMAT('0',5X,'FAILURE OF EQUIPMENT TYPE',I3,' ON SHIP',I3,' AT TI
     XME',I5,'.')
  681 FORMAT(6X,'RESULTED IN THE FOLLOWING SUPPLY ACTIONS:')
  683 FORMAT('0','END USE REQUIREMENT FILLED BY SSN',I3,'.',4X,'SUPPLY R
     XESPONSE TIME IS: ',F7.0)
  684 FORMAT('0', 'ORDERS FOR STOCK WERE GENERATED AS FOLLOWS:')
  685 FORMAT('0',5X,'REQUISITIONOR(SSN)',5X,'DUE-IN AT TIME',5X,'ISSUED
     XFROM(SSN)'/)
  686 FORMAT(10X,I4,20X,I5,16X,I2)
  688 FORMAT('0',80('-')/)
  695 FORMAT('1',20X,'MISSION: ',I4////)
  691 FORMAT('0','NO ORDERS FOR STOCK RESULTED FROM THIS ISSUE.')
      END
C
C
C
C
C
C
C
C
C   ****************************************************************
C   **                                                            **
C   **  THIS SUBROUTINE UPDATES AN ACTIVITIE'S DUE-IN-FOR-STOCK VEC-  **
C   **  TOR. DUE-IN'S ARE FILED CHRONCLOGICALLY IN THE VECTOR (QUEUE).**
C   **                                                            **
C   ****************************************************************
C
C
      SUBROUTINE ESDUE(ACT,EQTYP,DTIME,QTYD,DUEN,DUEA,DUEE,DUEQ,DUET)
      COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1
      INTEGER K,QTYD,KM1,ACT,EQTYP,DUEN
      INTEGER DUEA(MAXC),DUEQ(MAXD),DUEE(MAXD)
      REAL DUET(MAXD),CTIME
      K = DUEN + 1
      IF((K+1) .GE. MAXD) GO TO 25
C
C   ** THIS LOOP FINDS PROPER PLACE IN QUEUE AND MOVES OTHERS ACCORDINLY
C
      DO 20 I=1,K
         IF(CTIME .GE. DUET(I)) GO TO 20
```

```
      KMI=K-I
      IF(KMI .EQ. 0) GO TO 16
      DO 15 J=1,KMI
            DUET(K+1-J) = DUET(K-J)
            DUEA(K+1-J) = DUEA(K-J)
            DUEQ(K+1-J) = DUEQ(K-J)
            DUEE(K+1-J) = DUEE(K-J)
15    CONTINUE
16    DUET(I) = DTIME
      DUEA(I) = ACT
      DUEQ(I) = QTYD
      DUEE(I) = EQTYP
      GO TO 21
20  CONTINUE
21  DUEN = K
    GO TO 30
25  CONTINUE
    WRITE(6,600)ACT
600 FORMAT('0',5X,'WARNING: THE NUMBER OF DUE-INS FOR ACTIVITY NR',I4,
   1' HAS EXCEEDED MAX ALLOWABLE.',/,'SIMULATION CONTINUES, BUT DUE-IN
   2WILL NOT BE RECORDED FOR THIS ACTIVITY UNTIL SPACE IS AVAILABLE.')
    STOP
30  CONTINUE
    RETURN
    END
C
C
C
C
C
C
C
C   ****************************************************************
C   **                                                            **
C   **  THIS SUBROUTINE DETERMINES IF ANY DUE-IN'S HAVE ARRIVED AT **
C   **  OR BEFORE CURRENT TIME.  IF SO, IT ELIMINATES THOSE DUE-IN'S **
C   **  FROM THE QUEUE AND CALCULATES THE QUANTITY RECEIVED.      **
C   **                                                            **
C   ****************************************************************
C
C
C
    SUBROUTINE CHKDU(SSN,EQTYP,CTIME,DUEN,DUEA,DUEE,DUEQ,DUET,DUES)
C
    COMMON/MULTI/MAXD,MULTC,MFLAG,IOPTM,IRC,IOPTP1
    INTEGER DUES,SSN,EQTYP,DUEN
    INTEGER DUEA(MAXD),DUEE(MAXD),DUEQ(MAXD)
    REAL DUET(MAXD),CTIME
```

```
C
      DUES=C
      K=0
C
C  **  CALCULATE TOTAL DUES
C
   10 K = K+1
      IF(DUET(K) .GT. CTIME) GO TO 2C
      IF(DUEA(K) .NE. SSN) GC TO 10
      IF(DUEE(K) .NE. EQTYP) GO TO 10
         DUES = DUEQ(K) + CUES
         KR = CUEN+1
C
C  **  ADJUST CUE-IN VECTOR AS NECESSARY.
C
         DC 15 I = K,KR
               DUET(I) = DUET(I+1)
               DUEC(I) = DUEQ(I+1)
               CUEE(I) = DUEE(I+1)
               DUEA(I) = DUEA(I+1)
               DUEN = DUEN - 1
   15    CONTINUE
         GO TO 10
   20 CONTINUE
      RETURN
      END
C
C
C
C
C
C
C  *****************************************************************
C  **                                                             **
C  **  WHEN A REQLISITION IS RECEIVEC FOR END USE WHICH MUST BE BACK-**
C  **  ORDERED FRCM A REPAIR FACILITY OR MANUFACTURER, SUBROUTINE  **
C  **  'PRICR' WILL CHECK ALL DUE-IN'S FOR STOCK AT DEPOTS AND CEN-  **
C  **  TERS FOR EARLIER DELIVERY DATES.  IF FOUND, THE EARLIEST WILL **
C  **  BE DIVERTED FRCM THE STOCK POINT TO THE ENC USER (SHIP) AND   **
C  **  THAT WILL BECOME THE SRT. SIMILARLY, THE BACKORDER WILL BE    **
C  **  DIVERTED TC THE STK POINT TO SATISFY THEIR STOCK REQUIREMENT. **
C  **                                                             **
C  *****************************************************************
C
C
C
C
      SUBROUTINE PRIOR(OST,EQTYP,DESTN,SRT,NSHIP,SHPR,DUEN,DUEA,DUEE,
```

```
     1    DUEQ,DUET)                                                          MUL23050
C                                                                             MUL23060
      COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1                          MUL23070
      INTEGER SHPR,ECH,COAST,DESTN,ECTYP,NSHIP(14,14),DUEN,DNUM               MUL23080
      INTEGER DUEA(MAXD),DUEE(MAXD),DUEQ(MAXD)                                MUL23090
      REAL MIN,T,CST(2,14,3),SRT,DTIME,SRT1,CTIME,DUET(MAXD)                  MUL23100
C                                                                             MUL23110
      SHPR=0                                                                  MUL23120
      SRT1=SRT                                                                MUL23130
      MIN=99999                                                               MUL23140
C                                                                             MUL23150
      IF(DUEN .EQ. 0) GO TO 51                                                MUL23160
      DO 10 J=1,DUEN                                                          MUL23170
         IF(DUET(J) .GE. SRT) GO TO 11                                        MUL23180
         IF(DUEE(J) .NE. ECTYP) GO TO 10                                      MUL23190
         IF(DUEA(J).GT.35 .OR. DUEA(J).LT.33) GO TO 10                        MUL23200
         ECH = 3                                                              MUL23210
         IF(DUEA(J) .EQ. 33) ECH = 2                                          MUL23220
         COAST = 1                                                            MUL23230
         IF(DUEA(J) .EQ. 34) COAST = 2                                        MUL23240
         T = DUET(J) + CST(COAST,DESTN,ECH)                                   MUL23250
         IF(T .GE. MIN) GO TO 10                                              MUL23260
              SHPR=DUEA(J)                                                    MUL23270
              MIN = T                                                         MUL23280
              DNUM = J                                                        MUL23290
   10 CONTINUE                                                                MUL23300
   11 CONTINUE                                                                MUL23310
      IF(SHPR .EQ. 0 .OR. MIN .GE. SRT) GO TO 50                              MUL23320
      SHPR1 = SHPR - 24                                                       MUL23330
      NSHIP(SHPR1,DESTN) = NSHIP(SHPR1,DESTN) + 1                             MUL23340
      SRT=MIN                                                                 MUL23350
      DUEQ(DNUM) = DUEQ(DNUM) - 1                                             MUL23360
C                                                                             MUL23370
C  **  IF THE DUE-IN QUANTITY WAS ONE, ELIMINATE THE DUE-IN FROM QUEUE.       MUL23380
C                                                                             MUL23390
      IF(DUEQ(DNUM) .NE. 0) GO TO 20                                          MUL23400
         DO 12 I=DNUM,DUEN                                                    MUL23410
              DUEA(I) = DUEA(I+1)                                             MUL23420
              DUEE(I) = DUEE(I+1)                                             MUL23430
              DUEQ(I) = DUEQ(I+1)                                             MUL23440
              DUET(I) = DUET(I+1)                                             MUL23450
   12    CONTINUE                                                             MUL23460
         DUEN = DUEN - 1                                                      MUL23470
   20 CONTINUE                                                                MUL23480
C                                                                             MUL23490
C  **  INSERT NEW DUE-IN IN SHIPPER'S DUE-IN QUEUE.                           MUL23500
C                                                                             MUL23510
      DTIME=SRT1-CST(COAST,DESTN,ECH) + CTIME                                 MUL23520
```

```
      CALL ESDUE(SHPR,EQTYP,CTIME,1,DUEN,DUEA,DUEE,DUEQ,DUET)
      GO TO 51
   50 CONTINUE
      SHPR = 38
   51 CONTINUE
      RETURN
      END
C
C
C
C
C
C
C
C  ******************************************************************
C  **                                                              **
C  **  WHEN A SUPPLY RESPONSE TIME IS ESTABLISHED FOR AN END-USER, **
C  **  SUBROUTINE 'SWITCH' WILL CHECK THE END-USERS DUE-IN FILE TO **
C  **  TO ASCERTAIN IF ANY EQUIPMENTS OF THIS TYPE ARE DUE IN FOR  **
C  **  STOCK AT A TIME PRIOR TO THE SRT.  IF SO, THE EARLIEST SUCH **
C  **  STOCK DUE WILL BE SWITCHED TO SATISFY THE END USE REQUIRE-  **
C  **  MENT WHILE THE INCOMING SRT WILL BE DIVERTED TO STOCK.      **
C  **                                                              **
C  ******************************************************************
C
C
C
C
      SUBROUTINE SWITCH(SRT,ACT,EQTYP,DUEN,DUEA,DUEE,DUEQ,DUET)
C
      COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1
      INTEGER DUEN,DNUM
      INTEGER DUEA(MAXC),DUEE(MAXD),DUEQ(MAXD)
      REAL SRT,SRT1,DUET(MAXD)
C
      SRT1 = SRT
      IFLAG = 0
      IF(DUEN .EQ. 0) GO TO 50
      DO 10 J=1,DUEN
         IF(DUET(J) .GE. SRT) GO TO 11
         IF(DUEA(J).NE.ACT .OR. DUEE(J).NE.EQTYP) GO TO 10
         DNUM = J
         SRT = DUET(J)
         IFLAG = 1
         GO TO 11
   10 CONTINUE
   11 CONTINUE
      IF(IFLAG .EQ. 0) GO TO 50
```

```
      DUEQ(DNUM) = DUEC(DNUM) - 1
      IF(DUEQ(DNUM) .NE. 0) GO TO 20
         DO 12 I = DNUM,DUEN
               DUEA(I) = DUEA(I+1)
               DUEE(I) = CUEE(I+1)
               DUEC(I) = DUEC(I+1)
               DUET(I) = DUET(I+1)
12       CONTINUE
         DUEN = DUEN - 1
20    CONTINUE
      DTIME = SRT1
      CALL ESDUE(ACT,ECTYP,CTIME,1,DUEN,DUEA,DUEE,CUEQ,DUET)
50    CONTINUE
      RETURN
      END
C
C
C
C
C
C
C     ****************************************************************
C     **                                                            **
C     **   SUBROUTINE 'MPACK' READS AND INITIALIZES INPUT VARIABLES FOR **
C     **   THE 'MULTE' SUBROUTINE.  THE INITIAL DOLLAR VALUE INVESTED   **
C     **   IN INVENTORY IS CALCULATED FOR ALL ECHELONS.  ADDITIONALLY,  **
C     **   AT THE START OF EACH MISSION, IT RESETS APPROPRIATE VARI-    **
C     **   ABLES TO THEIR INITAIL CONDITIONS.                           **
C     **                                                            **
C     ****************************************************************
C
C
C
C
      SUBROUTINE MPACK(ERQ,HILIM,IP,ONHNC,MPLT,MRT,MSDT,REORD,
     1RPAIR,OTIME,DUEA,DUEE,CUEQ,DUET,DUEN,NTY)
C
      COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1
      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,NRRT,
     1NRF(200,4,2),NSHIP(14,14),IXD(200,4),IXT(4),IXG
      COMMON/MP/CRAR,ALFA1,ALFA2,SSRT,ECCST(200),CSTSR(6),OSTM(11),
     1CST(2,11,4)
      COMMON/NS/NUMSS(30),NRSHPS,ITOTEQ,NSSEQ(500),NRWCS
      INTEGER DUEN
      INTEGER DUEA(MAXC),DUEE(MAXD),CUEQ(MAXD),IP(38,200),ERQ(200),
     1HILIM(38,20C),ONHNC(38,200),RECRD(38,200),RPAIR(200),NSSS(30)
      REAL CUET(MAXD),MPLT(200),MRT(200),MSDT
```

```
C                                                                       MUL24490
      DATA ERQ/200*0/,HILIM/7600*0/,REORC/7600*0/,OSTM/11*0.0/,         MUL24500
     1OSTSR/6*0.0/,OST/88*0.0/                                          MUL24510
C                                                                       MUL24520
      MFLAG = 1                                                         MUL24530
      IF(MULTC .NE. 0) GO TO 50                                         MUL24540
      READ(5,502)M1,CRAR,MSDT,SSRT,ALFA1,ALFA2                          MUL24550
      DO 20 J=1,NTY                                                     MUL24560
         READ(5,504)RPAIR(J),MPLT(J),ECOST(J)                           MUL24570
         IF(RPAIR(J) .EQ. 1) READ(5,506)MRT(J),ERQ(J)                   MUL24580
         GO TO (5,20),M1                                                MUL24590
    5    READ(5,508)HILIM(NUMSS(1)-869,J),(HILIM(I,J),I=31,38)          MUL24600
         READ(5,508)RECRD(NUMSS(1)-869,J),(REORD(I,J),I=31,38)          MUL24610
         IF(NRSHPS .EQ. 1) GO TO 20                                     MUL24620
         DO 10 K=2,NRSHPS                                               MUL24630
            NMS = NUMSS(K)-869                                          MUL24640
            NMS1 = NUMSS(1)-869                                         MUL24650
            HILIM(NMS,J) = HILIM(NMS1,J)                                MUL24660
   10       REORC(NMS,J) = REORD(NMS1,J)                                MUL24670
   20 CONTINUE                                                          MUL24680
      GO TO (40,25),M1                                                  MUL24690
   25 DO 33 I=1,NRSHPS                                                  MUL24700
         NMS=NUMSS(I)-869                                               MUL24710
         READ(5,512)(HILIM(I,J),J=1,NTY)                                MUL24720
   33    READ(5,512)(REORD(I,J),J=1,NTY)                                MUL24730
      DO 35 I=31,38                                                     MUL24740
         READ(5,512)(HILIM(I,J),J=1,NTY)                                MUL24750
   35    READ(5,512)(RECRD(I,J),J=1,NTY)                                MUL24760
   40 CONTINUE                                                          MUL24770
      READ(5,516)(OSTSR(I),I=1,6)                                       MUL24780
      READ(5,516)(OSTM(I),I=1,11)                                       MUL24790
      DO 46 I=1,2                                                       MUL24800
         DO 46 K=1,4                                                    MUL24810
   46       READ(5,516)(OST(I,J,K),J=1,11)                              MUL24820
C                                                                       MUL24830
      WRITE(6,600)                                                      MUL24840
      WRITE(6,602)NRSHPS                                                MUL24850
      WRITE(6,604)NTY                                                   MUL24860
      WRITE(6,606)                                                      MUL24870
      WRITE(6,608)                                                      MUL24880
      WRITE(6,610)                                                      MUL24890
      DO 100 I=1,NTY                                                    MUL24900
  100    WRITE(6,612)I,RPAIR(I),MPLT(I),MRT(I),ECOST(I),ERQ(I)          MUL24910
      WRITE(6,626)                                                      MUL24920
      WRITE(6,627)                                                      MUL24930
      WRITE(6,6271)                                                     MUL24940
      DO 1011 I=1,NRSHPS                                                MUL24950
         NSSS(I) = NUMSS(I) - 869                                       MUL24960
```

```
1011 CONTINUE
     NRS = NRSHPS
     IF(NRSHPS .GT. 15) NRS = 15
     I1 = 1
 101 WRITE(6,628)(NSSS(I),I=I1,NRS)
     WRITE(6,629)
     DO 103 I=1,NTY
        WRITE(6,630)I,(HILIM(NUMSS(J)-869,I),J=I1,NRS)
        WRITE(6,632)(REORD(NUMSS(J)-869,I),J=I1,NRS)
 103 CONTINUE
     IF(NRSHPS.LE.15 .OR. I1.EQ.16) GO TO 104
     I1 = 16
     NRS = NRSHPS
     GO TC 101
 104 WRITE(6,634)
     WRITE(6,635)
     WRITE(6,629)
     DO 105 I=1,NTY
        WRITE(6,636)I,(HILIM(J,I),J=31,38)
        WRITE(6,638)(RECRD(J,I),J=31,38)
 105 CONTINUE
     WRITE(6,614)
     WRITE(6,616)
     WRITE(6,618)(I,I=1,14)
     DO 110 I=1,3
 110    WRITE(6,620)I,OSTSR(I)
     DO 115 I=4,6
 115    WRITE(6,622)I,OSTSR(I)
     IA = 1
     IB = 2
     IC = 7
     DO 120 K=1,4
        IF(K.EQ.1 .OR. K.EC.2) GO TG 118
              IA = 2
              IB = 1
 118    WRITE(6,624)IC,(OST(IA,J,K),J=1,11)
        IC = IC + 1
        IF(K .EQ. 2) GO TG 120
        WRITE(6,624)IC,(OST(IB,J,K),J=1,11)
        IC = IC + 1
 12C CONTINUE
     WRITE(6,624)IC,(CSTM(I),I=1,11)
C
     IXT(1) = 0
     DO 1002 I=1,NTY
        IXD(I,1) = 0
        DO 1001 J=1,3C
           IXD(I,1) = HILIM(J,I) + IXD(I,1)
```

```
1001     CONTINUE
         IXT(1) = IXD(I,1) + IXT(1)
1002  CONTINUE
      IXG = IXT(1)
      ITEMP = 28
      DO 1004 I=2,4
         ITEMP = ITEMP + 2
         IF(I .EQ. 4) ITEMP = ITEMP-1
         IXT(I) = 0
         DO 1003 J=1,NTY
            IXD(J,I)=0
            IXD(J,I) = HILIM(ITEMP+1,J) + IXD(J,I)
            IF(I .NE. 3) IXD(J,I) = HILIM(ITEMP+2,J) + IXD(J,I)
            IXT(I) = IXD(J,I) + IXT(I)
1003     CONTINUE
         IXG = IXT(I) + 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
1113           SUMXD(J,I) = 0.0
1114     XG = XT(I) + XG
      NRRT = 0
      NRA = 0
      NIST = 0
      DO 1125 K=1,3
         DO 1125 J=1,4
            DO 1125 I=1,NTY
               IF(K .EQ. 3) GO TC 1120
               NMFR(I,J,K) = 0
               NRF(I,J,K) = 0
1120           NNN(I,J,K) = 0
1125  CONTINUE
      DO 113C I=1,14
         DO 1130 J=1,14
1130        NSHIP(I,J) = 0
C
C
   50 CTIME = 0.0
      DO 51 I=1,4
         DO 51 J=1,NTY
   51       SUMXC(J,I) = FLOAT(IXD(J,I))
      DUEN = 0
      DO 55 I=1,MAXD
```

```
      DUEA(I) = 0
      DUEE(I) = 0
      DUEQ(I) = 0
   55 DUET(I) = 99999.
      DO 60 I=1,38
      DO 60 J=1,NTY
        IP(I,J) = HILIM(I,J)
   60   ONHND(I,J) = HILIM(I,J)
      RETURN
  502 FORMAT(I5,5F10.0)
  504 FORMAT(I10,2F10.0)
  506 FORMAT(F10.C,I10)
  508 FORMAT(9I5)
  512 FORMAT(16I5/)
  516 FORMAT(11F7.C)
  600 FORMAT('1',5X,'INPUT PARAMETERS:  MULTI-ECHELON SUPPLY SYSTEM')
  602 FORMAT('0',8X,'NUMBER OF SHIPS IN SIMULATION:',2X,I3)
  604 FORMAT(9X,'NUMBER CF ECUIPMENT TYPES:',I4)
  606 FORMAT('0',8X,'EQUIPMENT TYPE DATA')
  608 FORMAT('0','EQUIP      REPAIR      MEAN PROCMT      MEAN REPAIR     E
     1CUIP      ECCNOMIC')
  610 FORMAT(1X,'NR',8X,'CCDE',7X,'LEAD TIME',8X,'LEAD TIME',7X,'COST',
     15X,'REPAIR CTY',/)
  612 FORMAT(1X,I2,10X,I1,9X,F7.2,10X,F7.2,6X,F7.2,5X,I4)
  614 FORMAT(///,' ORDER AND SHIPPING TIMES')
  616 FORMAT('0',5X,'TC',6X,'SHIP LOCATICN',11X,'MLSF   DEPOT   CENTERS
     1   REP FAC    MFR')
  618 FORMAT(1X,'FROM',2X,I2,13(3X,I2))
  620 FORMAT(1X,I2,63X,F5.0)
  622 FORMAT(1X,I2,58X,F5.0)
  624 FORMAT(1X,I2,1X,11(F5.0))
  626 FORMAT(////,5X,'INVENTORY STOCKING OBJECTIVE/  BY ACTIVITY')
  627 FORMAT(16X,'REORCER PCINT')
 6271 FORMAT(1X,'SHIPS')
  628 FORMAT('0',8X,'SHIP NR.',2X,15(I4))
  629 FORMAT(1X,'ECUIPMENT')
  630 FORMAT('0',3X,I3,12X,15(I4))
  632 FORMAT(19X,15(I4))
  634 FORMAT(8X,'ACTIVITY:  MLSF-W MLSF-E DEPCT CENTER-E CENTER-W REP-E
     1REP-W    ICP')
  635 FORMAT(1X,'SLPPCRT ACTIVITIES')
  636 FORMAT('0',3X,I3,12X,3(2X,I4),3X,I4,4X,I4,2X,2(2X,I4),3X,I4)
  638 FORMAT(19X,3(2X,I4),3X,I4,4X,I4,2X,2(2X,I4),3X,I4)
C     DEBUG INIT(XC,XT,XG,CVII,TDVII,GTDVI,ADV,ATCV,AGTV)
C     AT 5
      END
C
C
```

```
C
C
C     ****************************************************************
C     **                                                            **
C     **   SUBROUTINE 'MSTAT' COMPILES AND PRINTS END-OF-RUN STATISTICS **
C     **   FOR THE MULTI-ECHELON SUPPLY NETWORK.                    **
C     **                                                            **
C     ****************************************************************
C
C
C
C
      SUBROUTINE MSTAT(ITMSN,NTY,TPM,IOPT)
C
      COMMON/STAT/XD(200,4),XT(4),XG,SUMC(200,4),SUMXD(200,4)
      COMMON/ISTAT/NIST,NMFR(200,4,2),NNN(200,4,3),NRA,NRRT,
     1NRF(200,4,2),NSHIP(14,14),IXD(200,4),IXT(4),IXG
      COMMON/MP/CRAR,ALFA1,ALFA2,SSRT,ECCST(200),OSTSR(6),OSTM(11),
     1OST(2,11,4)
      COMMON/MULTI/MAXC,MULTC,MFLAG,IOPTM,IRC,IOPTP1
      INTEGER NMFL(4,2),NMFE(200,2),NMFT(2),NRFL(4,2),NRFE(200,2),
     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),ANNN(200,4,3),ANNNE(200,3),ANNNL(4,3),ANSHIP(14,14),
     2AADV(200,4),AATDV(4),ANNNT(3),SUMDM(200,4),CSUMDM(200,4)
C
C     ** COMPUTE CROSS SUMS AND TOTALS
C
      DO 10 K=1,3
         DO 8 I=1,NTY
            IF(K .EQ. 3) GO TO 4
            NMFE(I,K) = 0
            NRFE(I,K) = 0
    4       NNNE(I,K) = 0
            DO 6 J=1,4
               IF(K .EQ. 3) GO TO 5
               NMFE(I,K) = NMFR(I,J,K) + NMFE(I,K)
               NRFE(I,K) = NRF(I,J,K) + NRFE(I,K)
    5          NNNE(I,K) = NNN(I,J,K) + NNNE(I,K)
    6       CONTINUE
    8    CONTINUE
   10 CONTINUE
      DO 30 K = 1,3
         IF(K.EQ.3) GO TO 12
         NMFT(K) = 0
         NRFT(K) = 0
   12    NNNT(K) = 0
         DO 25 J = 1,4
```

```
      IF(K.EQ.3) GC TO 14
      NMFL(J,K) = 0
      NRFL(J,K) = 0
14    NNNL(J,K) = 0
      DO 20 I = 1,NTY
         IF(K.EQ.3) GO TO 16
         NMFL(J,K) = NMFR(I,J,K) + NMFL(J,K)
         NRFL(J,K) = NRF(I,J,K) + NRFL(J,K)
16       NNNL(J,K) = NNN(I,J,K) + NNNL(J,K)
20    CONTINUE
      IF(K.EQ.3) GO TO 22
      NMFT(K) = NMFL(J,K) + NMFT(K)
      NRFT(K) = NRFL(J,K) + NRFT(K)
22    NNNT(K) = NNNL(J,K) + NNNT(K)
25    CONTINUE
30 CONTINUE
C
   NSPT = 0
   DO 60 I=7,14
      DO 55 J = 1,11
         NSPT = NSPT + NSHIP(I,J)
55    CONTINUE
60 CONTINUE
C
C  ** COMPUTE AVERAGES PER MISSION.
C
   TMSN=FLCAT(ITMSN)
   WRITE(6,7000)TMSN
7000 FORMAT('0',5X,'TCTAL NR OF MISSIONS IS: ',F5.0)
   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
90       ANNNE(I,K) = (FLOAT(NNNE(I,K)))/TMSN
100   CONTINUE
      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
102      DO 103 L=1,NTY
            ANNN(L,J,K) = (FLCAT(NNN(L,J,K)))/TMSN
103      CONTINUE
         ANNNL(J,K) = (FLOAT(NNNL(J,K)))/TMSN
105   CONTINUE
      IF(K .EQ. 3) GO TC 107
      ANMFT(K) = (FLOAT(NMFT(K)))/TMSN
      ANRFT(K) = (FLOAT(NRFT(K)))/TMSN
```

```
107      ANANT(K) = (FLOAT(NANT(K)))/TMSN                               MUL27370
110   CONTINUE                                                          MUL27380
      ANRRT = (FLOAT(NRRT))/TMSN                                        MUL27390
      ANIST = (FLOAT(NIST))/TMSN                                        MUL27400
      ANRA = (FLOAT(NRA))/TMSN                                          MUL27410
      ANSPT = (FLOAT(NSPT))/TMSN                                        MUL27420
      DO 115 I=7,14                                                     MUL27430
         DO 113  J=1,11                                                 MUL27440
            ANSHIP(I,J) = (FLOAT(NSHIP(I,J)))/TMSN                      MUL27450
113      CONTINUE                                                       MUL27460
115   CONTINUE                                                          MUL27470
      DO 120 J=1,4                                                      MUL27480
         DO 120 I=1,NTY                                                 MUL27490
            SUMDM(I,J) = SUMD(I,J)/TMSN                                 MUL27500
            CSUMDM(I,J) = SUMDM(I,J)*ECOST(I)                           MUL27510
            AADV(I,J) = CSUMDM(I,J)/TPM                                 MUL27520
120   CONTINUE                                                          MUL27530
      AAGTV = 0.0                                                       MUL27540
      DO 128 I=1,4                                                      MUL27550
         AATDV(I) = 0.0                                                 MUL27560
         DO 124 J=1,NTY                                                 MUL27570
            AATDV(I) = AADV(J,I) + AATDV(I)                             MUL27580
124      CONTINUE                                                       MUL27590
         AAGTV = AATDV(I) + AAGTV                                       MUL27600
128   CONTINUE                                                          MUL27610
      DO 130 I=1,NTY                                                    MUL27620
         IEQ(I) = I                                                     MUL27630
130   CONTINUE                                                          MUL27640
C                                                                       MUL27650
C  **  WRITE OUTPUT SUMMARIES.                                          MUL27660
C                                                                       MUL27670
      WRITE(6,600)                                                      MUL27680
      WRITE(6,602)ITMSN                                                 MUL27690
      WRITE(6,603)                                                      MUL27700
      WRITE(6,688)                                                      MUL27710
      WRITE(6,604)                                                      MUL27720
      IF(IOPT .EQ. 2) GO TO 200                                         MUL27730
      WRITE(6,606)                                                      MUL27740
      WRITE(6,608)                                                      MUL27750
      WRITE(6,610)(ANMFL(I,1),I=1,4)                                    MUL27760
      WRITE(6,612)(ANMFL(I,2),I=1,4)                                    MUL27770
200   IF(IOPT .EQ. 1) GO TO 205                                         MUL27780
      WRITE(6,614)                                                      MUL27790
      DO 202 I=1,NTY,11                                                 MUL27800
         I10 = I + 10                                                   MUL27810
         WRITE(6,616)(IEQ(J),J=I,I10)                                   MUL27820
         WRITE(6,620)(ANMFE(J,1),J=I,I10)                               MUL27830
         WRITE(6,622)(ANMFE(J,2),J=I,I10)                               MUL27840
```

```
  202 CONTINUE                                                      MUL27850
  205 WRITE(6,688)                                                  MUL27860
      WRITE(6,624)                                                  MUL27870
      IF(IOPT .EQ. 2) GO TO 208                                     MUL27880
      WRITE(6,606)                                                  MUL27890
      WRITE(6,626)                                                  MUL27900
      WRITE(6,628)(ANRFL(I,1),I=1,4)                                MUL27910
      WRITE(6,630)(ANRFL(I,2),I=1,4)                                MUL27920
  208 IF(IOPT .EQ. 1) GO TO 212                                     MUL27930
      WRITE(6,614)                                                  MUL27940
      DO 210 I=1,NTY,11                                             MUL27950
         I10 = I + 10                                               MUL27960
         WRITE(6,616)(IEQ(J),J=I,I10)                               MUL27970
         WRITE(6,632)(ANRFE(J,1),J=I,I10)                           MUL27980
         WRITE(6,634)(ANRFE(J,2),J=I,I10)                           MUL27990
  210 CONTINUE                                                      MUL28000
  212 WRITE(6,636)ANRRT                                             MUL28010
      WRITE(6,638)ANRA                                              MUL28020
      WRITE(6,688)                                                  MUL28030
      WRITE(6,640)                                                  MUL28040
      WRITE(6,642)                                                  MUL28050
      WRITE(6,644)                                                  MUL28060
      WRITE(6,646)(IEQ(I),I=1,11)                                   MUL28070
      WRITE(6,648)(ANSHIP(7,I),I=1,11)                              MUL28080
      WRITE(6,650)(ANSHIP(8,I),I=1,11)                              MUL28090
      WRITE(6,652)(ANSHIP(9,I),I=1,11)                              MUL28100
      WRITE(6,654)(ANSHIP(10,I),I=1,11)                             MUL28110
      WRITE(6,656)(ANSHIP(11,I),I=1,11)                             MUL28120
      WRITE(6,658)(ANSHIP(12,I),I=1,11)                             MUL28130
      WRITE(6,660)(ANSHIP(13,I),I=1,11)                             MUL28140
      WRITE(6,662)(ANSHIP(14,I),I=1,11)                             MUL28150
      WRITE(6,664)ANIST                                             MUL28160
      WRITE(6,688)                                                  MUL28170
      WRITE(6,666)                                                  MUL28180
      WRITE(6,668)                                                  MUL28190
      WRITE(6,670)                                                  MUL28200
      IF(IOPT .EQ. 1) GO TO 220                                     MUL28210
      WRITE(6,672)                                                  MUL28220
      DO 214 I =1,NTY                                               MUL28230
         WRITE(6,674)IEQ(I),(XD(I,J),J=1,4)                         MUL28240
  214 CONTINUE                                                      MUL28250
  220 CONTINUE                                                      MUL28260
      WRITE(6,676)(XT(I),I=1,4)                                     MUL28270
      WRITE(6,678)XG                                                MUL28280
      WRITE(6,680)                                                  MUL28290
      WRITE(6,670)                                                  MUL28300
      IF(IOPT .EQ. 1) GO TO 224                                     MUL28310
      WRITE(6,672)                                                  MUL28320
```

```
      DO 224 I=1,ATY
        WRITE(6,674)IEQ(I),(AADV(I,J),J=1,4)
  224 CONTINUE
      WRITE(6,676)(AATCV(J),J=1,4)
      WRITE(6,678)AAGTV
      WRITE(6,688)
      WRITE(6,682)
      WRITE(6,683)
      IF(IOPT .EQ. 1) GO TO 230
      WRITE(6,672)
      DO 23C I=1,NTY
       WRITE(6,684)IEQ(I),((ANNN(I,J,K),K=1,3),J=1,4),(ANNNE(I,K),K=1,3)
  230 CONTINUE
      WRITE(6,685)((ANNNL(I,K),K=1,3),I=1,4)
      WRITE(6,686)(ANNNT(K),K=1,3)
      WRITE(6,688)
      RETURN
C
  600 FORMAT('1',2CX,'CATA SUMMARY:  MULTI-ECHELON SUPPLY SYSTEM')
  602 FORMAT('0',5X,I4,' SIMULATED MISSICNS HAVE BEEN RUN.  THE FOLLLOWI
     XNG')
  603 FORMAT(6X,'SUMMARY STATISTICS ARE BASED ON AVERAGE NUMBERS PER MIS
     XSION.')
  604 FORMAT('0',5X,'I.  PRCCUREMENT COSTS')
  606 FORMAT('0',10X,'ECHELON SUMMARY')
  608 FORMAT('0',4X,'SHIPPED FROM MFR TO:',7X,'SHIPS',7X,'MLSF',7X,
     X 'DEPOT',7X,'SUPPLY CENTERS',/)
  610 FORMAT(1X,'NR. PROCUREMENTS',7X,3(8X,F4.1),12X,F4.1)
  612 FORMAT(1X,'NR. ITEMS PROCURED',5X,3(8X,F4.1),12X,F4.1)
  614 FORMAT('0',10X,'EQUIPMENT SUMMARY',/)
  616 FORMAT(5X,'EQUIPMENT NR.',11(2X,I3))
  620 FORMAT(1X,'NR. PROCUREMENTS',2X,11(1X,F4.1))
  622 FORMAT(1X,'NR. ITEMS PROCURED',11(1X,F4.1))
  624 FORMAT('0',5X,'II.  REPAIR COSTS',/)
  626 FORMAT('0',5X,'SHIPPED FR REPAIR FACILITY TO:',4X,'SHIPS',4X,
     X 'MLSF',4X,'DEPOT',4X,'SUPPLY CENTERS',/)
  628 FORMAT(1X,'NR. INDUCTIONS',19X,3(5X,F4.1),9X,F4.1)
  630 FORMAT(1X,'NR. ITEMS INDUCTED',21X,F4.1,2(5X,F4.1),9X,F4.1)
  632 FORMAT(1X,'NR. INDUCTIONS',4X,11(1X,F4.1))
  634 FORMAT(1X,'NR. ITEMS INDUCTED',11(1X,F4.1))
  636 FORMAT('0',5X,'NR. ITEMS RETURNED BY SHIPS TC REPAIR FACILITIES:',
     X F4.1)
  638 FORMAT('0',5X,'NR. REPAIRABLE CARCASSES LOST DUE TO ATTRITION:',
     X F6.1)
  640 FORMAT('0',5X,'III.  TRANSPORTATION COSTS (NR. SHIPMENTS)')
  642 FORMAT('0',30X,'DESTINATION ACTIVITY')
  644 FORMAT('0',18X,'(DESINATIONS 1-6 REFER TO SHIP LOCATIONS)')
  646 FORMAT(15X,11(4X,I2))
```

```
648 FORMAT(5X,'MLSF-W  (7)',11(2X,F4.1))                                MUL28810
650 FORMAT(1X,'S',7X,'-E  (8)',11(2X,F4.1))                             MUL28820
652 FORMAT(1X,'H',5X,'DEPCT (9)',11(2X,F4.1))                           MUL28830
654 FORMAT(1X,'I CENTER-E (10)',11(2X,F4.1))                            MUL28840
656 FORMAT(1X,'P',7X,'-W (11)',11(2X,F4.1))                             MUL28850
658 FORMAT(1X,'P REPAIR-E (12)',11(2X,F4.1))                            MUL28860
660 FORMAT(1X,'E',7X,'-W (13)',11(2X,F4.1))                             MUL28870
662 FORMAT(1X,'R',6X,'MFR (14)',11(2X,F4.1))                            MUL28880
664 FORMAT('0',5X,'TCTAL NR. OF ISSUES FROM SHIP STOCK:',F4.1)          MUL28890
666 FORMAT('0','IV.  INVENTORY COSTS')                                  MUL28900
668 FORMAT('0',20X,'INITIAL INVENTCRY INVESTMENT')                      MUL28910
670 FORMAT('0',1CX,'ECHELCN:',10X,'SHIPS',9X,'MLSF',10X,'DEPOT',7X,     MUL28920
   X 'CENTERS')                                                         MUL28930
672 FORMAT(5X,'ECUIPMENT')                                              MUL28940
674 FORMAT(7X,I3,10X,4(4X,F10.2))                                       MUL28950
676 FORMAT('0',11X,'TOTALS:',2X,4(4X,F10.2))                            MUL28960
678 FORMAT('0',20X,'TOTAL INVESTMENT:',F12.2)                           MUL28970
680 FORMAT('0',2CX,'AVERAGE ON-HAND INVENTORY DOLLAR VALUE')            MUL28980
682 FORMAT('0',5X,'V.  DEMAND HISTORY (TCTAL/NIS/NC)')                  MUL28990
683 FORMAT('0',5X,'ECHELON:',3X,'SHIPS',9X,'MLSF',10X,'DEPOT',8X,       MUL29000
   X  'CENTERS',8X,'TOTAL')                                             MUL29010
684 FORMAT(8X,I3,5(2X(F4.1,'/',F3.1,'/',F3.1)))                         MUL29020
685 FORMAT(5X,'TCTAL',4(1X(F5.1,'/',F4.1,'/',F4.1)))                    MUL29030
686 FORMAT('0',20X,'GRAND TOTAL:    ',F6.1,'/',F5.1,'/',F5.1)           MUL29040
688 FORMAT('0',80('-'),/)                                               MUL29050
C       DEBUG INIT(XC,AACV,AATCV,AAGTV,ADV,ATDV,AGTV,TMSN,TPM)           MUL29060
C       AT 1                                                            MUL29070
        END                                                             MUL29080
```

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8