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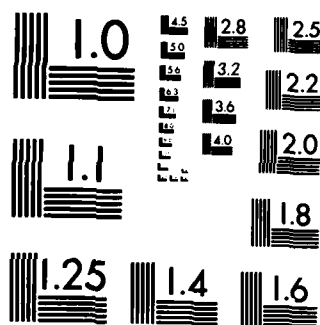
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Documentation was developed for the Parts Requirements and Costs Model (PARCOM) developed at the US Army Concepts Analysis Agency. PARCOM was designed to provide the Army with an analytical tool for quick reaction, gross estimation of wartime spare parts requirements and costs as they relate to flying hour and availability objectives. An ability to identify problem parts and possible causes of the problems was also desired. The PARCOM Functional Description is structured to provide a user with detailed			

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Block 20 - ABSTRACT Continued

information on PARCOM model logic, restrictions and potential for extension. Additional information on model application may be found in the PARCOM User's Guide, published separately. *For model extension*



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**PARTS REQUIREMENTS AND COST MODEL (PARCOM)
DOCUMENTATION
PARCOM FUNCTIONAL DESCRIPTION**

OCTOBER 1984

PREPARED BY
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PARTS REQUIREMENTS AND COST MODEL (PARCOM) DOCUMENTATION**PARCOM FUNCTIONAL DESCRIPTION****CHAPTER 1****GENERAL DESCRIPTION**

1-1. PURPOSE OF THE FUNCTIONAL DESCRIPTION. This functional description of the Parts Requirements and Cost Model (PARCOM) provides:

- a. The structure of the model logic which will serve as a basis for mutual understanding between the user and the developer.
- b. Information on model restrictions, potential for extension, and user impacts.

1-2. PROJECT REFERENCES

- a. Parts Requirements and Cost Model (PARCOM) User's Guide, CAA-D-84-10, US Army Concepts Analysis Agency, October 1984.
- b. Aircraft Spare Stockage Methodology (Aircraft Spares) Study, CAA-SR-84-12, US Army Concepts Analysis Agency, April 1984.
- c. Pickard, W. C., Zellner, P. A., and Bailey, D. R., DOD Assimilation of US Air Force Methodologies for Relating Logistics Resources to Materiel Readiness, SYNERGY, Inc., August 1983.

1-3. TERMS AND ABBREVIATIONS. The reader is directed to the glossary at the end of this document.

1-4. DEVELOPMENT BACKGROUND. The US Army Concepts Analysis Agency (CAA) developed PARCOM, a model for generating cost effective mixes of aircraft spare parts which satisfy specified scenario conditions. Development occurred during the course of the Aircraft Spare Stockage Methodology (Aircraft Spares) Study conducted by CAA. That study, and PARCOM development, were in response to interest shown by the Deputy Chief of Staff for Logistics (DCSLOG) in developing a methodology (or methodologies) relating aircraft spare parts stockage levels to combat readiness and flying hour capability. The calculation of spare parts requirements and of the effects of budgeting changes has been a slow and cumbersome peacetime-oriented exercise. The principal criterion for spares stockage has been the achievement of acceptable stockout, or fill rate, levels. To more realistically predict wartime spare parts requirements, and to better justify budget requests for spare parts procurement, the Army needed a more responsive methodology based on wartime flying hour expectations and system readiness/availability requirements.

1-5. STRUCTURE OF ARMY AIRCRAFT LOGISTICS

a. Governing Regulations. Policy and procedural guidance for the Army's inventory management efforts is largely contained in two regulations:

- AR 710-1 Centralized Inventory Management of the Army Supply System
- AR 710-2 Supply Policy Below the Wholesale Level

(1) AR 710-1 establishes responsibilities and procedures for centralized inventory management of Army materiel by the major subordinate commands (MSC) of the US Army Materiel Command (AMC).

(2) AR 710-2 prescribes supply procedures to be used at the retail level, including methods for determining authorized stockage lists and appropriate stockage levels.

b. Maintenance System Structure. Figure 1-1 illustrates the interaction of supply, maintenance, and industrial activities within the aircraft parts logistics system.

(1) **Parts Storage Locations.** Aircraft spare parts are stored with using units at the Aviation Unit Maintenance (AVUM) and the Aviation Intermediate Maintenance (AVIM) levels. Aircraft spare parts are stored in various CONUS depots for shipment to users upon requisition. Additionally, war reserve parts are stored in various CONUS depots or prepositioned in the appropriate theater.

(2) **Participating Organizations and Responsibilities.** AVUM facilities are organic to the lower echelon aviation units which actually fly and maintain the Army's aircraft. These user units stock a prescribed load list (PLL) of repair parts at the AVUM level. PLLs are sized to sustain the unit's anticipated wartime flight operations for a specified number of days (usually 15). Stockage levels and reordering procedures are governed by AR 710-2. AVIM units develop their own authorized stockage lists (ASL) based on demands for parts received from supported AVUM units and from their own AVIM operations. AVIM ASLs are exclusive of subordinate unit PSLs. The development of ASLs is also governed by AR 710-2. Part types are selected for PLL and ASL stockage based upon a combination of experienced demand frequency and mission essentiality. The AVIM/AVUM (retail) parts requirements are supported by stocks maintained in supply depots (wholesale) in CONUS. Automated inventory management techniques are employed by AVSCOM to authorize and record fill of retail requisitions by the appropriate wholesale depot. Depot stocks are replenished through procurement of new parts or repair of returned unserviceables.

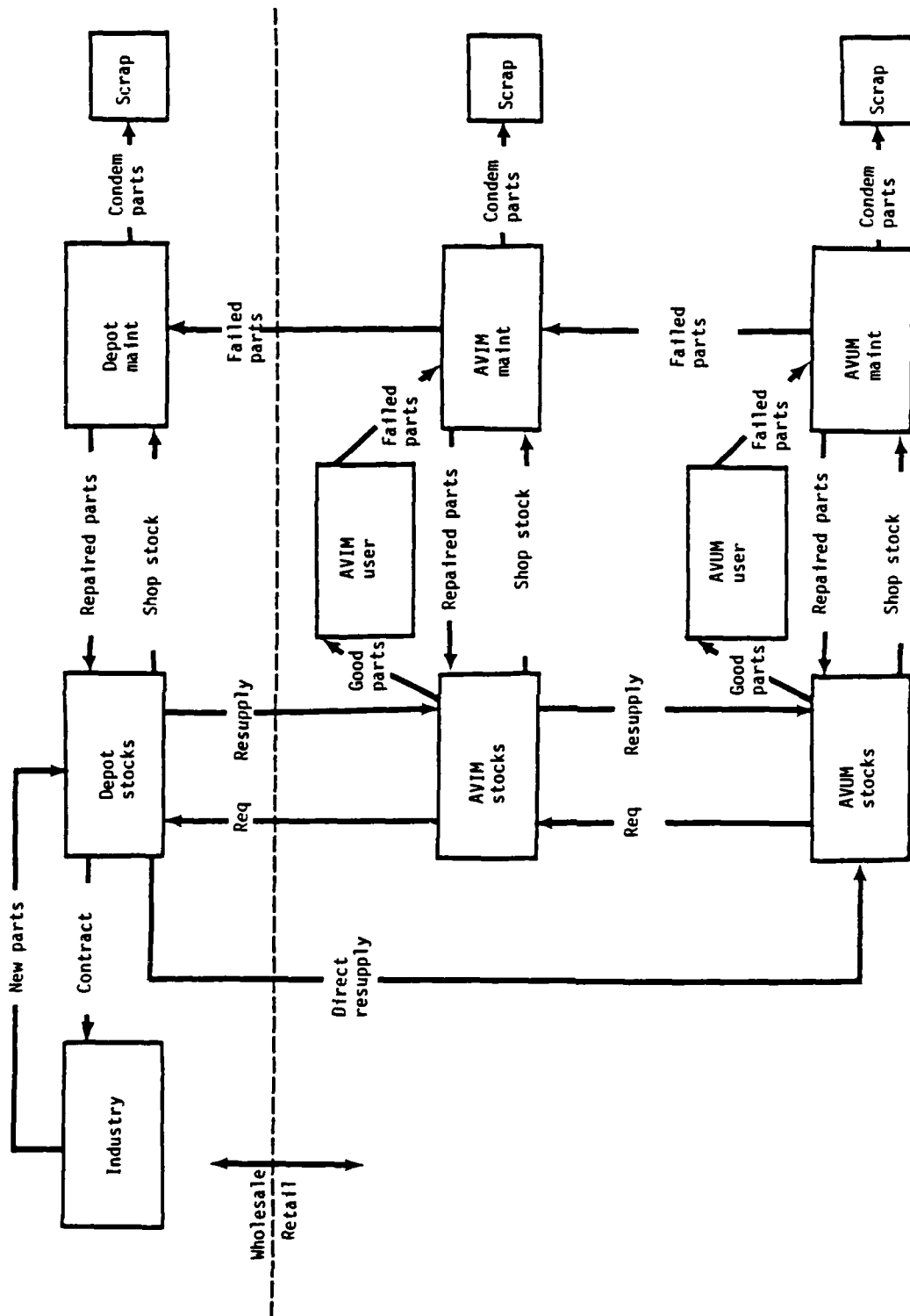


Figure 1-1. Aircraft Parts Logistics System

c. Areas of Consideration

(1) Peacetime versus Wartime. Peacetime requirements for spare parts are computed based upon experienced annual demand and projected peacetime usage. AVSCOM uses an automated system of data bases and models to forecast these requirements, and bases its computations on a supply availability goal. Wartime requirements are computed and funded separately from peacetime requirements, and address those parts required to sustain the force during the initial stages of war until lines of communication and supply can be established. The primary consideration for peacetime requirements is meeting supply availability goals, while that for war reserve requirements is meeting sustainability goals.

(2) Initial Provisioning versus Replenishment. Computation of the spare parts requirement for initial provisioning of new weapons systems is necessarily based on less concrete data than is that for replenishment parts for already fielded systems. No demand history has yet been developed, so engineering estimates of parts failure factors are used instead. In many cases, all the parts to be included in the new aircraft have not been fully identified, and their cost must be extrapolated from that of a list of major assemblies. AVSCOM has an automated capability to compute initial provisioning requirements based on these projected data. Over the first 2 years of a system's life, actual demand data is accumulated and given increasing weight in spare parts management decisions. After a system has been fielded for 2 years, its replenishment spare parts requirements are computed using actual demand data to the maximum extent possible.

(3) Retail versus Wholesale. The Army splits its inventory management into "retail" and "wholesale" activities. In the aviation logistics context, AVUM- and AVIM-level parts stockages are termed "retail," while those at the depot level are termed "wholesale." The methodologies used to compute spare parts requirements for the retail and wholesale levels are entirely different and essentially unrelated. Retail stockage levels are computed and authorized based upon a combination of demand experience, combat essentiality, and mobility requirements. AR 710-2 establishes computational procedures used by retail parts managers to determine their stockage levels and appropriate reorder points. Wholesale parts requirements are computed based upon average monthly demand experienced at the wholesale level. Wholesale item managers have little visibility of retail spare parts postures or weapons system availabilities. Rather, wholesale parts are procured or repaired at rates calculated to achieve a chosen demand satisfaction percentage without backorders.

(4) Fill Rate versus System Availability Criteria. AVSCOM computes spare parts requirements with the objective of achieving a target fill rate. Its goal is to fill a selected percentage of all demands received without having to backorder parts. The item manager does not base his parts management decisions on weapons system availability, and in fact, has little or no visibility of this retail level criterion. Department of Defense (DOD)

deployed. Computed "cumulative aircraft surviving" entries are defined by the difference between "cumulative aircraft deployed" and "cumulative aircraft lost." Since, for simplicity, our example shows a zero aircraft attrition rate, surviving aircraft is equal to deployed aircraft. The "program flying hours" column gives the flying hour objective in terms of required program flying hours for the fleet on each day. The last column gives the availability objective in terms of an input-specified daily minimum (fleet) aircraft availability required each day. The input-specified "maximum flying hours per aircraft per day" is also noted at the bottom of the table.

Table 2-4. Scenario Data

Day	Cumulative aircraft deployed	Cumulative aircraft lost	Cumulative aircraft surviving	Program flying hours	Minimum aircraft availability
1	150	0	150	500	.10
2	200	0	200	1,000	.09
3	200	0	200	1,000	.09
4	200	0	200	1,500	.09
5	200	0	200	1,500	.09

Maximum flying hours per aircraft per day = 10.

Cost limit for constrained cost case = \$4,300.

Desired convergence (constrained cost) = 0.

Maximum iterations (constrained cost) = 2.

c. **Calculation of Daily Allowable NMCS Aircraft.** Table 2-5 shows results of the calculation of allowable NMCS aircraft for each day. Each result in the rightmost column is the surviving aircraft minus the larger of:

(1) The minimum aircraft required to achieve the daily flying hour objective, for each day, computed as "program flying hours" divided by "maximum flying hours per aircraft per day."

(2) The minimum aircraft required to achieve the daily availability objective, for each day, computed as the product of "surviving aircraft" and "minimum aircraft availability."

Component calculations for the first day, using the data of Table 2-4, are shown.

2-2. EXAMPLE. The algorithm logic described in the previous paragraph can be better understood through use of a manual example. The tables to follow portray a stylized but useful hypothetical example which uses only "back-of-the-envelope" calculations. The tables all apply to one case and are presented in the same sequence as the model algorithms described in the previous paragraph.

a. Part Data Base. Tables 2-2 and 2-3 show a part data base for two part types. Recall that failure rate is in terms of failures per flying hour and QPA = number of parts installed per operational aircraft.

Table 2-2. Part Characteristic Data

Part	Failure rate	QPA	Unit cost	Initial inventory
1	.08	1	\$400	250
2	.02	1	\$ 50	10

The time units in Table 2-3 are in days. The last column of Table 2-3 is the computed repair cycle calculated from the other data in that row, e.g., for Part 1, the repair cycle = $2 * OST + \text{depot repair time}$ = 3 days. The repair cycle for a part is defined as the average time between failure of a part and its (repaired) return to the retail spare pool. Only the repair cycle entry will be used in succeeding calculations because it includes the effects of the other data in Table 2-3.

Table 2-3. Part Repair Time Data

Part	OST	Depot repair time	Retail repair time	NRTS fraction	Depot condemned	Retail condemned	Repair cycle
1	1	1	0	1.00	0	0	3
2	0	0	3	.00	0	0	3

b. Scenario Data Base. Table 2-4 shows the scenario data for the case. A 5-day "war" is shown. The aircraft status (deployed, lost) entries are for the start of the associated day of the war. Thus, for example, 50 aircraft are newly deployed at the start of day 2. By "cumulative aircraft deployed" is meant all aircraft deployed in theater from the start of the war through the given day. No aircraft are assumed withdrawn once

g. **Capability Assessment of Constrained Cost Requirements Mix.** PARCOM also generates the daily fleet availability and flying hour capability achieved with constrained cost solution mixes. Recall that these mixes are derived for a "no substitution" policy only. With unconstrained costs, net demand was based on the entire planned flying hour program being flown. For a constrained cost mix, some unknown (at first) number of hours will be flown. That number must initially be estimated and an iterative approach, as shown in Figure 2-6, applied to determine NMCS aircraft, availability, and achievable program flying hours. For each day, therefore, a starting estimate of flying hours flown is made (the first day's starting estimate is the program flying hours). Then, net demand, as based on the estimated flying hours, is computed, followed by implied NMCS aircraft (generated by the estimated flying hours), achievable flying hours, and flying hours per available aircraft. The achievable flying hours are compared with the estimated flying hours flown. If, based on input thresholds, they are close enough, the iterations stop. If not, the calculations are repeated based on a new starting estimate of flying hours equal to the average of the estimated and the achieved flying hours. After iterations for a day are completed, the available aircraft for the day and their flying hour potential are calculated based on the last calculation of NMCS aircraft and on the maximum flying hour potential per aircraft per day (an input). Processing for the next day uses a starting estimate of flying hours based on the "achieved flying hours" of the previous day.

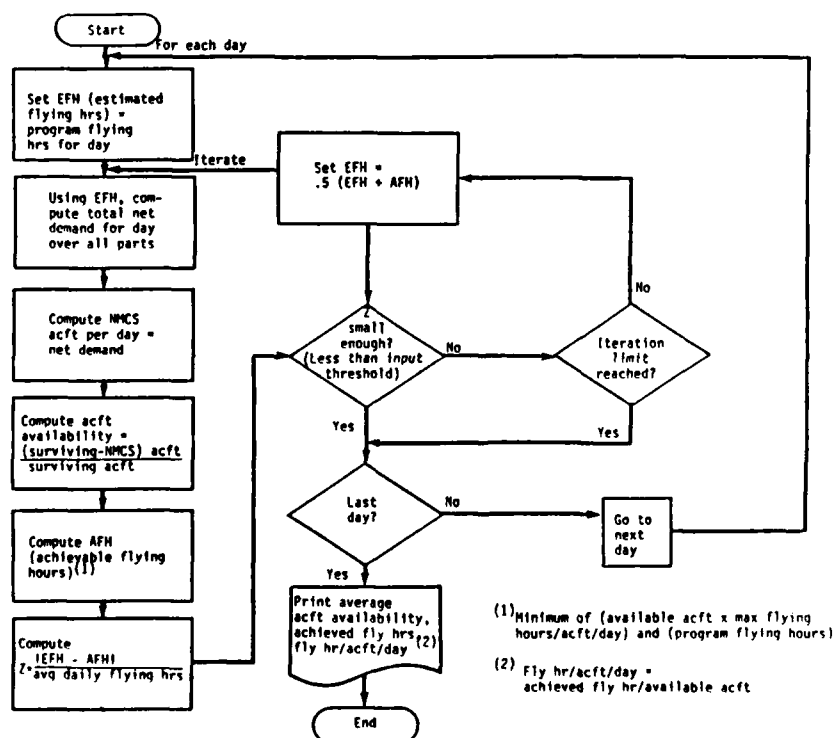


Figure 2-6. PARCOM Computation Algorithm for Constrained Cost Capability Assessment

initial inventory is assumed to be the sum of the computed requirement and the original initial inventory. For each computed unconstrained cost requirements mix, PARCOM generates a record of achieved daily and average aircraft availability, achieved program flying hours, and achieved flying hours per available aircraft per day. The achieved program flying hours are simply the program flying hours, by definition, of an unconstrained cost solution. Also by definition, aircraft availability = 1.00 for a "NMCS = 0" policy. The PARCOM capability assessment algorithm assesses daily and average availability for both the full substitution and "no substitution" policies. The calculations depend principally on the net demand and NMCS determinations explained earlier. Recall that for a "no substitution" policy, each stockout creates an NMCS aircraft, so the sum of stockouts over all parts is also the number of NMCS aircraft created. For a "full substitution" policy a single NMCS aircraft may have stockouts for several different parts. In this case the number of NMCS aircraft created is the largest value, over all parts, of the quotient of stockouts divided by QPA for each part type. For each day, the number of NMCS aircraft is subtracted from the number of surviving aircraft to yield available aircraft. Availability is then the ratio of available to surviving aircraft. Flying hours per available aircraft is just the daily program flying hours divided by the number of available aircraft for the day.

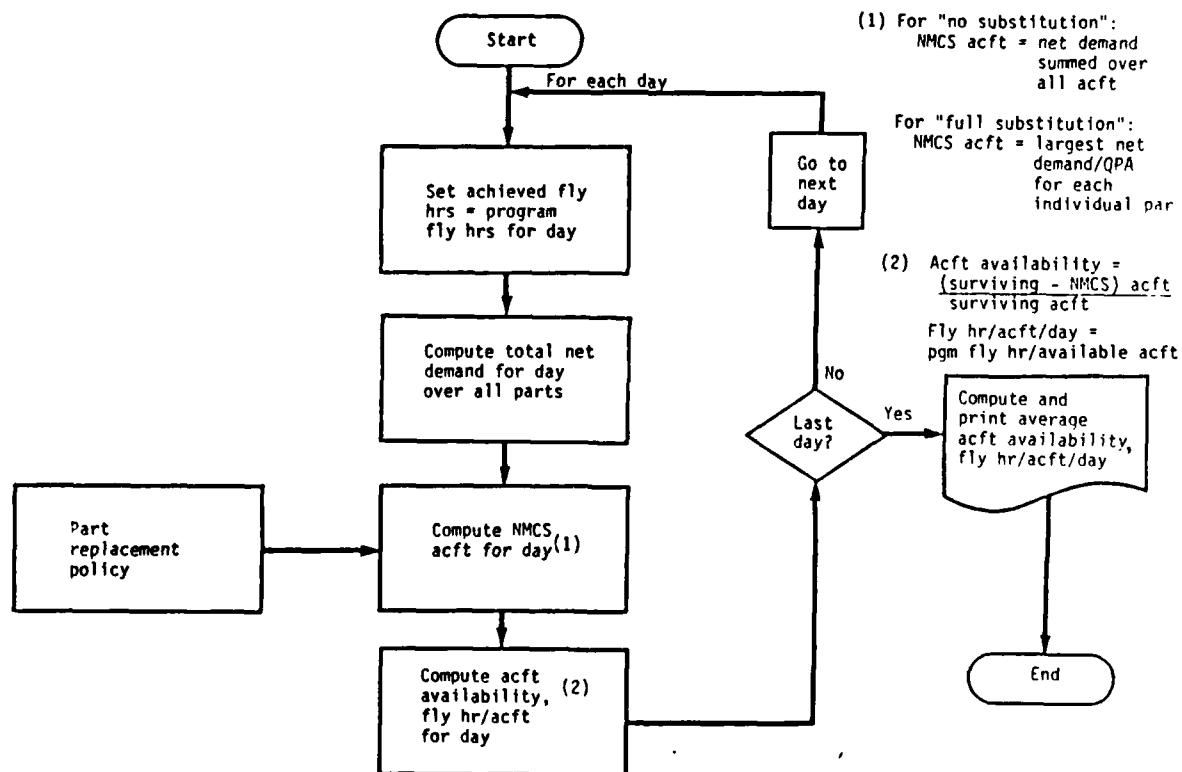


Figure 2-5. PARCOM Computation Algorithm for Unconstrained Cost Capability Assessment

item (regardless of part type) creates an NMCS aircraft. Therefore, our constrained cost solution mix minimizes the instances of NMCS created by the constrained funds. The solution tends, heuristically, toward the achievement of maximum cumulative flying hours.

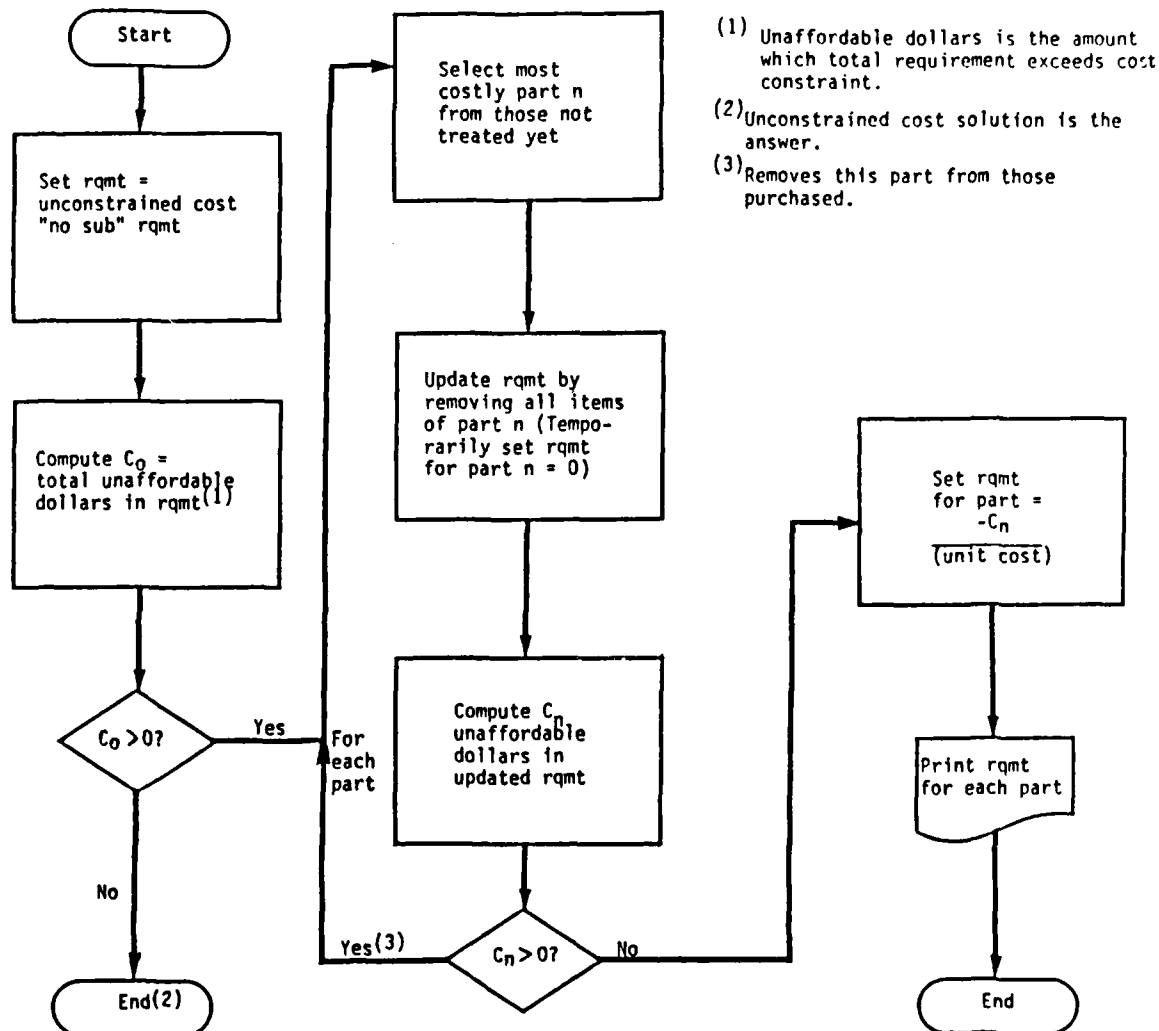


Figure 2-4. PARCOM Requirements Computation Algorithm for Constrained Cost with "No Substitution"

f. Capability Assessment of Unconstrained Cost Requirements Mix.

Figure 2-5 illustrates the PARCOM computation algorithm for capability assessment of the unconstrained cost requirements solutions. After each unconstrained cost solution mix for the "no substitution" and "full substitution" cases is computed, PARCOM generates a record of daily and average fleet operational capability achievable by stocking each computed requirement, i.e., the new

(2) With "no substitution," PARCOM determines allowed stockout and net demand for the most expensive parts first. Allowed stockout is, again, the number of permissible NMCS aircraft. Because there is no overlap/consolidation of stockout effects (as was the case for "full substitution"), requirements computations for parts are interdependent. An iterative algorithm is used to reflect part interdependence. The algorithm of Figure 2-3 also applies to the "no substitution" and "NMCS = 0" requirements. The points affected by policy differences during algorithm application are summarized in Table 2-1. Understanding of calculation of "no substitution" parts requirements is assisted by reference to the example of paragraph 2-2.

**Table 2-1. Differences in Application of PARCOM
Unconstrained Cost Requirements Algorithm by Policy**

Policy	Algorithm procedure/calculation	
	Allowable stockout	Order of processing
Full sub	Allowed NMCS acft x QPA	Irrevelant
No sub	Allowed NMCS acft	By decreasing part cost
NMCS = 0	0	Irrelevant

e. Constrained Cost "No Substitution" Requirement. After the unconstrained cost "no substitution" requirements are computed, they become the basis for the constrained cost solution. A cost limit on spares is input along with the other scenario and objective data. A constrained cost parts mix can be constructed by the simulated "spending" of money to "buy", in order of increasing part unit cost, the part requirements of the unconstrained cost solution until the money is exhausted. That would entail the procurement of the largest number of total parts from the unconstrained cost solution. However, another characteristic of such a constrained cost parts mix is that it is the mix which has the fewest "unbought" (hence, unstocked) items from the unconstrained cost solution. The PARCOM algorithm, shown in Figure 2-4, arrives at its solution by calculating "unbought" items. Initially, it "spends" the full cost of the unconstrained cost requirements mix assuming it to be the constrained cost solution. PARCOM subsequently selects the fewest number of items to remove from that solution until the remaining parts mix is priced at the input cost limit. Because the programed algorithm solves by "unbuying" items rather than "buying" them, parts are processed in decreasing order of part unit cost. Notice that under a policy of "no substitution" each "unbought"

(1) Net demand (for all three replacement policies) for a part at any point in time is the cumulative removals to that time minus the sum of cumulative returning repairs and initial inventory. Removals are generated by the product of failure rate, part QPA (quantity installed per aircraft), and programed flying hours. Returning repairs are generated by removed parts cycling through a "repair pipeline" and being returned to the point of removal. A positive net demand represents a shortage of the part.

(2) Under "full substitution" the aircraft frames providing the sources of parts substituted for failed parts when spares are unavailable are consolidated to the minimum possible number, i.e., there will be a maximum overlap of aircraft frames providing missing parts. Because of this overlap, the spare parts requirements for each part may be independently computed. For a "full substitution" policy, the allowable stockout for a part on any day is the product of allowable NMCS aircraft for that day and the part QPA.

(3) As indicated by Figure 2-3, the minimum spare requirement for a part needed to achieve the case objective on any day is the net demand for that part minus the allowable stockout. The overall spare requirement for a part is the largest of the daily minimum spare requirements for that part. It is a least cost solution because it is the smallest purchase of that part which will permit the case objective to be met on all days.

c. **Unconstrained Cost "NMCS = 0" Requirement.** The "NMCS = 0" policy corresponds to the case in which 100 percent aircraft availability is required every day. In such a case allowed NMCS aircraft and allowable stockout both must be zero every day. The "NMCS = 0" case could be considered a special case of a "full substitution" case with a 100 percent aircraft availability objective (the "no substitution" case with that objective would yield the same answer, because part substitution policy is irrelevant when no stockouts are allowed). The spares required by the solution to the "NMCS = 0" case also can be interpreted as the total expected net demand for a part during the war. It is a least cost solution because any amount less than that required to meet the expected demand will create an NMCS aircraft, i.e., will not meet the case objective.

d. Unconstrained Cost "No Substitution" Requirement

(1) Under "no substitution," the stockouts generated by parts removals in excess of on-hand spares must each be associated with separate aircraft frames. Every missing part results in an inoperable (NMCS) aircraft. It is most cost effective, therefore, to assign the allowed stockout (allowed number of NMCS aircraft) to the most expensive parts. For example, if 50 aircraft are allowed to be NMCS and a shortage exists of 50 expensive parts and 50 cheap ones, the 50 cheap ones need to be bought. If 75 expensive parts and 50 cheap ones are short, there will be no choice but to buy 25 expensive ones (leaving 50 unbought) and 50 cheap ones, in order to best meet the case objective.

b. Unconstrained Cost "Full Substitution" Requirement. Figure 2-3 shows the PARCOM algorithm used to compute a requirements solution for all three parts replacement policies with unconstrained costs. The difference between "full substitution" and "no substitution" calculations is in the ways that allowed stockouts are calculated. Net demand is the same for each.

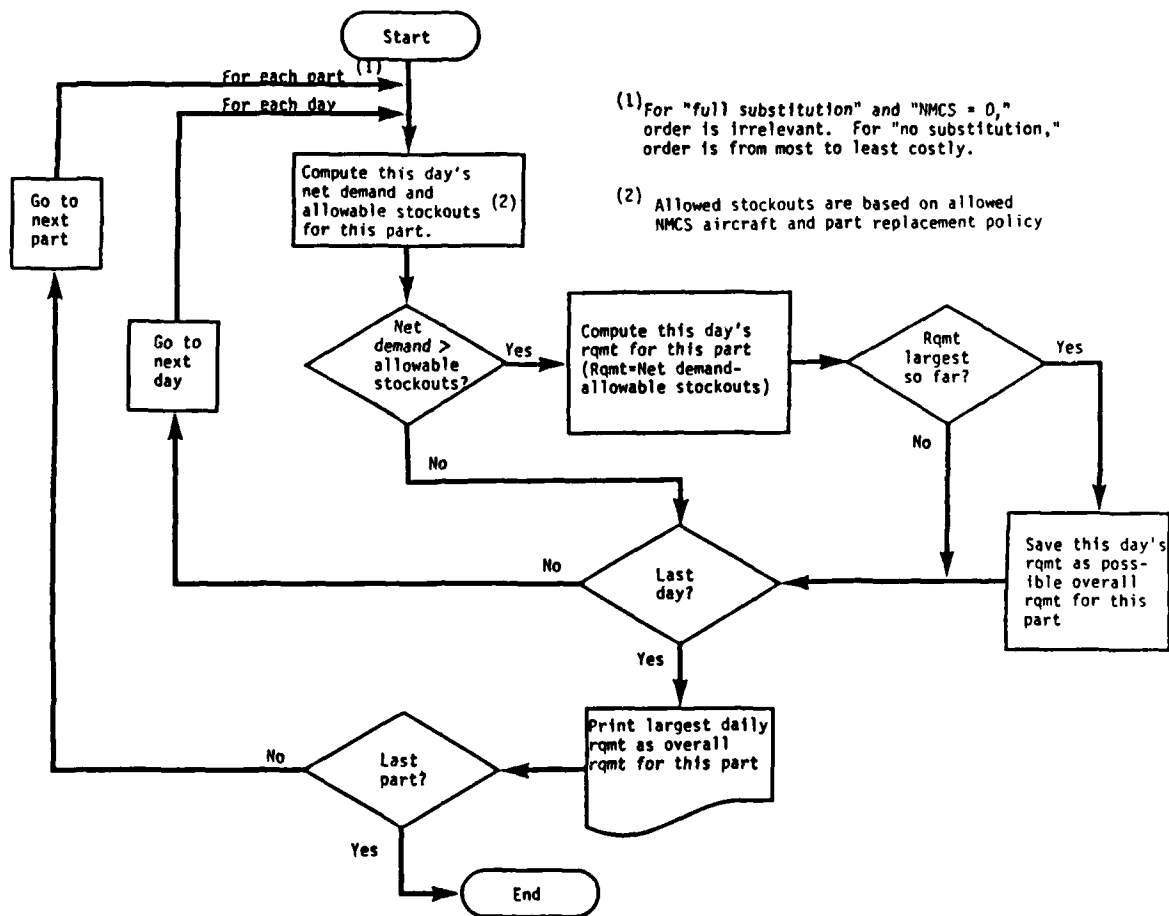


Figure 2-3. PARCOM Requirements Computation Algorithm for Unconstrained Costs, "Full Substitution", "No Substitution", and "NMCS = 0"

a. **Calculation of Daily Allowable NMCS Aircraft.** To meet flying hour and availability goals, the maximum number of aircraft allowed to be down due to a lack of parts (allowable NMCS aircraft) is determined for each day. As shown in Figure 2-2, separate minimums are computed of aircraft required to meet the flying objective and the availability objective (if any). The largest of the two minimums is subtracted from the number of surviving aircraft on each day to yield the "allowable NMCS aircraft" for that day. Within the subsequent processing algorithms, the "allowable NMCS aircraft" is converted to an "allowable stockout" for each part and replacement policy. The "allowable stockout" for a part on a day is just the maximum number of backorders (unfilled demands) for the part which will still allow accomplishment of the case objective (flying hour and availability) on that day, i.e., these are parts that are missing but which don't have to be bought.

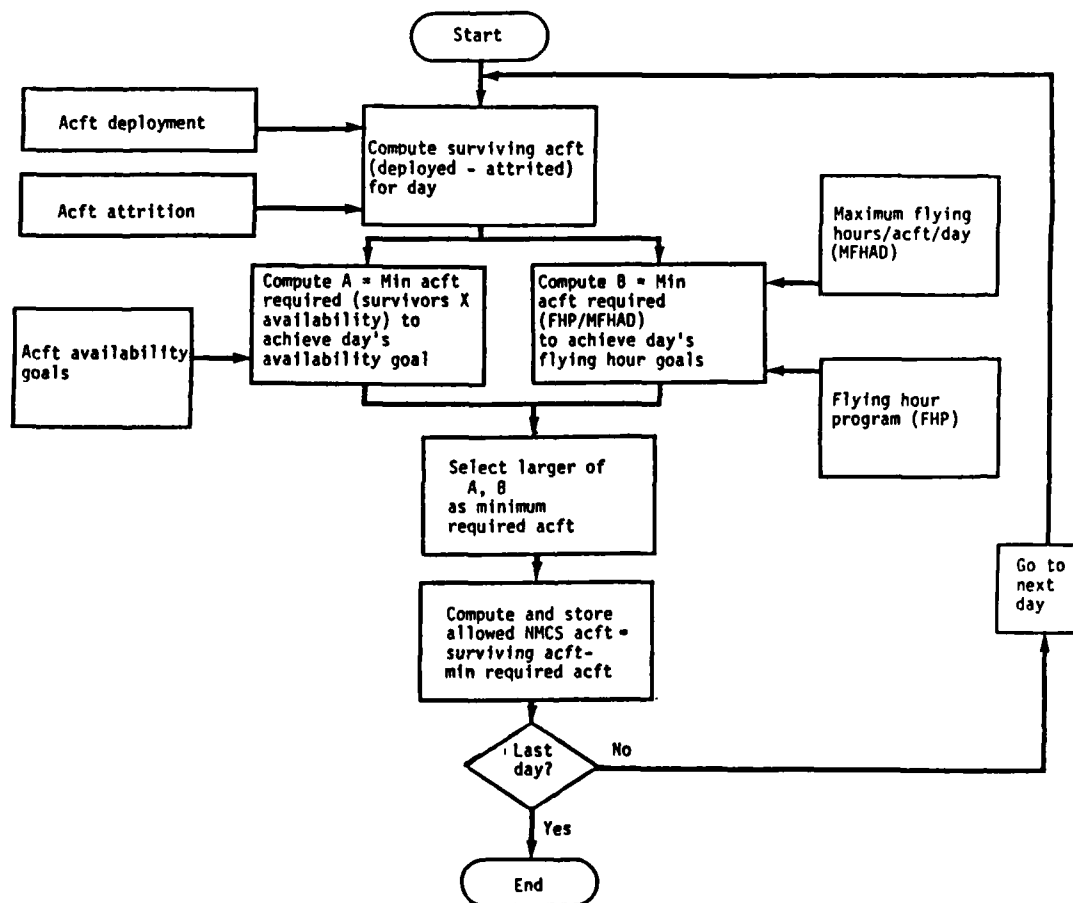


Figure 2-2. PARCOM Computation Algorithm for Allowable NMCS Aircraft

CHAPTER 2

PARCOM LOGIC

2-1. ALGORITHMS. PARCOM is a series of expected value simulations of the spare part requirements generation process for cases defined by a combination of parameters noted in the previous chapter. In addition, the model computes the capability potential of the force when operated with each computed spares mix. The assessed capability potential is in terms of achievable aircraft availability and fraction of the flying hour program which can be accomplished. Figure 2-1 illustrates the general nature and sequence of PARCOM processing. The basic model sequence, with logic diagrams as appropriate, is described as follows:

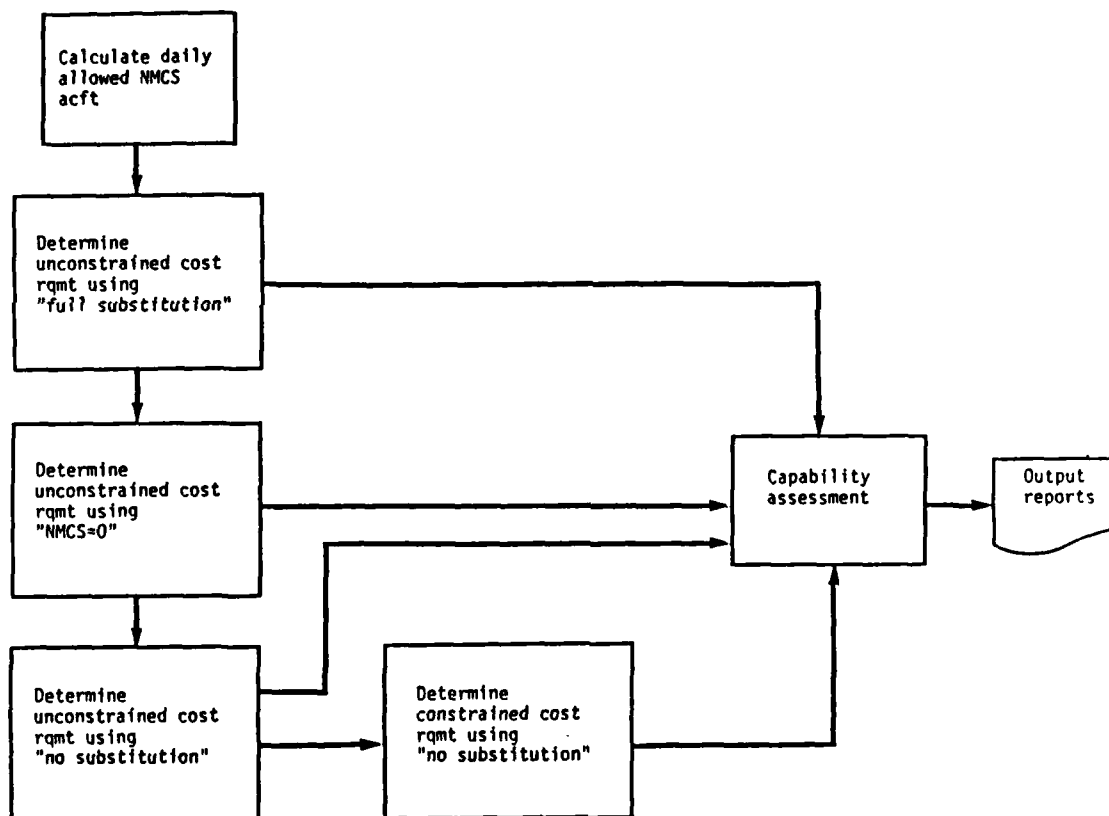


Figure 2-1. PARCOM Processing Sequence

(2) **Residual Requirement.** Best add-on (to input initial inventory) requirements mix, with a "no substitution" policy, that can be bought with a funding limit equal to the input cost limit.

(3) **Daily Aircraft Available.** For each day of the full scenario, the fraction of surviving aircraft which are not NMCS, assuming that the initial spare inventory is set equal to the sum of the computed parts requirement and the original initial inventory.

(4) **Daily Flying Hour Fraction.** For each day of the full scenario, the fraction of the fleet flying program which can be achieved assuming that the initial spare inventory is set equal to the sum of the computed parts requirement and the original initial inventory.

(5) **Daily Flying Hours per Aircraft per Day.** For each day of the scenario, the average achieved flying hours per aircraft per day, assuming the computed solution parts mix is stocked.

1-9. TYPICAL PROBLEMS ADDRESSED. A single PARCOM run can provide answers to several problems pertinent to a given scenario. From the user point of view, typical problem statements, given a specified aircraft deployment schedule, flying program, and attrition scenario are:

a. What is the least cost add-on buy needed to achieve the flying program using "full substitution" parts replacement and requiring that NMCS not exceed 0.15 on all days? What is the associated daily NMCS status?

b. With a budget limit of \$10,000,000, what spares should be added to current inventory, using a "no substitution" policy, to increase, to the extent possible, the fraction of the flying program achieved? What is the associated daily NMCS status? What is the associated fraction of the flying program that is achievable?

d. Aircraft Availability Objective. An aircraft availability objective is a requirement for a specific minimum aircraft availability on each day (different days may have different minimum required availabilities). In this context, aircraft availability = $1 - \text{NMCS}$, where NMCS = the fraction of surviving aircraft in "not mission capable supply" status. An aircraft is in an NMCS status if it is nonoperational because spare parts are needed but are not available to restore it to serviceability. Specification of availability objectives is in addition to the flying hour objective. Specification of a zero availability objective is equivalent to no availability objective at all.

1-8. SUMMARY OF PARCOM OUTPUT. The following are the basic types of print output produced by PARCOM for requirements problems. Details may be found in the PARCOM User's Guide.

a. Unconstrained Cost Cases

(1) Total Requirement. Total least-cost parts mix and costs required to achieve the case objectives (flying program and availability) given a zero initial inventory.

(2) Residual Requirement. The least-cost add-on parts mix (to an input initial inventory) and costs required to achieve the case objectives.

(3) Cumulative Cost by Day. For each day N ($N=1, 2, \dots$, through end of "war"), the total and the add-on cost of the full parts requirement to meet the case objectives through day N only, i.e., it is the cost of the requirement for a truncated scenario of N days. Parts mix is not shown.

(4) Cumulative Requirement by Day. For selected items, for each day N , the cumulative total requirement needed (in the full parts scenario) to meet the case objectives through N days. A zero initial inventory is assumed in this output.

(5) Daily Aircraft Available. For each day of the full scenario, the fraction of surviving aircraft which are not NMCS, assuming that the initial spare inventory is set equal to the sum of the computed parts requirement and this original initial inventory.

(6) Daily Flying Hours per Aircraft per Day. For each day of the scenario, the average achieved flying hours per available aircraft per day assuming the computed solution parts mix is stocked.

b. Constrained Costs

(1) Total Requirement. Total "best" requirements mix, with zero initial inventory, and with a "no substitution" policy, that can be bought with a funding limit equal to the sum of the value of "refunded" current spares inventory and the input cost limit. The objective of a "best" mix is to maximize flying hour productivity with the constrained funds.

failures. Gross part failures interact with initial spare inventory and the repair process at depot and at retail to produce a net demand for spare parts at user level. The net demand for spare parts at user level then determines the number of surviving aircraft that are mission capable or not mission capable supply (NMCS). As will be seen in the next chapter, PARCOM simulates all interactions in expected value terms, i.e., in terms of the product of an average process rate and the number of "items" subjected to that process.

1-7. PARCOM PROBLEM SPECIFICATION. The basic purpose of PARCOM is to generate cost-effective mixes of add-on spare parts needed to permit an aircraft fleet of specified type to achieve specified flying program and availability goals under various cost constraints, part replacement policies, and aircraft availability objectives. These are described below in summary fashion. Additional detail may be found in the PARCOM User's Guide.

a. Cost Constraints. The two cost constraint modes are:

(1) **Unconstrained Funds** - where unlimited funds for procurement of additional required parts are assumed available.

(2) **Constrained Funds** - where a cost (funding) limit for add-on spares is set. If unable to meet the flying hour and, possibly, availability objectives with the limited funds, the model generates a "best" solution mix with the funds available, i.e., it seeks to maximize program flying hours achievable within the funding constraint.

b. Part Replacement Policies. The two basic part replacement policies are:*

(1) **Full Substitution** - where a failed part on an aircraft may be replaced by either a spare (if available) or by a serviceable part from a "not mission capable" (NMC) aircraft (if a spare is not available).

(2) **No Substitution** - where a failed part on an aircraft may only be replaced by a spare part. With constrained funds, PARCOM operates in this mode only.

c. Flying Hour Objective. A flying hour objective is a requirement for the aircraft fleet to achieve a specified number of flying hours on each day of the scenario. An input flying hour program designates the daily goal. A basic PARCOM objective is to generate a parts mix which will achieve the specified flying program at least cost.

*"NMCS = 0" is treated as a third part replacement policy but is really a special case of "no substitution" in which aircraft availability is constrained to be 100 percent.

has expressed its support for implementation of system availability-driven parts requirements computation methodologies in all the armed services. The primary difficulty for the Army is the collection of accurate data to drive such automated models.

d. Similarity of Aircraft and Other Spares Procurement. Each of the MSCs uses the Commodity Command Standard System (CCSS) to meet its inventory management responsibilities. The processes used are essentially the same for all types of spares.

1-6. PARCOM REPRESENTATION OF LOGISTICS ENVIRONMENT. The PARCOM "world view" of the aircraft part logistics system is based on the representation in Figure 1-1. PARCOM, however, has only two echelons of stock and repair, viz.:

a. Wholesale Level. This level consists of the "depot stocks" and "depot maintenance" blocks of Figure 1-1. Depot maintenance is represented in terms of depot repair times, depot condemnation rates, and order ship times (OST) between depot and retail level. PARCOM assumes that initial spares stockage at depot can be made available to retail level before users at retail have "drawn down" initial in-theater stocks, i.e., efficient transportation and positioning of initial spares stock is assumed. The effect of this assumption is the same as that resulting from front-loading of initial stocks at retail level. Production of new parts by industry is not treated in PARCOM.

b. Retail Level. This level is treated as one pool (or "bin") of spare parts stocks consisting of all stocks at AVIM and AVUM levels in Figure 1-1. Retail maintenance is treated as an aggregate process and is represented in terms of retail repair times, not repairable this station (NRTS) percentages, and retail condemnation rates. Essentially, "retail" represents pooled AVIM and AVUM functions.

c. Users. Users of spare parts are deployed aircraft. PARCOM treats deployed aircraft only at retail level. These are augmented by (input) scheduled deployments of additional aircraft (from a presumed rear area) during the course of a simulated "war." Currently, PARCOM can treat only a homogeneous aircraft fleet of one type for a single force. Deployed aircraft are subject to attrition based on (input) attrition factors. Combat is not explicitly represented.

d. Failure Generation. The deployed aircraft fleet is assigned (via input) a flying hour program, broken into daily flying hour requirements. PARCOM finds a cost-effective mix of spare parts, which, over the course of the "war", will, on average, achieve the set flying program in addition to specified daily aircraft availability requirements. If spares procurement funds are constrained, PARCOM seeks a cost-effective spares mix achieving as much of the flying program as possible. Input failure rates for spare parts are in terms of failures per flying hour. In general, achieved flying hours interact with part failure rates to produce gross part

Table 2-5. Calculation of Allowable NMCS Aircraft

Day	Minimum aircraft required		Allowable NMCS acft
	Flying hour objective	Availability objective	
1	$500/10 = 50$	$150 \cdot .10 = 15$	$150 - 50 = 100$
2	100	18	100
3	100	18	100
4	150	18	50
5	150	18	50

d. **Unconstrained Cost Full Substitution Total Requirement.** Tables 2-6 and 2-7 show the calculations for the total requirement (initial inventory = 0) under full substitution. Each "cumulative net demand" entry is just the "cumulative failures" minus the sum of the "cumulative returning repairs" and the initial inventory. "Cumulative failures" is based on the program hours being flown and is computed by accumulating (over days) the product of failure rate, QPA, and program flying hours for each day (as taken from Tables 2-3 and 2-4). Initial inventory is set to zero as prescribed for the calculation of "total requirements." The "cumulative returning repairs" entries are the "cumulative failures" entries lagged by three days (the repair cycle from Table 2-3). Any condemnations (our case has none) would have to be deducted from the lagged failures. If R is the length of the repair cycle for a part (see Table 2-3), PARCOM treats all noncondemned failures occurring at the start of day n as being returned to the retail spare pool at the start of day n + R. If a part has both a depot repair cycle and a retail repair cycle, PARCOM would partition repairs over the two cycles. In our simplified example, Part 1 has only a depot repair cycle of three days while Part 2 has only a retail repair cycle of three days. The "allowable stockouts" under full substitution is calculated as the product of "allowable NMCS aircraft" (from Table 2-5) and the part QPA. Since QPA = 1 for both parts (see Table 2-2), allowable stockouts = allowable NMCS aircraft. The "day requirement" is calculated as the larger of zero and (cumulative net demand minus allowable stockouts). The overall requirement for each part is determined as the largest value (over days) of the "day requirement" entries. It is circled in each table. Component calculations are displayed for the first day based on the data of Tables 2-2 through 2-5. At the end of Table 2-7, the total cost of the computed requirements mix is also shown based on the unit cost data in Table 2-2.

Table 2-6. Unconstrained Cost Total Requirement (Initial Inventory = 0)
with Full Substitution - Part 1

Day	Cumulative failures	Cumulative returning repairs	Cumulative net demand	Allowable stockouts	Day rqmt
1	$.08 \times 500 = 40$	0	$40 - 0 - 0 = 40$	100	$\max(0, 40 - 60) = 0$
2	120	0	120	100	20
3	200	0	200	100	100
4	320	40	280	50	230
5	440	120	320	50	(270)

Table 2-7. Unconstrained Cost Total Requirement (Initial Inventory = 0)
with Full Substitution - Part 2

Day	Cumulative failures	Cumulative returning repairs	Cumulative net demand	Allowable stockout	Day rqmt
1	$.02 \times 500 = 100$	0	$10 - 0 - 0 = 10$	100	$\max(0, 10 - 100) = 0$
2	30	0	30	100	0
3	50	0	50	100	0
4	80	10	70	50	20
5	110	30	80	50	(30)

Total requirements cost = Part 1 rqmt * 400 + Part 2 rqmt * 50
 = $270 \times 400 + 30 \times 50 = \$109,500$.

e. **Unconstrained Cost Full Substitution Residual Requirement.** Tables 2-8 and 2-9 show calculations for the residual requirement under full substitution. The principal difference is that initial inventory = 250 for Part 1 and = 10 for Part 2. The "cumulative net demand" column entries are less than the previous case because the nonzero initial inventory is subtracted from the previous values. The logic is the same as in the previous case. The computed overall requirement (circled) is, now, just the add-on requirement to the specified initial inventory. The total cost also reflects only the add-on requirement.

Table 2-8. Unconstrained Cost Residual Requirement (Initial Inventory = 250)
with Full Substitution - Part 1

Day	Cumulative failures	Cumulative returning repairs	Cumulative net demand	Allowable stockout	Day rqmt
1	$.08 \times 500 = 40$	0	$\max(0, -210) = 0$	100	$\max(0, 0-100) = 0$
2	120	0	0	100	0
3	200	0	0	100	0
4	320	40	30	50	0
5	440	120	70	50	20

Table 2-9. Unconstrained Cost Residual Requirement (Initial Inventory = 10)
with Full Substitution - Part 2

Day	Cumulative failures	Cumulative returning repairs	Cumulative net demand	Allowable stockout	Day rqmt
1	$.02 \times 500 = 10$	0	$10-0-10 = 0$	100	$\max(0, 0-100) = 0$
2	30	0	20	100	0
3	50	0	40	100	0
4	80	10	60	50	10
5	110	30	70	50	20

Total residual requirements = Part 1 rqmt * 400 + Part 2 rqmt * 50 =
 $20 * 400 + 20 * 50 = \$9,000$.

f. Unconstrained Cost "NMCS = 0" Total Requirement. As noted previously, this is a special case of the unconstrained cost "full substitution" calculations in which we set "allowable stockouts = 0". Table 2-10 shows the calculations. "Cumulative net demand" is the same as in Tables 2-6 and 2-7 because it is not affected by part replacement policy. As a general rule, the "day requirement" under "NMCS = 0" is the same as "cumulative net demand" for that day. The overall requirement for each part is circled in the figure. Total costs are given below the figure.

Table 2-10. Unconstrained Cost Total Requirement (Initial Inventory = 0)
with "NMCS = 0"

Day	Part 1			Part 2		
	Cumulative net demand	Allowable stockouts	Day rqmt	Cumulative net demand	Allowable stockouts	Day rqmt
1	40	0	40-0 = 40	10	0	10-0 = 10
2	120	0	120	30	0	30
3	200	0	200	50	0	50
4	280	0	280	70	0	70
5	320	0	(320)	80	0	(80)

Total requirement cost = $320 * 400 + 80 * 50 = \$132,000$.

g. Unconstrained Cost "NMCS = 0" Residual Requirement. Table 2-11 shows calculations for the residual requirement under "NMCS = 0". The "cumulative net demand" entries are the same as in Tables 2-8 and 2-9. The same logic used in the "full substitution" case applies here. The computed overall requirement (circled) is only the add-on to the input-specified initial inventory.

Table 2-11. Unconstrained Cost Residual Requirement
with "NMCS = 0"

Day	Part 1 (init inv = 250)			Part 2 (init inv = 10)		
	Cumulative net demand	Allowable stockouts	Day rqmt	Cumulative net demand	Allowable stockouts	Day rqmt
1	0	0	0	0	0	0
2	0	0	0	20	0	20
3	0	0	0	40	0	40
5	30	0	30	60	0	60
5	70	0	(70)	70	0	(70)

Total residual requirement = $70 * 400 + 70 * 50 = \$31,500$.

h. Unconstrained Cost "No Substitution" Total Requirement. Tables 2-12 and 2-13 show calculations for our example problem. The tables are presented in the required sequence of computations, i.e., the most expensive part (Part 1) is processed first. The "cumulative net demand" is the same as used in Table 2-6 because it is not altered by the substitution policy used. The "day requirement" is just the cumulative net demand (the shortage on that day) minus the allowable stockout (the allowed shortage) for that day (but not less than zero). The overall Part 1 requirement is the circled largest "day requirement". The Part 1 requirement is treated as "purchased" during further processing (for other part requirements). Table 2-13 shows the calculation of the second part requirement which must be for the next most expensive part (i.e., Part 2 in our example). The "purchase" of the Part 1 requirement alters the initial inventory for that part. Therefore, the old cumulative net demand for Part 1 (based on initial inventory = 0) in Table 2-12 is reduced by 270 (the new initial inventory for Part 1) to generate the new cumulative net demand for that part. The new cumulative net demand for Part 1 is just the number of stockouts which must be allocated from that part. For a "no substitution" policy the total allowed stockout consists of the summed stockouts over all parts treated. For each day, the cumulative net demand for Part 1 acts as a "lock" or "claimant" on the same number of stockouts in the original allowable stockout. Requirements for Part 2 can only be based on the unallocated allowable stockout, tabulated in Table 2-13, which is the original allowed stockout minus all "claimant" stockouts (net demands) from parts already processed. Since the Part 2 requirement is not yet "purchased" (it is being computed), the "cumulative net demand" column of Table 2-7 is repeated in Table 2-13. The "day requirement" in Table 2-13 is calculated as the cumulative net demand for Part 2 minus the unallocated allowable stockout. As before, the overall requirement (circled) is the largest of the day requirements. The Part 2 requirement would be assumed "purchased," and the process would be continued with less expensive parts (if any). Each successive calculation would use an "unallocated allowable stockout" equal to the original (Table 2-12) allowable stockout reduced by the sum total of allocated stockouts reflected in "purchases" of parts already processed.

**Table 2-12. Unconstrained Cost Total Requirement (Initial Inventory = 0)
with No Substitution - Part 1 Requirement Calculation**

Day	Cumulative net demand	Allowable stockouts	Day rqmt
1	40	100	0
2	120	100	20
3	200	100	100
4	280	50	230
5	320	50	<u>270</u>

**Table 2-13. Unconstrained Cost Total Requirement (Initial Inventory = 0)
with No Substitution - Part 2 Requirement Calculation**

Day	Cumulative net demand		Unallocated allowable stockouts	Day rqmt
	Part 1 (init inv = 270)	Part 2 (init inv = 0)		
1	0	10	100-0 = 100	0
2	0	30	100-0 = 100	0
3	0	50	100-0 = 100	0
4	280-270 = 10	70	50-10 = 40	70-40 = 30
5	320-270 = 50	80	50-50 = 0	80-0 = <u>80</u>

Total requirements cost = $270 * 400 + 80 * 50 = \$112,000$.

i. **Unconstrained Cost "No Substitution" Residual Requirement.** Tables 2-14 and 2-15 show calculations for our example problem. The basic logic is exactly the same as for the previous case (initial inventory = 0). However, the residual requirements and the net demand used to compute them are based on the input-specified initial inventory (Part 1 = 250, Part 2 = 10). The "cumulative net demand" in Table 2-14 is the same as the "cumulative net demand" in Table 2-8 (because it depends only on initial inventory, not substitution policy). Part 1 requirements are calculated in the same manner as in the previous case. The calculations for the second part (Part 2) in Table 2-15 differ from those in Table 2-13 only because "cumulative net demand" for Part 2 is taken from Table 2-9, i.e., is based on initial inventory = 10. The "cumulative net demand" entries for Part 1 in Table 2-15 are the same as those in Table 2-13 because the "purchase" of 20 of Part 1 (the computed requirement in Table 2-13), when added to an initial inventory of 250, yields the same "new initial inventory" as the purchase of 270 of Part 1 (the computed requirement of Table 2-11) added to a zero initial inventory. The requirements for this case are add-on requirements.

Table 2-14. Unconstrained Cost Residual Requirement with No Substitution - Part 1 Requirement Calculation
(Initial Inventory = 250)

Day	Cumulative net demand	Allowable stockouts	Day rqmt
1	0	100	0
2	0	100	0
3	0	100	0
4	30	50	0
5	70	50	20

Table 2-15. Unconstrained Cost Residual Requirement with No Substitution - Part 2 Requirement Calculation

Day	Cumulative net demand		Unallocated allowable stockouts	Day rqmt
	Part 1 (init inv = 270)	Part 2 (init inv = 10)		
1	0	0	100-0 = 100	0
2	0	20	100-0 = 100	0
3	0	40	100-0 = 100	0
4	280-270 = 10	60	50-10 = 40	60-40 = 20
5	320-270 = 50	70	50-50 = 0	70-0 = 70

Total residual requirements cost = $20 * 400 + 70 * 50 = \$11,500$.

j. Constrained Cost Add-on Requirements. Table 2-16 shows calculations for the constrained cost add-on requirements with "no substitution" and with an add-on cost limit of \$4,300. The table is arranged in steps. In step 1 the constrained cost requirement is (temporarily) set equal to the unconstrained cost no substitution residual requirement computed in Tables 2-14 and 2-15. The "rqmt cost" column shows the cost of that requirement. The "unaffordable dollars" column shows the amount by which that requirement cost exceeds our specified cost limit. Since that entry is positive, the requirement is updated by selecting the most expensive part from those with nonzero add-on requirements (Part 1 in our case) and by setting the requirement for that part to zero. The new requirement is shown in step 2. Since the cost of the new requirement is less than the cost limit, the "unaffordable dollars" are negative. In that case the final requirements are set by updating the requirement for the last part processed (i.e., the

part with its requirement set to zero) to the quotient of the last unaffordable dollars entry and unit cost = $(-800)/400 = 2$ in our example. The final add-on requirements are circled in Table 2-16.

**Table 2-16. Constrained Cost Residual Requirement with
No Substitution - Cost Limit = \$4,300**

Step	Requirement (init inv = 250, 10)		Rqmt cost	Unaffordable dollars
	Part 1	Part 2		
1	20	70	\$11,500	\$7,200
2	0	70	\$ 3,500	\$ -800
3	2	70	\$ 4,300	0

k. **Constrained Cost Total Requirement.** Table 2-17 shows calculations for this case, which is based on a zero initial inventory and a cost limit equal to the cost of current inventory ($250 * 400 + 10 * 50 = 100,500$) plus the input cost limit (4,300). The resulting cost limit is \$104,800. The logic is the same as in the previous case. Only the numbers are changed to reflect the zero initial inventory base. Thus, the step 1 cost requirement is the unconstrained cost total requirement from Tables 2-12 and 2-13. Note that the final requirement is equivalent to the sum of the residual requirement computed in Table 2-16 and the input initial inventory. Such equivalence is not always true.

**Table 2-17. Constrained Cost Total Requirement with
No Substitution - Cost Limit = \$104,800**

Step	Requirement (init inv = 0)		Rqmt cost	Unaffordable dollars
	Part 1	Part 2		
1	270	80	\$ 112,000	\$ 7,200
2	0	80	\$ 4,000	\$-100,800
3	252	80	\$ 104,800	0

l. **Requirements Summary.** Table 2-18 presents a summary of all total requirement cases (initial inventory = 0) treated thus far. Table 2-19 summarizes the residual (add-on) requirement cases.

Table 2-18. Total Requirements (Initial Inventory = 0) Summary

Cost constraint	Requirements (init inv = 0)		Rqmt cost
	Part 1	Part 2	

Unconstrained cost

Full sub	270	30	\$109,500
No sub	270	80	\$112,000
NMCS = 0	320	80	\$132,000
Constrained cost (no sub) (Limit = \$104,800)	252	80	\$104,800

Table 2-19. Residual (Add-on) Requirements Summary

Cost constraint	Requirements (init inv = 250, 10)		Rqmt cost
	Part 1	Part 2	

Unconstrained cost

Full sub	20	20	\$ 9,000
No sub	20	70	\$11,500
NMCS = 0	70	70	\$31,500
Constrained cost (no sub) (Limit = \$4,300)	2	70	\$ 4,300

m. **Capability Assessment of Unconstrained Cost Total Requirements - Full Substitution.** Table 2-20 shows the capability assessment calculations of the expected effects of stocking the requirements computed in Tables 2-6 and 2-7. Cumulative net demand for each part type is based on initial inventories being set to the computed requirements. "NMCS aircraft" for each day are set equal to the larger of the (cumulative net demand) OPA entries for the day. "Surviving aircraft" are as in Table 2-4. "Available aircraft" are "surviving aircraft" minus "NMCS aircraft." Aircraft availability is the quotient of available and surviving aircraft. Flying hours per (available) aircraft per day are calculated by dividing the program flying hours for each day (see Table 2-4) by the number of available aircraft on that day. Average availability is constructed by weighting daily availabilities by the daily surviving aircraft. Average flying hours per (available) aircraft per day is weighted by the available aircraft on each day.

**Table 2-20. Capability Assessment for Unconstrained Cost
Total Requirement - Full Substitution**

Day	Cumulative net demand/QPA		NMCS acft	Surviving acft	Available acft	Aircraft availability	Flying hrs per acft per day
	Part 1 (init inv = 270)	Part 2 (init inv = 30)					
1	0	0	0	150	150	1.00	3.3
2	0	0	0	200	200	1.00	5.0
3	0	(50-30)/1	20	200	180	180/200 = .90	5.6
4	(280-270)/1	(70-30)/1	40	200	160	160/200 = .80	9.4
5	(320-270)/1	(80-30)/1	50	200	150	150/200 = .75	10.0

Avg availability = $[(150 * 1) + (200 * 1) + (200 * .9) + (200 * .8) + (200 * .75)] / 950 = .88$

Avg flying hrs/acft/day = $[(150 * 3.3) + (200 * 5) + (180 * 5.6) + (160 * 9.4) + (150 * 10)] / 840 = 6.6$

n. Capability Assessment of Unconstrained Cost Residual Requirements - Full Substitution. Table 2-20 also applies to this case because the residual requirements (calculated in Tables 2-8 and 2-9), when "stocked" and added to the input-specified initial inventory, yield the same new initial inventory as resulted from stocking the total (initial inventory = 0) requirements.

o. Capability Assessment of Unconstrained Cost Total Requirement - No Substitution. Table 2-21 shows the capability assessment calculations for the expected effects of stocking the requirements computed in Tables 2-12 and 2-13. Cumulative net demand for each part type is based on initial inventories being set to the computed requirements. Under a "no substitution" policy, "NMCS aircraft" for each day are then equal to the sum of the "cumulative net demands" entries for that day. "Surviving aircraft" are as in Table 2-4. Component calculations are displayed.

**Table 2-21. Capability Assessment for Unconstrained Cost
Total Requirement - No Substitution**

Day	Cumulative Net Demand		NMCS acft	Surviving acft	Aircraft availability	Flying hours per aircraft per day
	Part 1 (init inv = 270)	Part 2 (init inv = 80)				
1	0	0	0	150	1.00	500/150 = 3.3
2	0	0	0	200	1.00	1,000/200 = 5.0
3	0	0	0	200	1.00	5.0
4	280-270 = 10	0	10	200	190/200 = .95	1,500/190 = 7.9
5	320-270 = 50	80-80 = 0	50	200	150/200 = .75	1,500/150 = 10

Avg availability = $[(150 \times 1.) + (200 \times 1.) + (200 \times 1.) + (200 \times .95) + (200 \times .75)] / 890 = 6.2$

Avg flying hrs/acft/day = $[(150 \times 3.3) + (200 \times 5.) + (200 \times 5.) + (190 \times 7.9) + (150 \times 10.)] / 890 = 6.2$

p. Capability Assessment of Unconstrained Cost Residual Requirement- No Substitution. Table 2-21 also applies to this case because the residual requirements (calculated in Tables 2-14 and 2-15), when "stocked" and added to the input-specified initial inventory, yield the same new initial inventory as resulted from stocking the total requirements (initial inventory = 0).

q. Capability Assessment of Constrained Cost Residual (Add-on) Requirement. Tables 2-22 and 2-23 show the capability assessment calculations for the expected effects of stocking the requirements computed in Table 2-16. The scenario data (Table 2-4) specified a limit of two iterations in seeking convergence of "estimated flying hours" to "achieved flying hours" in the calculations. Each day starts (step 1) with an "estimated flying hours" based on the program flying hours for that day. Cumulative net demands are then generated for each part type, based on the estimated flying hours, resulting in NMCS aircraft as shown. The available aircraft then determine "achieved program flying hours". If the "achieved flying hours" are close enough (based on specified input convergence requirement) to the "estimated flying hours", the day's calculations are done. If not, a new step is made with a new flying hour estimate until either desired convergence is attained or the input-specified number of steps (iterations) have been performed on that day. For the first four days the achieved flying hours equal the estimated flying hours so only one iteration is required.

(1) By way of illustration, the entries for day 4 in Table 2-22 are calculated as follows:

- Flying hour estimate = 1,500 = program hours.
- Part 1 cumulative net demand (init inv = 252) = the largest of cumulative net demand from Table 2-8 (init inv = 250) - 2 = 30 - 2 = 28 or 0 = 0.
- Part 2 cumulative net demand (init inv = 80) = the larger of cumulative net demand from Table 2-9 (init inv = 10) - 70 = 60 - 70 = -10 or 0 = 0
- NMCS aircraft = sum of (2) and (3) = 28.
- Available aircraft = surviving acft - NMCS acft = 200 - 28 = 172.
- Achieved flying hours = available acft * max fly hr/acft/day or the program hours for the day (the smaller is chosen) = (172 * 10 or 1,500) = 1,500.

(2) On day 5, there is no convergence, as is shown in the calculations for step 1 shown below:

- Flying hour estimate = 1,500 = program hours.
- Part 1 cumulative net demand (init inv = 252) = cumulative failures from (500 + 1,000 + 1,000 + 1,500 + 1,500) flying hours - cumulative returned repairs - 252 = .08 * (5,500) - 120 - 252 = 68.
- In a similar way, Part 2 cumulative net demand = 0.
- NMCS aircraft = sum of (2) and (3) = 68.
- Available aircraft = surviving acft - NMCS acft = 200 - 68 = 132.
- Achieved flying hours = the smaller of program hours for day 5 (1,500) and the product of available aircraft and maximum flying hours per aircraft per day (= 132 * 10 = 1,320) = 1,320.

(3) At this point the day convergence, C , is calculated as (difference in estimated versus achieved flying hours for this day)/(average daily program flying hours in war). Total program flying hours in war = $500 + 1,000 + 1,000 + 1,500 + 1,500 = 5,500$. The daily average is $5500/5 = 1100$. Therefore, $C = (1,500 - 1,320)/1,100 = .16$. If C is less than the input convergence threshold ($= 0$ for this example), then iterations for the day stop. Otherwise, we check whether completed step (1) equals or exceeds the input-specified iteration limit ($= 2$ for this example). Since neither of these limits is satisfied, another iteration for day 5 proceeds as follows:

- New estimated flying hours = average of the estimated and achieved flying hours from last iteration = $(1,500 + 1,320)/2 = 1,410$.
- Part 1 cumulative net demand = cumulative failures from flying hours ($500 + 1,000 + 1,000 + 1,500 + 1,410$) - cumulative returned repairs - initial inventory = $.08 * (5,410) - 120 - 252 = 61$.
- Similarly, Part 2 net demand = 0.
- NMCS aircraft = $61 + 0 = 61$.
- Available aircraft = $200 - 61 = 139$.
- Achieved flying hours = $\min(1,500, 139*10) = 1,390$.

(4) Convergence, C , for day = $5 * (1,410 - 1,390)/5,500 = .02$. Since C equals or exceeds the convergence threshold, we check if this step (2) equals or exceeds our iteration limit. It does. Processing for this day is complete.

(5) Once all days are processed, final statistics are calculated based on the achieved flying hours from the last iteration of each day. The fraction flying hour program achieved is calculated by dividing the achieved flying hours for the day by the program flying hours for the day. Flying hours per (available) aircraft per day are calculated from achieved flying hours divided by available aircraft. Other calculations are analogous to those in Tables 2-20 and 2-21.

r. Capability Assessment of Constrained Cost Total Requirements.

Stocking the total constrained cost solution (computed in Table 2-17) is equivalent, for this example, to stocking the residual (add-on) solution. Therefore, Tables 2-22 and 2-23 also apply to the total requirements solution.

Table 2-22. Assessment Iterations for Constrained Cost Residual Requirement

Day	Step	Estimated flying hours	Cumulative Net Demand		NMCS acft	Available aircraft	Achieved flying hr
			Part 1 (init inv = 252)	Part 2 (init inv = 80)			
1	1	500	0	0	0	150	500
2	1	1,000	0	0	0	200	1,000
3	1	1,000	0	0	0	200	1,000
4	1	1,500	28	0	28	172	1,500
5	1	1,500	68	0	68	132	1,320
	2	1,410	61	0	61	139	1,390

Table 2-23. Capability Assessment for Constrained Cost Residual Requirement

Day	NMCS acft	Surviving acft	Aircraft availability	Fraction flying pgm acheived	Flying hour per acft per day
1	0	150	1.00	1.00	500/150 = 3.3
2	0	200	1.00	1.00	1,000/200 = 5.0
3	0	200	1.00	1.00	5.0
4	28	200	172/200 = .86	1.00	1,500/172 = 8.7
5	61	200	139/200 = .70	1,390/1,500 = .93	1,390/139 = 10.0

Avg availability = $[(150 \times 1.) + 2 \times (200 \times 1.) + (200 \times .86) + (200 \times .70)] / 950 = .91$

Avg frac pgm achieved = $[(150 \times 1.) + (200 \times 1.) + (200 \times 1.) + (172 \times 1.) + (139 \times .93)] / 861 = .99$

Avg flying hr/acft/day = $[(150 \times 3.3) + (200 \times 5.0) + (200 \times 5.0) + (172 \times 8.7) + (139 \times 10.0)] / 861 = 6.3$

328	C			OF PART. THUS IRC(J) IS THE 'PART NR' FOR
329				THE MOST EXPENSIVE PART TYPE.
330	QPA(J)	300	REAL	'QUANTITY PER APPLICATION' FOR PART J
331				I.E. NR OF PART J ITEMS INSTALLED PER AC
332				
333	RNCS(J)	300	REAL	TOTAL REQMT(INIT STK=0) FOR PART J USING A
334				'NO SUBSTITUTION' REPLACEMENT POLICY
335				WITH UNCONSTRAINED COST
336				
337	RNCS1(J)	300	REAL	RESIDUAL REQMT(INIT STK=CURR STK) FOR PART J
338				USING A 'FULL SUBSTITUTION' REPLACEMENT POLICY
339				WITH UNCONSTRAINED COST
340				
341	RNMCS(J)	300	REAL	TOTAL REQMT(INIT STK=0) FOR PART J USING A
342				'NMCS = 0' REPLACEMENT POLICY WITH
343				UNCONSTRAINED COST
344				
345	S(J)	300	REAL	WORKING VARIABLE CONTAINING INITIALIZED STOCK
346				POSITION (EITHER INIT STK=0 OR INIT STK=
347				CURR STK) FOR PART J DURING PROCESSING IN
348				SUBROUTINES NCRNCT AND NCRNCP
349				
350				
351				
352				NOTEWORTHY SINGLE-SUBSCRIPT NAMES
353				
354				
355	NAME		TYPE	DESCRIPTION
356				
357				
358	ADDOST		REAL	CONSTANT ADDED TO INPUT VALUE OF OST
359				(ORDER/SHIP TIME AS READ FROM OVERVIEW INPUT)
360				TO YIELD THE OST USED IN PARCOM. THE OST
361				IS THE SAME FOR ALL PART TYPES. ALSO
362				OST=1-WAY TRAVEL TIME IN PARCOM.
363				
364	AX		REAL	AVERAGE DAILY MINIMUM REQUIRED ACFT AVAIL
365				
366	RPR		REAL	NR OF RETURNING REPAIRS ARRIVING FROM RETAIL
367				REPAIR ON A SPECIFIED DAY
368				
369	CASE		CHAR	CASE ID
370				
371	CLNC		REAL	COST LIMIT ON TOTAL BUY(INIT STK=0)
372				ASSUMING CURR INV IS 'REFUNDED' AND CASH
373				VALUE IS ADDED TO THE INPUT COST LIMIT(CLNCR)
374				
375	CLNCR		REAL	INPUT COST LIMIT (DOLLARS) ON ADD-ON BUY
376				(INIT STK=CURR INV)
377				
378	CNC		REAL	DIFFERENCE BETWEEN TOTAL COST OF UNCONSTR
379				COST 'NO SUB' SOLUTION AND CLNC
380				
381	CONVF		REAL	AN INPUT 'CONVERGENCE FACTOR'. FOR EACH DAY,
382				ITERATIONS TO ASSESS FLY HRS FLOWN(USING THE
383				CONSTR COST SOLUTION) CONTINUE UNTIL THE
384				ITERATION LIMIT (LIMIT) IS REACHED OR UNTIL THE
385				DISCREPANCY IN FLY HRS (INITIAL-FINAL) IS LESS
386				THAN (CONVF/NW)*TOTAL PGM FLY HRS FOR WAR
387				
388	ORR		REAL	NR OF RETURNING REPAIRS ARRIVING FROM DEPOT
389				REPAIR ON A SPECIFIC DAY
390				
391	FHM		REAL	MAXIMUM FLYING HRS PER ACFT PER DAY(INPUT)
392				
393	IES		FIXED	ESSENTIALITY CODE IN PART DATA INPUT. ONLY
394				PARTS WITH ESSENTIALITY CODE .LE. IESS ARE
395				PROCESSED
396				
397	IESS		FIXED	ITEM ESSENTIALITY CODE USED IN SELECTION OF
398				ESSENTIAL PARTS (SEE IES)
399				
400	IMSEL		FIXED	NUMBER OF PART TYPES FOR WHICH INDIV ITEM
401				'CUMULATIVE TOTAL RQMTS THRU DAY N' ARE
402				DESIRED (SEE SM(I,J),SNCH(I,J),SNM(I,J))
403				
404	IOPT1		FIXED	OPTION (0=OMIT,1=DO) TO PRINT REQUIREMENTS
405				LISTS FOR UNCONSTR COST TOTAL RQMTS SOLUTIONS
406				
407	IOPT2		FIXED	OPTION (0=OMIT,1=DO) TO PRINT REQUIREMENTS
408				LISTS FOR UNCONSTR COST RESIDUAL RQMTS SOL
409				

```

246 C PART J (SR(I,J...)) AND ALLOWABLE BACKORDERS
247 C (ALLOWB(I)*QPA(J)) OVER DAYS 1,2,...
248 C
249 C LATER IN PROGRAM IT IS USED TO CALCULATE
250 C MINIMUM TOTAL STOCK REQMT (INIT STK=0)
251 C FOR PART J UNDER A 'NMCS=0' PARTS
252 C REPLACEMENT POLICY. IT IS COMPUTED AS
253 C THE RUNNING MAXIMUM (OVER TIME) OF
254 C THE RUNNING MAXIMUM (OVER TIME) OF
255 C OVER DAYS 1,2,...
256 C
257 C SRMAX21(J) 300 REAL A WORKING VARIABLE INITIALLY USED TO CALC
258 C MINIMUM RESIDUAL STOCK REQMT (INIT STK=
259 C CURR STK) FOR PART J UNDER A 'FULL SUBST'
260 C REPLACEMENT POLICY. IT IS COMPUTED
261 C AS THE RUNNING MAXIMUM (OVER TIME) OF
262 C THE DIFFERENCE BETWEEN NET DEMAND FOR
263 C PART J (SR(I,J...)) AND ALLOWABLE BACKORDERS
264 C (ALLOWB(I)*QPA(J)) OVER DAYS 1,2,...
265 C
266 C LATER IN THE PROGRAM IT IS USED TO CALC
267 C MINIMUM RESIDUAL STOCK REQMT (INIT STK=
268 C CURR STK) FOR PART J UNDER A 'NMCS=0'
269 C REPLACEMENT POLICY. IT IS COMPUTED AS
270 C THE RUNNING MAXIMUM (OVER TIME) OF
271 C THE DIFFERENCE BETWEEN NET DEMAND IN
272 C EXCESS OF CURRENT STOCK FOR PART J
273 C (SR(I,J...)-STK(J)) OVER DAYS 1,2,...
274 C
275 C STK(J) 300 REAL CURRENT STOCK OF PART J (=ISTK(J))
276 C
277 C SUM6(I) 120 REAL CUMULATIVE BACKORDERS (ALL PARTS ON DAY I
278 C
279 C ZLOSS(I) 61 REAL NUMBER OF DAILY AC LOSSES BY ATTRITION
280 C DURING I-TH TIME INTERVAL (IDAY(I) TO
281 C IDAY(I+1))
282 C
283 C ZNRT(J) 300 REAL NPTS (NOT REPAIRABLE THIS STATION) FRACTION
284 C FOR PART J
285 C
286 C
287 C
288 C COMMON BLOCK (UNLABELED) ENTRIES
289 C
290 C
291 C NAME DIMENSION TYPE DESCRIPTION
292 C
293 C ALLOWB(I) 120 REAL MAXIMUM ALLOWABLE NMCS AC ON DAY I WHICH
294 C WILL STILL ALLOW ACHIEVEMENT OF CASE OBJECTIVE
295 C (FLY HR AND AVAILABILITY) ON DAY I
296 C
297 C BCY(J) 300 REAL BASE REPAIR CYCLE TIME (DAYS) OF PART J
298 C (=BASE REPAIR TIME OF PART)/(BASE=RFTAIL)
299 C
300 C BF(J) 300 REAL A COEFFICIENT USED IN CALCULATION OF NET
301 C DEMANDS(SR(I,J...)) FOR PART J. IT=
302 C (1-BC(J))*(1-ZNRT(J))*CF(J)
303 C
304 C CF(J) 300 REAL A COEFFICIENT USED IN CALCULATION OF NET
305 C DEMANDS(SR(I,J...)) FOR PART J. IT=
306 C FR(J)*QPA(J)
307 C
308 C DCY(J) 300 REAL DEPOT RECYCLE TIME FOR PART TYPE J,I.E.
309 C TIME BETWEEN REMOVAL AND RETURN FROM DEPOT
310 C REPAIR. THIS = DEPOT REPAIR TIME + 2*ORDER
311 C SHIP TIME.
312 C
313 C DF(J) 300 REAL A COEFFICIENT USED IN CALCULATION OF NET
314 C DEMANDS(SR(I,J...)) FOR PART J. IT=
315 C (1-DC(J))*ZNRT(J)*CF(J)
316 C
317 C DMD(J) 700 REAL WORKING VARIABLE USED PRIMARILY IN CALC OF
318 C NET DEMAND(SR(I,J...)) FOR PART J ON DAY I.
319 C WHEN (CUM)NET DMD THRU DAY I IS BEING
320 C CALCULATED, DMD(J) IS (CUM) NET DMD THRU THE
321 C PREVIOUS DAY.
322 C
323 C IFC(J) 300 FIXED ARRAY WHICH STORES THE PART NUMBER (BASED ON
324 C ORDER OF INPUT) CORRESPONDING TO THE J-TH
325 C RANK ORDER BASED ON DECREASING UNIT COST
326 C
327 C

```

164 C CAPABILITY ASSESSMENT (IT IS ITERATED).

165 C

166 C FHR(I) 120 REAL FLYING HOUR REQUIREMENT FOR DAY I

167 C BASED ON INPUT FLYING HR PROGRAM

168 C

169 C FR(J) 300 REAL FAILURE (REPLACEMENT) RATE FOR PART J

170 C EXPRESSED AS EXPECTED NR OF FAILURES

171 C PER FLYING HOUR FLOWN.

172 C

173 C IDAY(I) 61 FIXED ARRAY WHICH TEMPORARILY STORES INPUT DATA ON

174 C DAYS BEGINNING 'DAY INTERVALS' (IDAY(I) TO

175 C IDAY(I+1)) IN WHICH VARIOUS INPUT DATA

176 C TAKE EFFECT

177 C

178 C INC(J) 300 FIXED TOTAL 'SOLUTION STOCK' (CURR INV + ADD-ON REQ)

179 C FOR PART TYPE J FOR UNCONST COST CASE

180 C (RESIDUAL REQUIREMENTS ONLY)

181 C

182 C IPT(J) 5 FIXED ARRAY STORING INTERNAL PART NRS (SUBSCRIPTS)

183 C FOR PARTS FOR WHICH A CUMULATIVE DAY BY DAY

184 C REQUIREMENT HISTORY IS TO BE PRINTED

185 C (FOR INIT STK=0 ONLY)

186 C

187 C ISTK(J) 300 FIXED CURRENT STOCK OF PART J (INPUT)

188 C

189 C NAC(I) 61 FIXED NR OF AC DEPLOYED AT START OF I-TH TIME

190 C INTERVAL (IDAY(I) TO IDAY(I+1))

191 C

192 C NFH(I) 61 FIXED FLYING HR REQMT DURING I-TH TIME

193 C INTERVAL (IDAY(I) TO IDAY(I+1))

194 C

195 C CPA(J) 300 REAL 'QUANTITY PER APPLICATION' FOR PART J

196 C I.E. NR OF PART J ITEMS INSTALLED PER AC

197 C

198 C RAV(I) 120 CHAR DESIGNATES DOMINANT SOURCE OF 'MINIMUM

199 C REQUIRED ACFT AVAIL' FOR DAY I, EITHER

200 C 'FLYING HR PROG' OR 'AVAIL CONSTR', I.E.

201 C EITHER INPUT FLYING HR PROGRAM GOAL OR

202 C ACFT AVAILABILITY CONSTRAINT (BOTH INPUT)

203 C

204 C RFC(I) 120 REAL AC AVAILABILITY WHEN TOTAL REQ (INIT STK=0)

205 C IS STOCKED USING A 'FULL SUBSTITUTION'

206 C REPLACEMENT POLICY WITH UNCONSTRAINED COST

207 C

208 C RFCS(J) 300 REAL TOTAL REQMT (INIT STK=0) FOR PART J USING A

209 C 'FULL SUBSTITUTION' REPLACEMENT POLICY

210 C WITH UNCONSTRAINED COST

211 C

212 C RFCS1(J) 300 REAL RESIDUAL REQMT (INIT STK=CURR STK) FOR PART J

213 C USING A 'FULL SUBSTITUTION' REPLACEMENT POLICY

214 C WITH UNCONSTRAINED COST

215 C

216 C PNC(I) 120 REAL AC AVAILABILITY WHEN TOTAL REQ (INIT STK=0)

217 C IS STOCKED USING A 'NO SUBSTITUTION'

218 C REPLACEMENT POLICY WITH UNCONSTRAINED COST

219 C

220 C RNMCS1(J) 300 REAL RESIDUAL REQMT (INIT STK=CURR STK) FOR PART J

221 C USING A 'NMCS =0' REPLACEMENT POLICY

222 C WITH UNCONSTRAINED COST

223 C

224 C SM(I,J) 120,5 REAL CUMULATIVE TOTAL (INIT STK=0) REQMT FOR

225 C PART IPT(J) THRU DAY I WITH A FULL SUBSTITUTION

226 C REPLACEMENT POLICY WITH UNCONSTRAINED COST

227 C (SEE DESCRIPTION OF IPT(J))

228 C

229 C SNCM(I,J) 120,5 REAL CUMULATIVE TOTAL (INIT STK=0) REQMT FOR

230 C PART IPT(J) THRU DAY I WITH A 'NO SUBSTITUTION'

231 C REPLACEMENT POLICY WITH UNCONSTRAINED COST

232 C (SEE DESCRIPTION OF IPT(J))

233 C

234 C SNM(I,J) 120,5 REAL CUMULATIVE TOTAL (INIT STK=0) REQMT FOR

235 C PART IPT(J) THRU DAY I WITH A 'NMCS=0'

236 C REPLACEMENT POLICY WITH UNCONSTRAINED COST

237 C (SEE DESCRIPTION OF IPT(J))

238 C

239 C SFMAX1(J) 300 REAL A WORKING VARIABLE USED INITIALLY TO CALC

240 C MINIMUM TOTAL STOCK REQMT (INIT STK=0)

241 C FOR PART J UNDER A 'FULL SUBSTITUTION'

242 C REPLACEMENT POLICY. IT IS COMPUTED

243 C AS THE RUNNING MAXIMUM (OVER TIME) OF

244 C THE DIFFERENCE BETWEEN NET DEMAND FOR

245 C

82	C	CNCS(J)	300	REAL	TOTAL COST (INIT STK=0) OF REQMT FOR PART J
83	C				USING A NO SUBSTITUTION REPLACEMENT POLICY
84	C				WITH UNCONSTR COST WITH CONSTR COST
85	C				
86	C	CNCS1(J)	300	REAL	RESIDUAL COST (INIT STK=CURR STK) OF REQMT
87	C				(IN EXCESS OF CURRENT STOCK) FOR
88	C				PART J USING A NO SUBSTITUTION REPLACEMENT
89	C				POLICY WITH UNCONSTR COST WITH CONSTR COST
90	C				
91	C	CNMCS(J)	300	REAL	TOTAL COST (INIT STK=0) OF REQMT FOR PART J
92	C				USING A 'NMCS=0' REPLACEMENT POLICY
93	C				WITH UNCONSTRAINED COST
94	C				
95	C	CNMCS1(J)	300	REAL	RESIDUAL COST (INIT STK=CURR STK) OF REQMT
96	C				(IN EXCESS OF CURRENT STOCK) FOR
97	C				PART J USING A 'NMCS=0' REPLACEMENT
98	C				POLICY WITH UNCONSTRAINED COST
99	C				
100	C				
101	C	COST(J)	300	REAL	COST OF A SINGLE ITEM OF PART J
102	C				
103	C	DC(J)	300	REAL	DEPOT CONDEMNATION RATE OF PART J
104	C				(FRAC FAILURES 'JUNKED' AT DEPOT LEVEL)
105	C				
106	C	DMDT(J)	300	REAL	TEMPORARY VALUE FOR DMD(J) USED WHILE
107	C				CONVERGING TO A SINGLE 'FLYING HRS FLOWN'
108	C				RESULT DURING CAPABILITY ASSESSMENT
109	C				
110	C	DCOSTF(I)	120	REAL	CUMULATIVE COST OF TOTAL (INIT STK=0) REQMT
111	C				(ALL PARTS) THRU DAY I USING A FULL
112	C				SUBSTITUTION POLICY WITH UNCONSTRAINED COST
113	C				
114	C	DCOSTN(I)	120	REAL	CUMULATIVE COST OF TOTAL (INIT STK=0) REQMT
115	C				(ALL PARTS) THRU DAY I USING A NO
116	C				SUBSTITUTION POLICY WITH UNCONSTRAINED COST
117	C				
118	C	DCOSTZ(I)	120	REAL	CUMULATIVE COST OF TOTAL (INIT STK=0) REQMT
119	C				(ALL PARTS) THRU DAY I USING A 'NMCS=0'
120	C				REPLACEMENT POLICY WITH UNCONSTRAINED COST
121	C				
122	C	ECOSTF(I)	120	REAL	CUMUL COST OF RESIDUAL (INIT STK=CURR STK)
123	C				REQMT (IN EXCESS OF CURRENT STOCK) THROUGH
124	C				DAY I USING A FULL SUBSTITUTION REPLACEMENT
125	C				POLICY WITH UNCONSTRAINED COST
126	C				
127	C	ECOSTN(I)	120	REAL	CUMUL COST OF RESIDUAL (INIT STK=CURR STK)
128	C				REQMT (IN EXCESS OF CURRENT STOCK) THROUGH
129	C				DAY I USING A NO SUBSTITUTION REPLACEMENT
130	C				POLICY WITH UNCONSTRAINED COST
131	C				
132	C	ECOSTZ(I)	120	REAL	CUMUL COST OF RESIDUAL (INIT STK=CURR STK)
133	C				REQMT (IN EXCESS OF CURRENT STOCK) THROUGH
134	C				DAY I USING A 'NMCS=0' REPLACEMENT POLICY
135	C				WITH UNCONSTRAINED COST
136	C				
137	C	FHA(I)	120	REAL	INITIAL ESTIMATE FOR FLYING HRS ACHIEVED ON
138	C				DAY I WHEN COMPUTED REQMT - BASED ON A COST
139	C				CONSTRAINED NO SUBSTITUTION REPLACEMENT POLICY-
140	C				IS STOCKED. (COMPUTED RECURSIVELY)
141	C				
142	C	FHPAPD(K,I)	3,120	REAL	FHPAPD(1,I)=FLYING HRS PER AVAILABLE ACFT PER
143	C				FOR DAY I UNDER FULL SUB USING THE UNCONSTR
144	C				COST SOLUTION STOCK.
145	C				
146	C				FHPAPD(2,I)=FLYING HRS PER AVAILABLE ACFT PER
147	C				FOR DAY I UNDER NO SUB USING THE UNCONSTR
148	C				COST SOLUTION STOCK.
149	C				
150	C				FHPAPD(3,I)=FLYING HRS PER AVAILABLE ACFT PER
151	C				FOR DAY I UNDER NO SUB USING THE CONSTRAINED
152	C				COST SOLUTION STOCK.
153	C				
154	C	FHNC(I)	120	REAL	CALCULATED ESTIMATE FOR FLYING HRS ACHIEVED ON
155	C				DAY I WHEN COMPUTED REQMT - BASED ON A COST
156	C				CONSTRAINED NO SUBSTITUTION REPLACEMENT POLICY-
157	C				IS STOCKED. (COMPUTED RECURSIVELY)
158	C				
159	C	FHNZ(I)	120	REAL	FRACTION OF FLYING PROGRAM COMPLETED ON DAY I
160	C				WHEN COST-CONSTRAINED SOLUTION IS STOCKED
161	C				USING A 'NO SUBSTITUTION' REPLACEMENT POLICY
162	C				
163	C	FHA(I)	120	REAL	ESTIMATED FLY HRS FLOWN ON DAY I DURING

MAIN PROGRAM

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1  NAME: PARCOM          TYPE: MAIN PROGRAM
2
3  PURPOSE: THE PARCOM (PARTS REQUIREMENTS AND COST MODEL) IS USED TO GENERATE
4  COST EFFECTIVE MIXES OF SPARE PARTS NEEDED TO ACHIEVE A FLYING PROGRAM UNDER
5  VARIOUS
6  -PART REPLACEMENT POLICIES
7  -NMCS (NOT MISSION CAPABLE SUPPLY) CONSTRAINTS
8  -PART INVENTORY COST CONSTRAINTS
9
10 ARGUMENTS: NOT APPLICABLE
11
12 CALLED BY: NOT APPLICABLE
13
14 CALLS
15 -FUNCTION MAXC
16 -FUNCTION SR
17 -SUBROUTINE NCRNCT
18 -SUBROUTINE NCRNCR
19
20 FILES USED : INPUT - UNIT 10 (PARTS DATA)
21                - UNIT 11 (SCENARIO DATA)
22                OUTPUT - PRINT
23                TEMP - UNIT 12
24                -FILE WITH (CURR INV + ADD-ON ROMNT) FOR
25                EACH PART TYPE (W/ NONZERO FAILURE RATE)
26                IN ORDER OF INPUT FOR THIS RUN, BASED ON
27                UNCONSTR COST. FILE IS IN FORMAT FOR
28                PARCOM INPUT(ISTK(J)).
29
30 LOCAL ARRAYS
31
32 NAME          DIMENSION  TYPE          DESCRIPTION
33
34 AC(I)          120      REAL          NR ACFT DEPLOYED ON DAY I
35
36 ADESC(J)       300      CHAR          16 CHAR DESCRIPTION OF SPARE PART J
37
38 ALR(I)         120      REAL          NR ACFT LOST(ATTRITION) ON DAY I
39
40 AM(I)          61       REAL          AC AVAILABILITY CONSTRAINT FOR I-TH
41                                     'DAY INTERVAL', I.E. MINIMUM REQUIRED ACFT
42                                     AVAILABILITY IN I-TH 'DAY INTERVAL'
43
44 AMSN(J)        300      CHAR          IDENTIFICATION NR(INSN) OF SPARE PART J
45
46 ASUPV(I)       120      REAL          NR AC SURVIVING (NOT ATTRITIED) ON DAY I
47
48 AVAVG(K)        6       REAL          INITIALLY AVAVG(1)=AVG ACFT AVAIL W/FULL
49                                     SUB SOLUTION-UNCONSTR COST. LATER AVAVG(1)=
50                                     AVG ACFT AVAIL W/NO SUP SOL.-CONSTR COST.
51                                     AVAVG(2)=AVG ACFT AVAIL W/NO SUB SOL.-
52                                     UNCONSTR COST.
53
54                                     AVAVG(3)=AVG MIN ACFT REQ'D TO ACHIEVE
55                                     GOAL/OBJECTIVE (ALL COST CONDITIONS)
56
57                                     AVAVG(4)=AVG FLY HR/AVAIL ACFT / DAY
58                                     W/FULL SUB SOL.-UNCONSTR COST
59
60                                     AVAVG(5)=AVG FLY HR/AVAIL ACFT / DAY
61                                     W/NO SUB SOL.-UNCONSTF COST.
62
63                                     AVAVG(6)=AVG FLY HR/AVAIL ACFT / DAY
64                                     W/NO SUB SOL.-CONSTR COST.
65
66 AVM(I)         120      REAL          AC AVAILABILITY CONSTRAINT FOR DAY I
67
68 BC(J)          300      REAL          BASE (RETAIL) CONDEMNATION RATE OF PART J
69                                     (=FRACTION FAILURES 'JUNKED' AT RETAIL LEVEL)
70
71 CFCS(J)        300      REAL          TOTAL COST (INIT STK=0) OF REQMT FOR PART J
72                                     USING A FULL SUSTITUION REPLACEMENT POLICY
73                                     WITH UNCONSTRAINED COST
74
75 CFCS1(J)       300      REAL          RESIDUAL COST (INIT STK=CURR STK) OF REQMT
76                                     (IN EXCESS OF CURRENT STOCK) FOR
77                                     PART J USING A FULL SUSTITUION REPLACEMENT
78                                     POLICY WITH UNCONSTRAINED COST
79
80 CLOSS(I)       120      REAL          CUMULATIVE AC LOST TO ATTRITION THRU DAY I
81

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CAA-D-84-15

(NOT USED)

APPENDIX A

PARCOM PROGRAM SOURCE CODE

MAIN PROGRAM

pages A-3 thru A-20

SUBROUTINE NCRNCT

pages A-21 and A-22

SUBROUTINE NCRNCR

pages A-23 and A-24

FUNCTION SR

pages A-25 and A-26

FUNCTION MAXC

page A-27

4-5. CAVEATS. If the day and/or parts limits are increased, the processing time required for a PARCOM execution increases by at least the product of the two limit multipliers, i.e., doubling the day limit and the part limit will at least quadruple processing time. In the PARCOM User's Guide, it was noted that the calculation of entries for "no substitution" in the output "Cumulative Total Requirement Cost List" and the output "Cumulative Residual Requirement Cost List" consumes most of the processing time required for a PARCOM run. Therefore, if those entries are not essential, time-consuming calculations can be minimized by setting IPRT4 = the day limit in record set 4 of the Scenario Input Data Base as described in the PARCOM User's Guide.

Table 4-1. PARCOM Arrays with a Day Limit Dimension

Array	Routine	Array	Routine	Array	Routine
AC(120)	Main	ECOSTZ(120)	Main	SNM(120,5)	Main
ALR(120)	Main	FHNC(120)	Main	SUMB(120)	Main
ASURV(120)	Main	FHNZ(120)	Main	FHR(120)	NCRNCT
AVM(120)	Main	FHAPD(3,120)	Main	FHR(120)	NCRNCR
ALLOWB(120)	COMMON	FHR(120)	Main	SUMBZ(120)	NCRNCT
DCOSTF(120)	Main	IFCD(120)	Main	SUMBZ(120)	NCRNCR
DCOSTN(120)	Main	RFC(120)	Main	SUMP(120)	NCRNCR
DCOSTZ(120)	Main	RNC(120)	Main	FHR(120)	SR
ECOSTF(120)	Main	SM(120,5)	Main	FHA(120)	Main
ECOSTN(120)	Main	SNCM(120,5)	Main	RAV(120)	Main

4-4. EXTENSION OF TOTAL PARTS LIMIT. In the PARCOM version delivered by CAA, 34 single-subscript arrays are defined in terms of the maximum number of parts to be processed. The current limit is 300 parts. Those arrays of size 300 may be increased in size (through user reprogramming) to any limit permitted by computer memory. The arrays associated with the parts limit and the routines defining them are shown in Table 4-2.

Table 4-2. PARCOM Arrays with a Parts Limit Dimension

Array	Routine	Array	Routine	Array	Routine
BC(300)	Main	INC(300)	Main	BF(300)	COMMON
CFCS(300)	Main	ISTK(300)	Main	CF(300)	COMMON
CFCS1(300)	Main	QPA(300)	Main	DCY(300)	COMMON
CNCS(300)	Main	RFCS(300)	Main	DF(300)	COMMON
CNCS1(300)	Main	RFCS1(300)	Main	DMD(300)	COMMON
CNMCS(300)	Main	RNMCS1(300)	Main	IRC(300)	COMMON
CNMCS1(300)	Main	SRMAX1(300)	Main	RNCS(300)	COMMON
COST(300)	Main	SRMAX2(300)	Main	RNCS1(300)	COMMON
DC(300)	Main	STK(300)	Main	RNMCS(300)	COMMON
DMDT(300)	Main	ZNRT(300)	Main	S(300)	COMMON
FR(300)	Main	BCY(300)	COMMON	ADESC(300)	Main
				AMSN(300)	Main

(5) Assesses the combat capability of the unconstrained cost "full substitution" and "no substitution" solution mixes.

(6) Computes all requirements for the constrained cost cases.

(7) Assesses the combat capability of the constrained cost solution mixes.

b. Function MAXC. Function MAXC is called only by the main program. No external routines are called by it. Function MAXC determines the subscript of the largest (in value) member of an array. Repeated application enables ordering of an array. In this way, the main program orders all part types in order of decreasing part unit cost. Function MAXC is also used to determine the smallest of the input "minimum required aircraft availability" specifications (for use in an output header).

c. Subroutine NCRNCT. Subroutine NCRNCT is called by the main program and calls function SR. This subroutine computes a least cost total requirements mix (zero initial inventory) for the unconstrained cost case with a "no substitution" policy.

d. Subroutine NCRNCR. Subroutine NCRNCR is called by the main program and calls function SR. This subroutine computes a least cost residual requirements mix (add-on to specified initial inventory) for the unconstrained cost case with a "no substitution" policy.

e. Function SR. Function SR is called by the main program, by subroutine NCRNCT, and by subroutine NCRNCR. It calculates the cumulative net demand through a specified day for a specified part (based on a specified flying program) prior to the adjustment (subtraction) for initial inventory.

4-2. ARRAY STORAGE. Definitions and sizes of PARCOM array variables are given in the comments of the program code displayed in Appendix A. The types of arrays are local, as defined by DIMENSION statements, common, as defined by unlabeled COMMON, and character, as defined by CHARACTER declarations. Character variables occupy four words per entry in PARCOM while other arrays require only one word per entry. During execution on the Sperry 1100/82 computer, PARCOM occupies 32,768 words of memory. Of this, 18,076 words, or 53 percent of total requirements are associated with arrays.

4-3. EXTENSION OF DAY LIMIT. In the PARCOM version delivered by CAA, 26 single-subscript arrays and 4 double-subscript arrays are defined in terms of the maximum number of days in the scenario. The current limit is 120 days. Those arrays of size 120 may be increased in size (through user reprogramming) to the scenario length desired insofar as computer memory permits. The arrays associated with the day limit, their dimensions, and the routines defining them are listed in Table 4-1.

CHAPTER 4

POTENTIAL PROGRAM MODIFICATION

4-1. MODULE FUNCTIONS. Figure 4-1 shows the main and subprogram modules of PARCOM. The subprograms consist of two subroutines and two functions. A summary of operational purpose is given below for each module. Details of module operations can be read in the commented FORTRAN code for PARCOM presented in Appendix A.

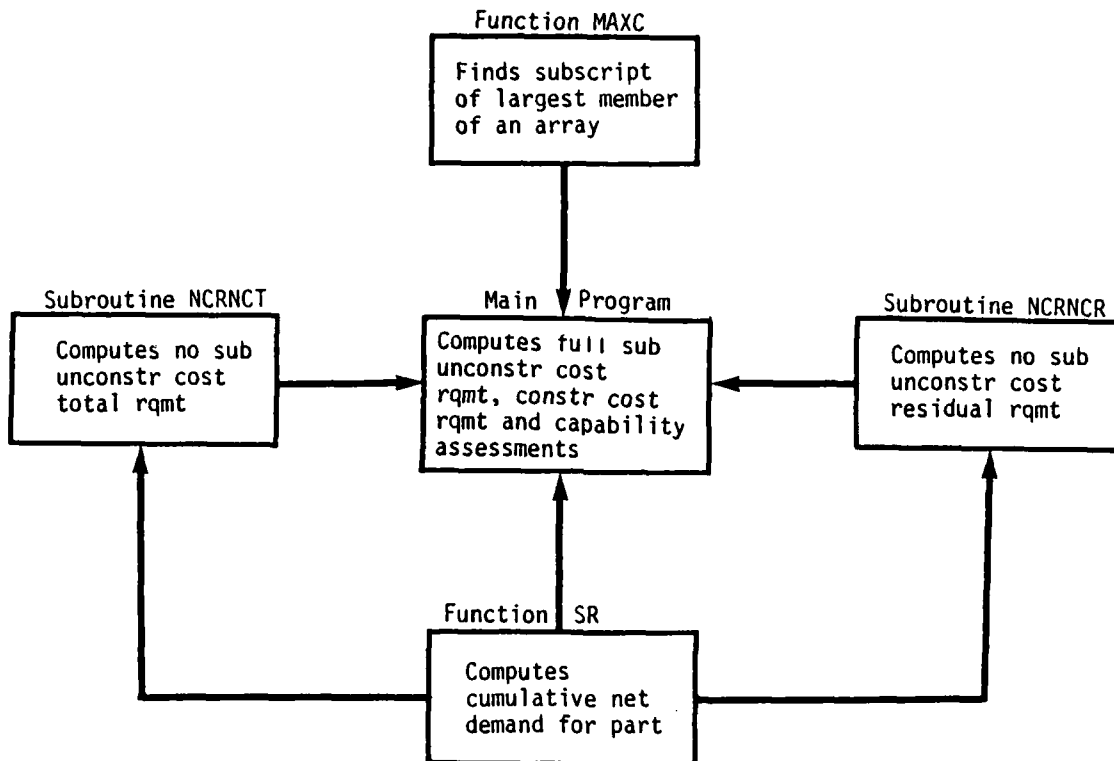


Figure 4-1. PARCOM Subprogram Modules

a. **Main Program.** The PARCOM main program:

- (1) Reads in all part and scenario data.
- (2) Computes all requirements and costs for unconstrained cost cases with full substitution.
- (3) Computes all requirements and costs for unconstrained cost cases with a "NMCS = 0" policy.
- (4) Calls subroutines NCRNCT and NCRNCR to obtain requirements and costs for unconstrained cost cases with a "no substitution" policy. Calls the functions MAXC and SR for reasons discussed later.

g. No Stochastic Results. All PARCOM results are "expected value." Neither input nor results have variable probabilistic aspects (e.g., confidence levels). Safety levels would have to be treated separately as an add-on to PARCOM quantities. However, use of expected values is meaningful for comparisons and parametric evaluations. Methodology for incorporating stochastic considerations into PARCOM would be complex. Conversion of the model into a stochastic simulation could entail high risk for an uncertain payoff.

availabilities are determined. At times, however, it is also desirable to be able to assess the degree to which an aircraft fleet, with its current or some other starting inventory (and no add-ons), can meet specified flying or availability goals. This can be done for the "no substitution" policy by running that inventory in a requirements mode with a constrained cost limit of zero (so that no parts will be added). In that case, the full complement of assessment outputs is available. With "full substitution", however, only the expected period (consecutive days from day 1) of full flying hour program sustainability is assessable for current inventory. This is accomplished by running an unconstrained cost "full substitution" requirements case and reading from the cumulative cost output the last day that no additional costs are experienced.

3-3. CAVEATS AND LIMITATIONS. The principal caveats and limitations on the PARCOM Model, as applied in the study, are discussed below. Program modification and/or restructuring is required to extend model capabilities beyond the cited limits.

a. Number of Part Types Processed. The PARCOM Model version demonstrated herein can process at most 300 different part types. Simple (but memory consuming) modifications to the structure of the program can significantly increase this capacity.

b. No "Partial Substitution". PARCOM currently processes only "full substitution," "no substitution," and "NMCS = 0" policies. There is no definitive logic yet for a "partial substitution" policy. In light of underlying data and process uncertainties, the bounds of costs and amounts reflected in the "no substitution" and "full substitution" solutions may well be sufficient.

c. Incomplete Assessment of "Full Substitution" Constrained Cost Solutions. Additional programming effort might enable a complete assessment of "full substitution" constrained cost solutions. Currently only the days of sustainability can be determined.

d. Only Two Centralized Supply Levels. PARCOM shares the Overview Model "world view" of a retail level and a wholesale level. With "full substitution", each level has full cross-leveling (lateral transferability) of parts.

e. No Indenture Levels. Part types in the PARCOM (and Overview) data base are nonoverlapping modular units, i.e., no part is a subcomponent of another listed part type. Therefore, the failures and repair of parts are independent of each other. Use of indentured data is not processable in PARCOM.

f. No Direct Maintenance Modeling. As with Overview, PARCOM treats maintenance only indirectly, by incorporation in the repair time or by using an aircraft deployment/attrition data base which is adjusted for aircraft down ("lost") due to maintenance constraints. Such adjustments could be based on results of a separate high-resolution simulation model which previously processed a "slice" of the scenario.

CHAPTER 3

OPERATIONAL CONSIDERATIONS AND CAVEATS

3-1. CASE OBJECTIVES. The user can specify a flying hour objective in conjunction with an aircraft availability objective. For each of these, one of two subobjectives is selected. The associated case types are noted below.

a. Maximizing Cumulative Flying Hours Achieved. This flying hour objective is always operating when running a constrained cost case. It entails the direct determination of the parts mix which will yield the greatest number of achieved flying hours for a specified cost limit. The flying hours achieved will be less than the desired flying hour program if the cost limit is less than the cost of the unconstrained cost solution mix.

b. Maximizing Consecutive Daily Program Flying Hours Achieved. This flying hour objective is relevant only to constrained cost cases since, for unconstrained cost cases, achieved flying hours = program flying hours. Obtaining a solution with this objective is a two-stage process. First, the user runs PARCOM in an unconstrained cost mode for the full wartime period. The output list from that run shows, for each day, the cumulative cost of the add-on parts that would have been required if the war had been truncated at that day. D, the last day on that list for which the associated cost is less than or equal to the "cost limit" of the constrained cost case, is then the maximum number of consecutive days of 100 percent flying program sustainability with "cost limit" spares dollars. Next, to get the solution mix associated with D, PARCOM is rerun, in the unconstrained cost mode, with a truncated "war" of D days length.

c. Minimum Specified Daily Aircraft Availability. This objective is in addition to any flying hour objective and is operative in all cases. The availability objective may increase the demand for available aircraft beyond those required to achieve the flying program. The input availability constraints are, as described previously, used to calculate daily "allowed NMCS aircraft", which, in turn, is used in all case calculations.

d. No Specified Aircraft Availability. PARCOM must always read in values for minimum daily aircraft availability objectives. However, entering blank or zero equates to not specifying an availability objective.

3-2. CAPABILITY ASSESSMENT. Normally, PARCOM capability assessments are performed when add-on requirements are determined for both unconstrained and constrained cost cases. In the unconstrained cost cases, flying hour and availability goals are fully met, so the assessed achievements are simply the same as the goals. However, average availability over the course of the war, which cannot be input as a goal, is also determined. For constrained cost cases days of sustainability, fraction of daily and total flying hour program achieved, and daily and average aircraft

```

410      C IOPT3      FIXED      OPTION (0=OMIT,1=DO) TO PRINT REQUIREMENTS
411      C           LISTS FOR CONSTR COST 'TOTAL BUY' SOLUTION
412      C           (BASED ON COST LIMIT= VALUE OF CURR INV*
413      C           INPUT COST LIMIT APPLIED TO INIT STK=0)
414
415      C IOPT4      FIXED      OPTION (0=OMIT,1=DO) TO PRINT REQUIREMENTS
416      C           LISTS FOR CONSTR COST 'ADD-ON BUY' SOLUTION
417      C           (BASED ON INPUT COST LIMIT APPLIED TO
418      C           INIT STK=CURR INV)
419
420      C IOPT5      FIXED      OPTION (0=OMIT,1=DO) TO PRINT TOTAL
421      C           (INIT STK=0) CUMULATIVE (BY DAY) RQMNTS
422      C           FOR SELECTED ITEMS (SEE IMSEL,SM(I,J),
423      C           SNCM(I,J),SNM(I,J))
424
425      C IOPT6      FIXED      OPTION (0=OMIT,1=DO) TO DO CONSTR COST CASE
426
427      C IPRT       FIXED      OPTION (0=OMIT,1=DO) TO PRINT SCENARIO
428      C           DATA BASE SUMMARY OUTPUT LIST
429
430
431      C IPRT4      FIXED      INTERVAL(DAYS) AT WHICH 'CUMULATIVE RQMNTS
432      C           COST THRU DAY N' ARE CALCULATED FOR 'NO SUB'
433      C           IN THE UNCONSTRAINED COST CASE
434
435      C KNT        FIXED      INDICATOR 1=TOTAL RQMNTS BEING PROCESSED,
436      C           2=RESIDUAL(ADD-ON) RQMNTS BEING PROCESSED
437
438      C LIMIT      FIXED      MAXIMUM NR OF ASSESSMENT ITERATIONS(EACH
439      C           DAY) SEEKING CONVERGENCE OF FLY HRS FLOWN
440
441      C NP         FIXED      NR OF PART TYPES PROCESSED IN RUN. (THIS
442      C           EXCLUDES PART TYPES WITH ESSENTIALITY CODE
443      C           .LE. IEES OR WITH A ZERO FAILURE RATE)
444
445      C NW         FIXED      LENGTH(DAYS) OF SCENARIO
446
447      C TCFCs      REAL       TOTAL(PROCUREMENT) COST OF 'UNCONSTR COST
448      C           TOTAL(INIT STK=0) RQMNT' SOLUTION WITH
449      C           FULL SUBSTITUTION
450
451      C TCNCs      REAL       TOTAL(PROCUREMENT) COST OF 'UNCONSTR COST
452      C           TOTAL(INIT STK=0) RQMNT' SOLUTION WITH
453      C           NO SUBSTITUTION
454
455      C TCNMCS     REAL       TOTAL(PROCUREMENT) COST OF 'UNCONSTR COST
456      C           TOTAL(INIT STK=0) RQMNT' SOLUTION WITH
457      C           'NMCS=0'
458
459      C UCFCs      REAL       TOTAL(PROCUREMENT) COST OF 'UNCONSTR COST
460      C           RESIDUAL(ADD-ON) RQMNT' SOLUTION WITH
461      C           FULL SUBSTITUTION
462
463      C UCNCs      REAL       TOTAL(PROCUREMENT) COST OF 'UNCONSTR COST
464      C           RESIDUAL(ADD-ON) RQMNT' SOLUTION WITH
465      C           NO SUBSTITUTION
466
467      C UCNMCS     REAL       TOTAL(PROCUREMENT) COST OF 'UNCONSTR COST
468      C           RESIDUAL(ADD-ON) RQMNT' SOLUTION WITH
469      C           'NMCS=0'
470
471      C
472      C DIMENSION
473      C   AC(120),      ALG(120),      AM(61),      ASURV(120),
474      C   AVAVG(61),    AVH(120),      RC(300),      CFCS(300),
475      C   CFCS1(300),   CNCS(300),   CNCS1(300),
476      C   CNMCS(300),   CNMCS1(300), COST(300),   DC(300),
477      C   DCOSTF(120), DCOSTN(120), DCOST2(120), DMDT(300),
478      C   ECOSTF(120), ECOSTN(120), ECOST2(120),   FHA(120),
479      C   FHNC(120),   FHNZ(120),   FHPAPD(3,120), FHR(120),
480      C   FR(300),     IDAY(61),     INC(300),
481      C   IPT(51),     ISTD(300),   NAC(61),     NFH(61),
482      C   OPA(300),     RFC(120),   RFCS(300),   RFCS1(300),
483      C   RNC(120),     SNM(120,5),  RNMCS1(300), SM(120,51),
484      C   SNCM(120,5), SUMB(120),   SRMAX1(300), SRMAX2(300),
485      C   STK(300),     ZLOSS(61),   ZNPT(300)
486      C EQUIVALENCE
487      C   (QPA,DMDT),  (ISTK,INC), (SRMAX1,CFCS), (SRMAX2,CNCS),
488      C   (DC,CNMCS),  (RC,RFCS1), (DCOSTF,FHA), (DCOSTN,FHNC),
489      C   (DCOST2,FHNZ), (ALR,RFCS)
490      C COMMON
491      C   ALLQWB(120), RCY(700),      BF(300),      CF(300),
492      C   DCY(300),    DF(300),      DMD(300),     IRC(300),

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497      * RNC5(300),      RNC51(300),      RNMCS(300),      S(300)
498      CHARACTER*16
499      * ADESC(300),      ADSC,      AMSN(300),      CASE,
500      * RAV(120),      71
501      DO 100 I=1,61
502      IDAY(I)=0
503      AVH(I)=0.
504      NAC(I)=0
505      NFH(I)=0
506      ZLOSS(I)=0
507 100 AM(I)=0.
508      ZZ=0.
509
510      C
511      C
512      C
513      C
514      C
515      C
516      C
517      C
518      C
519      C
520      C
521      C
522      C
523      C
524      C
525      C
526      C
527      C
528      C
529      C
530      C
531      C
532      C
533      C
534      C
535      C
536      C
537      C
538      C
539      C
540      C
541      C
542      C
543      C
544      C
545      C
546      C
547      C
548      C
549      C
550      C
551      C
552      C
553      C
554      C
555      C
556      C
557      C
558      C
559      C
560      C
561      C
562      C
563      C
564      C
565      C
566      C
567      C
568      C
569      C
570      C
571      C
572      C
573      C

```

* RNC5(300), RNC51(300), RNMCS(300), S(300)
 CHARACTER*16
 * ADESC(300), ADSC, AMSN(300), CASE,
 * RAV(120), 71
 DO 100 I=1,61
 IDAY(I)=0
 AVH(I)=0.
 NAC(I)=0
 NFH(I)=0
 ZLOSS(I)=0
 100 AM(I)=0.
 ZZ=0.

READ (CARD IMAGE) ORDER SHIP TIME OFFSET, FLY HR CONVERGENCE FACTOR
 AND PART ESSENTIALITY THRESHOLD

READ (11,9700) ADDOST,CONVF,IFSS
 NP=0

THIS SECTION READS(102 CHAR RECORDS ON LOGICAL UNIT 11) THE PARTS
 DATA BASE. DATA FOR EACH PART ARE CONTAINED IN SETS OF 12 CONSECUTIVE
 RECORDS(ONLY 3 OF WHICH ARE READ). INITIALLY SKIP 3 RECORDS WHICH
 HEAD THE FILE BUT ARE NOT PART OF ANY 'PART DATA SET'.

READ (11,9800)
 I=0

200 READ (10,9900,END=600) Z1,Z2,Z3,Z4,Z5,Z6,Z7,Z8,Z9,IES,INIT

SKIP 3 RECORDS

READ (10,9800,END=600)

READ QUANTITY PER APPLICATION

READ (11,10000,END=600) IOPA

READ PART DESCRIPTION, THEN SKIP 6 RECORDS. THEN SCREEN TO PROCESS ONLY
 PARTS WITHIN ESSENTIALITY THRESHOLD

READ (10,10100,END=600) ADSC
 IF (IES.GT.IESS) GO TO 400

COMPUTE TOTAL DEPOT CYCLE TIME. IN DOING SO ADJUST INPUT
 OST BY ADDOST

ZXD=Z1*Z3+Z7+2.*ADDOST
 Z2C=Z2/100.
 Z4F=Z4/100000.
 Z5N=Z5/100.
 Z10Q=IOPA
 Z88=Z8/100.
 Z9D=Z9/100.
 IF (MOD(NP+I,50).NE.0) GO TO 300
 WRITE (6,10200)
 WRITE (6,10300)
 WRITE (6,10400)
 WRITE (6,10500)

SCREEN TO PROCESS ONLY PARTS WITH NONZERO FAILURE RATES. COUNT ALL
 PARTS(INDEX=11. ALWAYS PRINT A PART DATA RECORD FOR EVERY INPUT PART,
 BUT CHECK IF PART HAS A NON-ZERO FAILURE RATE OR IS 'NONESSENTIAL'.
 IF SO, OMIT 'PART NR'(NP), OTHERWISE PRINT THE PART NR 100.

300 IF (Z4.GE..0000001) GO TO 500
 400 WRITE (6,10600) Z1,ADSC,Z2C,Z3,Z4F,Z5N,Z6,ZXD,Z7,Z88,Z9D,Z10Q,IES
 I=I+1
 GO TO 200

500 NP=NP+1
 WRITE (6,10700) NP,Z1,ADSC,Z2C,Z3,Z4F,Z5N,Z6,ZXD,Z7,Z88,Z9D,Z10Q,I
 ES,INIT
 AMSN(NP)=Z1
 COST(NP)=Z2C
 FR(NP)=Z4F
 ZNRT(NP)=Z5N
 BCY(NP)=Z6
 DCY(NP)=ZXD
 ISTK(NP)=INIT
 BC(NP)=Z88
 DC(NP)=Z9D
 QPA(NP)=Z10Q

```

574      ADESC(NP)=ADSC
575      GO TO 200
576      600 II=NP+1
577      C
578      C PRINT THE TOTAL NR OF PARTS INPUT (NP+1) AND THE TOTAL NR OF
579      C PARTS TO BE PROCESSED(NP).
580      C
581      WRITE (6,10800) II,NP
582      C
583      READ (CARD IMAGE) THE REST OF THE INPUT FACTORS
584      CARD 2= CASE ID
585      CARD 3= COST LIMIT, ITERATION LIMIT
586      CARD 4=MAX FLY HR/AC/DAY,NR DAYS IN WAR, OUTPUT PRINT OPTIONS
587      FOR A VARIETY OF INPUTS TO FOLLOW, READ, IN SEQUENCE
588      -NR OF 'DAY INTERVALS' SPECIFIC
589      -INITIAL DAY OF EACH 'DAY INTERVAL'
590      -THE STATUS(OF INPUT FACTOR) AT START OF EACH 'DAY INTERVAL'
591      THEREAFTER, SET STATUS VALUE FOR EACH DAY OF INTERVAL(=INITIAL VALUE)
592      C
593      READ (11,10900) CASE
594      READ (11,11000) CLNCR,LIMIT
595      READ (11,11100) FHM,NW,IOP11,IOP12,IOP13,IOP14,IOP15,IOP16,IPRT,
596      *IPRT4
597      IF (IPRT4 .LE. 0) IPRT4=1
598      C
599      C FOLLOWING SEQUENCE SETS CUMUL NR ACFT DEPLOYED(EACH DAY)
600      C
601      READ (11,11200) NACDEP
602      READ (11,11200) (IDAY(I),I=1,NACDEP)
603      READ (11,11200) (NAC(I),I=1,NACDEP)
604      DO 800 I=1,NACDEP
605      K1=IDAY(I)
606      K2=IDAY(I+1)-1
607      IF (I.EQ.NACDEP) K2=NW
608      DO 700 J=K1,K2
609      AC(J)=NAC(I)
610      800 CONTINUE
611      C
612      C FOLLOWING SEQUENCE SETS PROGRAM FLYING HRS(EACH DAY)
613      C
614      READ (11,11200) NFHDAY
615      READ (11,11200) (IDAY(I),I=1,NFHDAY)
616      READ (11,11200) (NFH(I),I=1,NFHDAY)
617      DO 1000 I=1,NFHDAY
618      K1=IDAY(I)
619      K2=IDAY(I+1)-1
620      IF (I.EQ.NFHDAY) K2=NW
621      DO 900 J=K1,K2
622      FHR(J)=NFH(I)
623      1000 CONTINUE
624      C
625      C FOLLOWING SEQUENCE SETS NR ACFT LOST(ATTRITION)ON EACH DAY
626      C
627      READ (11,11200) NLDAY
628      READ (11,11200) (IDAY(I),I=1,NLDAY)
629      READ (11,11300) (ZLOSS(I),I=1,NLDAY)
630      DO 1200 I=1,NLDAY
631      K1=IDAY(I)
632      K2=IDAY(I+1)-1
633      IF (I.EQ.NLDAY) K2=NW
634      DO 1100 J=K1,K2
635      ALR(J)=ZLOSS(I)
636      1200 CONTINUE
637      C
638      C FOLLOWING SEQUENCE SETS INPUT MIN ACFT AVAIL REQMT FOR
639      C EACH DAY
640      C
641      READ (11,11200) NMDAY
642      READ (11,11200) (IDAY(I),I=1,NMDAY)
643      READ (11,11400) (AM(I),I=1,NMDAY)
644      DO 1400 I=1,NMDAY
645      K1=IDAY(I)
646      K2=IDAY(I+1)-1
647      IF (I.EQ.NMDAY) K2=NW
648      DO 1300 J=K1,K2
649      OMD(J)=-AM(I)
650      1400 CONTINUE
651      C
652      C DETERMINE MIN INPUT DAILY ACFT AVAIL REQMT(OVER ALL DAYS)
653      C
654      IK=MAXC(NW)
655      XAV=-OMD(IK)

```

```

656 DO 1500 I=1,NW
657 1500 AVH(I)=-DMO(I)
658 C
659 C READ PART NRS(SUBSCRIPTS) OF 5 ITEMS SELECTED FOR OUTPUT OF
660 C CUMULATIVE TOTAL(INIT STK=0) UNCONSTR COST RMT ON EACH DAY
661 READ (11,11200) IMSEL
662 READ (11,11200) (IPT(K),K=1,5)
663 WRITE (6,10200) CASE
664 WRITE (6,10300)
665 WRITE (6,12200)
666 WRITE (6,10500)
667 C
668 C PRINT INPUT-ORDERED LIST CONTAINING RANK,PART NR(FROM INPUT),
669 C NSN(STK NR OF PART),DESCRIPTION, UNIT COST AND INIT STOCK OF PART
670 C
671 DO 1510 K=1,NP
672 IF (MOD(K,51).NE.0) GO TO 1510
673 WRITE (6,10200) CASE
674 WRITE (6,10300)
675 WRITE (6,12200)
676 WRITE (6,10500)
677 1510 WRITE (6,12400) K,K,AMSN(K),ADESC(K),COST(K),ISTK(K)
678 C
679 C PRINT SCENARIO INPUT DATA BASE SUMMARY IF IPRT .NE. 0
680 C
681 IF (IPRT .EQ. 0) GO TO 1545
682 DO 1540 J=1,NW
683 IF (MOD(J,51).NE.0 .AND. J.GT. 1) GO TO 1535
684 WRITE (6,10200) CASE
685 WRITE (6,10210)
686 WRITE (6,10214) ADDOST,CONVF,LIMIT,IESS
687 WRITE (6,10215) FHM,CLNCR,IPRT4
688 WRITE (6,10220)
689 WRITE (6,10222)
690 1535 CALR=CALR+ALR(J)
691 1540 WRITE (6,10230) J,AC(J),FHR(J),AVH(J),ALR(J),CALR
692 1545 DO 1600 I=1,NP
693 1600 STK(I)=ISTK(I)
694 C
695 C CALCULATE TOTAL VALUE OF CURR INV (FOR PARTS PROCESSED)
696 C
697 ZCOST=0.
698 DO 1900 I=1,NP
699 1900 ZCOST=ZCOST+STK(I)*COST(I)
700 WRITE (6,10200) CASE
701 WRITE (6,11900)
702 WRITE (6,12000) ZCOST
703 M1=IPT(1)
704 M2=IPT(2)
705 M3=IPT(3)
706 M4=IPT(4)
707 M5=IPT(5)
708 DO 2000 I=1,NW
709 DCOSTF(I)=0.
710 DCOSTZ(I)=0.
711 ECOSTN(I)=0.
712 ECOSTZ(I)=0.
713 ECOSTF(I)=0.
714 2000 DCOSTN(I)=0.
715 DO 2100 I=1,NP
716 2100 DMO(I)=COST(I)
717 C
718 C ORDER PARTS BY DECR UNIT COST,SO IRC(1) IS PART NR(BASED ON INPUT
719 C ORDER ) OF MOST EXPENSIVE ITEM
720 C
721 DO 2200 K=1,NP
722 IRC(K)=MAXC(NP)
723 II=IRC(K)
724 2200 DMO(II)=-1.
725 WRITE (6,10200) CASE
726 WRITE (6,12100)
727 WRITE (6,12200)
728 WRITE (6,10500)
729 C
730 C PRINT COST-RANKED LIST CONTAINING RANK,PART NR(FROM INPUT),
731 C NSN(STK NR OF PART),DESCRIPTION OF PART, AND UNIT COST OF PART
732 C
733 DO 2400 K=1,NP
734 IF (MOD(K,51).NE.0) GO TO 2300
735 WRITE (6,10200) CASE
736 WRITE (6,12100)
737 WRITE (6,12200)

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738      WRITE (6,10500)
739      II=IRC(K)
740      2300 WRITE (6,12400) K,II,AMSN(II),ADESC(II),COST(II),ISTK(II)
741      2400 WRITE (6,10200) CASE
742
743      C      CALC MAX NR OF NMCS ACFT ALLOWED EACH DAY AND SOURCE OF
744      C      THIS LIMIT
745      C
746      CALR=0.
747      DO 2700 I=1,NW
748          ASURV(II)=AC(II)-CALR
749          XX=AMAX1(0.,ASURV(II)*(1.-AVM(II)))
750          YY=AMAX1(0.,ASURV(II)-FHP(II)/FHM)
751          ALLOWB(II)=AMIN1(XX,YY)
752          IF (ALLOWB(II).EQ.YY) RAV(II)=* FLYING HR PROG*
753          IF (ALLOWB(II).EQ.XX) RAV(II)=* AVAIL CONSTRAIN*
754      2700 CONTINUE
755      TTFH=0.000001
756
757      C      CALC TOTAL FLYING HRS IN FULL WAR PROGRAM
758      C
759      DO 2800 I=1,NW
760      2800 TTFH=TTFH+FHR(I)
761      WRITE (6,12500) TTFH
762
763      C      THRU STMT 3100 CALC 'FULL SUB' UNCONSTR COST PQMNTS(RFCS1(J),RFCS1(J))
764      C      FOR TOTAL(INIT STK=0)RQMNTS AND RESIDUAL(INIT STK=CURR INV)RQMNTS
765      C      FOR ALL PARTS
766      C
767      DO 3100 J=1,NP
768          CF(J)=FR(J)*OPA(J)
769          BF(J)=(1.-BC(J))*(1.-ZNRT(J))*CF(J)
770          DF(J)=(1.-DC(J))*(ZNRT(J))*CF(J)
771          CMD=0.
772          SRMAX2(J)=-999.
773          SRMAX1(J)=-999.
774          DO 3000 I=1,NW
775              CMD=SR(I,J,FHR,CMD)
776              XXX=CMD-ALLOWB(I)*OPA(J)
777              SR1=XXX-STK(I)
778              IF (XXX.GE.SRMAX1(J)) SRMAX1(J)=XXX
779              IF (SR1.GE.SRMAX2(J)) SRMAX2(J)=SR1
780              X1=AMAX1(0.,SRMAX1(J))
781
782      C      CALC *COST OF CUMUL (FULL SUB)RQMNTS THRU DAY I*FOR TOTAL(DCOSTF(I))
783      C      AND FOR RESIDUAL PQMNT (ECOSTF(I)) CASES
784      C
785          DCOSTF(I)=DCOSTF(I)+X1*COST(J)
786          ECOSTF(I)=ECOSTF(I)+AMAX1(0.,X1-STK(J))*COST(J)
787
788      C      CALC DAILY UNCONSTR COST (FULL SUB) RQMNT FOR PARTS SELECTED
789      C      FOR OUTPUT OF INDIV *CUMUL RQMNT THRU DAY I*
790      C
791          DO 2900 M=1,IMSEL
792              IF (J.NE.IPT(M)) GO TO 2900
793              SM(I,M)=AMAX1(0.,SRMAX1(J))
794      2900 CONTINUE
795      3000 CONTINUE
796          RFCS1(J)=AMAX1(0.,SRMAX1(J))
797          RFCS2(J)=AMAX1(0.,SRMAX2(J))
798      3100 CONTINUE
799
800      C      THRU STMT 32 CALC UNCONSTR COST *NMCS=0* TOTAL(INIT STK=0)
801      C      RQMNT(RNMCS(J)) AND RESIDUAL(INIT STK=CURR INV) RQMNT (RNMCS1(J))
802      C      FOR EACH PART. ALSO CALC *CUMUL COST OF RQMNT THRU DAY I* FOR
803      C      TOTAL RQMNT(DCOST2(I)) AND RESIDUAL RQMNT (ECOST2(I))
804      C
805      DO 4000 J=1,NP
806          CND=0.
807          SRMAX2(J)=-999.
808          SRMAX1(J)=-999.
809          DO 3900 I=1,NW
810              CND=SR(I,J,FHR,CND)
811              SR2=CND-STK(I)
812              IF (CND.GE.SRMAX1(J)) SRMAX1(J)=CND
813              IF (SR2.GE.SRMAX2(J)) SRMAX2(J)=SR2
814              X2=AMAX1(0.,SRMAX1(J))
815              R2=AMAX1(0.,SRMAX2(J))
816              DCOST2(I)=DCOST2(I)+X2*COST(J)
817              ECOST2(I)=ECOST2(I)+R2*COST(J)
818          DO 3800 M=1,IMSEL
819              IF (J.NE.IPT(M)) GO TO 3800

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820          SNM(I,M)=AMAX1(0.,SRMAX1(J))
821      7600      CONTINUE
822      3900      CONTINUE
823          RNMC1(J)=AMAX1(0.,SRMAX1(J))
824          RNMC2(J)=AMAX1(0.,SRMAX2(J))
825      4000      CONTINUE
826  C
827  C CALC DAYS FOR WHICH THE 'NO SUB' 'CUMUL COST OF ROMNT THRU DAY I'
828  C WILL BE COMPUTED
829  C
830      IF (IPRT4.LE.0) IPRT4=1
831      IF (IPRT4.GT.NW) IPRT4=NW
832      INST=NW/IPRT4
833      IST=NW-IPRT4*INST+1
834  C
835  C THRU STMT 3400 CALC UNCONSTR COST 'NO SUB' TOTAL (INIT STK=0)
836  C ROMNT(RNCS(J)) FOR EACH PART . ALSO CALC 'CUMUL COST OF ROMNT
837  C THRU DAY I'(DCOSTN(I))
838  C
839      DO 3200 L=1,NP
840      3200      S(L)=0.
841          NWT=NW+1
842          DO 3400 I=IST,NWT,IPRT4
843              IF (I.EQ.1) GO TO 3400
844              II=I-1
845              DCOSTN(II)=0
846              CALL NCRNCT (II,FHR,NP)
847              DO 3300 J=1,NP
848                  DCOSTN(II)=DCOSTN(II)+RNCS(J)*COST(J)
849                  DO 3300 M=1,IMSEL
850                      IF (J.EQ.IPT(M)) SNCH(II,M)=RNCS(J)
851      3300      CONTINUE
852      3400      CONTINUE
853          IF (MOD(NW,IPRT4) .EQ. 0) GO TO 3310
854          CALL NCRNCT(NW,FHR,NP)
855          DO 3320 J=1,NP
856              DCOSTN(NW)=DCOSTN(NW)+RNCS(J)*COST(J)
857              DO 3320 M=1,IMSEL
858                  IF (J.EQ.IPT(M)) SNCH(NW,M)=RNCS(J)
859      3320      CONTINUE
860  C
861  C THRU STMT 3700 CALC UNCONSTR COST 'NO SUB' RESIDUAL(INIT STK=CURR INV)
862  C ROMNT(RNCS(J)) FOR EACH PART . ALSO CALC 'CUMUL COST OF ROMNT
863  C THRU DAY I'(ECOSTN(I))
864  C
865      3310      DO 3500 L=1,NP
866      3500      S(L)=STK(L)
867          DO 3700 I=IST,NWT,IPRT4
868              IF (I.EQ.1) GO TO 3700
869              II=I-1
870              ECOSTN(II)=0
871              CALL NCRNCR (II,FHR,NP)
872              DO 3600 J=1,NP
873                  ECOSTN(II)=ECOSTN(II)+RNCS1(J)*COST(J)
874      3600      CONTINUE
875      3700      CONTINUE
876          IF (MOD(NW,IPRT4) .EQ. 0) GO TO 3410
877          CALL NCRNCR(NW,FHR,NP)
878          DO 3420 J=1,NP
879              ECOSTN(NW)=ECOSTN(NW)+RNCS1(J)*COST(J)
880      3420      ECOSTN(NW)=ECOSTN(NW)+RNCS1(J)*COST(J)
881      3410      WRITE (6,10200) CASE
882          TCNMC1=0.
883          TCFC1=0.
884          UCNMC1=0.
885          UCFCS=0.
886          UCNMC1=0.
887  C
888  C FOR EACH PART UNDER EACH POLICY WITH UNCONSTR COST,CALC TOTAL COST
889  C OF THAT PART(TYPE) IN THE TOTAL ROMT SOLUTIONS AND IN THE RESIDUAL
890  C ROMNT SOLUTIONS.
891  C THEN CALC TOTAL COST ,OVER ALL PARTS,OF EACH SOLUTION UNDER EACH
892  C POLICY.
893  C
894      DO 4100 J=1,NP
895          CNMC1(J)=COST(J)*RNMC1(J)
896          CNMC2(J)=COST(J)*RNMC2(J)
897          CFCS(J)=COST(J)*RFCS(J)
898          CFCS1(J)=COST(J)*RFCS1(J)
899          TCNMC1=TCNMC1+CNMC1(J)
900          UCNMC1=UCNMC1+CNMC1(J)
901          UCFCS=UCFCS+CFCS1(J)

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902      TCFCSS=TCFCSS+CFCS(J)
903      CNCS(J)=COST(J)*RNCS(J)
904      CNCS1(J)=COST(J)*PNCS1(J)
905      UCNCS=UCNCS+CNCS1(J)
906      4100 TCNCS=TCNCS+CNCS(J)
907
908      C PRINT TOTAL COST(OVER ALL PARTS) OF THE TOTAL(INIT STK=0) RQMNT
909      C SOLUTION FOR EACH POLICY
910      C
911      WRITE (6,10200) CASE
912      WRITE (6,12600)
913      WRITE (6,12700)
914      WRITE (6,12800) TCNCS
915      WRITE (6,12900) TCFCSS
916      WRITE (6,13000) TCNMCS
917
918      C PRINT TOTAL COST(OVER ALL PARTS) OF THE RESIDUAL(INIT STK=CURR INV )
919      C RQMNT SOLUTION FOR EACH POLICY
920      C
921      WRITE (6,10200) CASE
922      WRITE (6,13100)
923      WRITE (6,12700)
924      WRITE (6,12800) UCNCS
925      WRITE (6,12900) UCFCS
926      WRITE (6,13000) UCNMCS
927
928      C CALC COST OF REQUIRED CURRENT INVENTORY, I.E. THE VALUE OF INVENTORY
929      C EXCLUDING STOCKAGE IN EXCESS OF THE "NMCS=0" RQMNT FOR EACH PART.
930      C
931      SCOST=0.
932      DO 4200 I=1,NP
933          TSTK=AMIN1(STK(I),RNMCS(I))
934      4200 SCOST=SCOST+TSTK*COST(I)
935
936      C CALC CLNC=THE VALUE OF "REFUNDED" CURR INV + THE INPUT COST LIMIT.
937      C THIS NUMBER BECOMES THE COST LIMIT USED TO COMPUTE "TOTAL(INIT STK=0)
938      C RQMNTS" IN THE CONSTRAINED COST CASE.
939      C
940      CLNC=CLNCR+ZCOST
941
942      C PRINT SUMMARY OF CURRENT INVENTORY VALUE AND COST LIMITS FOR THE
943      C CONSTRAINED COST TOTAL RQMNT AND RESIDUAL(INIT STK=CUR INV) RQMNT CASE
944      C
945      WRITE (6,11900)
946      WRITE (6,13200)
947      WRITE (6,13300) CLNCR
948      WRITE (6,13400) SCOST
949      WRITE (6,13500) CLNC
950      IF (IOP1.EQ.0) GO TO 4500
951
952      C PRINT LIST (IN ORDER OF DECR PART UNIT COST) OF TOTAL(INIT STK=0)
953      C UNCONSTRAINED COST RQMNTS FOR EACH PART UNDER EACH POLICY.
954      C ALSO CALC FRAC OF TOTAL RQMNT(ALL PARTS) REPRESENTED BY EACH PART.
955      C
956      DO 4400 I=1,NP
957          II=IRC(I)
958          IF (MOD(I-1,50).NE.0) GO TO 4300
959          WRITE (6,10200) CASE
960          WRITE (6,13600) XAV
961          WRITE (6,10500)
962          WRITE (6,13700)
963          WRITE (6,10500)
964          WRITE (6,13800)
965          WRITE (6,10500)
966      4300 TC=100.*CNCS(II)/(TCNCS+.000001)
967          TA=100.*CNMCS(II)/(TCNMCS+.000001)
968          TB=100.*CFCS(II)/(TCFCSS+.000001)
969      4400 WRITE (6,13900) AMSN(II),ADESC(II),PFCS(II),CFCS(II),TB,RNCS(II),
970          +CNCS(II),TC,RNMCS(II),CNMCS(II),TA
971      4500 IF (IOP2.EQ.0) GO TO 4900
972
973      C PRINT LIST (IN ORDER OF DECR PART UNIT COST) OF RESIDUAL
974      C UNCONSTRAINED COST RQMNTS FOR EACH PART UNDER EACH POLICY.
975      C ALSO CALC FRAC OF TOTAL RQMNT(ALL PARTS) REPRESENTED BY
976      C EACH PART.
977      C
978      DO 4700 I=1,NP
979          II=IRC(I)
980          IF (MOD(I-1,50).NE.0) GO TO 4600
981          WRITE (6,10200) CASE
982          WRITE (6,14000) XAV
983          WRITE (6,10500)

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984      WRITE (6,13700)
985      WRITE (6,10500)
986      WRITE (6,13800)
987      WRITE (6,10500)
988      4600 TC=100.*CNCS1(II)/(UCNCS+.000001)
989      TA=100.*CNMCS1(II)/(UCNMCS+.000001)
990      TB=100.*CFCS1(II)/(UCFCS+.000001)
991      4700 WRITE (6,13900) AMSN(II),ADFCS(II),RFCS1(II),CFCS1(II),TB,
992      +RNCS1(II),CNCS1(II),TC,RNMCS1(II),CNMCS1(II),TA
993      C
994      C WRITE ONTO UNIT 12 A 'CURRENT INVENTORY' FOR EACH PART BASED
995      C ON THE RESIDUAL 'NO SUB' ROMNT BEING 'BOUGHT' AND ADDED TO CUPR INV
996      C
997      DO 4800 J=1,NP
998      4800 INC(J)=RNCS1(J)+STK(J)+.5
999      WRITE (12,11200) (INC(J),J=1,NP)
1000      4900 KNT=1
1001      5000 DO 5200 L=1,NW
1002      DO 5100 M=1,3
1003      FHPAPD(M,L)=0.
1004      5200 SUMB(L)=0.
1005      DO 5300 I=1,6
1006      5300 AVAVG(I)=0.
1007      DO 5400 J=1,NP
1008      5400 DMD(J)=0.
1009      TSURV=0.
1010      IND=0
1011      C
1012      C THRU STMT 6100 CALC THE DAILY ACFT AVAIL AND FLY HRS/ACFT/DAY RESULTING
1013      C WHEN THE 'FULL SUB' AND THE 'NO SUB' UNCONSTR COST ROMNTS ARE 'BOUGHT'
1014      C AND STOCKED. THESE STMTS WILL BE EXECUTED TWICE, ONCE (KNT=1) FOR
1015      C THE 'TOTAL INIT STK=Q1 ROMNT' CASE AND ONCE FOR THE RESIDUAL
1016      C (INIT STK=CURR INV) CASE. FOR CAPABILITY ASSESSMENT, RESIDUAL ROMNTS
1017      C ARE ADDED TO CURRENT INVENTORY.
1018      C
1019      TAV=0.
1020      TAV1=0.
1021      DO 6100 I=1,NW
1022      BMAX=0.
1023      DO 6000 K=1,NP
1024      II=IRCKI
1025      X=DMD(II)
1026      OMC(II)=SP(I,II,FHR,X)
1027      ZP=PNCS(II)
1028      IF (KNT.EQ.2) ZP=RNCS1(II)+STK(II)
1029      SUMP(II)=SUMB(II)+AMAX1(0.,OMC(II)-ZP)
1030      AUNCS=ASURV(II)-SUMB(II)
1031      IF (AUNCS.LT..001) AUNCS=0.
1032      FHPAPD(2,II)=AMINI(FHM,FHR(II)/(AUNCS+.01))
1033      ZZ=AUNCS
1034      AUNCS=AUNCS/(ASURV(II)+.00001)
1035      ZP=PFCS(II)
1036      IF (KNT.EQ.2) ZP=RFCS1(II)+STK(II)
1037      BOFCS=(DMD(II)-ZP)/QPA(II)
1038      IF (BOFCS.LE.0.) BOFCS=0.
1039      ZMAX=AMAX1(BMAX,BOFCS)
1040      IF (ZMAX.GT.BMAX) BMAX=ZMAX
1041      AUFCS=ASURV(II)-BMAX
1042      IF (AUFCS.LT.0.) AUFCS=0.
1043      FHPAPD(1,II)=AMINI(FHM,FHR(II)/(AUFCS+.01))
1044      ZZ=AUFCS
1045      AUFCS=AUFCS/(ASURV(II)+.00001)
1046      Z=ALLOWB(II)*QPA(II)
1047      6000 CONTINUE
1048      RNC(II)=AUNCS
1049      RFC(II)=AUFCS
1050      TAV=TAV+RFC(II)*ASURV(II)
1051      TAV1=TAV1+RNC(II)*ASURV(II)
1052      6100 CONTINUE
1053      C
1054      C PRINT THE DAILY ACFT AVAIL AND FLY HRS/ACFT/DAY RESULTING
1055      C WHEN THE 'FULL SUB' AND THE 'NO SUB' UNCONSTR COST ROMNTS ARE 'BOUGHT'
1056      C AND STOCKED.
1057      C
1058      DO 6300 I=1,NW
1059      AX=1.-(ALLOWB(I)/(ASURV(I)+.000001))
1060      IF (MOD(I-1,50).NE.0) GO TO 6200
1061      WRITE (6,10200) CASE
1062      WRITE (6,14700)
1063      IF (KNT.EQ.1) WRITE (6,14100)
1064      IF (KNT.EQ.2) WRITE (6,14200)
1065      WRITE (6,10500)

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1066      WRITE (6,14800)
1067      WRITE (6,10500)
1068      WRITE (6,14900)
1069      WRITE (6,15000)
1070      WRITE (6,10500)
1071      6200 TSURV=TSURV+ASURV(I)
1072      AVAVG(1)=AVAVG(1)+RFC(I)*ASURV(I)
1073      AVAVG(2)=AVAVG(2)+RNC(I)*ASURV(I)
1074      AVAVG(3)=AVAVG(3)+AX*ASURV(I)
1075      AVAVG(4)=AVAVG(4)+FHPAPD(1,I)*RFC(I)*ASURV(I)/(TAV+.0001)
1076      AVAVG(5)=AVAVG(5)+FHPAPD(2,I)*RNC(I)*ASURV(I)/(TAV1+.0001)
1077      6300 WRITE (6,15100) I,RFC(I),RNC(I),AX,RAV(I),AVH(I),FHPAPD(1,I),
1078      +FHPAPD(2,I),I
1079      DO 6400 K=1,3
1080      6400 AVAVG(K)=AVAVG(K)/TSURV
1081      WRITE (6,15200) (AVAVG(K),K=1,5)
1082      KNT=KNT+1
1083      IF (KNT.LE.2) GO TO 5000
1084      IF (IOPTS.EQ.0) GO TO 6600
1085      C
1086      C PRINT 'CUMULATIVE TOTAL (INIT STK=0) RQMNTS THRU DAY I' FOR THE
1087      C 5 SELECTED PARTS (SEE IPT(J))
1088      C
1089      DO 6500 I=1,NW
1090      IF (MOD(I-1,50).NE.0) GO TO 6500
1091      WRITE (6,10200) CASE
1092      WRITE (6,15300)
1093      WRITE (6,14100)
1094      WRITE (6,10500)
1095      WRITE (6,15400) AMSN(M1),AMSN(M2),AMSN(M3),AMSN(M4),AMSN(M5)
1096      WRITE (6,15400) ADESC(M1),ADESC(M2),ADESC(M3),ADESC(M4),ADESC(M5)
1097      +
1098      WRITE (6,15500)
1099      WRITE (6,10500)
1100      6500 WRITE (6,15600) I,(SM(I,K),SNCH(I,K),SNM(I,K),K=1,5)
1101      C
1102      C PRINT 'CUMULATIVE TOTAL (INIT STK=0) RQMNTS THRU DAY I' (FULL RQMNT)
1103      C FOR EACH POLICY
1104      C
1105      6600 DO 6700 I=1,NW
1106      IF (MOD(I-1,50).NE.0) GO TO 6700
1107      WRITE (6,10200) CASE
1108      WRITE (6,15700)
1109      WRITE (6,10500)
1110      WRITE (6,15800)
1111      6700 WRITE (6,15900) I,DCOSTF(I),DCOSTN(I),DCOSTZ(I)
1112      C
1113      C PRINT 'CUMULATIVE RESIDUAL (INIT STK=CURR INV) RQMNTS THRU DAY I'
1114      C (FULL RQMNT) FOR EACH POLICY
1115      C
1116      DO 6800 I=1,NW
1117      IF (MOD(I-1,50).NE.0) GO TO 6800
1118      WRITE (6,10200) CASE
1119      WRITE (6,16000)
1120      WRITE (6,10500)
1121      WRITE (6,15800)
1122      6800 WRITE (6,15900) I,ECOSTF(I),ECOSTN(I),ECOSTZ(I)
1123      IF (IOPT6.EQ.0) GO TO 17500
1124      C
1125      C REST OF PROGRAM PROCESSES THE CONSTRAINED COST CASE ONLY.
1126      C FIRST CHECK WHETHER COST LIMIT OF 'TOTAL (INIT STK=0) RQMNT'
1127      C CASE(='REFUNDED' CURR INV +INPUT COST LIMIT) EXCEEDS THE COST
1128      C OF THE CORRESP UNCONST COST RQMNT SOLUTION. IF SO,DO ONLY
1129      C THE RESIDUAL (INIT STK=CUPR INV) RQMNT CASE.
1130      C
1131      KCT=0
1132      CNC=TCNCS-CLNC
1133      IF (CNC.GT.0.) GO TO 6900
1134      WRITE (6,10200) CASE
1135      WRITE (6,16100) CLNC,TCNCS
1136      IOPT3=0
1137      GO TO 7200
1138      C
1139      C CALC CONST COST 'TOTAL RQMNT SOLUTION' BY REMOVING THE MOST
1140      C EXPENSIVE PARTS FROM THE UNCONSTRAINED COST TOTAL SOLUTION UNTIL THE
1141      C COST OF THE REMOVED ITEMS=THE COST LIMIT FOR THE 'TOTAL RQMNT' CASE.
1142      C
1143      6900 DO 7100 I=1,NP
1144      II=IPC(II)
1145      CNCS(II)=RNCN(II)*COST(II)
1146      IF (CNCS(II).LT.CNC) GO TO 7000
1147      RNCN(II)=RNCN(II)-CNC/(COST(II))

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1148      CNCS(II)=RNCS(II)*COST(II)
1149      GO TO 7200
1150 7000      RNCS(II)=0.
1151          CNC=CNC-CNCS(II)
1152          CNCS(II)=0.
1153 7100 CONTINUE
1154 C
1155 C CALC CONSTR COST 'RESIDUAL ROMNT SOLUTION' BY REMOVING THE MOST
1156 C EXPENSIVE PARTS FROM THE UNCONSTRAINED COST RESIDUAL SOLUTION UNTIL
1157 C COST OF THE REMOVED ITEMS=TOTAL COST OF UNCONSTRAINED COST 'NO SUB'
1158 C
1159 C SOLUTION (TCNCS) MINUS THE INPUT COST LIMIT (CLNCP)
1160 C
1161 7200 CNC=UCNCS-CLNCR
1162      IF (CNC.GT.0.) GO TO 7300
1163      WRITE (6,10200) CASE
1164      WRITE (6,16200) CLNCR,UCNCS
1165      KCT=2
1166      GO TO 8300
1167 7300 DO 7500 I=1,NP
1168      II=IRC(II)
1169      CNCS1(II)=RNCS1(II)*COST(II)
1170      IF (CNCS1(II).LT.CNC) GO TO 7400
1171      RNCS1(II)=RNCS1(II)-CNC/(COST(II))
1172      CNCS1(II)=RNCS1(II)*COST(II)
1173      GO TO 7600
1174 7400      RNCS1(II)=0.
1175          CNC=CNC-CNCS1(II)
1176          CNCS1(II)=0.
1177 7500 CONTINUE
1178 7600 IF (IOPT3.EQ.0) GO TO 7900
1179 C
1180 C PRINT, IN ORDER OF DECR PART UNIT COST, INDIV PART ROMNTS FOR
1181 C THE CONSTRAINED COST 'TOTAL ROMNT' CASE.
1182 C
1183      DO 7800 I=1,NP
1184      II=IRC(I)
1185      IF (MOD(I-1,50).NE.0) GO TO 7700
1186      WRITE (6,10200) CASE
1187      WRITE (6,16300) CLNC
1188      WRITE (6,16400) CLNC
1189      WRITE (6,10500)
1190      WRITE (6,13700)
1191      WRITE (6,10500)
1192      WRITE (6,13800)
1193      WRITE (6,10500)
1194      TC=100.*CNCS(II)/(CLNC+.000001)
1195      7700 WRITE (6,16500) AMSN(II),ADESC(II),RNCS(II),CNCS(II),TC
1196      7900 IF (IOPT4.EQ.0) GO TO 8200
1197 C
1198 C PRINT, IN ORDER OF DECR PART UNIT COST, INDIV PART ROMNTS FOR
1199 C THE CONSTRAINED COST 'RESIDUAL ROMNT' CASE.
1200 C
1201      DO 8100 I=1,NP
1202      II=IRC(I)
1203      IF (MOD(I-1,50).NE.0) GO TO 8000
1204      WRITE (6,10200) CASE
1205      WRITE (6,16600) CLNCR
1206      WRITE (6,16700) CLNCR
1207      WRITE (6,10500)
1208      WRITE (6,13700)
1209      WRITE (6,10500)
1210      WRITE (6,13800)
1211      WRITE (6,10500)
1212      8000 TC=100.*CNCS1(II)/(CLNCR+.000001)
1213      8100 WRITE (6,16500) AMSN(II),ADESC(II),RNCS1(II),CNCS1(II),TC
1214      8200 KNT=1
1215 C
1216 C      IF CONSTR COST 'TOTAL(INIT STK=0) ROMNT' ROMNT WAS NOT
1217 C      CALCULATED
1218 C      DO CAPABILITY ASSFSMENT FOR RESIDUAL ROMNT CASE ONLY.
1219 C
1220 8300 IF (IOPT3.EQ.0) GO TO 9500
1221 C
1222 C THE REST OF THE PROGRAM DOES A CAPABILITY ASSESSMENT FOR THE
1223 C CONSTRAINED COST CASE(S). I.E. THE PROGRAM CALCULATES DAILY(AVERAGE)
1224 C ACFT AVAILABLE, FRACTION PROGRAM FLYING HRS FLOWN, AND
1225 C FLYING HRS/AVAIL ACFT/DAY GIVEN THAT
1226 C (1) THE CONSTR COST 'TOTAL(INIT STK=0) ROMNT' IS STOCKED
1227 C AND (2) THE CONSTR COST RESIDUAL(UNIT STK=CURR INV) IS STOCKED
1228 C ALONG WITH CURR INV.
1229 C TO GENERATE THESE, THE FOLLOWING STMTS ARE EXECUTED TWICE, FOR

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1230 C KNT=1 AND FOR KNT=2. THE FIRST TIME(KNT=1) THE NEW 'CURR INV' FOR
1231 C EACH PART IS SET= THE CONSTP COST 'TOTAL RQMNT'. THE SECOND TIME,
1232 C (KNT=2) THE NEW 'CURR INV' FOR EACH PART IS SET = OLD 'CURR INV' +
1233 C THE CONSTR COST RESIDUAL RQMNT. IN EACH CASE ,THE NEW 'CURR INV' IS
1234 C DENOTED BY RNCS(J).
1235 C
1236 8400 AVAVG(1)=0.
1237 AVAVG(6)=0.
1238 TFHNC=0.
1239 IND=0
1240 DO 8500 I=1,NW
1241 SUMB(I)=0.
1242 8500 CONTINUE
1243 DO 8600 J=1,NP
1244 DMD(J)=0.
1245 8600 DMD(J)=0.
1246 XX=ASURV(1)
1247 TAV=0.
1248 DO 9200 I=1,NW
1249 IF (I.GT.1) XX=RNC(I-1)*ASURV(I-1)+AC(I)-AC(I-1)
1250 FHA(I)=AMIN1(XX*FHM,FHR(I))
1251 INDX=0
1252 DO 8800 K=1,NP
1253 XX=DMD(K)
1254 DMD(K)=SR(I,K,FHA,XX)
1255 ZP=DMD(K)-RNCS(K)
1256 SUMR(I)=SUMB(I)+AMAX1(0.,ZP)
1257 AUNCS=ASURV(I)-SUMB(I)
1258 IF (AUNCS.LT..001) AUNCS=0.
1259 XX=FHR(I)
1260 YY=AUNCS*FHM
1261 FHNC(I)=AMIN1(XX,YY)
1262 FHPAPD(3,I)=AMIN1(FHM,FHR(I)/(AUNCS+.01))
1263 FHNZ(I)=FHNC(I)/(FHR(I)+.000001)
1264 AUNCS=AUNCS/(ASURV(I)+.00001)
1265 8800 CONTINUE
1266 Z=ABS(FHNC(I)-FHA(I))
1267 INDX=INDX+1
1268 IF (INDX.GE.LIMIT.OR.(Z/(TFH+1.)).LE.(CONVF/NW).OR.INDX.GT.30)
1269 * GO TO 9000
1270 FHA(I)=.5*(FHA(I)+FHNC(I))
1271 SUMB(I)=0.
1272 DO 8900 J=1,NP
1273 DMD(J)=DMD(J)
1274 GO TO 8700
1275 9000 TFHNC=TFHNC+FHNC(I)
1276 DO 9100 J=1,NP
1277 DMD(J)=DMD(J)
1278 TNCD=TNCD+Z
1279 RNC(I)=AUNCS
1280 TAV=TAV+RNC(I)*ASURV(I)
1281 9200 CONTINUE
1282 Z=100.*TNCD/(TFHNC+.001)
1283 C
1284 C PRINT THE DAILY(AVERAGE) ACFT AVAIL,FRAC PGM FLY HRS
1285 C FLOWN,AND
1286 C FLY HRS/AVAIL ACFT/DAY FOR THE CONSTR COST CAPABILITY
1287 C ASSESSMENT.
1288 C
1289 C
1290 DO 9400 I=1,NW
1291 AX=1.-(ALLOWB(I)/(ASURV(I)+.000001))
1292 IF (MOD(I-1,50).NE.0) GO TO 9300
1293 WRITE (6,10200) CASE
1294 WRITE (6,14700)
1295 IF (KNT.EQ.1) WRITE (6,16400) CLNC
1296 IF (KNT.EQ.2) WRITE (6,16700) CLNCR
1297 WRITE (6,10500)
1298 WRITE (6,16900) Z
1299 WRITE (6,10500)
1300 WRITE (6,17000)
1301 WRITE (6,10500)
1302 WRITE (6,17100)
1303 WRITE (6,17200)
1304 WRITE (6,10500)
1305 9300 AVAVG(1)=AVAVG(1)+RNC(I)*ASURV(I)/TSURV
1306 AVAVG(6)=AVAVG(6)+FHPAPD(3,I)*RNC(I)*ASURV(I)/TAV
1307 9400 WRITE (6,17300) 1,RNC(I),AX,I,FHNZ(I),FHPAPD(3,I)
1308 FNC=TFHNC/TFH
1309 WRITE (6,17400) AVAVG(1),AVAVG(6),FNC,AVAVG(6)
1310 9500 IF (KNT.EQ.2.OR.IOPT4.EQ.0.OR.KCT.EQ.2) GO TO 17500
1311 DO 9600 I=1,NP
1312 RNCS(I)=STK(I)+RNCS(I)

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1312      KNT=KNT+1
1313      GO TO 8400
1314      9700 FORMAT (2F5.2,I5)
1315      9800 FORMAT (//)
1316      9900 FORMAT (2X,A15,F9.0,5X,F3.0,F5.0,5F3.0,I1,10X,I5)
1317      10000 FORMAT (I2)
1318      10100 FORMAT (A16,////////)
1319      10200 FORMAT (1H1,3CX,'CASE= ',A16)
1320      10210 FORMAT (///,10X,'SCENARIO INPUT DATA SUMMARY')
1321      10214 FORMAT (///,5X,'OST OFFSET=',F6.1,' DAYS DESIRED CONVERGECE=',
1322      *F5.3,3X,'MAX ITERATIONS=',I3,3X,'MAX ESSENTIALITY=',I3)
1323      10215 FORMAT (//,5X,'MAX FLY HRS/ACFT/DAY=',F5.1,4X,'ADD-ON COST LI',
1324      *'MIT=',F14.0,3X,'NO SUB CUM RCMT COST CALC EA',I3,' DAYS')
1325      10220 FORMAT (//,13X,'CUM ACFT PROGRAM MIN REQ ACFT CUM ACFT')
1326      10222 FORMAT (7X,'DAY DEPLOYED FLY HRS AVAIL LOST',7X,
1327      *'LOST')
1328      10230 FORMAT (5X,I5,F11.0,F10.0,F10.2,F8.1,F11.1)
1329      10300 FORMAT (///,'ITEMS RANK ORDERED IN NORMAL INPUT ORDER')
1330      10400 FORMAT (//,'PART',5X,'MSN',14X,'DESCRIPTION',7X,' COST OST FAIL',
1331      *RT NRYS BCY DCY DRT BCON DCON QPA ESS INIT STK')
1332      10500 FORMAT (//)
1333      10600 FORMAT (9X,A16,2X,A16,F8.0,F3.0,F8.6,F5.2,3F5.0,2F5.2,1X,F3.0,I5,
1334      *I10)
1335      10700 FORMAT (1X,I4,4X,A16,2X,A16,F8.0,F3.0,F8.6,F5.2,3F5.0,2F5.2,1X,
1336      *F3.0,I5,I10)
1337      10800 FORMAT (//,'TOTAL NR PARTS=',I4,' NR USED=',I4)
1338      10900 FORMAT (1X,A16)
1339      11000 FORMAT (1X,F14.0,I5)
1340      11100 FORMAT (1X,F9.1,I5,5X,6I5,10X,2I5)
1341      11200 FORMAT (16I5)
1342      11300 FORMAT (16F5.1)
1343      11400 FORMAT (16F5.2)
1344      11500 FORMAT (//,5X,'CURRENT INVENTORY FOR EACH PART PROCESSED')
1345      11600 FORMAT (//,5X,'PART NR/PART NR/NR PARTS IN TOTAL INVENTORY')
1346      11700 FORMAT (//,'RANK PART NR RANK PART NR RANK PART NR RANK PART',
1347      *NR RANK PART NP RANK PART NR)
1348      11800 FORMAT (20I5)
1349      11900 FORMAT (///)
1350      12000 FORMAT (//,10X,' COST OF CURRENT INVENTORY=',F14.0)
1351      12100 FORMAT (//,'ITEMS RANK ORDERED BY DECREASING PART COST')
1352      12200 FORMAT (//,'RANK PART',8X,'MSN',18X,'DESCRIPTION',13X,'COST',3X,
1353      *' INIT STK')
1354      12300 FORMAT (//,5X,'COST RANKING/PART NR/STOCK NR/PART DESCRIP',/UNIT C
1355      *OST(I5))
1356      12400 FORMAT (2I5,5X,A16,5X,A16,2X,F14.0,4X,I8)
1357      12500 FORMAT (2X,'F10.1)
1358      12600 FORMAT (//,10X,'TOTAL(INIT STK=0) COST OF POLICIES')
1359      12700 FORMAT (//,'POLICY TOT COST')
1360      12800 FORMAT (//,'NO SUB',F14.0)
1361      12900 FORMAT (//,'FULL SUB',F14.0)
1362      13000 FORMAT (//,'NMCS=0',F14.0)
1363      13100 FORMAT (//,10X,'RESIDUAL(INIT STK=CURR STK) COST OF POLICIES')
1364      13200 FORMAT (42X,'NO SUBST')
1365      13300 FORMAT (//,7X,' COST CONSTRAINT OF ADDED BUY=',F14.0)
1366      13400 FORMAT (//,1X,' COST OF CURRENT REQUIRED INVENTORY=',F14.0)
1367      13500 FORMAT (//,3X,' TOTAL (CURP INV+ADDED BUY) COST=',F14.0)
1368      13600 FORMAT (//,' TOTAL (INIT STK=0) STK RQMTS BY POLICY ** MINIMUM AC A
1369      *VAIL=',F5.2,' ** PARTS IN ORDER OF DECREASING UNIT COST')
1370      13700 FORMAT (44X,'FULL SUBST',19X,'NO SUBST',23X,'NMCS=0')
1371      13800 FORMAT (114X,'PART',21X,'RCMT',7X,'COST',7X,'RCMT',7X,'COS
1372      *T',7X,'RCMT',7X,'COST',7X,'RCMT',7X,'COS')
1373      13900 FORMAT (2X,A16,2X,A16,3(F8.1,F12.0,F6.2,4X))
1374      14000 FORMAT (//,'RESIDUAL(INIT STK=CURR STK) STK RQMT BY POLICY *MINI',
1375      *'MUM AC AVAIL=',F5.2,' ** PARTS IN ORDER OF DECREASING UNIT COST')
1376      14100 FORMAT (///,30X,'** CASES ASSUME TOTAL(INIT STK=0) RQMTS', ' ARE S
1377      *TOCKED **')
1378      14200 FORMAT (///,30X,'** CASES ASSUME RESIDUAL(INIT STK=CURR STK)', ' RE
1379      *QMTS ARE STOCKED **')
1380      14300 FORMAT (//,22X,' CRIT',8X,' AC',6X,'AC',27X,'ALLOWED NET',23X,' P
1381      *ART')
1382      14400 FORMAT (//,'POLICY DAY',8X,'PART',8X,'DEPLOY SURVIV NMCS AC',
1383      *AC UP AC OA BORDERS DEPENDS',23X,' NR')
1384      14500 FORMAT (//,'NO SUBST',15,4X,A16,F7.0,3F8.0,F6.3,F8.1,F8.1,6X,A16,I6
1385      *)
1386      14600 FORMAT (//,'FULL SUB',14,3X,A16,F7.0,3F8.0,F6.3,F8.0,F8.1,6X,A16,I6
1387      *)
1388      14700 FORMAT (//,30X,'** FORCE CAPABILITY GIVEN THAT THE COMPUTED', ' REQ
1389      *UIREMENT (FOR EACH POLICY) IS STOCKED **')
1390      14800 FORMAT (//,9X,'AIRCRAFT AVAILABILITY',36X,'FLY HRS / ACFT / DAY')
1391      14900 FORMAT (14X,'FULL',9X,'NO',38X,'FULL',8X,'NO')
1392      15000 FORMAT (6X,'DAY',6X,'SUB',8X,'SUB', ' REQ AVAIL', ' SOURCE'
1393      *, ' AVAIL',7X,'SUB',7X,'SUB',5X,'DAY')

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1394 15100 FORMAT (5X,I4,4X,F5.3,6X,F5.3,6X,F5.3,A16,F5.?,2F10.1,I8)
1395 15200 FORMAT (/ ,1X,10X,AVERAGE= ,F5.3,6X,F5.3,6X,F5.3,21X,2F10.1)
1396 15300 FORMAT (/ ,42X,"CUM STOCK REQUIRED THROUGH GIVEN DAY")
1397 15400 FORMAT (8X,5(A16,8X))
1398 15500 FORMAT (3X,"DAY FULL SB NO SUB NMCS=0 FULL SB NO SUB", NMCS=0
1399 * FULL SB NO SUB NMCS=0 FULL SB NO SUB NMCS=0", " FULL SB NO SU
1400 *B NMCS=0")
1401 15600 FORMAT (2X,I4,15F8.1)
1402 15700 FORMAT (/ ,12X,"CUM TOTAL (INIT STK=0) COST OF REQ THRU GIVEN DAY")
1403 15800 FORMAT (/ ,6X,"DAY",3X," FULL SUB NO SUB NMCS=0")
1404 15900 FORMAT (6X,I3,3X,3F11.0)
1405 16000 FORMAT (/ ,12X,"CUM RESIDUAL (INIT STK= CURR STK) COST OF REQ THRU",
1406 * " GIVEN DAY")
1407 16100 FORMAT (/ ,10X,"TOTAL (CURR INV+ADDED BUY) COST CONSTRAINT=",F12.0,"
1408 * EXCEEDS UNCONSTRAINED POLICY COST=",F12.0)
1409 16200 FORMAT (/ ,10X,"ADDED BUY CONSTRAINT=",F12.0," EXCEEDS RESIDUAL R
1410 * EOMT COST=",F12.0)
1411 16300 FORMAT (/ ,10X,"TOTAL (INIT STK=0) STK REQ BY POLICY **FULL REQ COS"
1412 * "T LIMIT =",F12.0," ** PARTS IN ORDER OF DECR UNIT COST")
1413 16400 FORMAT (/ ,30X,"** TOTAL (INIT STK=0) COST OF *CURR INVENTORY",** A
1414 * "DDED BUY* (=",F14.0," ) AVAIL FOR REALLOCATION")
1415 16500 FORMAT (2X,A16,2X,A16,30X,F8.1,F12.0,F6.2,4X)
1416 16600 FORMAT (/ ,10X,"RESIDUAL (INIT STK=CURR STK STK REQ ** ADD-ON COST"
1417 * " LIMIT =",F12.0," ** PARTS IN ORDER OF DECR UNIT COST")
1418 16700 FORMAT (/ ,30X,"** CURR STK=INIT STK, ONLY COST OF ADDED BUY (=",F
1419 * "14.0," ) IS AVAIL FOR REALLOCATION")
1420 16900 FORMAT (1," TOTAL FLY HRS CONVERGED TO", " WITHIN",F7.3," PERCENT")
1421 17000 FORMAT (9X,"AIRCRAFT AVAILABILITY",41X," FRAC FLY HR ACH",4X," F
1422 *LY HR/AC/DAY")
1423 17100 FORMAT (27X,"NO",48X,"NO",20X,"NO")
1424 17200 FORMAT (16X,"DAY",7X,"SUB",13X,"REQ AVAIL",16X,"DAY",6X,"SUB",19X,
1425 * "SUB")
1426 17300 FORMAT (15X,I4,5X,F5.3,17X,F5.3,15X,I4,4X,F5.3,14X,F8.1)
1427 17400 FORMAT (/ , " AVERAGE AVAIL",10X,F5.3,17X,F5.3,13X,"FRAC FLY", " HRS
1428 * DONE= ",F5.3," AVG FH/AC/DAY= ",F5.1)
1429 17500 END

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SUBROUTINE NCRNCT

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1 SUBROUTINE NCRNCT (NO,FPR,NP)
2 NAME: NCRNCT TYPE: SUBROUTINE
3
4 PURPOSE: THE NCRNCT (NO CANNIBALIZATION REQUIREMENTS-TOTAL) SUBROUTINE
5 GENERATES A LEAST COST TOTAL (INIT INV=0) REQNTS MIX OF SPARE PARTS
6 NEEDED TO MEET A FLYING HR PROGRAM USING A 'NO SUBSTITUTION' PART
7 REPLACEMENT POLICY AND UNCONSTRAINED COSTS.
8
9 ARGUMENTS:
10
11 NAME DIMENSION TYPE DESCRIPTION
12
13 FHR(I) 120 REAL SEE ARGUMENT LIST ABOVE
14
15 NO 1 FIXED INPUT ARGUMENT SET TO NR DAYS (FROM
16 DAY 1) FOR WHICH FULL REQNT IS TO BE
17 COMPUTED
18
19 FHR(I) 120 REAL PROGRAM FLYING HRS REQUIRED ON DAY I
20 (SAME AS FHR(I) IN MAIN PROG)
21
22 NP 1 FIXED NR OF PART TYPES TREATED (SAME AS NP
23 IN MAIN PROGRAM)
24
25 CALLED BY: MAIN PROGRAM
26
27 CALLS
28 -FUNCTION SR
29
30 FILES USED : NO FILES READ OR WRITTEN
31
32 LOCAL ARRAYS
33
34 NAME DIMENSION TYPE DESCRIPTION
35
36 SUMBZ(I) 120 REAL CUMULATIVE RAW (INIT STK=0) DEMANDS
37 (ALL PARTS) THRU DAY I
38
39
40 COMMON BLOCK (UNLABELED) ENTRIES USED IN THIS ROUTINE
41
42 NAME DIMENSION TYPE DESCRIPTION
43
44 ALLOWP(I) 120 REAL MAXIMUM ALLOWABLE NMCS AC ON DAY I WHICH
45 WILL STILL ALLOW ACHIEVMENT OF CASE OBJECTIVE
46 (FLY HR AND AVAILABILITY) ON DAY I
47
48 IRC(J) 300 REAL PART NR CORRESPONDING TO THE J-TH MOST
49 COSTLY PART TYPE. (SEE MAIN PROGRAM COMMON)
50 THIS ROUTINE MUST PROCESS PARTS IN ORDER
51 OF DECREASING UNIT COST.
52
53 RNCST(J) 300 REAL TOTAL REQNT (INIT STK=0) FOR PART J USING A
54 'NO SUBSTITUTION' REPLACEMENT POLICY
55 WITH UNCONSTRAINED COST. THIS QUANTITY
56 IS CALCULATED ONLY IN THIS ROUTINE, AND
57 IS PASSED THRU COMMON TO THE MAIN PROG
58
59
60 COMMON
61 + ALLOWP(120), RCY(700), OF(300), CF(300),
62 + DCY(300), OF(300), OMD(300), IRC(300),
63 + RNCST(300), PNCS1(300), RNMCS(300), S(300)
64 + DIMENSION
65 + FHR(120), SUMBZ(120)
66
67 SUMR=0.
68 DO 100 L=1,NO
69 100 SUMBZ(L)=0.
70 TSUMB=0.
71
72 C
73 PROCESS PARTS IN DECREASING COST ORDER
74
75 DO 300 K=1,NP
76 II=IRC(K)
77
78 C

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82 C          INITIALIZE ROMNT TO INITIAL INVENTORY(=0) (S(II)=0)
83 C
84 C          RNCS(II)=S(II)
85 C          CDMO=C.
86 C          DO 200 I=1,ND
87 C
88 C          CALC CUMULATIVE NET DEMAND (CDMO) FOR PART II THRU DAY I.
89 C          THEN CALC (SUMRZ(I)) TOTAL NET DEMAND THRU DAY I OVER THE K MOST
90 C          EXPENSIVE PART TYPES. FINALLY CALC (TSUMR) THE NET TOTAL STOCKOUT
91 C          ('HOLES') THRU DAY I AND SET THE ROMNT FOR PART II= THE DIFFERENCE
92 C          BETWEEN THE NET TOTAL STOCKOUT AND THE ALLOWABLE STOCKOUT(ALLOWB(I)).
93 C          THIS CALC IMPLICITLY ASSUMES (THRU SUMR) THAT THE ROMNTS FOR THE
94 C          (K-I) MOST EXPENSIVE PARTS HAVE BEEN COMPUTED AND BOUGHT.
95 C
96 C          CDMO=SR(I,II,FHR,CDMO)
97 C          SUMBZ(II)=SUMBZ(II)+CDMO
98 C          TSUMR=AMAX1(SUMBZ(II)-SUMR,0.)
99 C          IF ((TSUMR-RNCS(II)).GE.ALLOWB(I)) RNCS(II)=TSUMR-ALLOWB(I)
100 C          200 CONTINUE
101 C
102 C          CALC (SUMR) TOTAL UNITS STOCK REQUIRED FOR THE K MOST EXPENSIVE
103 C          PARTS
104 C
105 C          SUMR=SUMR+RNCS(II)
106 C          300 CONTINUE
107 C          RETURN
108 C          END

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SUBROUTINE NCRNCR

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1  SUBROUTINE NCRNCR (ND,FHR,NP)
2  NAME: NCRNCR TYPE: SUBROUTINE
3
4  PURPOSE: THE NCRNCT (NO CANNIBALIZATION REQUIREMENTS-RESIDUAL) SUBROUTINE
5  GENERATES A LEAST COST RESIDUAL (INIT INV=CURRENT INVENTORY) REQNTS MIX
6  OF SPARE PARTS NEEDED TO MEET A FLYING HR PROGRAM USING A 'NO SUBSTITUTION
7  REPLACEMENT POLICY AND UNCONSTRAINED COSTS.
8
9  ARGUMENTS:
10
11      NAME      DIMENSION  TYPE      DESCRIPTION
12
13  FHR(I)      120  REAL      SEE ARGUMENT LIST ABOVE
14
15      ND          1  FIXED    INPUT ARGUMENT SET TO NR DAYS (FROM
16      DAY 1) FOR WHICH FULL REQNT IS TO BE
17      COMPUTED
18
19  FHR(I)      120  REAL      PROGRAM FLYING HRS REQUIRED ON DAY I
20      NP          1  FIXED    (SAME AS FHR(I) IN MAIN PROG)
21      NR OF PART TYPES TREATED (SAME AS NP
22      IN MAIN PROGRAM)
23
24  CALLED BY: MAIN PROGRAM
25
26  CALLS
27  -FUNCTION SR
28
29  FILES USED : NO FILES READ OR WRITTEN
30
31  LOCAL ARRAYS
32
33      NAME      DIMENSION  TYPE      DESCRIPTION
34
35  SUMBZ(I)    120  REAL      CUMULATIVE RAW (INIT STK=0) DEMANDS
36      (ALL PARTS) THRU DAY I
37
38  SUMP(I)     120  REAL      TOTAL UNITS (ALL PARTS) STOCKED IN EXCESS
39      OF EXPECTED DEMAND ON DAY I
40
41  COMMON BLOCK (UNLABELED) ENTRIES USED IN THIS ROUTINE
42
43      NAME      DIMENSION  TYPE      DESCRIPTION
44
45  ALLOWB(I)   120  REAL      MAXIMUM ALLOWABLE NMCS AC ON DAY I WHICH
46      WILL STILL ALLOW ACHIEVEMENT OF CASE OBJECTIVE
47      (FLY HR AND AVAILABILITY) ON DAY I
48
49  IRC(J)      300  REAL      PART NR CORRESPONDING TO THE J-TH MOST
50      COSTLY PART TYPE. (SEE MAIN PROGRAM COMMON)
51      THIS ROUTINE MUST PROCESS PARTS IN ORDER
52      OF DECREASING UNIT COST.
53
54  RNCS1(J)    300  REAL      RESIDUAL REQNT (INIT STK=CURR STK) FOR PART J
55      USING A 'FULL SUBSTITUTION' REPLACEMENT POLICY
56      WITH UNCONSTRAINED COST. THIS QUANTITY
57      IS CALCULATED ONLY IN THIS ROUTINE, AND
58      IS PASSED THRU COMMON TO THE MAIN PROG
59
60  COMMON
61  * ALLOWB(120), RCY(300), BF(300), CF(300),
62  * DCY(300), DF(300), DND(300), IRC(300),
63  * RNCS(300), FNCS1(300), RNMCS(300), S(300)
64
65  DIMENSION
66  * FHR(120), SUMBZ(120), SUMP(120)
67
68  SUMR=0.
69  DO 100 I=1,NO
70  SUMP(I)=0.
71  100 SUMBZ(I)=0.
72  TSUMB=0.
73
74  PROCESS PARTS IN DECREASING COST ORDER
75
76
77
78
79
80
81

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82      DO 300 K=1,NP
83      11=IRCI(K)
84      C
85      C      INITIALIZE RESIDUAL REQMT TO INITIAL INVENTORY(S(II))
86      C
87      RNCS1(II)=S(II)
88      IF (S(II) .GT. RNMCS(II)) GO TO 300
89      CDMO=N.
90      DO 200 I=1,ND
91      C
92      C      CALC CUMULATIVE NET DEMAND (CDMO) FOR PART II THRU DAY I.
93      C      THEN CALC EXCESS (SUMP(I)) OF CURRENT INVENTORY OVER NET DEMAND
94      C      THEN CALC (SUMBZ(II)) TOTAL NET DEMAND THRU DAY I OVER THE K MOST
95      C      EXPENSIVE PART TYPES. FINALLY CALC (TSUMR) THE NET TOTAL STOCKOUT
96      C      ('HOLES') THRU DAY I AND SET THE REQMT FOR PART II= THE DIFFERENCE
97      C      BETWEEN THE NET TOTAL STOCKOUT AND THE ALLOWABLE STOCKOUT(ALLOWB(I)).
98      C      THIS CALC IMPLICITLY ASSUMES (THRU SUMR) THAT THE REQMTS FOR THE
99      C      (K-1) MOST EXPENSIVE PARTS HAVE BEEN COMPUTED AND BOUGHT.
100     C
101     CDMO=SR(I,II,FHR,CDMO)
102     SUMP(I)=SUMP(I)+AMAX1(0.,(RNCS1(II)-CDMO))
103     SUMBZ(II)=SUMBZ(II)+CDMO
104     TSUMB=AMAX1(SUMBZ(II)-SUMR+SUMP(I),0.)
105     IF ((TSUMB-RNCS1(II)).GE.ALLOWB(I)) RNCS1(II)=TSUMB-ALLOWB(I)
106     200 CONTINUE
107     C
108     C      CALC (SUMR) TOTAL UNITS STOCK REQUIRED FOR THE K MOST EXPENSIVE
109     C      PARTS
110     C
111     SUMR=SUMR+RNCS1(II)
112     300 CONTINUE
113     DO 400 J=1,NP
114     400 RNCS1(J)=RNCS1(J)-S(J)
115     RETURN
116     END

```

FUNCTION SR

```

1  FUNCTION SR (I,J,FHR,COMD)
2  NAME: SR                                TYPE: FUNCTION
3
4  PURPOSE: THE SR (STOCK REQUIRED) FUNCTION CALCULATES THE CUMULATIVE
5  NET DEMAND THRU A SPECIFIED DAY FOR A SPECIFIED PART BASED
6  ON A SPECIFIED FLYING PROGRAM. INITIAL INVENTORY IS ASSUMED
7  IN THIS CALCULATION. NET DEMANDS IS BASICALLY
8  FAILED ITEMS OFFSET BY RETURNING REPAIRS. IN A SENSE IT'S THE
9  NET NR OF 'HOLES' (CAUSED BY THE ITEM) WHICH ARE PRESENT ON
10 A SPECIFIED DAY, ASSUMING A ZERO INITIAL INVENTORY.
11
12 ARGUMENTS:
13
14 NAME      DIMENSION  TYPE      DESCRIPTION
15
16 COMD      1          REAL      THE CUMULATIVE NET DEMAND THRU THE
17                                PREVIOUS DAY(I-I) FOR PART NR J.
18                                IT= 0 OF A PREVIOUSLY CALCULATED VALUE
19                                (FOR DAY I-I) OF SR.
20
21 FHR(I)    120        REAL      PROGRAM FLYING HRS FLOWN ON DAY I.
22                                SOMETIMES THIS WILL BE THE SAME AS
23                                FHR(I) IN THE MAIN PROG. SOMETIMES (IN
24                                CAPABILITY ASSESSMENT) THIS WILL BE AN
25                                ESTIMATE OF 'FLYING HRS FLOWN' ON DAY I.
26
27 I          1          FIXED     CURRENT DAY
28
29 J          1          FIXED     PART NR OF PART BEING PROCESSED
30
31 CALLED BY: MAIN PROGRAM
32 CALLS
33 -FUNCTION SR
34 FILES USED : NO FILES READ OR WRITTEN
35
36 LOCAL ARRAYS
37
38 NAME      DIMENSION  TYPE      DESCRIPTION
39
40 FHR(I)    120        REAL      SEE ARGUMENT LIST ABOVE
41
42 COMMON BLOCK (UNLABELED) ENTRIES USED IN THIS ROUTINE
43
44 NAME      DIMENSION  TYPE      DESCRIPTION
45
46 BCY(J)    300        REAL      BASE REPAIR CYCLE TIME (DAYS) OF PART J
47                                (=BASE REPAIR TIME OF PART)(BASE=RETAIL)
48
49 BF(J)     300        REAL      A COEFFICIENT USED IN CALCULATION OF NET
50                                DEMANDS(SR(I,J,...)) FOR PART J. IT=
51                                (1-BC(J))*(1-ZNRT(J))*CF(J)
52
53 CF(J)     300        REAL      A COEFFICIENT USED IN CALCULATION OF NET
54                                DEMANDS(SR(I,J,...)) FOR PART J. IT=
55                                FR(J)*GPA(J)
56
57 DCY(J)    300        REAL      DEPOT RECYCLE TIME FOR PART TYPE J, I.E.
58                                TIME BETWEEN REMOVAL AND RETURN FROM DEPOT
59                                REPAIR. THIS = DEPOT REPAIR TIME + 2*ORDER
60                                SHIP TIME.
61
62 COMMON
63 *   ALLOWB(120),   BCY(300),   BF(300),   CF(300),
64 *   DCY(300),     PF(300),     DMO(300),   IRC(300),
65 *   RNCS(300),     RNCS1(300),  RNMC(300),  S(300)
66 *   DIMENSION
67 *   FHR(120)
68
69 CALC (ID,IP) THE DAYS ON WHICH 'ITEMS RETURNING TODAY(DAY I)
70 FROM DEPOT' FAILED.
71
72
73
74
75
76
77
78
79
80

```

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```
82      IC=I-DCY(J)
83      IB=I-BCY(J)
84      DPR=D.
85      BRR=0.
86
87 C      CALC (DPR) RETURNING REPAIRS (RETURNING ON DAY I) FROM DEPOT AND
88 C      CALC (BRR) RETURNING REPAIRS FROM RETAIL. THEN DETERMINE CUMULATIVE
89 C      NET DEMAND (THRU TODAY (DAY I)) BY ADD NET DEMANDS GENERATED
90 C      TODAY TO CUMULATIVE NET DEMANDS THRU YESTERDAY,
91 C
92      IF (ID.CT.0) DPR=DF(J)*FHR(ID)
93      IF (IB.CT.0) BRR=BF(J)*FHR(IB)
94      CP=CMD*CF(J)*FHR(I)-DPR-BRR
95      RETURN
96      END
```

FUNCTION MAXC

```

1  FUNCTION MAXC (NP)
2  C NAME: FMAX TYPE: FUNCTION
3  C
4  C PURPOSE: THE FMAX FUNCTION FINDS THE SUBSCRIPT OF THE LARGEST IN VALUE
5  C MEMBER OF AN ARRAY (DMD(J))
6  C
7  C ARGUMENTS:
8  C
9  C NAME DIMENSION TYPE DESCRIPTION
10 C
11 C NP 1 FIXED NR OF ITEMS IN ARRAY TO BE ORDERED.
12 C USUALLY, THIS IS THE NR OF PART TYPES
13 C PROCESSED, BUT ONCE IN THE MAIN PGM
14 C IS THE NR OF 'MIN REQ ACFT AVAIL'
15 C SPECIFICATIONS READ IN.
16 C
17 C CALLED BY: MAIN PROGRAM
18 C
19 C CALLS : NONE
20 C
21 C FILES USED : NO FILES READ OR WRITTEN
22 C
23 C LOCAL ARRAYS : NONE
24 C
25 C COMMON BLOCK (UNLABELED) ENTRIES USED IN THIS ROUTINE
26 C
27 C NAME DIMENSION TYPE DESCRIPTION
28 C
29 C DMD(J) 300 REAL WORKING ARRAY USED HERE TO STORE THE
30 C ARRAY BEING ORDERED.
31 C
32 C COMMON
33 C * ALLOWB(120), BCY(300), BF(300), CF(300),
34 C * BCY(300), DF(300), UMD(300), IRC(300),
35 C * RNC(300), RNC1(300), RNMCS(300), S(300)
36 C
37 C SMAX=-1.
38 C JMAX=1
39 C DO 100 J=1,NP
40 C X=DMD(J)
41 C ZMAX=AMAX1(SMAX,X)
42 C IF (ZMAX.LE.SMAX) GO TO 100
43 C JMAX=J
44 C SMAX=ZMAX
45 C 100 CONTINUE
46 C MAXC=JMAX
47 C RETURN
48 C END

```

GLOSSARY

ABBREVIATIONS, ACRONYMS, AND SHORT TERMS

acft	aircraft
AFH	achievable flying hours
AFLC	Air Force Logistics Command
AMC	US Army Materiel Command
AR	Army regulation
ASL	authorized stockage list(s)
avail	availability
avg	average
AVIM	aviation intermediate maintenance
AVSCOM	US Army Aviation Systems Command
AVUM	aviation unit maintenance
CAA	US Army Concepts Analysis Agency
CCSS	Commodity Command Standard System
CONUS	Continental United States
cont	continued
cum	cumulative
curr	current
DCSLOG	US Army Deputy Chief of Staff for Logistics
DESCOM	US Army Depot Systems Command
DOD	Department of Defense

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EFH	estimated flying hours
FH	flying hour(s)
FHP	flying hour program
hr	hour
MFHAD	maximum flying hours per aircraft per day
min	minimum
MSC	major subordinate command
NMC	not mission capable
NMCS	not mission capable due to supply
NRTS	not repairable at this station
OST	order and ship time
PARCOM	Parts Requirements and Cost Model
PLL	prescribed load list(s)
QPA	quantity per application
rqmt(s)	requirement(s)
sub	substitution

END

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