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DORCA COMPUTER PROGRAM

Volume I: User's Guide

Prepared by
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Vehicle Analysis Programming Department
Information Processing Division
Engineering Science Operations

THE AEROSPACE CORPORATION

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ABSTRACT

The Dynamic Operational Requirements and Cost Analysis Program (DORCA) was written to provide a top level analysis tool for NASA. This is the first step to full development, as several restrictions have been imposed on the program to ease the developmental problem. These restrictions are to be fixed in the effort for FY 72. DORCA does not include any optimization capabilities, but rather relies on a man-machine interaction to optimize results based on external criteria. DORCA relies heavily on outside sources to provide cost information and vehicle performance parameters as the program does not determine these quantities but rather uses them.

Given data describing missions, vehicles, payloads, containers, space facilities, schedules, cost values and costing procedures, the program computes flight schedules, cargo manifests, vehicle fleet requirements, acquisition schedules and cost summaries. The program is designed to consider the Earth Orbit, Lunar, Interplanetary and Automated Satellite Programs. A general outline of the capabilities of the program are provided in the main body of this volume. Appendices are included which contain: a detailed description of the input data, a quick reference input guide, a description of error messages, an outline of some valuable input tricks, and the input and output of a sample case.

Volume II of this document provides a detailed description of the program and is called the Programmer's Guide.

Volume III of this document contains a computer listing of the DORCA Program.

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SECTION 1

INTRODUCTION

The Dynamic Operational Requirements and Cost Analysis Program (DORCA) is designed as a tool to be used in long range planning of future space programs. It was written for the CDC 6000 series computers and is compatible to the Univac 1108 Computer.

The philosophy of the DORCA program is that the NASA programs for Earth Orbit Space Station, Lunar Orbit Space Station, Lunar Surface Base, Interplanetary Missions and the Automated Satellite Program can be viewed as exercises in shipping cargo items from one place to another. Therefore the user must stipulate to the program what cargo is to be shipped when, where, and how. Thus, the Earth Orbit Space Station can be approached as an initializing shipment of the station and first crew, a sustaining phase of rotating crew and providing life support and scientific equipment and a termination phase of returning the station to Earth.

DORCA provides a capability of determining detailed and total costs, flight schedules, vehicle fleet acquisition schedules, and propellant requirements for a specified group of space programs. The program computes these results by processing definitive data which describes: 1) vehicle performance, propellant requirements, development costs, production costs and operational costs; 2) facility weights, schedules and costs; 3) container capacities; 4) cargo element weights, volumes and procurement costs; 5) flight leg geometry; 6) program and/or mission cargo requirements and schedules.

This volume provides, for the user of the program (planning analyst), a definition of the program capabilities and limitations and procedures for using the program to accomplish analyses. Detailed descriptions of input data, error messages, sample outputted reports and some useful input tricks are provided in appendices. A Programmers Guide, Volume 2 of the series of documents, provides a detailed definition of the DORCA Program from a programmer's point of view.

SECTION 2

BASIC PROGRAM CONCEPTS AND DEFINITIONS

This section contains the definitions of the basic elements of the program.

2.1 PROGRAM

A program is defined as a set of missions that are grouped for the purpose of identification or for the collection and summarization of the various computed quantities such as number of flights per year, number of vehicles acquired each year, number of propellant tanks launched each year, or the total costs per year. For example: the Lunar Program may consist of several missions such as 1) initialization and maintenance of lunar orbiting space station, 2) the initialization and maintenance of tugs at the space station, and 3) the installation and maintenance of one or more lunar surface bases.

Each program is given a name consisting of 18 or less characters. These characters may be alphabetic letters, numeric integers 0 through 9, or special characters such as: (, .) * - + / .

The allowable set of characters applies to all names described in later paragraphs.

2.2 MISSION

A mission is a subset of a program. It is a basic unit or function by which computed results are tallied and summarized for the various printed reports. For example: the Interplanetary Program may use two satellites which could be costed separately by assigning each satellite with unique mission name. Each mission is given a name consisting of 18 or less characters. Two programs may have missions with equal names.

2.3 LEG

The trajectory that a particular element of cargo travels, between its original point of launch from the earth's surface to its desired termination point, is divided into a set of contiguous segments called legs. A terminal may be a surface of a planetary body or an orbit about such a body. DORCA is capable of handling several terminal points by having one or more groups of legs. Each leg ends at a terminal point. Two groups of legs may share a common smaller group of legs and ultimately diverge into final legs connected to separate final terminal points.

Up is defined as away from the earth launch point and toward the terminal point. Down is defined as moving from the terminal point to the earth surface launch point. If cargo elements are moving in the "up" direction, they may travel over one or more common legs and then separate and travel on different legs to different terminal points. That is: the trajectories of two cargo elements may separate as the cargo moves in an "up" direction, but may not come back together again. Likewise, cargo elements traveling in a down direction and on different legs may come together and travel together to the end of the down portion of the flight. The reverse is not true. When moving an an "up" direction, legs may not join together. When moving in a "down" direction, legs may not separate or split apart.

Each leg is given a unique name of 1 to 10 characters. A predecessor leg is defined as the leg that attaches to a given leg on the down side. A leg that begins at the earth's surface, by definition has a "null" predecessor leg.

2.4 VEHICLE

A vehicle is a unit of hardware having propulsive capabilities. Such as a unit of hardware, a vehicle has a cost of development, a cost of unit procurement and a cost for operations. It is used to transport cargo from one terminal to another terminal via a path called a leg.

The performance of a vehicle is measured by weight on each leg and volume. The up weight is that maximum weight the vehicle could carry on the up portion of a leg and leave at the next terminal point with the vehicle returning on the down portion of the leg. After the vehicle has flown the up portion of the leg, the down weight is that maximum weight the vehicle could retrieve at the next terminal point and subsequently return on the down portion of the leg. The up and down weights require the vehicle to make a round trip. Typically the up weight is larger than the down weight. An even larger weight can be carried up to the next terminal point if the vehicle does not return. This weight is referred to as the expended weight. Most vehicles operate in a weight restricted mode, but the EOS more typically is volume limited. Therefore the volume constraint is based on the EOS bay. If a vehicle has a volume of 1 unit, this means it has the volumetric capacity of an EOS bay. If a cargo element to be carried in an EOS has a volume of .3, this means that 3 of these cargo elements will fit in the bay with 1/10th of the bay still available.

Vehicles in an operational environment are expected to eventually wear out. The life expectancy of a reusable vehicle is given as flights per year (restricted by turnaround time + flight time), total number of flights and/or total number of years. Due to the finite usability of a vehicle and therefore the need for more than one vehicle at a time, the computer program includes a algorithm for estimating fleet size. DORCA also computes the cost with spreading of developing and producing the vehicles in the fleet.

Each vehicle is given a unique name of 1 to 10 characters. The vehicle up, down and expended weights must be determined outside the DORCA program for each leg the vehicle will service.

2.5 FACILITY

A facility is a unit of hardware to be moved from the Earth's surface to an orbiting position or the surface of another planet. A facility has a weight and a volume, and may be carried by several vehicles on a sequence of legs to reach its ultimate destination. If a large facility; i.e., Lunar Surface Base, be subdivided into modules for ease and practicality, then each module would be considered as a separate facility.

Each facility is an entity which cannot be divided any smaller. One or more facilities can be carried on a vehicle subject to the performance limitations of the vehicle. As a unit of hardware a facility has a cost of development and a cost of production.

Each facility is given a unique name of 1 to 10 characters. Each facility is described twice in the input to the program. The first description provides the necessary cost information and the second, the values for weight and volume.

2.6 CONTAINERS

A container is a unit of hardware used for environmental protection of other items being sent on a vehicle on a leg. Each container has a structural limitation to support a maximum weight internally during propulsive maneuvers. This weight is the capacity of the container. The empty weight of the container is the structural weight of an empty container. A container is considered as weight limited internally and whatever is stored inside does not exceed the available volume regardless. Externally, the container has a volume which must be compatible with the volumetric limitations of the transporting vehicle. Every container makes a complete round trip.

Containers are classified by the item the container was designed to carry. Propellant tanks are used to transport propellant up from the Earth's surface to the vehicles requiring propellant. The propellant tanks are always shipped fully loaded, never partially filled. Bulk containers are used to protect the logistics support items needed by crews for their life support and scientific activities. Crew modules or containers are used to transport crew members from the Earth's surface to a life support facility. Logistics bulk cargo can be loaded into a crew container along with the crew as life support until a later flight can replenish the supplies.

Each container is given a unique name of 1 to 10 characters and is assigned to carry a single class of cargo, bulk, crew or propellant.

2.7 CARGO ELEMENT

A cargo element is an item of cargo to be transported by a vehicle on a set of legs one or more times per year for one or more years. The cargo element may be logistics bulk cargo, a crew to be rotated, a facility such as a satellite or a module of an orbiting space station, or a vehicle intended to service an upper leg. All containers are automatically classified as cargo elements.

Each cargo element has an up weight, a down weight and a volume. If a cargo element has a non-zero up weight, the item is to be sent from the Earth's surface to the destination point. If a cargo element has a non-zero down weight, the item is to be brought down to the Earth's surface from some retrieval point. By judiciously choosing the values for up and down weights, the user can affect the delivery of a satellite to its required orbit, the return of Lunar rock samples, the launching of a probe toward Mars and the servicing of a synchronous orbiting satellite by a man with a tool box.

A cargo element either is a discrete item or it fits into a container. If it is discrete, then the cargo element is a self-contained entity. It is carried on a vehicle as a complete element, and its weight includes any necessary packaging support rings or adapters. If the cargo element fits into a container, then the classification of the container to be used is compatible with the cargo element. Bulk cargo is to be put into a bulk container; crew members are placed in crew containers. A value for the volume of the cargo element is significant only if the cargo element is a discrete. For cargo elements put into containers, the volume limitation is obtained from the container.

Each cargo element is given a unique name of 1 to 10 characters. Each cargo element is given a category of vehicle, facility, personnel, or material.

2.8 PHASE

A phase is a portion of time during which one of three specific activities are being performed. The initialization phase defines the period when facilities are established and then manned by the first crew. The sustaining phase defines the period when crews are rotated, life support materials are supplied and scientific information is returned. The termination phase defines the period when the facility is returned to Earth or abruptly abandoned at the end of its usefulness.

2.9 LONGSHORING

The concept of longshoring involves the manual operations of handling cargo packaged in a container. A vehicle carrying discrete cargo items on a leg can be more effectively used on an individual flight if the weight carried can be adjusted to be very near maximum capacity. As logistics bulk cargo can be divided almost as fine as desired, the vehicle can be used at capacity by adding bulk cargo. At some point in transit from the Earth's surface to final destination, the bulk cargo must be placed in the appropriate container. There are several choices of where and how the loading of containers is done. Since propellant is required to operate the vehicles, the amount of propellant is reduced by requiring the furthest-out legs to be very efficiently loaded. The number of flights on the outer leg is held to a minimum, thereby reducing the propellant shipped to fuel the vehicle and reducing the propellant required to ship the propellant. Therefore the vehicle loading on the outer leg determines the packaging of bulk in a container. Then the container could be filled as necessary on the Earth's surface, sealed and sent to be opened only at the destination. This solution yields good loading on the outer legs, but does not necessarily give good loading on vehicles servicing intermediate legs.

A higher overall efficiency can be achieved if the bulk cargo can be shifted from container to container as needed to top off the next vehicle. This operation is a manual shifting of cargo in space and is referred to as longshoring. The current version of the DORCA program presumes longshoring is always available and therefore all vehicle flights will be loaded to capacity by topping off with bulk cargo as available. The program is not yet capable of filling a bulk cargo container and then declaring that partially filled container to suddenly become a discrete cargo element.

2.10 COSTS WITH SPREADING

DORCA presents the user with the results of shipping all the cargo in the form of a cost report. In the report are the costs of vehicles, facilities and vehicle operations profiled by year.

The production schedule for each vehicle is determined and then costed out for development and production. Each vehicle has been given by the user a total development cost and a spreading function by which the cost is to be spread. With the spreading function is the year in the spread period when the vehicle is to be delivered. The year of the first production unit determined by DORCA is the year of delivery for positioning the spread function. The total development cost is then prorated into the years surrounding the delivery date by application of the spread function. The production costs are found by computing the product of the number of units produced in any one year by the production unit cost given by the user. The user's production spreading function is then applied to distribute the costs over the years. Facilities are similarly costed by a total development cost with a spreading function and by a production unit cost with its spreading function. Operating costs are not spread, but simply consist of the number of flights in a given year in support of an objective times the operating cost per flight as supplied by the user.

The following two tables show the spreading functions currently used in the DORCA input data. The entries are percentages, and the year of delivery is indicated by an asterisk (*).

Year	Percentage of Total Cost									
	3 Yr	4 Yr	5 Yr	6 Yr	7 Yr	8 Yr	9 Yr	10 Yr	11 Yr	12 Yr
1	20.99	10.64	6.13	3.87	2.61	1.85	1.37	1.04	0.82	0.65
2	56.38*	38.31	25.23	17.12	12.06	8.79	6.60	5.09	4.01	3.22
3	22.64	39.23*	35.36	27.97	21.55	16.65	13.01	10.32	8.30	6.77
4		11.82	26.29*	28.41	25.57	21.67	18.00	14.90	12.38	10.34
5			6.99	18.12*	22.16	21.92	19.99	17.60	15.27	13.18
6				4.51	12.95*	17.31*	18.39	17.76	16.39	14.79
7					3.11	9.56	13.67*	15.36	15.53	14.90
8						2.25	7.27	10.94*	12.85	13.51
9							1.70	5.67	8.88*	10.82*
10								1.32	4.52	7.30
11									1.05	3.67
12										0.85

Table I. Spreading Functions for Development Costs

Year	Percentage of Total Cost						
	1 Yr	2 Yr	3 Yr	4 Yr	5 Yr	6 Yr	7 Yr
1	100*	50	33.33	25	20	16.66	14.3
2		50*	33.33	25	20	16.66	14.3
3			33.33*	25	20	16.66	14.3
4				25*	20	16.66	14.3
5					20*	16.66	14.3
6						16.66*	14.3
7							14.3*

Table II. Spreading Functions for Production Costs

2.11 TIME SPANS

DORCA is built to produce printouts of 30 year width. That is, the cost analysis begins in the year 1970 and terminates in the year 1999. The starting date is an internal constant. Considering the effects of spreading before and after a date of delivery, the user should not ship cargo prior to 1975 nor after 1998. These figures provide a rough guide.

Any computations of the vehicle loading and vehicle fleet sizer algorithms are based on a granularity of one year. Everything occurring in a one year interval can occur at any time in that year. Anything occurring in a two year interval is separated in time by one group happening in one year before the other group in its year. Thus the user may find that the program has scheduled some articles to be sent before other articles which, in the user's mind, is completely impossible. Consider the delivery of a Lunar Surface Base crew arriving before the base is put down on the surface. The flight numbering sequence is entirely arbitrary, and the user may rearrange the sequence of flights should another order be more representative of the time phasing of some elements.

SECTION 3
BASIC PROGRAM PROCEDURES AND ALGORITHMS

This section describes the operations performed by the program to process the input data, perform the complete cargo handling described by the input, add propellant tanks, containers and vehicles as additional cargo, and generate the final data required to issue reports on fleet size, program costs, flight schedules, cargo manifests, etc.

3.1 INPUT DATA

The input data to the DORCA Program is a deck of cards containing descriptions of cargo containers, legs and leg sequences to be used for shipping cargo elements, spreading functions for the cost report, vehicles with performance capabilities, costs, propellant requirements, flight rates and life expectancy, cost elements for facilities, cargo elements to be shipped on legs, the actual shipments to take place with date, vehicle, leg and phase assignments and reports to be supplied back to the user. The detailed descriptions of the input data is provided in Appendix A and a quick reference synopsis is in Appendix B. Descriptive interpretations of error messages produced by improper input by the user are given in Appendix C. A procedure for guiding the user in setting up a data deck is given in Section 5.

The input data is separated into tables. DORCA loads a table into memory, performing certain checks on each card as described in Appendix A. If an input error is encountered, an error message will be issued and the program will continue to process the data. This feature gives the user a complete set of errors on one run. After the table has been loaded, consistency checks are performed on the table and cross reference checks between separate tables are resolved. The loading and checking of individual tables is done for each table until the Mission Input Data section of the deck is reached. The processing of the Mission Input Data generates the phase I cargo table, a list of every item being shipped with the necessary shipment information: date, vehicles, final leg, phase, program and mission. The next section of the data deck is the Requests for Reports which are processed to set indicators to tell the program to assemble the necessary information at a later time and then generate the report as requested. The report options are described in Section 4.

At this point the input data processing is complete and control is passed to the leg processing section of the program discussed in Section 3.3. After the reports have been completed, control again passes back to the input data processing area, whereupon another group of Mission Input Data and Requests for Reports can be processed for another case using the previous tables. When the input data processing area recognizes the "END" card processing is completely terminated.

3.2 LOADING CARGO ONTO VEHICLES

Each vehicle has the capability of carrying one or more cargo elements up a leg and carrying another set down the leg. This section describes the loading algorithm used in DORCA to assign those cargo elements to specific flights of a vehicle up and down a leg in a given year.

The candidate list of cargo elements, crews, bulk items and discretes, are collected together for a specific leg, vehicle and year combination. The vehicle information on up weight, down weight, and expended weight are obtained for the specified leg. The volumetric capacity is also noted.

The cargo element down weights are converted to equivalent up weights by multiplying by the ratio of vehicle up weight to vehicle down weight. During loading of the vehicle the following rules will be obeyed:

1. The total weight loaded on the vehicle cannot exceed the vehicle up weight.

2. Each cargo element has a volume. Therefore the total volume accumulated for the up cargo elements and for the down cargo elements cannot exceed the volumetric capacity of the vehicle.

3. To ensure adequate flights for crew rotations, only one crew with its crew container is allowed per flight.

4. If a very heavy cargo element is sent in excess of the vehicle up capacity, the vehicle will be expended subject to the limitation of the vehicle expended weight.

5. No down cargo is permitted on a vehicle that is being expended.

6. The program will refuse to load any cargo element that is by itself too heavy or too big for the vehicle.

Subject to those rules, the algorithm then attempts to pick an item from the candidate list and assign the item to the flight. If the item is assigned, it is deleted from the candidate list. If no more items can be assigned, the flight is considered filled; and processing passes to the next flight, repeating the process until the candidate list is exhausted.

The order of preference for selecting cargo elements to be loaded on a vehicle from the candidate list is as follows:

1. If a crew is available, it and its container are loaded.

2. If a discrete is available, find the heaviest discrete that fits and does not also exceed the remaining available volume. If none will fit, proceed to Step 5.

3. If the remaining weight capacity is less than the available capacity in the crew container and the crew container is present on the flight, load the crew container with bulk cargo (if available) and repeat Step 2.

4. If Step 3 fails, load the heaviest item from Step 2 and retry Step 2.

5. There are no more discretes that will fit, so attempt to top off the vehicle with bulk cargo. First, if there is a crew container on the vehicle, the program will place as much bulk cargo as available within the remaining capacity of the crew container. There is a bulk cargo restriction which states: it is not economical to return a cargo container unless at least 20% of the container capacity is occupied on the up leg. Select the smaller of the bulk available or the remaining vehicle capacity, and attempt to load the combination on the vehicle. Add to the candidate list the return of the empty cargo container.

6. The last criterion is whether the candidate list is exhausted. If not, select the next flight and attempt Step 1.

This algorithm considers each flight individually and will efficiently load flights while the candidate list is long. The last flights of the year are not necessarily well loaded. The method is an automated one and does not permit the unique circumstances visualized by the user. In a sense it is a non-optimizing technique for getting the minimum number of flights in a year. No items are carried over to the next year.

The cargo loading is done by the ASINER routine and the FIND routine. These two routines are referred to in the error messages listed in Appendix C.

3.3 LEG PROCESSING

All the cargo elements input to the program in the Mission Input Data were assigned a leg, vehicle, and date. The first function of the leg processor is to collect together those cargo elements going on the earliest leg in the leg table. The collection is separated by vehicle and year. Each group for this leg, with its vehicle and year is designated as the candidate cargo element list to be loaded onto flights as described in the previous section. After the flight assignment is completed, the next function of leg processing is performed.

The leg that connects to this leg but one segment closer to the Earth's surface is located. The user tells DORCA the final leg on which the cargo element is delivered and tells DORCA the chain of legs connecting this last leg with the Earth's surface. The program uses this information to deliver the cargo elements on the next lower leg (predecessor) to make sure that the items reach the necessary final leg. Also on this lower leg will be vehicles and propellant tanks required to service the leg just processed. These items must be added to the candidate list for the lower leg. Thus the lower leg will eventually have a candidate list that includes those cargo elements just processed on the upper leg, the vehicles and propellant tanks required to support the upper leg and also any cargo elements processed on an upper leg that also connects via this same lower leg with supporting vehicles and propellant tanks.

Therefore the first function of leg processing is to assemble a current candidate list; and after it has been assigned flights, the next function is to pass down the chain items for future candidate lists.

Also, after the flights have been assigned, the third function of leg processing is performed. The total equivalent up weight is computed for each flight; and each cargo element is entered into the Cargo Table -- Phase II which list the cargo element with the leg, vehicle, year, phase, program, mission and now the flight number and the effective fraction of the weight the cargo element contributed to the whole weight on the flight. Also included is vehicle and facility acquisition and propellant tank generation.

If a leg connects to the Earth's surface, no cargo elements can be passed down. The program destroys items that have been processed, converting them into assigned items in the Cargo Table -- Phase II and cargo elements placed on lower legs if possible. The leg processor processes all legs, vehicles, and years until eventually there are no items to process.

3.4 PROPELLANT

The propellant required to fuel the flights on a leg in a year is determined from the premise that each flight is performed by a fully fueled vehicle. The user has supplied the pounds of propellant required for one flight. That value is multiplied by the number of flights and divided by the number of pounds that is carried in the propellant tank provided in the container table yielding the number of propellant tanks needed. The number may be increased by one, as no partially filled propellant tanks are shipped in the system.

Each propellant tank is entered as a discrete making a fully loaded trip up the lower leg and the empty container returning down the same leg.

3.5 VEHICLE/FACILITY ACQUISITION

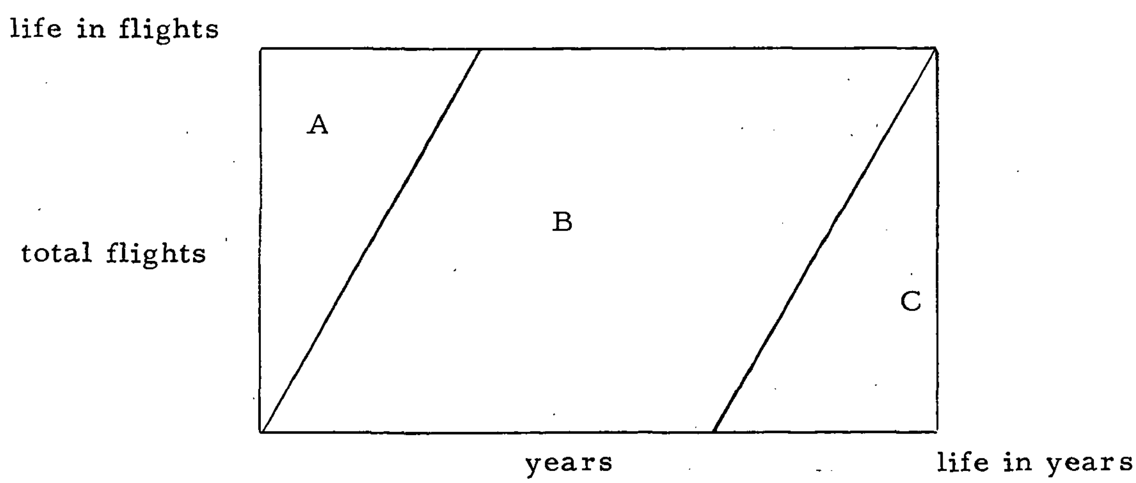
The DORCA Program determines the development and production costs of each vehicle fleet, and the development and production costs of all the facilities used. To do this cost analysis, the program must know the dates on which each vehicle or facility item is acquired or equivalently produced. The rule of acquisition is: when a facility or a vehicle is designated for shipment as a "CARGO" in the Mission Input Data, the corresponding IOC date is the date of acquisition. Thus the user tells the computer program when vehicles and facilities are acquired. As DORCA processes the Mission Input Data, lists are made up internally for vehicles and facilities with the name of the vehicle and the date of acquisition. Later these lists are used for generation of reports on vehicle traffic, vehicle acquisition, facility acquisition, and corresponding cost elements.

In Section 4.7, Request for Shipment of Vehicles, a technique is described whereby DORCA will internally ship vehicles to establish fleet sizes and charge the operating cost of delivery of the vehicles to the necessary legs. Those vehicles shipped internally are also added to the internal vehicle acquisition list and thereby included in the development and production costs.

3.6 TRAFFIC/FLEET SIZER

One of the functions performed by DORCA is the estimation of the fleet size required to support the vehicle traffic rates from year to year. The traffic rate of the first year combined with the maximum flight rate in a year results in a fleet capable of supporting the year. As the years progress, the vehicles reach their lifetimes in years or total number of flights flown and the vehicles are retired from the fleet. The fleet size must be adjusted yearly adding vehicles and retiring them on the basis of the total number of flights to be supported in a year and the lifetime of the vehicle in years and flights.

Consideration of the three parameters life in years, life in flights and maximum flight rate per year yields the envelope of desired utilization of each vehicle in the fleet as in the diagram following:



The slopes of the slanted lines are given by the maximum flight rates per year. Area A is impossible because the vehicle would have to be used at a rate higher than the permitted max rate. Area C is not desired; for even at the max flight rate the vehicle would not yield all possible flights before expiring because of age in years. Thus the problem is to cause the individual vehicles to move on the graph from the lower left hand corner to the uppermost boundary of B.

The algorithm proceeds as follows:

1. In the first year the fleet size is initially estimated from the number of flights required divided by the maximum flight rate per year for the vehicle. No fractional vehicles are allowed, thus 1.1 vehicles is forced to become 2 vehicles. The required spares are determined by taking 10% of the fleet size and correcting for fractional vehicles. The spares count is added to the initial fleet size.

2. The fleet is now established with each vehicle being assigned the number of flights remaining from the total number of flights the vehicle can fly.

3. The first vehicle is then assigned to fly a number of flights determined by the number of flights remaining to be assigned for this year divided by the size of the fleet available for service (fixed for partial flights).

4. If the number of flights to be serviced by this vehicle causes the vehicle usage over the span of years to enter the area of the envelope designated by NO, increase the number of flights (if possible) so that the vehicle will fall on the maximum rate line (avoiding entry into area C).

5. If the vehicle will retire at the end of this year on the basis of years or flights, increase the number of flights (if possible) to use the vehicle to the utmost.

6. At no time can the number of flights to be performed by a vehicle exceed the maximum number of flights per year limitation.

7. Retire the vehicle if the end of lifetime has been reached in either years or flights.

8. Adjust the flights remaining for the year by subtracting the number of flights assigned from the previous value of flights remaining for the year. Adjust the size of the fleet available by subtracting one.

9. Check: if the current fleet size were to fly at the maximum flight rate, could all the remaining flights be handled. If not, increase the fleet size by one and add an additional vehicle with the appropriate flights remaining in life.

10. Continue to repeat Step 3 on until all flights for this year have been assigned.

11. For the next year repeat Step 1 to estimate the required fleet. Step 2 is modified by the constraint: if the vehicle is already in the fleet, the flights remaining to be serviced by this vehicle cannot be defined as the total number of flights the vehicle can fly. That value has already been defined and decreased through usage. Proceed with Step 3 as before.

12. The above procedure is performed until there are no more years to be processed for a vehicle and all vehicles have had their fleet sized by the algorithm.

The algorithm represents an averaging process, attempting to use the vehicles to the extent of both lifetimes in years and flights in the presence of spares and a fluctuating demand for service in each year. Vehicles remain in the fleet at the end of the years of operation, available to service future efforts. The user might be unrealistically tempted to terminate the fleet in the last year, and by doing some juggling of flight assignments the fleet size and the costs are reduced. However, in real life the process cannot just abruptly terminate.

3.7 STAGING

The staging option described in this section is restricted to being used only when another option is also being used. The other option is fully described in Section 4.7, Requests for Shipments of Vehicles. That option will ship vehicles on lower legs to regions where they are needed to support the user's program. That option will ship only whole vehicles. But the EOS bay cannot accommodate neither the two stage Tandem Tug nor the three stage Triple Tug. The composite vehicles are too large for the EOS bay and therefore the staging option was put in to permit the user to describe a vehicle as consisting of up to six stages or components. The format of the STAGES card is described in Appendix A, page A-10.

The components may or may not have lifetime limitations and development and production costs. For this reason the DORCA Program requires the stages to be listed in the vehicle table; and more restrictively, the stages must appear in the vehicle table prior to the vehicle using the stages. A vehicle may stage itself. A cargo element may also be staged; as for example, a crew may be provided with the vehicle. The cargo element is placed in the vehicle table with one leg given the key word of "NONE." Then the cargo element acting as a dummy vehicle will not be included in the reports on vehicle traffic and acquisition.

The propellant required to fuel one flight of the vehicle is defined on the first card describing the vehicle. Staging does not have any connection with propellant, and the individual stage propellant requirements are ignored. Only the vehicle defines the propellant needs.

SECTION 4
REPORTS

This section describes the optional reports available to the user. The reports are obtained by using the REPORT cards feature of the input data. The last page of Appendix A shows the format. Each report is requested via a single card. More than one report requested implies several cards in the REPORT format.

DORCA has been successfully run from a remote terminal connected to the UNIVAC 1108 facility in Washington, D.C. In this mode of usage, the user will find the reports on containers, vehicles (short form) and cost (short form) to be sufficient for development of graphs for presentations.

4.1 CARGO MANIFEST

Pages 20-23 of Appendix D show a sample layout of the Cargo Manifest Report. This report is generated by entering the key word SPRINT on a REPORT card described on the last page of Appendix A. The report quotes which cargo items have been assigned to fly together on a specific flight in a given year on a particular leg. Due to its great detail, the report is always lengthy.

The items printed horizontally across the page are identified by the headings at the top of page D-20. Each line is a cargo element identified by: program name, mission name, leg being flown, vehicle being used on the leg, year of the flight, flight number of this vehicle on this leg in this year, cargo element name, up weight of cargo element, down weight of cargo element, and the effective load factor of the cargo element on the flight.

The program name and mission name are those provided by the user in the Mission Input Data except for the special cargo elements of vehicles, containers and propellants which are given a program name of overhead and a mission name of vehicle, container or propellant. The operating expenses of carrying these items is charged to an overhead account as agreement has not been reached on how to suitably prorate these costs among the input specified programs and missions.

The lines of print have been sorted by leg (leg order as in leg table), vehicle (order by vehicle table), year, and flight. That is: the first line of print is for the earliest leg actually used, the earliest vehicle used to service the leg, the earliest year for flights for that leg and vehicle and the first flight on the vehicle. All the flights for the leg, vehicle, year combination appear in sequence. Then the year advances and the procedure repeats until the years for the leg vehicle pair are all printed. Then the vehicle is changed, the process repeated until all the vehicles used on the leg are printed. Then the leg is changed and the process again repeated. Eventually all the data for all flights is printed.

For any specific flight, all the cargo elements are shown together as a group. If there is an entry in the up weight column, the item was shipped up the leg. Correspondingly, a down weight implies a downward shipment.

The effective load factor for a flight always totals to 1. Each cargo element on the flight is given an effective load factor as its share of the total weight carried on the flight. Down weights are converted to equivalent up weights by the ratios of vehicle up weight to vehicle down weight on the particular leg.

A detailed examination of the Cargo Manifest Report enables the user to verify that his Mission Input Data correctly describes the NASA program being analyzed by DORCA. Dates, vehicles, legs can all be confirmed.

4.2 CONTAINER REPORT

Page 24 of Appendix D shows a sample container report. This report is generated by entering the key word CONTAINER on the appropriate REPORT card. The report details the containers required on the various legs to support the cargo provided by the Mission Input Data. This report requires typically one page in the output.

The sequence of numbers following the word TOTAL is the years of operation of the program. For example, 79 is 1979. Under each of the years is the count of the containers used in that vertical year on that leg named near the left margin. The figure under TOTAL is the sum over the years. The line titled ONES LEAVING EARTH is a sum over the legs that originate at the Earth's surface.

Each container in the container table is listed with the legs it is used upon and the line ONES LEAVING EARTH if appropriate. All containers are printed, thereby showing use and non-use.

4.3 FACILITY REPORT

Page 25 of Appendix D shows a sample facility report. This report is generated by entering the key word FACILITY on the appropriate REPORT card. The report details the facilities to be shipped in support of programs and missions. These facilities should have development and production costs in the cost report. This report is typically moderate in length -- 1 to 2 pages.

As with the container report the number sequence is the years of operation of the program. The number of times a facility is shipped is shown in the column for the appropriate year. The TOTAL column is the sum over the years.

Each program name is printed followed by the mission name. Then the list of facilities with yearly schedules is shown for each facility shipped in support of a program/mission pair. The next mission name for the same program is then shown with all the facilities shipped in support of this pair. All program/mission pairs as quoted in the Mission Input Data are listed.

4.4 TRAFFIC REPORT

Pages 26-29 in Appendix D show sample traffic reports. This report is generated by entering the key word TRAFFIC on the appropriate REPORT card. A traffic report is generated for each vehicle in the vehicle table actually used in support of the programs and missions in the Mission Input Data.

The individual traffic reports are typically less than 1 page each.

The vehicle name appears at the top of the page. Following the word TOTAL, the sequence of numbers is the years 1979, 1980, etc. of operation of the program. In each year column the number of flights that the vehicle is assigned to perform is shown for each vehicle in the fleet. The entry in the TOTAL column is the sum over the years. The line TOTALS is yearly number of flights supported by the whole fleet.

The remaining three lines provide statistical summaries of the fleet. The line No. VEH. AVAILABLE shows the variation of fleet size with year. The line VEHICLES ACQUIRED shows the production schedule of the vehicle. The line VEHICLES ACQUIRED TO DATE shows the total number of vehicles purchased as a function of year.

4.5 VEHICLE REPORT

Pages 30-32 of Appendix D show a sample vehicle utilization report. This report is generated by entering the key word VEHICLE on the appropriate REPORT card. The report details the fractions of vehicle flights flown in support of the programs and missions. The section of the report is directly related to that portion of the cost report showing the operating costs incurred in supporting the Mission Input Data. The section of the report is typically 1-3 pages in length. The report also details the summary of the flights flown by each vehicle in each year on 1 page. The report also details the vehicle production schedules on 1 page. If the "SHORT" form of the report is requested, only the latter two pages are printed.

Following the word TOTAL, the sequence of numbers is the years of operations of the program. Under each year appears the fraction of flights flown for the program/mission pair. As for example, 2.2 flights were flown in 1979 on the EOS-WOAB vehicle in support of the OVERHEAD program/PROPELLANT mission. Under the word TOTAL is the sum over the years. All program/mission pairs listed in the Mission Input Data plus the overhead program with the propellant, vehicle, and container missions are shown with all vehicles actually used. All vehicles are totaled and suppressed if not used.

The next to the last page of the report is the flight summary section. Each line of this page lists the total flights made by the vehicle in a given year. This report is a summarized collection of the TOTALS line in the traffic report.

The last page of the report is the vehicle acquisition summary section. This quotes the production schedule for each vehicle by year. This report is a summarized collection of the VEHICLES ACQUIRED line in the traffic report.

4.6 COST REPORT

Pages 33-38 of Appendix D show a sample cost report. This report is generated by entering the key word COST on the appropriate REPORT card. The report details the costs of the entire set of programs for vehicle development and production, facilities development and production, and operating costs for transporting the cargo elements to their destinations and carrying the support elements: vehicles, propellant tanks, and containers. A cost report is typically 8-14 pages in length. The "SHORT" form of the report prints total costs only.

The cost report is divided into six parts occurring in pairs. Certain characteristics of the parts are identical. Following the word TOTAL is the sequence of years for which the printout applies. The entries under the years are the cost values in millions of dollars. The entry under the word TOTAL is the sum over the years. At the end of each part is a total line for all costs by year shown thus far.

The first part of the report is the development and production costs of the vehicles for the period 1970-1984. Immediately following is the same cost elements for the period 1985-1999. Each vehicle is identified with its development cost on one line, its production cost on the next line, and the total costs for that vehicle on the third line. Each cost has been spread by the appropriate spreading function. At the end of this part is the line showing the total costs for all vehicles procured in support of the set of programs.

The two middle parts of the report are the development and production costs for the facilities for the period 1970-1984 followed by the same cost elements for the period 1985-1999. Each program/mission pair is listed with any non-zero costs of development and production of facilities. The first program/mission pair to use a facility is charged the development cost for the facility. Each pair is separately charged for its share of production. Each cost has been spread by the appropriate spreading function. The total cost of development and production of all facilities used in support of a mission is shown on the line MISSION. The costs of the missions are then totaled to the program level shown on the line PROGRAM. A grand total line shows the yearly costs of all hardware required to support the set of programs.

The remaining two parts are the operating costs for the vehicles for the period 1970-1984, followed by the operating costs for the period 1985-1999. The structure of these two parts of the report is similar to the preceding two parts in breakdown by program/mission pair and totals by mission and program. Under each mission name is the list of vehicles with their operating costs charged against the mission. In this part of the report the user will find the operating costs of supporting the set of programs with vehicle propellant tanks and containers delivered to orbit. The last line is the grand total of hardware plus operations.

4.7 REQUEST FOR SHIPMENT OF VEHICLES

This option is activated by entering the key word CALVEH on the appropriate REPORT card. This option changes a procedure internal to the program. DORCA estimates the vehicle fleet, thereby establishing the vehicle production schedule. Ordinarily the program does not attempt to ship the vehicles up the leg sequence to place the vehicle in a position where it can service a leg. The user can perform the shipping through the Mission Input Data and assign the program/mission pair to pay the operating costs incurred in delivering the vehicle. This option, if invoked, will cause the program to estimate the fleet required to service a group of legs connected to a common lower leg. The small fleet will be shipped up the legs and the operating cost charged to overhead. This feature can lead to an oversized fleet, for the program has no way to bring a vehicle which is still usable down to Earth's surface and then send it up another leg to be used to the end of a lifetime. But in producing a quick ball park answer, this feature is an aid to the user.

4.8 TRAFFIC REPORTS TO SUPPORT THE SHIPMENT OF VEHICLES

This option is provided as a supplement to the previously discussed option to internally cause the shipment of vehicles. The reports are generated by entering the key word PRTCAL on the appropriate REPORT card. The reports are identical in form to those discussed in Section 4.4, Traffic Report. The difference is that the other report is global in nature, showing fleet activity without regard for the leg structure. The reports generated by this option show the sub fleets required to support the leg structure used by the set of programs.

4.9 PRINTOUT OF INTERNAL TABLES

Pages D-10 - 19 show a sample printout of the internal tables. This report is generated by entering the key word TABLES on the appropriate REPORT card. The report shows the internal tables used by the program. The tables are very similar to the data input by the user. For explanations to resolve the differences between the information given in this report and the user's input data, the user is referred to Vol. II of this document. This report usually will not be requested by the user unless the DORCA Program appears to be malfunctioning.

4.10 DEBUGGING REPORT

This report is generated by entering the key word DEBUG on the appropriate REPORT card. This report provides the user with a view of the internal computational procedure. For a detailed explanation of the information printed, the user is referred to Vol. II of this document. This report usually will not be requested by the user unless the DORCA program appears to be malfunctioning. A sample is not available in Appendix D.

SECTION 5
HOW TO SET UP A DATA DECK

This section will lead the user through the mechanics of setting up a data deck. There are two problems facing the user in the beginning. The first is obvious: how to do the process? This section should answer that question. The second problem is: what information is required and where do I obtain it? The section will indicate the needed quantities and their interpretation; but the obtaining process is beyond the scope of this document. This computer program relies on cost information and vehicle performance parameters that are beyond the definition of the problem accommodated. Other computer programs may have to be consulted to provide the information.

In setting up a DORCA input data deck for the first time, the user must realize that the data formats for the various tables defined in Appendix A are interrelated by the structure of the table and cross referencing between tables. Thus the user must prepare himself for the problem of doing all tables somewhat simultaneously. Assuming the user prepares the data deck on keypunch forms (or quadrille paper), he then begins by writing the start of the container table as TABLE CONTAINER at the top of the sheet. Tear off the sheet and similarly prepare sheets with table names for LEG, SPREAD, VEHICLE, FACILITY, CARGO ELEMENT. Prepare a sheet with three lines at the top of the page: line 1, PROGRAM; line 2, PROGRAM followed by an 18 letter name; line 3, MISSION followed by an 18 letter name.

Find the sheet for spread functions and copy from page D-4 of Appendix D, Sample Computer Run. Put the spread functions aside and arrange the other sheets for easy access.

Pick up the container sheet, review mentally the problem the user wishes to solve and ask what types of containers are required. Will a propellant tank, a crew module or a bulk container be needed? If so, enter each on a line according to Appendix A. The user supplies: capacity, empty weight, classification and external volume. Only one propellant tank is permitted; but several bulk and crew containers can be used. The order in the table is immaterial, so simply list them as they come to mind. Containers can be added to the list later as needed. The program has a limit of 10 containers. The user may refer to page D-2 of Appendix D for a guide on filling out a container table.

Make a list of places the user wishes to put items; i.e., Lunar surface, Lunar orbit, near Earth orbit, 100 x 300 nautical miles - 28.5° inclination, etc. Make a tentative list of vehicles to be used in this exercise. From an outside source obtain performance information for each vehicle in connection with the previously listed destinations. Define legs as those segments of a trajectory serviced by a vehicle. A single leg, Earth surface to Lunar orbit, can be serviced by a Saturn V with a command module. Alternatively, the same trajectory could be two legs with two vehicles, Earth surface to Earth orbit on an EOS and Earth orbit to Lunar orbit on a Tug. The two legs arrive at the same place as the one leg, the difference being the vehicles used. The user must determine the paths and the vehicles to service the paths or legs. A vehicle may service more than one leg, and a leg may be serviced by more than one vehicle. The legs are entered on the leg table sheet with the predecessor leg, longshoring option and the vehicle preferred to service the leg. List legs beginning with final destinations and working back to the Earth's surface. For example, enter the Earth orbit to Lunar orbit leg with a predecessor leg of Earth surface to Earth orbit followed by the Earth surface to Earth orbit leg. Otherwise the program will inform the user that the leg table is out of sequence. The Earth surface to Earth orbit leg has a predecessor leg of NONE. Lay the sheet for the leg table down within easy reach.

On page D-3 of Appendix D the user will find a leg table with 29 legs. The vehicles are versions of the Tug with a 25K propellant capacity and an EOS. The Tug is available as 1, 2 and 3 stages. The first leg in the table is Lunar Orbit to Lunar Surface, LO-LS. The predecessor is the 28.5^{o} inclination/100 nautical mile circular orbit transfer to Lunar Orbit, 28/1 - LO. Farther down in the table is the next predecessor leg of Earth Surface to 28.5^{o} inclination/100 nautical miles circular orbits, ES - 28/1. The leg table contains inclinations of 9, 5, 28.5, planetary, 90, 100, 103. The numeral following the / generally represents altitude in thousands of miles or upper stage ΔV requirement for planetary missions. Exceptions to the above are /1, /3.5, and /2.7 where miles are in hundreds for the case given on page D-3. Notation used is a responsibility of the user.

Take the vehicle table sheet and enter the first two cards for the first vehicle that comes to mind. Provide the cost of development and production on the second card as obtained from an outside source. Refer back to the sheet for the spread functions or to page D-5 of Appendix D to get the names of the development and production spread functions. Enter the propellant, max flight rate, max life in years, max life in flights and the volumetric capacity, if any. Enter a stages card if applicable. List the legs (named in the leg table) that this vehicle can service with the up, down and expended weights obtained from an external performance analysis of the vehicle. If the vehicle is mentioned in the leg table, be sure to enter that leg after the vehicle in the vehicle table. When the information is completed for the vehicle, repeat the process for another vehicle on a new sheet of paper leaving room to add legs to the previous vehicle. Enter all vehicles into the vehicle table and place the collection of sheets within easy reach.

On pages D-5 and D-6 the user will find the vehicle table that goes with the sample leg table. The EOS is the first vehicle listed and the user can see the legs following the first two cards. The next few vehicles are being used in the stages option. The versions of the tug then appear.

Take the sheet for the cargo element table and enter the items to be shipped, each with an up and/or down weight and a volumetric entry.

Put into the table those vehicles that do not fly from the Earth's surface (the Tug must be carried in the EOS). Enter satellites, surface bases, orbiting space stations, crew groups, bulk logistics support, scientific equipment, etc. required in exercise being analyzed. Take the sheet for the facility table. Go down the cargo element list and enter the cargo elements in the facility table if cost information is available. The facility table accepts the externally obtained information of cost of development and production with spreading for discrete items. Place the cargo element table and facility nearby.

On page D-7 and D-8 of Appendix D, the user will find samples of the facility table and cargo element table. These tables include vehicles and a few satellites from the Automated Satellite Program. In this sample, if the name includes the phrase +AG, this means the satellite has been mated to an Agena upper stage. The weights and costs include the Agena. Costs of the individual satellites were not available.

Retrieve the sheet with the lines for programs and mission. This is the Mission Input Data. The names have already been entered on the sheet.

Begin shipping cargo by specifying the IOC date, the leg, the vehicle and the phase. The leg name and the vehicle should be in their corresponding tables. If the default vehicle in the leg table is acceptable, an entry is not required on the vehicle card. As the cargo item will be sent up and down the leg sequence dictated by the leg on the leg card, the default vehicle is actually a set of vehicles, each of which can be overridden on the vehicle card. The first date entered should be of the form 1979. On the cargo card enter the name and count of the first cargo elements to be shipped. Continue shipping cargo elements, entering new dates, legs, phases and vehicles as appropriate. The user may find it necessary to go back to the other sheets and add cargo elements, facilities vehicles and legs.

On page D-9 of Appendix D, the user will find a sample of the Mission Input Data. This is an abbreviated portion of the Automated Satellite Program that actually requires over 6 pages. For the sample case, the data was shortened to keep the appendix size reasonable. The satellite NPL-14 with an Agena is sent in 1986 on the final leg, $28.5^{o}/100$ n.mi. to planetary orbit for injection towards Uranus. In 1989 a second satellite will be sent to Uranus. For the Grand Tour mission, in the year 1979, an NPL-10 with an Agena will be injected on the Grand Tour path. The launches out of WTR are illustrated by an initialization of the NEO-2 satellite with a sustaining phase in which the satellite is replaced on an annual frequency for an 11 year period.

Following the Mission Input Data are the requests for reports. The user is advised to select the following reports for the first try:

REPORT	CONTAINER
REPORT	FACILITY
REPORT	TRAFFIC
REPORT	VEHICLE
REPORT	COST

At a later time the user may elect to add or delete other reports. The deck is supplied to the computer and the first run performed. The user then looks at the last page of the output which will appear as on page D-39 of Appendix D. If the fatal error count is zero, the run is probably free from errors. If the count is not zero, the user will review the printout to locate typical input errors and overly large cargo elements. Reference to Appendix C will assist in interpretation of error messages. The user will continue to correct the deck and submit the computer runs until the results are as to be produced by a valid input deck.

APPENDIX A
DETAILED FORMATS OF INPUT DATA

This appendix describes the structure of the input data the user will supply into the DORCA program. The input will consist of a deck of computer cards from 400 to 2000 cards in length depending on the complexity of the problem in mind.

The deck of cards is subdivided into groups of cards called tables. Each table is input as a unit into the program and supplies a specific block of information; i.e., vehicles, cargo elements, or requests for reports. The tables are in the following specific order:

Container Table: This table lists the crew modules, propellant tanks and bulk containers that are potential candidates for the user's program.

Leg Table: This table describes the leg sequences to be used for shipping cargo from the Earth's surface to the Lunar surface or to a synchronous equatorial orbit.

Spread Table: This table provides the spreading functions to be used in the cost analysis.

Vehicle Table: This table provides for each vehicle the performance on various legs, the propellant required for one flight, the cost of development and production and the life expectancy of the vehicle.

Facilities Table: This table provides the development and production costs of major facilities.

Cargo Element Table: This table lists the candidate cargo items with their weight, volume and required containers.

Mission Input Data: This is the major data group specifying to the program how to link all the tables together to ship the cargo elements. This is the user's presentation of his program, Lunar Base or Automated Satellite Program, to the computer program.

Reports: This is a list of reports the user has selected as output from the computer program.

Each 80 column card is subdivided into fields of 10 columns each, resulting in 8 fields per card. The information on each card begins in the first field on the left and continues occupying fields as far to the right as necessary. The extent of the information per card varies with the nature of the information contained. To describe a cargo element; i.e., a satellite, requires 8 fields of information; whereas, to describe a propellant tank requires only 5 fields. Also, the amount of information may be more than 8 fields in length. Then continuation of information is indicated by the subsequent card having a blank entry for the first field on the left.

The information on the cards is divided into two possibilities, numeric or alphabetic. Where numeric data is required, the user will supply the appropriate value; i.e., weight of a satellite. Where alphabetic information is required, the user is faced with three choices. Some fields are restricted to key words; i.e., a container must be identified as propellant, crew or bulk classification. Some fields are defined by the user; i.e., names of legs, vehicles and cargo elements. When the user picks his names, he should select meaningful names: EOS, TUG, PROP TANK, etc. Other fields expect names that the user has defined elsewhere in his data deck. If the user wants to send a cargo element X on vehicle Y, then the user must have X named in the cargo element table and Y named in the vehicle table.

The remainder of this appendix is a detailed description of the structure and data provided by each table.

CONTAINER TABLE

All data describing bulk containers, propellant tanks and crew capsules is stored in the container table. The first card of the table is:

TABLE	CONTAINER	PRINT

Field 1 contains the word "TABLE."

Field 2 contains the word "CONTAINER."

Field 3 is the print option indicator for printing the table. If this entry is the word "OFF," the table will not be printed.

Following this card can be any number of cards, each describing a single container identified by a unique name. The container table terminates when another "TABLE" card is found. The program has a capacity of 20 containers.

The format of a card describing a container is:

NAME	CAPACITY	EMPTY WEIGHT	CLASSIFICATION	VOLUME FRACTION

Field 1 contains the unique name of the cargo container.

Field 2 contains the weight capacity in pounds (lbs) for this container.

Field 3 contains the empty weight in pounds (lbs) for this container.

Field 4 contains the classification for handling the cargo. Possible classifications are:

BULK, CREW, PROPELLANT

Field 5 contains the volume of the container, expressed in a fraction of the total internal volume of the EOS cargo bay; i.e., a value of .5 means that only two of those containers will fit on one EOS flight. The default value is 1.

SAMPLE

TABLE	CONTAINER			
CLPRM	30000	3500	PROPELLANT	.49
CLPRM-B/P	30000	3500	BULK	.49
TCC-25	30001	4198	CREW	.39

This sample for a container table has one of each classification of container: propellant, bulk and crew. The CLPRM is a propellant tank with a capacity of 30,000 pounds; it always travels fully loaded as a 33,500 pound unit. The CLPRM-B/P is a propellant tank being handled as a bulk container; it travels with a load varying between 6000 and 30,000 pounds. The TCC-25 is a crew module being used in a trick described in Appendix E, Trick 8.

Types of errors reported by the program:

Duplicate container names.
Entry for capacity is non-numeric.
Entry for penalty is non-numeric.
Unknown classification.
Table capacity exceeded.
Entry for volume is non-numeric.

LEG TABLE

The purpose of the leg table is to provide a list of leg names in order of precedence, and with each leg, to provide 1) the name of the next successor leg, 2) an indication of the longshoring capacity at the intermediate terminus and 3) the name of the default vehicle. The first card of the leg table is:

TABLE	LEG

Field 1 contains the word "TABLE."

Field 2 contains the word "LEG."

Field 3 is the print option indicator for printing the table. If this entry is the word "OFF," the table will not be printed.

Following this card may be any number of cards, each describing a single leg identified by a unique name. The leg table terminates when another "TABLE" card is found. The program has a capacity of 31 legs.

The format of a card describing a leg is:

NAME	*NEXT DOWN LEG*	*LONGSHORE*	*VEHICLE*

Field 1 contains the unique name of the leg.

Field 2 contains the word NONE or the name of the NEXT DOWN leg which must be defined on a subsequent card.

Field 3 contains the word YES or NO indicating longshoring capability at the lower terminus or the word SINGLE for a single deployment leg.

Field 4 contains the name of a default vehicle to be used on this leg to carry cargo if no such vehicle is specified in the Mission Data.

SAMPLE

TABLE	LEG		
LO-LS2	EO-LO	YES	TUG-25K
LO-LS	EO-LO	YES	TUG-25K
EO-LO	ES-EO	NO	TUG-25K
EO-EO	ES-EO	NO	TUG-25K
EO-IP	ES-EO	NO	TUG-25K
28/1-P/12	ES-28/1	SINGLE	TDTUG-25K
28/1-P/11	ES-28/1	SINGLE	TDTUG-25K
ES-90/.5	NONE	NO	EOS-WOAB
ES-EO	NONE	NO	EOS-WOAB

This example provides for two lunar bases, termini LS and LS2, having a common intermediate terminus in lunar orbit with longshoring capability. The legs used to supply the two Lunar Surface bases are LO-LS2 and LO-LS. The other legs used in supporting the two bases are EO-LO for the Earth Orbit-Lunar Orbit shuttle and ES-EO for the launch from Earth Surface to Earth Orbit.

This example also provides for an Earth Orbit to Earth Orbit shuttle leg (EO-EO) and an Interplanetary Probe leg (EO-IP), both supported by the Earth Surface launch leg (ES-EO).

Also, three legs from the sample in Appendix are included. The leg, 28/1-P/12, is meant to be a transfer from 28.5° inclination/100 n.mi. to a interplanetary injection point requiring 12000 ft/sec ΔV. The leg, 28/1-P/11 implies 11000 ft/sec ΔV. The leg, ES-90/.5 is a launch out of WTR into an orbit, 90° inclination/500 n.mi.

Type of errors reported by the program:

Duplicate leg name.

Next down leg has been already defined.

Leg table capacity exceeded.

Longshore option not yes, no or single.

Next down leg does not exist.

SPREAD TABLE

The purpose of the spread table is to provide the program with a set of cost spreading values for vehicles and facilities. Each group of cost spreading values provide the program with cost spreading factors for a continuous set of years. The first card of the table is:

TABLE	SPREAD	PRINT

Field 1 contains the word "TABLE."

Field 2 contains the word "SPREAD."

Field 3 is the print option indicator for printing the table. If this entry is the word "OFF," the table will not be printed.

Following this card can be any number of groups of cards, each group describing a particular set of cost spreading factors. Each group begins with an entry in field 1. Thereafter, field 1 is vacant for the remainder of the group. The beginning of the next group is indicated by the presence of an entry in field 1. The spread table ends when another "TABLE" card is found. The program has a capacity of a maximum of 20 spread functions.

The format of the first card of the group describing a spreading function is:

NAME	NO. OF YEARS	IOC YEAR	FACTOR 1	FACTOR 2	FACTOR 3	ETC

Field 1 contains the name of the specific spreading function. This name is to be used in the vehicle or facility tables.

Field 2 contains the number of years over which this group of spreading factors apply and must equal the number of factors entered in the group. Each factor is a percentage and states the percentage of the total cost to be paid in a given year.

Field 3 contains the sequence number of the spreading factor that corresponds to the vehicle or facility IOC date. For example: If field 2 equals 6, the cost is to be spread over six years. If field 3 equals 5, the item, vehicle or facility, is to be delivered in the fifth year of the six year span. The program will know the year of delivery and given fields 2 and 3, it can determine the actual years over which the cost is to be spread.

Field 4 contains the cost spreading factor for the earliest year. Fields 5 through Fields 8 contain the factors for years 2 through 5, respectively.

If field 2 contains a year value greater than 5, then additional factor cards must follow. These continuation cards are of the following format.

	FACTOR 6	FACTOR 7	ETC.

Field 1 is vacant.

Fields 2 through 8 contain additional factors until all factors have been entered. Any number of continuation cards are allowed.

<u>SAMPLE</u>

TABLE	SPREAD						
SPDEV7	7	6	2.61	12.06	21.55	25.57	22.16
	12.95	3.11					
SPPROD3	3	1	33.3	33.3	33.3		

This sample spread table includes the 7 year development and the 3 year production spread functions quoted in Section 2.10.

<u>Type of errors reported by the program:</u>

Spread table does not total to 1.00 $\pm$ .01.

Entry contains a non-numeric.

Duplicate spread tables names.

Too many spread tables.

VEHICLE TABLE

The purpose of the vehicle table is to provide the program with a list of vehicles with their many required characteristics as defined below. The first card of the table is:

TABLE	VEHICLE	PRINT

Field 1 contains the word "TABLE."

Field 2 contains the word "VEHICLE."

Field 3 is the print option indicator for printing the table. If this entry is the word "OFF," the table will not be printed.

Following this card can be any number of groups of cards, each group describing a single vehicle identified by a unique name. Each group begins with an entry in field 1. Thereafter, field 1 is vacant for the remainder of the group. The beginning of the next group is indicated by the presence of an entry in field 1. The vehicle table terminates when another "TABLE" card is found. The program has a capacity of 30 vehicles.

The format of the first card of the group describing a vehicle is:

NAME	PROPELLANT	MAX/YEAR	LIFE FLT	LIFE YRS	MIN LOAD	VOLUME CONSTRAINT

Field 1 contains the unique name of the vehicle.

Field 2 contains the propellant weight in pounds (lbs) for a complete fueling of the vehicle.

Field 3 contains the maximum number of flights the vehicle can perform in one year due to earth-lunar geometry or refurbishment cycle.

Field 4 contains the maximum number of flights the vehicle can perform before replacement occurs.

Field 5 contains the maximum number of years the vehicle is allowed to operate before replacement occurs.

Field 6 contains the percentage of the up capacity the vehicle must carry on a leg to justify the flight.

Field 7 contains the volume constraint of the vehicle, expressed in a multiple of the internal volume of the EOS cargo bay. The EOS cargo bay should equal 1.0. The default value is 1000 (implies vehicle is not volume limited).

The data in the second card of the vehicle group is cost values in millions of dollars. The format of the card is:

	NR DEV	DEV SPREAD	R PROD	PROD SPREAD	R FLT	REFURB

Field 1 is vacant.

Field 2 contains the cost of non-recurring development.

Field 3 contains the name of a spreading table for non-recurring development costs.

Field 4 contains the cost of recurring production.

Field 5 contains the name of a spreading table for recurring production costs.

Field 6 contains the cost of recurring flight operations.

Field 7 contains the cost of refurbishment.

The next card is the optional stages card. The format of the card is:

	STAGES	51	52	53	54	55	56

Field 1 is vacant.

Field 2 contains the word "STAGES."

Fields 3, 4, 5, 6, 7, 8 contain the names of the stages of the vehicle. The stage names must appear previously in the vehicle table. The stage names must appear in the cargo element table.

The next card defines the vehicle up-down curve of payload capability for a specific leg. There will be a card for each leg the vehicle will fly. The format of the card is:

	LEG	UP WT	DOWN WT	EXPENDED WT

Field 1 is vacant.

Field 2 contains the leg name associated with this up-down curve or the word "NONE."

Field 3 contains the number of pounds (lbs) the vehicle can transport up to the next terminus if the vehicle returns empty (up wt).

Field 4 contains the number of pounds (lbs) the vehicle can transport back to the lower terminus had the vehicle flown up empty (down wt).

Field 5 contains the number of pounds (lbs) the vehicle can transport up to the next terminus if the vehicle does not return (expended wt).

SAMPLE

TABLE	VEHICLE					
EOS-WOAB	0	20	100	10		1.0
	10213	SPDEV9	600	SPPROD3	4.42	360
	ES-28/1	79000	9999999	79000		
	ES-90/.5	40000	9999999	40000		
CRGTUG-25K	0	0	0	0	0	0
	608.48	SPDEV3	13.15	SPPROD2	0	0
	LO-LS	0	0	0		
TUG-25K	25000	0	0	0		
	0	SPDEV3	0	SPPROD2	0	0
	STAGES	TUG-25K	CRTUG-25K			
	28/1-P/12	2394	1017	2394		
	28/1-P/11	5507	2490	5507		

This sample vehicle table shows an EOS and a Tug with a 25K propellant capacity. The EOS requires no propellant, makes a maximum of 20 flights per year, has 100 flights or 10 years life expectancy, has a volume of 1 EOS bay (15 x 60), costs $10 billion over a 9 year period to develop, costs $600 million per production unit paid over 3 years, costs $4.42 million per flight and can fly on the legs ES-28/1 (ETR) and ES-90/.5 (WTR). The tug is being used in a trick, Appendix E, trick 8. It can fly on the legs, 28/1 - P/12 and 28/1 - P/11, both used for interplanetary flights. Also the Tug is using the STAGES card.

Type of errors reported by the program:

Entry M contains non-numeric.

Duplicate vehicle name.

Non-existent leg name.

No payload capability tables.

Default vehicle in leg table has no payload capability for that leg.

Current vehicle lacks cost data.

Spread table named does not exist.

Vehicle table exceeded.

Stage not in vehicle table.

Default vehicle not in vehicle table.

FACILITY TABLE

The purpose of the facility table is to provide the program with a list of facilities with their development and production costs. The first card of the table is:

TABLE	FACILITY	PRINT

Field 1 contains the word "TABLE."

Field 2 contains the word "FACILITY."

Field 3 is the print option indicator for printing the table. If this entry is the word "OFF," the table will not be printed.

Following this card are a series of cards each of which describes a single facility identified by a unique name. The facility table terminates when another "TABLE" card is found.

The format of the first card describing a facility is:

NAME	LIFE YRS	NR DEV	SPREAD	R PROD	SPREAD

Field 1 contains the unique name of the facility.

Field 2 contains the maximum number of years the facility is allowed to operate before replacement occurs.

Field 3 contains the cost of non-recurring development in thousands of dollars.

Field 4 contains the name of the spread table for the development spreading prior to the IOC date of installation.

Field 5 contains the cost of recurring production in thousands of dollars.

Field 6 contains the name of the spread table for the production spreading prior to the date of delivery of each delivered unit.

SAMPLE

TABLE	FACILITY				
NEO-2	100	0	SPDEV3	0	SPPROD2
NPL-10+AG	100	0	SPDEV3	5.6	SPPROD2

This facility table has two satellites taken from the sample in Appendix D. The one named NEO-2 is not given any costs. The one named NPL-10+AG is an NPL-10 without costs, but mated to an Agena for injection into interplanetary orbit. There are no development costs for the Agena, but the production cost of $5.6 million is spread over a 2 year period.

Type of errors reported by the program:

Spread table named does not exist.

Field M contains non-numeric.

Blank facility name.

Duplicate facility name.

CARGO ELEMENT TABLE

The purpose of the cargo element table is to provide a complete description of cargo items which are shipped according to mission data specifications.

The first card of the cargo element table is:

TABLE	CARGO	PRINT

Field 1 contains the word "TABLE."

Field 2 contains the word "CARGO."

Field 3 is the print option indicator for printing the table. If this entry is the word "OFF," the table will not be printed.

Following this card may be any number of cards each describing a single cargo element identified by a unique name. The cargo element terminates when the program encounters a card with the word "PROGRAM" in field 1.

The format of a card describing a cargo element is:

NAME	DESCRIPTOR	CONTAINER	CATEGORY	UP WT	DOWN WT	VOLUME

Field 1 contains the unique name of the cargo element to be used later in the mission data.

Fields 2 and 3 together contain the 18 letter descriptor to be used as identification in the printouts.

Field 4 contains the name of the bulk container or crew capsule in which this cargo will be carried or the word "DISCRETE" indicating the element is a self-contained package which must travel as a unit.

Field 5 contains the category of the shipment. Acceptable entries are:

FACILITY	MATERIAL	VEHICLE
FACILITIES	PERSONNEL	

Field 6 contains the up weight of the cargo element if the cargo element is to be shipped up the leg.

Field 7 contains the down weight of the cargo element if the cargo element is to be shipped down the leg.

Field 8 contains the volume of the cargo element if it is DISCRETE. Default value is 0. Crew and bulk material which are shipped inside containers do not require their own volume entries.

All containers previously defined in the container table are automatically entered into the cargo table as discrete elements. The up and down weights are taken as the container weight, the category is defined as MATERIAL, and the descriptor is the name of the element. Thereby the containers are available as cargo elements.

SAMPLE

TABLE	CARGO					
NEO-2	POLAR EARTH OBS	DISCRETE	FACILITY	5980	0	.27
NPL-10+AG	GRAND TOUR	DISCRETE	FACILITY	16502	0	.54
CRTUG-25K	CARGO TUG-25K	DISCRETE	MATERIAL	4190	0	.39

This table has two satellites and the 25K Tug as a vehicle. All three elements might be shipped as discretes on a one way trip up. The volumetric values are such that if they were traveling on the same leg in the same year any pair could fit in the EOS bay together.

Type of errors reported by the program:

Duplicate cargo element names.

Blank cargo element name.

No descriptor.

No such container or the word "DISCRETE" is missing.

Category not recognized.

Both up and down weights are zero.

Field X contains a non-numeric.

MISSION INPUT DATA

The purpose of Mission Input Data is to supply those entries required to ship a single cargo element. Once the required entries are available, the cargo element is sent. The cargo entry is removed, thereby making the shipment incomplete. More mission data is processed until the cargo element can be considered as completed for shipment again. The process is repeated until all mission data is processed.

In considering the logistics of space operations over a span of many years, it becomes convenient to divide the overall plan into parts. The parts referred to in this application are the overall plan, program, and mission. A program could be the Lunar Exploration Program or the Automated Satellite Program or the Interplanetary Program. The Lunar Exploration Program could be broken down into missions; i.e., the Lunar Space Station, the Lunar Ground Base. The cost analysis will be subtotaled to the mission level and then to the program level.

To define the breakpoint, a program definition card is put in the input data deck. The format of the card is:

PROGRAM	NAME	PRINT

Field 1 contains the word "PROGRAM."

Fields 2 and 3 contain an 18 letter name of the program.

The first program name card is used to control the print option for the mission input data. On this first program name card, the program name should be left blank, field 4 is blank and field 5 (column 41) may contain the word "OFF" to suppress the printout of the mission input data. The next card should be the first program card with a program name.

All data following a program card is associated with the program named until another program name is introduced. A program card marks the beginning of a set of cards belonging to one or more missions. The next card after a program card should be a mission card. Other data entries are described on the following pages. When a program card is encountered, all previous data entries are forgotten and must be reentered.

The mission card defines a similar cost level and again marks the beginning of a set of cards belonging to the mission. The format of the mission card is:

MISSION	NAME

Field 1 contains the word "MISSION."

Fields 2 and 3 contain an 18 letter name of the mission.

The next few card formats may occur in any order and at any time deemed appropriate to define a value that will remain defined until changed. These cards are aimed at supplying the necessary information for the transportation of a cargo element. The required information is: date of shipment, final leg of shipment, phase of operations, and vehicles to be used for transport.

The date of shipment is provided by the card:

IOC	DATE

Field 1 contains the word "IOC."

Field 2 contains the date in years in two forms:

a) As for example 1980 is an absolute year and should appear as the first date of the mission.

b) As for example 4 is four years after the previous absolute date.

In this way the mission is specified by an absolute date and the various elements of the mission are stipulated relative to the initial date.

The final leg of the shipment is provided by the card:

LEG	LEG NAME

Field 1 contains the word "LEG."

Field 2 contains the name of a leg defined in the LEG TABLE.

The leg card must precede the vehicle card.

The phase of operations for this mission are provided by the card:

PHASE	NAME

Field 1 contains the word "PHASE."

Field 2 contains one of the following:

a) INITIALIZE or 1

b) SUSTAINING or 2

c) TERMINATE or 3

The numerics 1, 2 or 3 are provided as short form equivalents for the self-explanatory words. Either entry is acceptable.

To define the vehicle to be used for transport, the following card is available.

VEHICLE	L-V1	L-V2	L-V3	L-V4

Field 1 contains the word "VEHICLE."

Fields 2, 3, 4 and 5 contain the names of the vehicles to be used on the leg sequence associated with this mission or the word "NONE." These entries are used instead of the default vehicles in the leg table. Any vacant field implies the use of the default vehicle. The default vehicle is provided by having the leg card precede the vehicle card. This reference to the vehicle is used internally to establish the IOC date of the vehicle. After all mission data has been processed, the program will have established the earliest required date for each vehicle based on date of the earliest shipment of cargo on the vehicle.

As the purpose of a mission is to segment the delivery of cargo into initializing, sustaining, and terminating phases, time lines are required to define when the phases occur. In particular, the sustaining phase requires a definition of a start date and a stop date. All cargo mentioned in a sustaining phase is shipped as cargo again and again on a once per year basis. The following two cards are required before a sustaining phase can begin:

START	DATE

Field 1 contains the word "START."

Field 2 contains the date, either of the form 1978 or 4 (the 4 is added to the previous IOC date).

STOP	DATE

Field 1 contains the word "STOP."

Field 2 contains the date as above.

Once the necessary scheduling information is available, cargo items can be sheduled for shipment. An item of cargo (a single element defined in the cargo element table) departs on a trip when the following card is encountered:

CARGO	NAME	NUMBER

Field 1 contains the word "CARGO."

Field 2 contains the name of an item defined in the cargo element table.

Field 3 contains the number of such cargo elements to be sent.

In the sustaining phase this cargo element will be sent every year beginning with the "START" date and continuing through the "STOP" date.

Before a cargo element can be shipped, the cards: PROGRAM, MISSION, PHASE, DATE, LEG, VEHICLE must all be provided. Once they are provided, any number of cargo cards may be entered until the phase, vehicle, leg, or date changes.

These cards describe the overall plan by focusing the user's attention to specific areas of concern. Thus the plan is built up of missions and programs.

Sample:

PROGRAM	PLANETRY SATELLITE
MISSION	GRAND TOUR
PHASE	1
IOC	1979
LEG	28/1-P/11
VEHICLE	
CARGO	NPL-10+AG
PROGRAM	WTR AUTO SATELLITES
MISSION	POLAR EARTH OBSERV
PHASE	1
IOC	1979
LEG	ES-90/.5
VEHICLE	EOS-WOAB
CARGO	NEO-2
PHASE	2
START	1
STOP	11
CARGO	NEO-2
CARGO	NEO-2-R

REPORT	TABLES
REPORT	SPRINT
REPORT	CONTAINER
REPORT	FACILITY
REPORT	TRAFFIC
REPORT	VEHICLE
REPORT	COST

This sample of Mission Input Data shows the sending in 1979 of NPL-10 Uranus Tops orbiting probe with an agena stage on an interplanetary orbit. From WTR the satellite NEO-2 is launched in 1979 into a 500 mile polar orbit and replaced annually thereafter by sending NEO-2 up and retrieving the equivalent down satellite NEO-2-R.

Type of errors reported by the program:

Mission card does not follow program card.

Field 1 not recognizable as key word.

Cargo entry missing

a) Shipment date.

b) Leg name.

c) Phase name.

d) Vehicle name (not in mission data nor defaulted in Leg Table).

Bad IOC date entry (no reference date).

Card N, Field M contains non-numeric character.

Vehicle card appears before leg card.

Phase entry not recognized.

Leg name not recognized.

Vehicle name not recognized.

Duplicate program name.

Cargo name not recognized.

REQUESTS FOR REPORTS

When field 1 contains the word "REPORT," the Mission Data is presumed terminated. At this time the program will perform the scheduling of all cargo input in the Mission Data and internally generate as cargo elements the necessary propellant tanks required to support the missions. At this time then, individual reports may be requested.

The format of the report requesting card is:

REPORT	NAME	LENGTH

Field 1 contains the word "REPORT."

Field 2 contains one of the following report names: SPRINT, CONTAINER, FACILITY, TRAFFIC, VEHICLE, COST, TABLES, DEBUG, CALVEH, PRTCAL. Any other name or a misspelled name will be ignored.

Field 3 contains a length specification applicable to the reports VEHICLE and COST. The short form of the reports can be requested by the word "SHORT."

Any number of the reports may be requested via several "REPORT" cards. Each individual report is printed only once. The first card encountered that is not a "REPORT" card will terminate the requests for reports section of the data deck.

APPENDIX B

QUICK REFERENCE TO INPUT DATA FORMATS

This appendix is provided as a quick reference to the input data formats for the user who has studied the detailed descriptions in the previous appendix. Such a user possesses a familiarity with the primary aspects of the input and needs only a quick reminder to trigger the human memory to recall other details. An effort has been made to place all the necessary information on one sheet for each table or input group. The input tables begin on the following pages in this order:

CONTAINER TABLE

LEG TABLE

SPREAD TABLE

VEHICLE TABLE

FACILITY TABLE

CARGO ELEMENT TABLE

MISSION INPUT DATA

REPORTS

CONTAINER TABLE

- Describes bulk containers, propellant tanks and crew capsules.

- First card is:

TABLE	CONTAINER	OFF

- Each container is a card:

NAME	CAPACITY	EMPTY WT	CLASSIFICATION	VOLUME FRACTION

- CLASSIFICATION is BULK, CREW or PROPELLANT.

- Default volume fraction is 1 full EOS cargo bay.

LEG TABLE

- Provides a list of leg and leg sequences.
- First card is:

TABLE	LEG

- Each leg is a card:

NAME	NEXT DOWN LEG	LONGSHORE	VEHICLE

- LONGSHORE is YES, NO or SINGLE.
- Last leg in sequence has NEXT DOWN LEG of NONE.

SPREAD TABLE

- Provides spreading functions for costs.

- First card:

TABLE	SPREAD	OFF

- Each spreading function is:

NAME	NO. OF YEARS	IOC YEAR	FACTOR1 - FACTOR5

- Optional second card (used if spread is over more than 5 years).

	FACTOR6 - FACTOR12

- Factors are in percent.

VEHICLE TABLE

- Provides information on lifetime, cost and performance of all vehicles.
- First card:

TABLE	VEHICLE	OFF

- Each vehicle is a group of cards:

NAME	PROPELLANT	MAX/YEAR	LIFE FLT	LIFE YRS	MIN LOAD	VOLUME CONSTRAINT

	NR DEV	DEV SPREAD	R PROD	PROD SPREAD	R FLT	REFURB

- Costs in millions.
- SPREAD is the name of a spreading function.
- Optional staging card:

	STAGES	S1 - S6

- Card for vehicle performance on a leg:

	LEG NAME	UP WT	DOWN WT	EXPENDED WT

FACILITY TABLE

- Defines the development and production costs of facilities.

- First card:

TABLE	FACILITY	OFF

- Each facility is:

NAME	LIFE YRS	NR DEV	SPREAD	R PROD	SPREAD

- NR DEV and R PROD are in millions of dollars.

- SPREAD is the name of a spreading function.

CARGO ELEMENT TABLE

- Provides up/down weights and container/discrete assignments of potentially shipable items.

- First card:

TABLE	CARGO	OFF

- Each cargo element is:

NAME	DESCRIPTOR	CONTAINER	CATEGORY	UP WT	DOWN WT	VOLUME

- CONTAINER is defined in container table or DISCRETE.

- CATEGORY is FACILITIES, FACILITY, MATERIAL, PERSONNEL or VEHICLE.

- VOLUME is 0 if no entry.

MISSION INPUT DATA

- Describes overall plan.
- Card formats are:

PROGRAM	NAME	OFF

- NAME is 18 letters.

MISSION	NAME

- NAME is 18 letters.

IOC	DATE

- DATE is 1984 or 6.

LEG	LEG NAME

VEHICLE	L-V1	L-V2	L-V3	L-V4

PHASE	TYPE

- TYPE is INITIALIZE, SUSTAINING, TERMINATE or 1, 2, 3.

START	DATE

STOP	DATE

CARGO	NAME	NUMBER

REQUESTS FOR REPORTS

- Provides requests for results.

- A report card is:

REPORT	NAME	SHORT

- NAME is: SPRINT, CONTAINER, FACILITY, TRAFFIC, VEHICLE, COST, TABLES, DEBUG, CALVEH or PRTCAL.

- SHORT is effective only on VEHICLE and COST.

APPENDIX C

PROGRAM ERROR MESSAGES

The program has a variety of built-in error messages intended to inform the user of potential problem areas. The program will note an error when encountered and continue to run the job whenever feasible. In some extreme circumstances the program encounters an error from which recovery is impossible and the job is abandoned. The user is advised to check the printout for error messages and to take appropriate action.

In the following descriptions of error messages, the messages relevant to input data are grouped by the particular table being input when the error message is printed. The messages generated during processing to satisfy the mission then appear.

The following symbols are used in the places where the program outputs internal information as a key to the error

NN	a numeric, usually a card count.
XXXXXX	an alphabetic ten letter entry in the data.
YYYYYY	also an alphabetic ten letter entry in the data.

<u>Errors in processing the container table:</u>

1) THE CONTAINER TABLE CAPACITY IS EXCEEDED.

   The user should review the job setup to ascertain that this set of containers is really required. The program has a limit of 20 containers.

2) IN THE CONTAINER TABLE ON CARD NN, THIS CONTAINER NAME XXXXXXX HAS ALREADY BEEN USED.

   Each container name is unique, so that a later reference is to a definite container. Which of the two containers named XXXXXX do you wish to use?

3) IN THE CONTAINER TABLE ON CARD NN, THERE IS AN ERROR IN THE (WEIGHT) CAPACITY VALUE, XXXXXX.

The entry XXXXXX is not numeric.

4) IN THE CONTAINER TABLE ON CARD NN, THERE IS AN ERROR IN THE PENALTY (WEIGHT) VALUE, XXXXXX.

The entry XXXXXX is not numeric.

5) IN THE CONTAINER TABLE ON CARD NN, ONLY THE OPTIONS BULK, CREW OR PROPELLANT CAN BE USED, NOT XXXXXX.

The entry XXXXXX is not one of the acceptable options for container classifications.

6) IN THE CONTAINER TABLE ON CARD NN, THE VOLUME FACTOR XXXXXXX IS NOT A VALID ENTRY.

The volume factor XXXXX is not a numeric entry.

Errors in processing the leg table:

1) THE CAPACITY OF THE LEG TABLE IS EXCEEDED.

The user should review the job setup to ascertain that this set of legs is really required. The program has a limit of 31 legs.

2) IN THE LEG TABLE OR CARD NN, THE LEG NAME, XXXXXX, HAS ALREADY BEEN USED.

XXXXXX appears on two leg table cards. The user is requested to remove one of the cards or change one of the leg names.

3) IN THE LEG TABLE ON CARD NN, THE LEG NAME PRECEDES THE SUCCESSOR NAME.

While processing the card NN a check has been made of those legs previously defined and the successor name has already been defined. This suggests the deck is out of order.

4) IN THE LEG TABLE ON CARD NN, THERE IS, XXXXXX - NOT THE OPTION OF YES, NO OR SINGLE.

In the longshoring slot, only one of the above options may be entered.

5) NO FOLLOWING LEG XXXXXX YYYYY.

The leg table has been completely loaded into the computer and a final check made on the successor legs. For the leg XXXXXX, the program cannot find the successor leg YYYYY.

Errors in processing the spread table:

1) TOO MANY SPREAD TABLES.

The user should review the job setup to ascertain that this set of spread tables is really required. The program has a limit of 20 spread tables.

2) IN THE SPREAD TABLE ON CARD NN, THE NAME - XXXXXX - HAS ALREADY BEEN USED.

Each spread table must have a unique name for an unambiguous later reference. Which of the two spread tables named XXXXXX do you wish to use?

3) IN THE SPREAD TABLE ON CARD NN, THE FIELD - XXXXXX - IS NON-NUMERIC.

The entry XXXXXX contains non-numerics.

4) THE SPREAD TABLE XXXXXX DOES NOT TOTAL 100 PERCENT.

The sum of the percentages in the spread table XXXXXX does total to 100% $\pm$ 1%.

Errors in processing the vehicle table:

1) VEHICLE TABLE CAPACITY EXCEEDED.

The user should review the job setup to ascertain that this set of vehicles is really required. The program has a limit of 30 vehicles.

2) IN THE VEHICLE TABLE ON CARD NN, THE NAME - XXXXXX - HAS ALREADY BEEN USED.

Each vehicle must have a unique name for an unambiguous later reference. Which of the two vehicles names XXXXXX do you wish to use?

3) IN THE VEHICLE ON CARD NN, THE FIELD - XXXXXX - CONTAINS A NON-NUMERIC.

The entry XXXXXX contains non-numerics.

4) IN THE VEHICLE TABLE, VEHICLE XXXXXX DOES NOT HAVE THE MINIMUM AMOUNT OF DATA.

Each vehicle requires a minimum of two cards of basic data plus at least one leg card. The vehicle XXXXXX does not have these three cards.

5) THE STAGE XXXXXX HAS NOT BEEN ENTERED IN THE VEHICLE TABLE.

If the "STAGES" option is to be used, the individual stages must be entered into the vehicle table prior to referencing the stages in a "STAGES" card. The program has reviewed the previous data entries and cannot find XXXXXX.

6) THE LEG XXXXXX FOR VEHICLE YYYYYY IS NOT IN THE LEG TABLE.

A leg card for vehicle YYYYYY stipulates the vehicle capability on leg XXXXXX. The program cannot find the leg XXXXXX in the leg table.

7) UP/DOWN CAPABILITY FOR DEFAULT VEHICLE XXXXXX ON LEG YYYYYY DOES NOT EXIST.

The program has referred back to the leg table to check that on leg YYYYYY, the vehicle XXXXXX has its capability defined for later usage. The necessary leg card is missing.

8) THE DEFAULT VEHICLE XXXXXX IS NOT IN THE VEHICLE TABLE.

The program has referred back to the leg table and finds that the default vehicle XXXXXX is not defined in the vehicle table.

9) **NO SUCH SPREAD TABLE AVAILABLE XXXXXX**.

The program has checked the previously input spread tables and finds that the spread table XXXXXX does not exist. For no spread table, the entry should be zero.

<u>Errors in processing the facility table:</u>

1) ERROR OCCURRED ON CARD NN OF FACILITY TABLE...

This error message is used to identify the card in error in the facility table. The card will be printed on the next line. Any errors in the card will precede this message and will be one or more of the following messages.

2) BLANK FACILITY NAME

Field 1 on the card is blank.

3) FACILITY NAME DUPLICATES ONE PREVIOUSLY INPUT.

Each name used in the facility table must be unique.

4) THE FIELD - XXXXX - CONTAINS A NON-NUMERIC.

The field XXXXX contains a non-numeric.

5) NO SUCH SPREAD TABLE AVAILABLE XXXXXX **.

The program has checked the previously input spread table and finds that the spread table XXXXXX does not exist. For no spread table, the entry should be zero.

Errors in processing the cargo element table:

1) IN THE CARGO ELEMENT TABLE ON CARD NN THE NAME IS BLANK.

Field 1 on the card is blank.

2) IN THE CARGO ELEMENT TABLE ON CARD NN THE NAME - XXXXXX - HAS ALREADY BEEN USED.

Each cargo element must have a unique name for an unambiguous later reference. Which of the two cargo elements named XXXXXX do you wish to use?

3) IN THE CARGO ELEMENT TABLE ON CARD NN THE FIELD - XXXXXX - CONTAINS A NON-NUMERIC.

The entry XXXXXX contains a non-numeric.

4) IN THE CARGO ELEMENT TABLE ON CARD NN THE UP AND DOWN WEIGHTS ARE BOTH ZERO.

A cargo element must have an up or a down weight of at least one pound in order to be shipped anywhere. Either revise the weight or delete the cargo element.

5) IN THE CARGO ELEMENT TABLE ON CARD NN THE DESCRIPTOR IS MISSING.

The descriptor entry is provided in the data as a place to put a clarifying phase on a cargo element. It need not be entered.

6) THE CARGO ELEMENT ON CARD NN DOES NOT POINT TOWARD THE CONTAINER, VEHICLE OR FACILITIES TABLE.

As the cargo element does not refer to any of those tables, there will be no development and production costs associated with the item; nor does the item fit in a container. A brief review of the item on card NN is recommended.

7) IN THE CARGO ELEMENT TABLE ON CARD NN THE CONTAINER XXXXXX IS NOT DEFINED, OR THE WORD - DISCRETE - IS MISSING.

The program has determined that the entry XXXXXX is not the word "DISCRETE" and therefore must be the name of a container. A check of this name against the names in the container table shows the name is not that of a container.

8) IN THE CARGO ELEMENT TABLE ON CARD NN THE CATEGORY, XXXXXX, IS NOT RECOGNIZABLE.

The category of a cargo element is restricted to be one of the following: MATERIAL, PERSONNEL, FACILITY, FACILITIES, VEHICLE. The entry XXXXXX does not match with any item in the list.

Errors in processing mission data:

1) MISSION ENTRY DOES NOT IMMEDIATELY FOLLOW A PROGRAM ENTRY IN MISSION DATA. LAST PROGRAM ENTRY WAS XXXXXX.

After the user specifies the program name XXXXXX on a PROGRAM card, the MISSION card must be next to provide the mission name.

2) UNIDENTIFIED ENTRY IN MISSION DATA. LAST PROGRAM ENTRY WAS XXXXXX.

LAST MISSION ENTRY WAS YYYYYY.
CARD IMAGE IN ERROR IS XYXYXY ---

The key word in field 1 of the data card XYXYXY --- for program XXXXXX, mission YYYYYY is not recognized by the computer program. Please check spelling or description of valid mission data key word in Appendix B.

3) DUPLICATE PROGRAM ENTRY IN MISSION DATA. LAST PROGRAM ENTRY WAS XXXXXX.

The data for program XXXXXX has all been entered previously and terminated by the next program card. Use of the same program name is an attempt to add more data to the previous program. If the user wishes to add more data to a previous program, then the cards should be physically placed in the deck so as to be a part of that program. Otherwise, the user should change the name of duplicated program.

4) MISSION OR PROGRAM TABLE OVERFLOW. NMISS = NN NPROG = MM.

5) UNIDENTIFIED PHASE ENTRY IN MISSION DATA.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
CARD IMAGE IN ERROR IS PHASE ---

On the phase-specification data card PHASE -----, field 2 does not contain the digit 1, 2 or 3 or the entry INITIALIZE, SUSTAIN or TERMINATE for program XXXXXX and mission YYYYYY.

6) IOC ENTRY IN MISSION DATA IS NOT NUMERIC.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
CARD IMAGE IN ERROR IS IOC ----

Field 2 of the IOC specification card contains a non-numeric entry under program XXXXXX and mission YYYYYY.

7) FIRST IOC ENTRY AFTER A MISSION ENTRY IS NOT A YEAR DATE.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
CARD IMAGE IN ERROR IS IOC -----

Field 2 of the first IOC specification card after a mission card must contain a year form of the date; for instance, 1980 not 3. See program XXXXXX and mission YYYYYY for the error.

8) LEG ENTRY IN MISSION DATA IS NOT IN LEG TABLE.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
CARD IMAGE IN ERROR IS LEG -----

The leg name in field 2 has been compared against the names previously entered in the leg table. There was no corresponding name in the leg table. See program XXXXXX and mission YYYYYY for the error.

9) VEHICLE CARD APPEARS BEFORE A LEG CARD.
PROGRAM = XXXXX MISSION = YYYYYY
CARD IMAGE IN ERROR IS VEHICLE ----

The program requires the leg card to appear before the vehicle card so that the default vehicles for the legs can be located before the external VEHICLE card overrides the default vehicles. See program XXXXXX and mission YYYYYY for the error.

10) VEHICLE NAME XXXXXX IS NOT IN VEHICLE TABLE.
PROGRAM = YYYYYY MISSION = XYXYXY
CARD IMAGE IN ERROR IS VEHICLE ----

The vehicle named XXXXXX has not been located in the previously input vehicle table. The default vehicle on the appropriate leg will be used. See program YYYYY and mission XYXYXY for the card in error.

11) START ENTRY IN MISSION DATA IS NOT NUMERIC.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
CARD IMAGE IN ERROR IS START ----

Field 2 of a start specification card is not numeric. See program XXXXXX and mission YYYYYY for the card in error.

12) START ENTRY IN MISSION DATA CANNOT BE ACCEPTED FOR LACK OF A PREVIOUS IOC DATE.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
UNACCEPTABLE CARD IMAGE IS START ----

An IOC specification card has not been entered or has been rejected after the preceding mission card. See program XXXXXX and mission YYYYYY for the card in error.

13) STOP ENTRY IN MISSION DATA IS NOT NUMERIC.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
CARD IMAGE IN ERROR WAS STOP ----

Field 2 of a stop specification card is not numeric. See program XXXXXX and mission YYYYYY for card in error.

14) STOP ENTRY IN MISSION DATA CANNOT BE ACCEPTED FOR LACK OF A PREVIOUS IOC DATE.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
UNACCEPTABLE CARD IMAGE IS STOP ----

An IOC specification card has not been entered or has been rejected after the preceding mission card. See program XXXXXX and mission YYYYYY for the card in error.

15) LEG, VEHICLE, PHASE OR IOC DATE UNDEFINED.
PROGRAM = XXXXXX MISSION = YYYYYY.

At this point the program is processing the first cargo card after a mission card and finds that at least one of required specifications for leg, vehicle, phase and IOC date have not been supplied. See program XXXXXX and mission YYYYYY for the problem area.

16) CARGO NAME ENTRY IN MISSION DATA IS NOT IN THE CARGO ELEMENT TABLE.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
CARD IMAGE IN ERROR IS CARGO ---

The program has taken the name in field 2 of the above cargo card and scanned the cargo element table for that name. The name did not appear in the cargo element table, and therefore the item is not sent. See program XXXXXX and mission YYYYYY for the card in error.

17) CARGO NUMBER ENTRY IN MISSION DATA IS NOT NUMERIC.
LAST PROGRAM ENTRY WAS XXXXXX.
LAST MISSION ENTRY WAS YYYYYY.
CARD IMAGE IN ERROR IS CARGO ----

The entry in field 3 of the cargo card is not numeric and therefore the program does not know how many items with this name are to be sent. See program XXXXXX and mission YYYYYY for the card in error.

Error messages from LEGPRO:

1) TOO MANY YEARS ----- NYRS = NN

The program is limited to processing a span of 30 years; the user has tried to do NN years.

2) NO FOLLOW-ON LEG XXXXXX YYYYYY

The program has thoroughly checked for this type of error previously; and if this is the first occurrence of the message, the user is advised to suspect a computer malfunction.

Error messages from TRAFIC:

1) ABORT - EXCEEDED VEHICLE CAPACITY IN TRAFFIC PLANNER -NN- XXXXXX

The program has a limit of 200 vehicles in a fleet. The vehicle XXXXXX requires NN vehicles in its fleet. The program will terminate after printing the message.

2) STAGED VEHICLE IS NOT IN CARGO ELEMENT TABLE - XXXXXX.

The user is invoking the staging option and thereby having the program ship the elements that make up the vehicle. The program cannot find the staging element XXXXXX in the cargo element table.

3) ****ADDITIONAL VEHICLE NEEDED. **** XXXXXX NN.

The user is shipping vehicles as cargo elements on the legs. The program has determined the fleet size required to support the mission data and finds that in year NN the fleet needs a vehicle XXXXXX shipped. The results of the computations are correct except they lack the operating cost for shipping the vehicle.

Error message from SPDAP:

1) **SPREADING ERROR IN DEV + PROD OF XXXXXX OCCURS TOO EARLY.

In spreading the costs for production or development for item named XXXXXX an attempt was made to spread the costs too far back in time. The earliest permissible date is set to 1970.

Error messages from ASINER and FIND:

1) INVALID VOLUME LIMIT NN FOR CURRENT VEHICLE XXXXXX.

The volume limit NN was found to be a negative number. Since the input routine RDVEH checks for this also and since the default value is 1000, this problem is not an input error, but rather arises from some blow-up elsewhere in DORCA. ASINER will skip all passes for vehicle XXXXXX.

2) ASINER CANNOT FIND DATA FOR LEG XXXXXX ON VEHICLE YYYYYY.

Most likely the user simply forgot to input this data. Program will skip this vehicle/leg combination for all years.

3) CARGO ELEMENT NAMED XXXXXX HAS ILLEGAL VALUE FOR CONTAINER CLASS NN IN SUBROUTINE ASINER.

This means that bits 12-23 of word 6 for this element in the cargo element table do not contain the value 1, 2, 3, or 4. This is an internal programming problem. ASINER will simply skip this element and continue processing other elements.

4) *REJECT* CARGO XXXXXX CONT. CCCCCC VEH. VVVVVV LEG LLLLLL.

This means that the container volume exceeds the vehicle volume limit or that the weight of the empty container plus 20% of its capacity exceeds the vehicle weight limit in the down direction. ASINER will skip all cargo elements which must travel in the container indicated. Most likely an input error.

5) CARGO ELEMENT NAMED XXXXXX HAS WEIGHT OF WWW IN DIRECTION N (1-UP, 2-DOWN)
WEIGHT MUST EXCEED CUTOFF VALUE OF EEE FOR PROPER PROCESSING.

Currently, EEE is taken as 0.99 lbs. Most likely this is an input error, or possibly an instance where the user input a dummy cargo item of very little or no weight for convenience. Program will skip this cargo element.

6) *REJECT* CARGO XXXXXX WT. NN VOL. MM VEH. YYYYYY LEG XYXYXY.

This is either a discrete item whose volume exceeds the vehicle volume capacity or a discrete or crew cargo item whose weight exceeds the weight capacity of the vehicle in the direction(s) the cargo is travelling. Input error. Program ignores this cargo element.

7) TOO MANY CARGO ITEMS ON VEHICLE XXXXXX, LEG YYYYYY LIMIT IS NN.

This is due to a large amount of data which exceeded the dimensions of matrices FLTA and WS. This is probably due simply to a lot of cargo, in which case the problem can be alleviated by increasing the dimensions of FLTA and WS or by rearranging the data somehow to reduce the cargo; or could be due to an input error, such as a bulk container with a ridiculously small capacity. ASINER may have already made assignments for some of the cargo before the problem arises. If the problem was detected in ASINER, it will immediately discontinue processing the current vehicle/leg/year and go on to the next one; if the problem was detected in subroutine FIND, it will abort the entire program.

8) TOO MANY FLIGHTS OF VEHICLE XXXXXX ON LEG YYYYYY. OUTGREW TW MATRIX.

This means that the dimension of matrix TW was exceeded. Program will discontinue the current vehicle, leg and year and go on to the next. To solve this problem increase the dimension of TW and also the value of variable MAXF, which contains the dimension of TW.

9) ASINER FOUND CONTAINER NAMED XXXXX HAS INADEQUATE CAPACITY (NN). VEHICLE YYYYYY, LEG XYXYXY.

This means capacity was found to be zero or negative. Since the input routine RDCONT also checks for this, this message indicates that the data were destroyed somehow and that a programming error exists somewhere. Program will abort immediately.

10) TOO MANY CONTAINERS REQUISITIONED BY ASINER FOR VEHICLE XXXXXX ON LEG YYYYYY. LIMIT IS NN. OUTGREW CR LIST.

This indicates that dimension of CR array was exceeded. Program will abort immediately. A possible solution is to increase the dimension of CR and the value of variable MAXC. One should also carefully examine the input data, since this problem could arise from an input error such as a container with a ridiculously small capacity or an astronomical amount of bulk material to be shipped.

11) CARGO ASINER IS APPARENTLY IN AN INFINITE LOOP, HAVING MADE NN CONSECUTIVE UNSUCCESSFUL CALLS TO SUBROUTINE FIND.

This means that the cargo items remaining unassigned do not match the records, so that ASINER is searching for something that does not exist. This may be caused by some internal programming error. Program will abort immediately.

APPENDIX D

SAMPLE COMPUTER RUN

TABLE CONTAINER

CLPRM	30000	3500	PROPELLANT	.49
CLPRM-S/B	30000	3500	BULK	.49
TCC-25	30001	4198	CREW	.39

TABLE LEG

LO-LS	28/1-LO	YES	TUG-25K
LO-LS2	28/1-LO	YES	TUG-25K
28/1-LO	ES-28/1	NO	TRTUG-25K
28/1-0/19	ES-28/1	SINGLE	TDTUG-25K
28/1-5/19	ES-28/1	SINGLE	TDTUG-25K
28/1-28/2	ES-28/1	SINGLE	TUG-25K
28/1-28/3	ES-28/1	SINGLE	TUG-25K
28/1-28/19	ES-28/1	SINGLE	TDTUG-25K
28/1-28/20	ES-28/1	SINGLE	TUG-25K
28/1-28/30	ES-28/1	SINGLE	TDTUG-25K
28/1-28/38	ES-28/1	SINGLE	TDTUG-25K
28/1-P/5.5	ES-28/1	SINGLE	TUG-25K
28/1-P/6.7	ES-28/1	SINGLE	TUG-25K
28/1-P/9	ES-28/1	SINGLE	TDTUG-25K
28/1-P/11	ES-28/1	SINGLE	TDTUG-25K
28/1-P/12	ES-28/1	SINGLE	TRTUG-25K
90/1-90/.7	ES-90/1	SINGLE	TUG-25K
90/1-90/2	ES-90/1	SINGLE	TUG-25K
90/1-90/3	ES-90/1	SINGLE	TUG-25K
90/1-90/20	ES-90/1	SINGLE	TUG-25K
100/1-0/.7	ES-100/1	SINGLE	TUG-25K
ES-28/1	NONE	NO	EOS-WOAB
ES-28/3.5	NONE	NO	EOS-WOAB
ES-55/2.7	NONE	NO	EOS-WOAB
ES-90/.3	NONE	NO	EOS-WOAB
ES-90/.5	NONE	NO	EOS-WOAB
ES-90/1	NONE	NO	EOS-WOAB
ES-100/1	NONE	NO	EOS-WOAB
ES-103/.5	NONE	NO	EOS-WOAB

TABLE SPREAD

SPPROD1	1	1	100.				
SPPROD2	2	2	50.	50.			
SPPROD3	3	3	33.33	33.33	33.33		
SPPROD4	4	4	25.	25.	25.	25.	
SPPROD5	5	5	20.	20.	20.	20.	20.
SPPROD6	6	6	16.66	16.66	16.66	16.66	16.66
	16.67						
SPPROD7	7	7	14.3	14.3	14.3	14.3	14.3
	14.3	14.3					
SPDEV3	3	2	20.99	56.38	22.64		
SPDEV4	4	3	10.64	38.31	39.23	11.82	
SPDEV5	5	4	6.13	25.23	35.36	26.29	6.99
SPDEV6	6	5	3.87	17.12	27.97	28.41	18.12
	4.51						
SPDEV7	7	6	2.61	12.06	21.55	25.57	22.16
	12.95	3.11					
SPDEV8	8	6	1.85	8.79	16.65	21.67	21.92
	17.31	9.56	2.25				
SPDEV9	9	7	1.37	5.60	13.01	18.00	19.99
	18.39	13.67	7.27	1.70			
SPDEV10	10	8	1.04	5.09	10.32	14.90	17.60
	17.75	15.36	10.94	5.67	1.32		
SPDEV11	11	9	0.82	4.01	8.30	12.38	15.27
	16.39	15.53	12.85	8.88	4.52	1.05	
SPDEV12	12	9	0.65	3.22	5.77	10.34	13.18
	14.79	14.90	13.51	10.82	7.30	3.67	0.85

TABLE VEHICLE

EOS-WOAB	0	20	100	10		1.0
	10213	SPDEV9	600	SPPROD3	4.42	360
	ES-28/1	79000	9999999	79000	31600	
	ES-55/2.7	51000	9999999	51000	20400	
	ES-90/1	40000	9999999	40000	16000	
	ES-90/.5	8300	9999999	8300	3320	
	ES-100/1	33500	9999999	33500	13400	
	ES-103/.5	6400	9999999	6400	2560	
	ES-90/.3	31500	9999999	31500	12600	
	ES-28/3.5	65500	9999999	65500	26000	
CRGTUG-25K0		0	0	0		
	608.48	SPDEV3	13.15	SPPROD2	0	0
	LO-LS	0	0	0		
TCC-25-CR	0	0	0	0		
	0	SPDEV3	0	SPPROD2	0	0
	NONE	0	0	0		
TCC-25-B/P3		0	0	0		
	0	SPDEV3	0	SPPROD2	0	0
	NONE	0	0	0		
PADTUG-25K0		0	0	0		
	608.48	SPDEV3	13.15	SPPROD2	0	0
	LO-LS	0	0	0		
TUG-25K	25000	10	20	5		
	0	SPDEV3	0	SPPROD2	.91	8.2
	STAGES	TUG-25K	CRGTUG-25K			
	28/1-P/12	2394	1017	2394		
	28/1-P/11	5507	2430	5507		
	28/1-28/2	07579	3574	7579		
	90/1-90/2	07579	3574	7579		
	28/1-P/9	14515	7662	14515		
	LO-LS	14102	8487	14102		
	LO-LS2	14102	8487	14102		
	28/1-P/6.7	28989	18106	28989		
	28/1-P/5.5	40997	27904	40997		
	28/1-28/3	70480	54095	70480		
	90/1-90/3	70480	54095	70480		
	28/1-28/2	128774	109494	128774		
	90/1-90/2	128774	109494	128774		
	90/1-90/.7	169446	149097	169446		

```
           100/1-D/.7169446    149037     169446
           28/1-28/19673       276        673

           28/1-0/19 0         0          0
           28/1-5/19 0         0          0
           28/1-28/300         0          0
           28/1-28/380         0          0
TDTUG-25K  50000     10        20         5
           0         SPDEV3    0          SPPROD2   2.0       0
           STAGES    TCC-25-CR TCC-25-B/PTCC-25-CR TCC-25-B/P
           28/1-0/13 8486      2826       8486
           28/1-28/309304      3141       9304
           28/1-5/13 9519      3229       9519
           28/1-28/3810380     3579       10380
           28/1-LO   11027     3841       11027
           28/1-P/12 16596     6256       16596
           28/1-P/11 21998     8867       21998
           28/1-28/2025673     10777      25673
           90/1-90/2025673     10777      25673
           28/1-P/9  38285     17941      38285
           LO-LS     46304     24535      46304
           LO-LS2    46304     24535      46304
           28/1-P/6.765721     36412      65721
           28/1-P/5.589022     55525      89022
           28/1-28/3 147060    107893     147060
           90/1-90/3 147060    107893     147060
           28/1-28/1913669     4937       13669
TRTUG-25K  75000     10        20         5
           0         SPDEV3    0          SPPROD2   3.0       0
           STAGES    TRTUG-25K CRGTUG-25KCRGTUG-25KCRGTUG-25K
           28/1-0/19 19004     5730       19004
           28/1-28/3020144     6154       20144
           28/1-5/19 20446     6271       20446
           28/1-28/3821654     6739       21654
           28/1-LO   22560     7090       22560
           28/1-P/12 30424     10332      30424
           28/1-P/11 38156     13824      38156
           28/1-28/2043460     16374      43460
           90/1-90/2043460     16374      43460
           28/1-P/9  61820     25920      61820
           28/1-28/1926272     8556       26272
```

TABLE FACILITY

NEO-2	100	0	SPDEV3	0	SPPROD2
NEO-2-R	100	0	SPDEV3	0	SPPROD2
NPL-10+AG	100	0	SPDEV3	5.6	SPPROD2
NPL-7+AG	100	0	SPDEV3	5.6	SPPROD2
NPL-13+AG	100	0	SPDEV3	5.6	SPPROD2
NPL-14+AG	100	0	SPDEV3	5.6	SPPROD2

TABLE CARGO

NEO-2	POLAR EARTH OBS SA	DISCRETE	FACILITY	5980	0	.27
NEO-2-R	POLAR EARTH OBS SA	DISCRETE	FACILITY	0	5980	.27
NPL-10+AG	GRAND TOUR	DISCRETE	FACILITY	16502	0	.54
NPL-13+AG	JUPITER TOP ORB/PR	DISCRETE	FACILITY	18280	0	.59
NPL-14+AG	URANUS TOPS ORB/PR	DISCRETE	FACILITY	18690	0	.59
TUG-25K	SINGL 25K PROP TUG	DISCRETE	MATERIAL	1	0	0
TDTUG-25K	TANDM 25K PROP TUG	DISCRETE	MATERIAL	1	0	0
TRTUG-25K	TRIPL 25K PROP TUG	DISCRETE	MATERIAL	1	0	0
CRGTUG-25K	CARGO TUG-25K	DISCRETE	MATERIAL	4198	0	.39
PADTUG-25K	PROD+DEV TUG ONLY	DISCRETE	VEHICLE	1	0	0
TCC-25-CR	25K TCC CREW	TCC-25	PERSONNEL	1	1	
TCC-25-B/P	25K TCC PROPELLANT	CLPRM-G/B	MATERIAL	25000	0	

PROGRAM-MISSION DATA

PROGRAM	PLANETRY SATELLITE
MISSION	URANS TOPS ORB/PRB
PHASE	1
IOC	1986
LEG	28/1-P/12
VEHICLE	
CARGO	NPL-14+AG
IOC	1989
CARGO	NPL-14+AG
MISSION	GRAND TOUR
PHASE	1
IOC	1979
LEG	28/1-P/11
VEHICLE	
CARGO	NPL-10+AG 2
PROGRAM	WTR AUTO SATELLITES
MISSION	POLAR EARTH OBSERV
PHASE	1
IOC	1979
LEG	ES-90/.5
VEHICLE	EOS-WOAB
CARGO	NEO-2
PHASE	2
START	1
STOP	11
CARGO	NEO-2
CARGO	NEO-2-R

1	CLPRM	30000.0	3500.0	4.0	.5
2	CLPRM-G/B	30000.0	3500.0	2.0	.5
3	TCC-25	30001.0	4196.0	1.0	.4
4		0.0	0.0	0.0	0.0
5		0.0	0.0	0.0	0.0
6		0.0	0.0	0.0	0.0
7		0.0	0.0	0.0	0.0
8		0.0	0.0	0.0	0.0
9		0.0	0.0	0.0	0.0
10		0.0	0.0	0.0	0.0
11		0.0	0.0	0.0	0.0
12		0.0	0.0	0.0	0.0
13		0.0	0.0	0.0	0.0
14		0.0	0.0	0.0	0.0
15		0.0	0.0	0.0	0.0
16		0.0	0.0	0.0	0.0
17		0.0	0.0	0.0	0.0
18		0.0	0.0	0.0	0.0
19		0.0	0.0	0.0	0.0
20		0.0	0.0	0.0	0.0

1	LO-LS	28/1-LO	1.0	000006100100	16
2	LO-LS2	28/1-LO	1.0	000006100100	16
3	28/1-P/5.5	ES-28/1	3.0	000006010000	22
4	28/1-28/38	ES-28/1	3.0	000007010000	22
5	28/1-P/6.7	ES-28/1	3.0	000006010000	22
6	28/1-P/9	ES-28/1	3.0	000007010000	22
7	28/1-P/11	ES-28/1	3.0	000007010000	22
8	28/1-P/12	ES-28/1	3.0	000010010000	22
9	28/1-28/30	ES-28/1	3.0	000007010000	22
10	28/1-28/20	ES-28/1	3.0	000006010000	22
11	28/1-28/19	ES-28/1	3.0	000007010000	22
12	28/1-28/3	ES-28/1	3.0	000006010000	22
13	28/1-28/2	ES-28/1	3.0	000006010000	22
14	28/1-5/19	ES-28/1	3.0	000007010000	22
15	28/1-0/19	ES-28/1	3.0	000007010000	22
16	28/1-LO	ES-28/1	0.0	000010010000	22
17	90/1-90/20	ES-90/1	3.0	000006010000	27
18	90/1-90/3	ES-90/1	3.0	000006010000	27
19	90/1-90/2	ES-90/1	3.0	000006010000	27
20	90/1-90/.7	ES-90/1	3.0	000006010000	27
21	100/1-0/.7	ES-100/1	3.0	000006010000	28
22	ES-28/1	NONE	0.0	000001000000	31
23	ES-28/3.5	NONE	0.0	000001000000	31
24	ES-55/2.7	NONE	0.0	000001000000	31
25	ES-90/.3	NONE	0.0	000001000000	31
26	ES-90/.5	NONE	0.0	000001000000	31
27	ES-90/1	NONE	0.0	000001000000	31
28	ES-100/1	NONE	0.0	000001000000	31
29	ES-103/.5	NONE	0.0	000001000000	31
30			0.0	000000000000	0

1	SPPROD1	2
2	SPPROD2	5
3	SPPROD3	9
4	SPPROD4	14
5	SPPROD5	20
6	SPPROD6	27
7	SPPROD7	35
8	SPDEV3	44
9	SPDEV4	49
10	SPDEV5	55
11	SPDEV6	62
12	SPDEV7	70
13	SPDEV8	79
14	SPDEV9	89
15	SPDEV10	100
16	SPDEV11	112
17	SPDEV12	125

1	1	1.0000											
2	2	.5000	.5000										
3	3	.3333	.3333	.3333									
4	4	.2500	.2500	.2500	.2500								
5	5	.2000	.2000	.2000	.2000	.2000							
6	6	.1666	.1666	.1666	.1666	.1666	.1667						
7	7	.1430	.1430	.1430	.1430	.1430	.1430	.1430					
3	2	.2099	.5638	.2264									
4	3	.1064	.3831	.3923	.1182								
5	4	.0613	.2523	.3536	.2629	.0699							
6	5	.0387	.1712	.2797	.2841	.1912	.0451						
7	6	.0261	.1206	.2155	.2557	.2216	.1295	.0311					
8	6	.0185	.0879	.1665	.2167	.2192	.1731	.0956	.0225				
9	7	.0137	.0660	.1301	.1800	.1399	.1839	.1367	.0727	.0170			
10	8	.0104	.0509	.1032	.1490	.1760	.1776	.1536	.1094	.0567	.0132		
11	9	.0082	.0401	.0830	.1238	.1527	.1639	.1553	.1285	.0888	.0452	.0105	
12	9	.0065	.0322	.0677	.1034	.1318	.1479	.1490	.1351	.1082	.0730	.0367	.0085

1	EOS-WOAB	000070000213	000000000000
2	CRGTUG-25K	000025000303	000000000000
3	TCC-25-CR	000025000330	000000000000
4	TCC-25-8/P	000025000355	000000000000
5	PADTUG-25K	000025000402	000000000000
6	TUG-25K	000164000427	060200000000
7	TDTUG-25K	000145000613	030403040000
8	TRTUG-25K	000107000760	100202020000
9		000000000000	000000000000
10		000000000000	000000000000
11		000000000000	000000000000
12		000000000000	000000000000
13		000000000000	000000000000
14		000000000000	000000000000
15		000000000000	000000000000
16		000000000000	000000000000
17		000000000000	000000000000
18		000000000000	000000000000
19		000000000000	000000000000
20		000000000000	000000000000
21		000000000000	000000000000
22		000000000000	000000000000
23		000000000000	000000000000
24		000000000000	000000000000
25		000000000000	000000000000
26		000000000000	000000000000
27		000000000000	000000000000
28		000000000000	000000000000
29		000000000000	000000000000
30		000000000000	000000000000

1	EOS-WOAB		0.0	20.0	100.0	10.0	0.0	10213.0	89.0
			0.0	600.0	9.0	0.0	4.4	360.0	1.0
		ES-28/1	79000.0	9999999.0	79000.0				
		ES-55/2.7	51000.0	9999999.0	51000.0				
		ES-90/1	40000.0	9999999.0	40000.0				
		ES-90/.5	8300.0	9999999.0	8300.0				
		ES-100/1	33500.0	9999999.0	33500.0				
		ES-103/.5	6400.0	9999999.0	6400.0				
		ES-90/.3	31500.0	9999999.0	31500.0				
		ES-28/3.5	65500.0	9999999.0	65500.0				
2	CRGTUG-25K		0.0	0.0	0.0	0.0	0.0	608.5	44.0
			0.0	13.1	5.0	0.0	0.0	0.0	1000.0
		LO-LS	0.0	0.0	0.0				
3	TCC-25-CR		0.0	0.0	0.0	0.0	0.0	0.0	44.0
			0.0	0.0	5.0	0.0	0.0	0.0	1000.0
		NONE	0.0	0.0	0.0				
4	TCC-25-B/P		0.0	0.0	0.0	0.0	0.0	0.0	44.0
			0.0	0.0	5.0	0.0	0.0	0.0	1000.0
		NONE	0.0	0.0	0.0				
5	PADTUG-25K		0.0	0.0	0.0	0.0	0.0	608.5	44.0
			0.0	13.1	5.0	0.0	0.0	0.0	1000.0
		LO-LS	0.0	0.0	0.0				
6	TUG-25K		25000.0	10.0	20.0	5.0	0.0	0.0	44.0
			0.0	0.0	5.0	0.0	.9	8.2	1000.0
		28/1-P/12	2394.0	1017.0	2394.0				
		28/1-P/11	5507.0	2490.0	5507.0				
		28/1-28/20	7579.0	3574.0	7579.0				
		90/1-90/20	7579.0	3574.0	7579.0				
		28/1-P/9	14515.0	7662.0	14515.0				
		LO-LS	14102.0	8487.0	14102.0				
		LO-LS2	14102.0	8487.0	14102.0				
		28/1-P/6.7	28989.0	13106.0	28989.0				
		28/1-P/5.5	40997.0	27904.0	40997.0				
		28/1-28/3	70480.0	54095.0	70480.0				
		90/1-90/3	70480.0	54095.0	70480.0				
		28/1-28/2	128774.0	109494.0	128774.0				
		90/1-90/2	128774.0	109494.0	128774.0				

		90/1-90/.7	169446.0	149097.0	169446.0				
		100/1-0/.7	169446.0	149097.0	169446.0				
		28/1-28/19	673.0	276.0	673.0				
		28/1-0/19	0.0	0.0	0.0				
		28/1-5/19	0.0	0.0	0.0				
		28/1-28/30	0.0	0.0	0.0				
		28/1-28/38	0.0	0.0	0.0				
7	TDTUG-25K		50000.0	10.0	20.0	5.0	0.0	0.0	44.0
			0.0	0.0	5.0	0.0	2.0	0.0	1000.0
		28/1-0/19	8486.0	2826.0	8486.0				
		28/1-28/30	9304.0	3141.0	9304.0				
		28/1-5/19	9519.0	3229.0	9519.0				
		28/1-28/38	10380.0	3579.0	10380.0				
		28/1-LO	11027.0	3841.0	11027.0				
		28/1-P/12	16596.0	6256.0	16596.0				
		28/1-P/11	21998.0	8867.0	21998.0				
		28/1-28/20	25673.0	10777.0	25673.0				
		90/1-90/20	25673.0	10777.0	25673.0				
		28/1-P/9	38285.0	17941.0	38285.0				
		LO-LS	46304.0	24535.0	46304.0				
		LO-LS2	46304.0	24535.0	46304.0				
		28/1-P/6.7	65721.0	36412.0	65721.0				
		28/1-P/5.5	89022.0	55525.0	89022.0				
		28/1-28/3	147060.0	107893.0	147060.0				
		90/1-90/3	147060.0	107893.0	147060.0				
		28/1-28/19	13669.0	4937.0	13669.0				
8	TRTUG-25K		75000.0	10.0	20.0	5.0	0.0	0.0	44.0
			0.0	0.0	5.0	0.0	3.0	0.0	1000.0
		28/1-0/19	19004.0	5730.0	19004.0				
		28/1-28/30	20144.0	6154.0	20144.0				
		28/1-5/19	20446.0	6271.0	20446.0				
		28/1-28/38	21654.0	6733.0	21654.0				
		28/1-LO	22560.0	7090.0	22560.0				
		28/1-P/12	30424.0	10332.0	30424.0				
		28/1-P/11	38156.0	13824.0	38156.0				
		28/1-28/20	43460.0	16374.0	43460.0				
		90/1-90/20	43460.0	16374.0	43460.0				
		28/1-P/9	61820.0	25920.0	61820.0				
		28/1-28/19	26272.0	8556.0	26272.0				

1	NEO-2	100.0	0.0	44.0	0.0	0.0	5.0
2	NEO-2-P	100.0	0.0	44.0	0.0	0.0	5.0
3	NPL-10+AG	100.0	0.0	44.0	0.0	5.6	5.0
4	NPL-7+AG	100.0	0.0	44.0	0.0	5.6	5.0
5	NPL-13+AG	100.0	0.0	44.0	0.0	5.6	5.0
6	NPL-14+AG	100.0	0.0	44.0	0.0	5.6	5.0

1	NEO-2	POLAR EARTH OBS SA	000100030003	5980.0	0.0	.3
2	NEO-2-R	POLAR EARTH OBS SA	000200030003	0.0	5980.0	.3
3	NPL-10+AG	GRAND TOUR	000300030003	16502.0	0.0	.5
4	NPL-13+AG	JUPITER TOP ORB/PR	000500030003	18280.0	0.0	.5
5	NPL-14+AG	URANUS TOPS ORB/PR	000600030003	18690.0	0.0	.6
6	TUG-25K	SINGL 25K PROP TUG	000600030004	1.0	0.0	0.0
7	TDTUG-25K	TANDM 25K PROP TUG	000700030004	1.0	0.0	0.0
8	TRTUG-25K	TRIPL 25K PROP TUG	001000030004	1.0	0.0	0.0
9	CRGTUG-25K	CARGO TUG-25K	000200030004	4198.0	0.0	.4
10	PADTUG-25K	PROD+DEV TUG ONLY	000500030004	1.0	0.0	0.0
11	TCC-25-CR	25K TCC CREW	000300010002	1.0	1.0	0.0
12	TCC-25-B/P	25K TCC PROPELLANT	000200020001	25000.0	0.0	0.0
13	CLPRM	CLPRM	000000030001	33500.0	3500.0	.5
14	CLPRM-G/B	CLPRM-G/B	000000030001	3500.0	3500.0	.5
15	TCC-25	TCC-25	000300030001	4198.0	4198.0	.4

1	OVERHEAD
2	PLANETRY SATELLITE
3	WTR AUTO SATELLITE

1	PROPELLANTS
2	CONTAINERS
3	VEHICLES
4	URANS TOPS ORB/PRB
5	GRAND TOUR
6	POLAR EARTH OBSERV

SAMPLE CASE OUTPUT

PROGRAM	MISSION	LEG	VEHICLE	YEAR	FLIGHT	CARGO	WT UP	WT DOWN	ELF
PLANETRY SATELLITE	GRAND TOUR	28/1-P/11	TDTUG-25K	1979	1	NPL-10+AG	16502	0	1.0000
						TOTALS	16502	0	1.0000
PLANETRY SATELLITE	GRAND TOUR	28/1-P/11	TDTUG-25K	1979	2	NPL-10+AG	16502	0	1.0000
						TOTALS	16502	0	1.0000
PLANETRY SATELLITE	URANS TOPS ORB/PRB	28/1-P/12	TRTUG-25K	1986	1	NPL-14+AG	18690	0	1.0000
						TOTALS	18690	0	1.0000
PLANETRY SATELLITE	URANS TOPS ORB/PRB	28/1-P/12	TRTUG-25K	1989	1	NPL-14+AG	18690	0	1.0000
						TOTALS	18690	0	1.0000
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	1	TCC-25-B/P	5000	0	.0738
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	1	TCC-25-B/P	25000	0	.3689
OVERHEAD	CONTAINERS	ES-28/1	EOS-WOAB	1979	1	TCC-25	4198	0	.0619
OVERHEAD	CONTAINERS	ES-28/1	EOS-WOAB	1979	1	TCC-25	0	4198	.0005
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	1	TCC-25-CR	1	0	.0000
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1979	1	CLPRM	33500	0	.4944
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	1	TCC-25-CR	0	1	0.0000
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1979	1	CLPRM	0	3500	.0004
						TOTALS	67699	7699	1.0000
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	2	TCC-25-B/P	5000	0	.0738
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	2	TCC-25-B/P	25000	0	.3689
OVERHEAD	CONTAINERS	ES-28/1	EOS-WOAB	1979	2	TCC-25	4198	0	.0619
OVERHEAD	CONTAINERS	ES-28/1	EOS-WOAB	1979	2	TCC-25	0	4198	.0005
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	2	TCC-25-CR	1	0	.0000
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1979	2	CLPRM	33500	0	.4944
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	2	TCC-25-CR	0	1	0.0000
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1979	2	CLPRM	0	3500	.0004
						TOTALS	67699	7699	1.0000
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	3	TCC-25-B/P	25000	0	.3689
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	3	TCC-25-B/P	5000	0	.0738
OVERHEAD	CONTAINERS	ES-28/1	EOS-WOAB	1979	3	TCC-25	4198	0	.0619
OVERHEAD	CONTAINERS	ES-28/1	EOS-WOAB	1979	3	TCC-25	0	4198	.0005
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	3	TCC-25-CR	1	0	.0000
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1979	3	CLPRM	33500	0	.4944
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	3	TCC-25-CR	0	1	0.0000

OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1979	3	CLPRM	0	3500	.0004
						TOTALS	67699	7699	1.0000
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	4	TCC-25-B/P	10000	0	.2094
OVERHEAD	CONTAINERS	ES-28/1	EOS-WOAB	1979	4	TCC-25	4198	0	.0879
OVERHEAD	CONTAINERS	ES-28/1	EOS-WOAB	1979	4	TCC-25	0	4198	.0007
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	4	TCC-25-CR	1	0	.0000
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1979	4	CLPRM	33500	0	.7014
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	4	TCC-25-CR	0	1	0.0000
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1979	4	CLPRM	0	3500	.0006
						TOTALS	47699	7699	1.0000
PLANETRY SATELLITE GRAND TOUR		ES-28/1	EOS-WOAB	1979	5	NPL-10+AG	16502	0	1.0000
						TOTALS	16502	0	1.0000
PLANETRY SATELLITE GRAND TOUR		ES-28/1	EOS-WOAB	1979	6	NPL-10+AG	16502	0	1.0000
						TOTALS	16502	0	1.0000
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1986	1	TRTUG-25K	1	0	.0000
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1986	1	CLPRM	33500	0	.4996
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1986	1	CLPRM	33500	0	.4996
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1986	1	CLPRM	0	3500	.0004
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1986	1	CLPRM	0	3500	.0004
						TOTALS	67001	7000	1.0000
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1986	2	CRGTUG-25K	4198	0	.1113
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1986	2	CLPRM	33500	0	.8880
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1986	2	CLPRM	0	3500	.0007
						TOTALS	37698	3500	1.0000
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1986	3	CRGTUG-25K	4198	0	.1834
PLANETRY SATELLITE GRAND TOUR ORB/PRB		ES-28/1	EOS-WOAB	1986	3	NPL-14+AG	18690	0	.8166
						TOTALS	22888	0	1.0000
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1986	4	CRGTUG-25K	4198	0	1.0000
						TOTALS	4198	0	1.0000
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1989	1	CLPRM	33500	0	.4996
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1989	1	CLPRM	33500	0	.4996
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1989	1	CLPRM	0	3500	.0004
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1989	1	CLPRM	0	3500	.0004
						TOTALS	67000	7000	1.0000

OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1989	2	CLPRM	33500	0	.9992
OVERHEAD	PROPELLANTS	ES-28/1	EOS-WOAB	1989	2	CLPRM	0	3500	.0008
						TOTALS	33500	3500	1.0000
PLANETRY SATELLITE	URANS TOPS ORB/PRB	ES-28/1	EOS-WOAB	1989	3	NPL-14+AG	18690	0	1.0000
						TOTALS	18690	0	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1979	1	NEO-2	5980	0	1.0000
						TOTALS	5980	0	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1980	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1980	1	NEO-2-R	0	5980	.0008
						TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1981	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1981	1	NEO-2-R	0	5980	.0008
						TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1982	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1982	1	NEO-2-R	0	5980	.0008
						TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1983	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1983	1	NEO-2-R	0	5980	.0008
						TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1984	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1984	1	NEO-2-R	0	5980	.0008
						TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1985	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1985	1	NEO-2-R	0	5980	.0008
						TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1986	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1986	1	NEO-2-R	0	5980	.0008
						TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1987	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1987	1	NEO-2-R	0	5980	.0008
						TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1988	1	NEO-2	5980	0	.9992

WTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1988	1	NEO-2-R	0	5980	.0008
					TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1989	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1989	1	NEO-2-R	0	5980	.0008
					TOTALS	5980	5980	1.0000
WTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1990	1	NEO-2	5980	0	.9992
WTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1990	1	NEO-2-R	0	5980	.0008
					TOTALS	5980	5980	1.0000

CONTAINER SUMMARY

	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
CLPRM													
ES-28/1	10	4	0	0	0	0	0	0	3	0	0	3	0
ONES LEAVING EARTH	10	4	0	0	0	0	0	0	3	0	0	3	0
CLPRM-G/8													
TCC-25													
ES-28/1	4	4	0	0	0	0	0	0	0	0	0	0	0
ONES LEAVING EARTH	4	4	0	0	0	0	0	0	0	0	0	0	0

FACILITIES SCHEDULE REPORT

	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
PLANETRY SATELLITE													
URANS TOPS ORB/PRB													
NPL-14+AG	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0
GRAND TOUR													
NPL-10+AG	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HTR AUTO SATELLITE													
POLAR EARTH OBSERV													
NEO-2	12.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
NEO-2-R	11.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

TRAFFIC TABLE FOR EOS-WOAB

YEAR / VEHICLE	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
1	17	4	1	1	1	1	1	1	5	1	1	0	0
2	3	3	0	0	0	0	0	0	0	0	0	0	0
3	5	0	0	0	0	0	0	0	0	0	0	4	1
TOTALS	25	7	1	1	1	1	1	1	5	1	1	4	1
NO. VEH. AVAILABLE		2	2	2	2	2	2	2	2	2	1	1	1
VEHICLES ACQUIRED	3	2	0	0	0	0	0	0	0	0	0	1	0
VEHICLES ACQUIRED TO DATE		2	2	2	2	2	2	2	2	2	2	3	3

TRAFFIC TABLE FOR CRGTUG-25K

YEAR	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
VEHICLE													
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	0	0	0	0	0	0	0	0	0	0	0	0	0
NO. VEH. AVAILABLE		0	0	0	0	0	0	0	3	3	3	3	3
VEHICLES ACQUIRED	3	0	0	0	0	0	0	0	3	0	0	0	0
VEHICLES ACQUIRED TO DATE		0	0	0	0	0	0	0	3	3	3	3	3

TRAFFIC TABLE FOR TDTUG-25K

YEAR	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
VEHICLE													
1	1	1	0	0	0	0	0	0	0	0	0	0	0
2	1	1	0	0	0	0	0	0	0	0	0	0	0
TOTALS	2	2	0	0	0	0	0	0	0	0	0	0	0
NO. VEH. AVAILABLE		2	2	2	2	2	2	2	2	2	2	2	2
VEHICLES ACQUIRED	2	2	0	0	0	0	0	0	0	0	0	0	0
VEHICLES ACQUIRED TO DATE		2	2	2	2	2	2	2	2	2	2	2	2

TRAFFIC TABLE FOR TRTUG-25K

YEAR	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
VEHICLE 1	2	0	0	0	0	0	0	0	1	0	0	1	0
TOTALS	2	0	0	0	0	0	0	0	1	0	0	1	0
NO. VEH. AVAILABLE		0	0	0	0	0	0	0	1	1	1	1	1
VEHICLES ACQUIRED	1	0	0	0	0	0	0	0	1	0	0	0	0
VEHICLES ACQUIRED TO DATE		0	0	0	0	0	0	0	1	1	1	1	1

VEHICLE UTILIZATION REPORT

	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
OVERHEAD													
PROPELLANTS													
EOS-WOAB	6.1	2.2	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	2.0	0.0
CONTAINERS													
EOS-WOAB	.3	.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES													
EOS-WOAB	2.8	1.5	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0
PLANETRY SATELLITE													
URANS TOPS ORB/PRB													
EOS-WOAB	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.8	0.0	0.0	1.0	0.0
TRTUG-25K	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0
GRAND TOUR													
EOS-WOAB	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTUG-25K	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WTR AUTO SATELLITE													
POLAR EARTH OBSERV													
EOS-WOAB	12.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

VEHICLE FLIGHT SUMMARY REPORT

	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
EOS-WOAB	25.0	7.0	1.0	1.0	1.0	1.0	1.0	1.0	5.0	1.0	1.0	4.0	1.0
TRTUG-25K	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0
TDTUG-25K	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

VEHICLE ACQUISITION SUMMARY REPORT

YEAR / VEHICLE	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
EOS-WOAB	3	2	0	0	0	0	0	0	0	0	0	1	0
CRGTUG-25K	3	0	0	0	0	0	0	0	3	0	0	0	0
TDTUG-25K	2	2	0	0	0	0	0	0	0	0	0	0	0
TRTUG-25K	1	0	0	0	0	0	0	0	1	0	0	0	0

COST REPORT

VEHICLE	TOTAL	70.	71	72	73	74	75	76	77	78	79	80	81	82	83	84
EOS-WOAR																
DEV.	10213.0	0.0	0.0	0.0	139.9	674.1	1328.7	1838.3	2041.6	1878.2	1396.1	742.5	173.6	0.0	0.0	0.0
PROD.	1800.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	400.0	400.0	400.0	0.0	0.0	0.0	0.0	0.0
TOTAL	12013.0	0.0	0.0	0.0	139.9	674.1	1328.7	1838.3	2441.6	2278.2	1795.1	742.5	173.6	0.0	0.0	0.0
CRGTUG-25K																
DEV.	608.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROD.	39.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	648.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL VEH.	12661.0	0.0	0.0	0.0	139.9	674.1	1328.7	1838.3	2441.6	2278.2	1736.1	742.5	173.6	0.0	0.0	0.0

COST REPORT

VEHICLE	TOTAL	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
EOS-HOAB																
DEV.	10213.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROD.	1800.0	0.0	0.0	200.0	200.0	200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	12013.0	0.0	0.0	200.0	200.0	200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CRGTUG-25K																
DEV.	608.6	127.7	343.1	137.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROD.	39.4	19.7	19.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	648.0	147.4	362.8	137.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL VEH.	12661.0	147.4	362.8	337.8	200.0	200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

COST REPORT

FACILITIES	TOTAL	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
OVERHEAD																
PROPELLANTS																
CONTAINERS																
VEHICLES																
PLANETRY SATELLITE																
URANS TOPS ORB/PRB																
NPL-14+AG																
PROD.	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRANC TOUR																
NPL-10+AG																
PROD.	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	5.6	0.0	0.0	0.0	0.0	0.0
MISSION	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	5.6	0.0	0.0	0.0	0.0	0.0
PROGRAM	22.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	5.6	0.0	0.0	0.0	0.0	0.0
WTR AUTO SATELLITE																
POLAR EARTH OBSERV																
NEO-2																
NEO-2-P																
GRAND TOT.	12683.4	0.0	0.0	0.0	139.9	674.1	1328.7	1838.3	2441.6	2283.8	1801.7	742.5	173.6	0.0	0.0	0.0

COST REPORT

FACILITIES	TOTAL	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
OVERHEAD																
PROPELLANTS																
CONTAINERS																
VEHICLES																
PLANETRY SATELLITE																
URANS TOPS ORB/PRB																
NPL-14+AG																
PROD.	11.2	2.8	2.8	0.0	2.8	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	11.2	2.8	2.8	0.0	2.8	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOUR																
NPL-13+AG																
PROD.	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROGRAM	22.4	2.8	2.8	0.0	2.8	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WTR AUTO SATELLITE																
POLAR EARTH OBSERV																
NEO-2																
NEO-2-R																
GRAND TOT.	12683.4	150.2	365.6	337.8	202.8	202.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

COST REPORT

OPERATIONS	TOTAL	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
OVERHEAD																
PROPELLANTS																
EOS-WOAB	26.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.7	0.0	0.0	0.0	0.0	0.0
MISSION	26.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.7	0.0	0.0	0.0	0.0	0.0
CONTAINERS																
EOS-WOAB	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0
MISSION	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0
VEHICLES																
EOS-WOAB	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.0
MISSION	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.0
PROGRAM	40.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.7	0.0	0.0	0.0	0.0	0.0
PLANETRY SATELLITE																
URANS TOPS ORB/PRB																
EOS-WOAB	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRTUG-25K	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	14.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOUR																
EOS-WOAB	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0
TDTUG-25K	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0
MISSION	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8	0.0	0.0	0.0	0.0	0.0
PROGRAM	26.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8	0.0	0.0	0.0	0.0	0.0
WTR AUTO SATELLITE																
POLAR EARTH OBSERV																
EOS-WOAB	52.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	4.4	4.4	4.4	4.4	4.4
MISSION	52.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	4.4	4.4	4.4	4.4	4.4
PROGRAM	52.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	4.4	4.4	4.4	4.4	4.4
GRAND TOT.	12903.5	0.0	0.0	0.0	139.9	674.1	1328.7	1838.3	2441.6	2283.8	1436.6	746.9	178.0	4.4	4.4	4.4

COST REPORT

OPERATIONS	TOTAL	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
OVERHEAD																
PROPELLANTS																
EOS-WOAB	26.8	0.0	8.3	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	26.8	0.0	8.3	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONTAINERS																
EOS-WOAB	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES																
EOS-WOAB	12.5	0.0	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	12.5	0.0	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROGRAM	40.5	0.0	14.0	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PLANETRY SATELLITE																
URANS TOPS ORB/PRB																
EOS-WOAB	8.0	0.0	3.6	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRTUG-25K	6.0	0.0	3.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	14.0	0.0	6.6	0.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOUR																
EOS-WOAB	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTUG-25K	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	12.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROGRAM	26.8	0.0	6.6	0.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WTR AUTO SATELLITE																
POLAR EARTH OBSERV																
EOS-WOAB	52.8	4.4	4.4	4.4	4.4	4.4	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISSION	52.8	4.4	4.4	4.4	4.4	4.4	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PROGRAM	52.8	4.4	4.4	4.4	4.4	4.4	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOT.	12803.5	154.6	390.6	342.2	207.2	223.4	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

```
                              CASE  1
    0 FATAL ERRORS...A RUNNING TOTAL
   49 PHASE  I ITEMS
   78 PHASE II ITEMS
33917 CELLS OF UNUSED BLANK COMMON
```

APPENDIX E
TECHNIQUES USED TO TRICK DORCA

DORCA embodies a set of algorithms used to analyze what was an original problem. As time passed, the nature of the problem changed and simultaneously the techniques needed for the analysis shifted in parallel. It eventually became a matter of tricking the program to perform some operational aspect not originally included in the design. Some of the trickery forced changes in the program, and these were made as broad as possible so that the capabilities of the program were extended.

Most of the trickery is a straightforward matter of a thorough understanding of what the program does (in this document) and how the program actually functions (in Vol. II). Therefore many of the tricks are implemented by using the input in what might be a slightly obscure way. This appendix will describe some of the techniques used to "trick" the DORCA program via the input.

Trick 1

The users wish to do the Automated Satellite Program in a single deployment mode. The user will find that Appendix D, page D-2 contains a leg table with word SINGLE. This option in the leg table was implemented for this application, restricting one cargo item up and one down per flight.

Trick 2

The user wishes to assign another vehicle to carry the propellant on the cislunar leg in support of Lunar surface legs. The program normally assigns the same vehicle as carrying cargo to also carry the propellant. The user creates a dummy cargo discrete called "prop vehicle" weighing one pound for one way (up) delivery on a mission leg. The user also creates a new first program/mission pair in the Mission Input Data for the purpose of assigning vehicles to carry the "prop vehicle." The user specifies the years during which the propellant is to be delivered by the vehicle specified in this new program/mission.

The user specifies the years the propellant is delivered the predecessor legs utilizing the IOC/START/STOP cards. The vehicle is specified by utilizing the VEHICLE card and the cargo, "prop vehicle," is shipped via the CARGO card. The leg processor provides the list of cargo items to be loaded onto flights of a vehicle. After the number of propellant tanks has been determined, the tanks are designated for shipment on the lower leg on that vehicle assigned to service the lower leg for the first cargo item in the list for that leg being processed. The extra program/mission places the vehicles assigned to "prop vehicle" at the head of the line for the leg processor to use for shipping propellant tanks. The years should be chosen with care as cargo should be shipped on the cislunar leg in those years.

Trick 3

The user specifies a remote mission that is a single legged mission and blocks the shipment of cargo along predecessor legs. The propellant, however, has to be shipped up to the mission leg. This was a sortie mission by a crew from Lunar orbit to Lunar surface. The same crew made several flights. The user creates in the Mission Input Data a new mission entry for the desired activity using a unique leg name for the outermost leg or legs. On the new mission's VEHICLE cards, the user defines the vehicle to be used on the outermost legs, but enters NONE in the fields for the predecessor vehicles. This will block the shipment of personnel and material along the predecessor legs. The user also enters in the Mission Input Data a new mission preceding the mission just described. This mission will specify the activity of the "prop vehicle" used in Trick 2. Thus the propellant needs of the sortie mission will be supplied.

Trick 4

The user wishes to export large shuttle vehicles to Earth orbit in stages for weight/volume exporting and costing purposes, but still identify shuttle flights to the large vehicle. The triple tug cannot be carried in the EOS vehicle and therefore must be shipped in stages and assembled in orbit. This trick can be found in the data printout in Appendix D on pages D-4 and D-5. The triple tug contains the staging card that refers to itself (for counting triple tugs on the EOS) and to the three stages of the tug (the cargo tug element). The single stage of the tug contains the cost for development and production while the triple tug contains its operating cost.

Trick 5

The user wishes to supply export vehicles on a regular basis rather than on an as-needed basis. The intent is to obtain a smooth production schedule. The user ships vehicles (as cargo items) on a mission leg to get it to its operational locale. A dummy leg may be necessary for the shipment as the EOS may be shipped to the launch site on a railroad line. A vehicle that has been shipped is automatically put into service and costed as a part of the fleet.

Trick 6

The user wishes to use more than one vehicle per mission leg if discrete payloads for individual vehicles can be defined. This is referred to as a parallel trajectory problem. For example, if an integrated space station requires an INT-21 vehicle to put the station in orbit because of excessive weight, some of the cargo assigned to the EOS could fly free on the INT-21. The user adds a parallel path (leg or legs) to the leg table. New vehicles (INT-21) are added to the vehicle table providing performance data for the legs which they are to service in addition to other required data. The user delineates cargo which the additional vehicles are to transport in the Mission Input Data under new leg and vehicle entries. The user could make available all cargo and allow the program to load the vehicles. In a follow-up run the user could express a preference based on the results of the previous run.

Once a parallel (split) leg is established in a mission, the balance of the mission trajectory must remain parallel (split). The program does not have the capability to reconstitute common legs once a leg has been split. Cargoes for each vehicle have to be discretely assigned since the program will not segregate that cargo into individual vehicle cargoes.

Trick 7

The performance of the EOS is rectangular on a graph. The performance capability of a vehicle is expressed as an up weight and a down weight. Though not stated as such, the performance is triangular in shape. The capability to deliver payload weights upwards is penalized by the expenditure of propellant in returning payloads. The EOS can carry a full payload bay to Earth orbit, and return to the surface with the same full load. With the EOS, propellant required for landing (retro at surface) is replaced by aerodynamic drag as the means of braking. Therefore the performance of the EOS is rectangular. In the sample output, Appendix D on page D-4 is the trick data entries. The EOS up weight is correct, but the down weight is very high. This results in an elongated rectangular shape. The EOS is correctly weight limited and volume limited on the up flights. It is volume limited on the down flights. As the amount of cargo going up outweighs the amount returned (propellant fluid does not return), the number of EOS flights is correct.

Trick 8

The user wishes to send tugs on the EOS in a partially-filled-with-propellant mode (to top off the EOS vehicle performance). The user does the following: 1) describes the vehicle as a crew container in the container table; 2) creates a dummy bulk cargo container (for "bulk" propellant) and enters it in the container table; 3) creates a dummy crew weighing one pound and enters it in cargo element table signifying the vehicle as the container; 4) describes a full propellant load as bulk cargo in the cargo element table signifying dummy bulk cargo container as the container; 5) enters the crew and the "bulk" propellant in the vehicle table as vehicles; and 6) enters the stages card on the vehicle. The program recognizes the capability of crew modules to accommodate bulk cargo (propellant) in addition to the one pound crew. The loading algorithm does give the assignment of discrete cargo items preference to assignment of bulk cargo. Therefore, by using this technique, the vehicle could be loaded with propellant from 0 to 100 percent depending on the inventory of cargo items to be assigned.

Trick 9

The user wishes to use a staged vehicle, SI-C, (with stages having different flight lifetimes/frequencies on a previously defined leg) to loft heavy payloads to Earth orbit in addition to using the EOS to put cargo into Earth orbit. In this trick the Earth Orbiting Space

Station was to be put into orbit by an SI-C as the upper stage of the EOS vehicle because the normal EOS could not lift the excessive weight. To accommodate this dual-staged vehicle, EOS booster with EOS orbiter or SI-C, before the staging option was implemented, the user split the Earth surface to Earth orbit leg into two legs, one for each of the stages. The stages were entered as three distinct vehicles in the vehicle table. The first stage was assigned the propellant for the entire vehicle. The upper stages had zero propellant requirements, thereby no propellant tanks were sent up the lowest leg to support the upper stages. The performance capability (in terms of payload weight) of various stages should be described as equal and be the same as the capability of the total vehicle. This forces the loading algorithm to fly an equal number of flights for each stage.

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