DORCA II Computer Program

Volume I: User's Guide

Prepared by STANLEY T. WRAY, Jr.
Information Processing Division

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Prepared for OFFICE OF MANNED SPACE FLIGHT
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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ABSTRACT

The Dynamic Operational Requirements and Cost Analysis Program (DORCA II) was written to provide a top level analysis tool for NASA. DORCA II does not include any optimization capabilities, but rather relies on a man-machine interaction to optimize results based on external criteria. DORCA II relies heavily on outside sources to provide cost information and vehicle 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 II Program.

Volume IV of this document is an executive level summary of the capabilities of the DORCA II program.

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SECTION 1

INTRODUCTION

The Dynamic Operational Requirements and Cost Analysis Program (DORCA II) 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 II 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 II 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 II 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 <u>Lunar Program</u> 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 II 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. If the vehicle consists of several stages, there are then two values of expended weight. DORCA II permits expending either only the upper (last) stage or the entire vehicle. 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 $1/10^{th}$ 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 II 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 may be determined outside the DORCA II program for each leg the vehicle will service or the program can be provided the staging sequence of the vehicle, and for each stage: engine Isp, structure weight, propellant capacity, etc., and the program will compute the performance capability of the vehicle.

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 unless the user designates the container as expendable in which case the container is not returned.

Containers are classified by the item the container was designed to carry. Propellant takes are used to transport propellant up from the Earth's surface to the vehicles requiring propellant. The propellant tanks are shipped fully loaded or 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.

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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. The user can override the weight criteria by designating a cargo element for deployment (up only), retrieval (down only) or round trip (both ways).

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.

A coupled item consists of 2 or more cargo elements coupled together. Any cargo element may be coupled to any other cargo element, the composite being defined as a discrete. The cargo elements are placed in a box with computed up and down weights and a computed volume. The box is shipped as a unit, but the cost of delivery is charged to the individual cargo elements.

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 destina-
tion. 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 DORCA II program presumes longshoring is available
because of increased efficiency in vehicle loading. The user does have
the option of specifying at specific nodal points that longshoring is not
available, thereby forcing a partially filled container to carry over onto
the next lower leg. The program is capable of filling a bulk cargo container
and then declaring that partially filled container to suddenly become a
discrete cargo element. This partially filled container will now be shipped
as an internally generated coupled item.

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 II 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

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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 II input data. The entries are percentages, and the year of delivery is indicated by an asterisk (*).

Percentage of Total Cost

Year	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

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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.

2.12 OPERATIONAL MODES

In this section the discussion will emphasize the various operational modes built into the DORCA II program as available on option to the user. These include ground based versus space based, fully loaded vehicles versus off-loaded vehicles (propellant), coupling of payloads and vehicles (a part of ground based but also available as a user option), capture analysis, automatic versus manual delivery of vehicles, payload multiplicity, restrictions, and the unavailable capability of performing the phase-in of the EOS.

The program tends to favor the space based mode of operations because the original program development was oriented toward the Lunar Program. A space based option implies the following activities:

1. Payloads, vehicles, and propellants can be shipped to and stored on-orbit for subsequent use and delivery.

2. On-orbit propellant transfer capability assumed practical. Propellant tanks are shipped fully loaded to propellant depots.

3. Tugs (reusable vehicles) remain on-orbit until completion of specified lifetime in years or in flights.

4. Multiple stage vehicles permitted for payloads that exceed single tug capability. This capability is limited to three stages including expendable stages.

5. Payloads and vehicles can dock on-orbit (includes stage-to-stage docking).

6. There are no restrictions on mated vehicle payload weight or dimensions.

7. On-orbit checkout and servicing and minor maintenance capability is assumed.

8. Replacement vehicles are delivered to orbit fueled within EOS capability.

The ground based option implies the following activities:

1. The tug returns to earth surface at completion of each flight.

2. Single and multiple payload deployment is a desirable option.

3. Tug propellant off-loading is optional.

4. The tug weight and volume plus the payload weight and volume should be within the EOS capability.

5. Oversize payloads may prevent the tug and the payload from fitting together on the EOS by bay size or EOS performance, thereby requiring two EOS flights.

6. It is a program option to restrict the number of payloads that may be carried on a vehicle (to avoid the old phrase of putting all one's eggs in one basket).

7. On-orbit propellant transfer not permitted.

8. No payload to payload docking permitted. Vehicle stage may dock with another stage if necessary to complete the mission.

9. Multiple stage vehicles are permitted if necessary to complete the mission. This is limited to three stages and may require more than one EOS flight to deliver payload and vehicle to near earth orbit.

The DORCA II program includes the capability of computing the propellant necessary to deliver a payload based on ΔV required, payload weight being delivered, engine I_{sp} and weight description of each stage involved. The vehicle can be operating fully loaded with propellant or off-loaded with propellant. In the space based mode the net effect is to reduce the amount of propellant delivered to depot, which can amount to a substantial savings economically. In the ground based mode some payloads fit in the EOS bay with the tug (weight wise) only because the tug is off loaded. A fully loaded tug would probably force many on-orbit dockings between payloads and tugs.

DORCA II permits the user to couple several payloads together into a unit. In the ground based mode the program automatically couples multiple payloads together when they are delivered on the same flight and then attempts to couple the payloads to the delivery vehicle for later shipment on the EOS. Similarly, the user can define logistical units made up of payloads, vehicles and/or anything available for shipment as a logical part of the mission model to be analyzed. Thereby the user has the ability to simulate other modes of logistic operations not yet conceived of in the programming of DORCA II.

In the normal mode of assigning vehicle flights to deliver payloads to destinations the program is given an a priori designation of vehicle to perform the delivery. In the capture mode, the vehicle is not preassigned, but rather the program uses a complex loading algorithm in conjunction

with a vehicle preference list. The algorithm is described in detail in sections 3.1 and 3.2. The preference list is a list of vehicles in order of preference, the first vehicle being preferred. The vehicles have date limitations as to the years they are in the fleet. The vehicles are selected to deliver the payloads if 1) the year is within the vehicle availability span, 2) the vehicle can fly on the specified leg and 3) the vehicle is capable of delivering the payload. The first vehicle in the preference list to satisfy these requirements is assigned to deliver the payload.

In the ground based mode each vehicle required to deliver a payload and correspondingly to be delivered on the EOS to near earth orbit is automatically delivered to orbit. In the space based mode the vehicle can be delivered automatically to orbit or if the user wishes he may stipulate the delivery and return of vehicles from orbit. For instance, DORCA II is not able to transfer a tug from the ETR sphere of activity to the WTR sphere of activity. Only the user can perform the transfer based on some rationale not possible to implement in DORCA II.

In delivering payloads for a satellite program there arise occasions where it is necessary to restrict the multiplicity of payloads on individual flights DORCA II provides for restrictions by vehicle (the EOS can be limited to a maximum of 3 payloads) by leg (similarly 3 payloads) or by payload (single or multiple only). An entire mission model can be switched from multiple delivery to single or any segment of a mission model.

If a vehicle preference list is set up to include the phase-in period of the EOS, DORCA II will not restrict the flight rates. DORCA II does not have any flight rate restrictions; nor does it have any criteria for selection of which payloads take advantage of reduced cost due to the availability of the EOS. The user must apply the criteria of selection and forcibly assign the non EOS payloads to other vehicles.

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 II 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 II 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 II 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.

7. The number of cargo elements being shipped and down a leg will be a minimum of restrictions placed by individual cargo elements, vehicles, and legs.

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 capture technique is implemented by having the program look at the contents of a bin of payloads available for capture. After all possible discretes and bulk cargos have been assigned a flight from the a priori list each flight may be further filled by the same set of rules from the capture bin. In this way the capture bin is used to extend the payload list to yield better loading of the earlier flights. The captured payloads use space which would ordinarily not be used but not at the expense of the a priori payloads. When the a priori payloads are finished processing, the program passes control to the LEGPRO routine to assist in completing the capture.

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.

If items remain to be captured, the candidate list is searched for the heaviest payload (one requiring the greatest amount of propellant) and the vehicle preference list is searched for a vehicle capable of carrying the payload (constrained by year, leg and performance). This payload is then changed from a capture status to an a priori status and the problem is sent back to ASINER to add other capture candidate payloads onto the flight. The process is repeated until there remain no further payloads to be captured.

The leg that connects to this leg but one segment closer to the Earth's surface is located. The user tells DORCA II the final leg on which the cargo element is delivered and tells DORCA II 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 or each flight is performed by a partially fueled vehicle if sufficient performance information is supplied so that the program can compute the propellant required for each flight. The user has supplied the weight of propellant required for one flight. That value is multiplied by the number of flights or totaled individually and divided by the total weight 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 in a space based mode.

In a propellant off-loaded mode combined with ground based mode, the propellant is shipped within the vehicle as partially filled vehicles.

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.
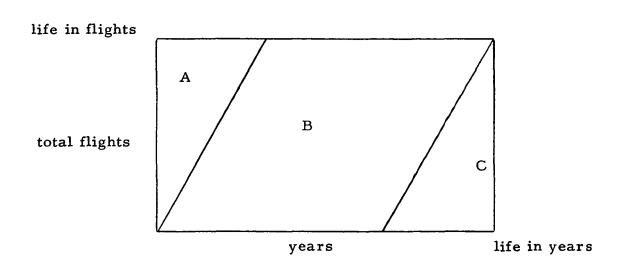
3.5 VEHICLE/FACILITY ACQUISITION

The DORCA II 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 II 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 II 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 II 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:

life in flights

total flights

A

B

C

years   life in years

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 (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. The vehicle can retire by means of end of lifetime in years or the fact that a vehicle is expended. In the latter case, the vehicle is used as much as possible before it is expended.

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, 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 of both propulsive type and inert type. 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 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.

In the fully loaded propellant mode 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.

In the off-loaded propellant mode the converse is true for the program can perform performance computations to determine the fuel requirements of each stage. Only the lowest stage is off-loaded for it is more efficient to discard the lowest stage as soon as possible.

In the area of expending stages of a vehicle, DORCA II either expends the entire vehicle or just the upper stage. This is a limitation imposed by the performance computations which is restricted to these two modes for expending stages and vehicles.

3.8 PERFORMANCE COMPUTATIONS

The program includes the capability of computing the propellant required to deliver a payload to a destination orbit. The program also computes performance of a vehicle by iterating the payload until the propellant required matches the propellant capacity of the vehicle. The algorithm is discussed in detail in the Programmer's Manual, Vol. II.

The algorithm has the following restrictions:

1. The maximum number of propulsive stages in a vehicle cannot exceed 3.

2. The vehicle can be totally reusable.

3. The vehicle can be totally expendable.

4. If a single stage is expended it must be the upper stage.

5. Only the lowest stage can have propellant off-loaded.

The following assumptions are inherent in the algorithm:

1. Total propellant losses due to start-stop, restart and attitude control are put overboard at a constant rate.

2. The interstage adapter is always attached to the lower stage.

3. Slingshot mode is used in which each stage flies itself home with zero propulsive propellant residual.

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 II 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. Page 11 of Appendix D shows sample requests for reports.

4.1 CARGO MANIFEST

Pages 19-22 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-19. 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. The true weight load factor in the up direction (total weight up compared to performance in the up direction) is printed on the right margin in addition to the true volume load factor in the up direction. These two parameters are useful in assessing the efficiency of the loading algorithm for the particular cargo mix in the run.

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 II. Dates, vehicles, legs can all be confirmed.

Following the detailed report are two summaries of weight and volume loadings for all vehicles on all legs. Page D-23 of Appendix D shows the average weight load factors. For the EOS-WOAB on leg ES-28/1 the average

load factor for 1979 is .60 (60% of capacity) whereas the figure under TOTAL of .52 (52%) is a combination of all flights in 1979, 1986 and 1982. The grand total line shows the fleet is operating at .63 (63%) in a delivery mode. Some of the figures may be depressed by returning payloads. On page D-24 is a similar report for volume factors.

4.2 CONTAINER REPORT

Page 25 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 DISCRETE PAYLOADS SCHEDULE REPORT

Page 26 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 27-30 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. Any vehicle with an E in the left margin has been retired from the fleet by being expended in delivering a payload. The entry in the TOTAL column is the sum over the years. The line TOTALS is the 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 UTILIZATION REPORT

Pages 31-33 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 34-39 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 destina-
tions 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

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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 II 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-12-18 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 II 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.

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° 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° 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 over-ridden 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, $28.5^{\circ}/100$ 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.

Vehicle Perference List: This is a list of vehicles to be used in the capture analysis - mating a payload to a potential transport vehicle.

Option List: This is a list of options built into the program and at the disposal of the user to explore the effects of some operational modes.

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 6 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.

To provide a certain flexibility of using the program from a remote console, the DORCA II input routine will accept the data squashed to the left margin with an equal sign (=) as an indicator of where the end of each group of 10 columns terminates. The program expands the input card internally to the correct structure and then processes the card.

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 normal mode of operation of the program is to list all the input cards. At a remote console terminal, the output can be a nuisance, so the program responds to the commands PRINT=OFF and PRINT=ON as a part of the input data. Appropriate usage of these two commands can expose the necessary information to the user.

The user can document his data deck by introducing commentary into the deck at strategic locations. A card with the word COMMENT will cause the program to ignore (except for printing) several cards following until the first 10 columns contain some non blank entry. This is not recommended in the vehicle where a blank first field has similar significance. A card with COMMENT1 will create a page eject before the commentary.

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

Field 1 contains the word "TABLE."

Field 2 contains the word "CONTAINER."

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 WT	CLASS	VOL FRACTION	EXPEND

Field 1 contains the unique name of the cargo container.

Field 2 contains the weight capacity for this container.

Field 3 contains the empty weight 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.

Field 6 contains the word "EXPEND" if the container is to be expended. Otherwise the entry is blank or the word "RETURN" to return the container.

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 weight capacity of 30,000; it always travels up fully loaded with a total weight of 33,500. 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.

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.

No propellant tank in table.

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 capability 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 63 legs.

The format of a card describing a leg is:

NAME	NEXT DOWN LEG	MAX OCCUP	VEHICLE	ΔV	PROP VEH	LONG SHORE

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 maximum occupancy indicator of the word SINGLE or MULTIPLE or a numeric value (3 means a limit of 3 payloads in either direction).

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.

Field 5 contains the ΔV required for the transfer orbit. The program increased the value by 2% for a performance margin. This entry is dependent on the details of the transfer orbit.

Field 6 contains either the name of the vehicle designated to carry propellant on this leg or, if blank, the default vehicle (Field 4) will be used.

Field 7 contains the word YES or NO indicating longshoring capability at the lower terminus.

SAMPLE

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

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).

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 or no.

Next down leg does not exist.

Non-numeric entry.

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

Field 1 contains the word "TABLE."

Field 2 contains the word "SPREAD."

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.

SAMPLE

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

Field 1 contains the word "TABLE."

Field 2 contains the word "VEHICLE."

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	PROP WT	MAX/ YEAR	LIFE FLT	LIFE YRS	VOL LIMIT	MAX OCCUP

Field 1 contains the unique name of the vehicle.

Field 2 contains the propellant weight 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 is not used.

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).

Field 8 contains the maximum occupancy indicator of the word SINGLE or MULTIPLE or a numeric value (an entry of 3 means a maximum of 3 payloads on any flight made by the vehicle).

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	

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 or the value 0.

Field 4 contains the cost of recurring production.

Field 5 contains the name of a spreading table for recurring production costs or the value 0.

Field 6 contains the cost of recurring flight operations.

Field 7 is not used.

Field 8 contains the name of the propellant tank to be used for propellant for this vehicle. If the entry is blank, the last propellant tank listed in the container table will be used.

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

	STAGES	S1	S2	S3	S4	S5	S6

Field 1 contains the right justified entries WET or DRY or is blank.

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 STAGES card is optional and the user may enter both WET and DRY cards. If the entry is blank, DRY is assumed.

If this vehicle is a propulsive stage, the optional ISP card should be included according to the following format.

ISP	ISP#	WSD	WNUP	WINT	WPBO	WNIE	WACP

Field 1 contains the right justified entry ISP.

Field 2 contains the vacuum Isp.

Field 3 contains the structural dry weight.

Field 4 contains the weight of the non-usable propellant.

Field 5 contains the interstage adapter weight.

Field 6 contains the weight of propellant remaining at burnout.

Field 7 contains the weight of the non-impulsive expendables.

Field 8 contains the weight of the attitude control propellant.

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 weight the vehicle can transport
up to the next terminus if the vehicle returns empty (up wt).

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

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

If the necessary ISP cards and WET stages cards are present, the program will compute the values for fields 3, 4 and 5 if they are blank. Otherwise user input overrides the computation.

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 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

Field 1 contains the word "TABLE."

Field 2 contains the word "FACILITY."

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

Field 1 contains the word "TABLE."

Field 2 contains the word "CARGO."

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	SATELLITE

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.

VEHICLE PREFERENCE LIST

The vehicle preference list can be input at any time after the vehicle table has been established. Typically this list and the option list are input just prior to the mission data.

The vehicle preference list begins with the card:

PREFERENCE	LIST	

The vehicles are entered one per card in order of preference; i.e., if the first vehicle will satisfy the requirements, it is accepted and no further checking is done. Each vehicle is entered via:

	VEH NAME	FIRST YEAR	LAST YEAR

Field 1 is blank.

Field 2 contains the name of a vehicle in the vehicle table.

Field 3 contains the first year the vehicle will be available. If blank, 1970 is assumed.

Field 4 contains the last year the vehicle will be available. If blank, 2470 is assumed.

The list is terminated when a card is encountered with a non-blank field 1.

OPTION LIST

The option list is a set of cards used to set internal switches to enable or disable internal program modes. Each card contains the word OPTION in field 1. The following is a table of the option switches in the program. The default entry is what the user will have if the specific option is not used (input on a card). Some options affect the processing of mission data and they are termed local. Those options may be intermixed with mission data (causing some payloads to be captured or assigned as the option switched back and forth).

Option Switch	Default Setting	Alternative Setting	
PROPELLANT	FULL TANK	OFF-LOAD	
BASE	SPACE	GROUND	
DEPLOY	MULTIPLE	SINGLE	LOCAL
CALVEH	MANUAL	AUTOMATIC PRINT	
CONTAINER	RETURN	EXPEND	
CARGO	ASSIGN	CAPTURE	LOCAL

The internal units used in the propellant computations is defaulted to English (g = 32.174 ft/sec^2). The units may be changed by entering an OPTION = METRIC before the vehicle table is input. The value of g will be 9.8066 in/sec^2.

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

Field 1 contains the word "PROGRAM. "

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

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 for vehicles, legs, and data are forgotten and must be reentered. The internal cargo table is stored for later reference.

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)   INITIAL or 1
 b)   SUSTAINING or 2
 c)   TERMINAL 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" or the word "ANY." 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.

The exception is the word "ANY" or the capture flag being set, both implying capture is to be done. In this case no vehicle is assigned at this time as the capture mode of the program will determine the vehicle later in processing.

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	MAX OCCUP	TYPE

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.

Field 4 contains the maximum occupancy entry either multiple (if blank) or single (if SINGLE).

Field 5 contains the type of delivery/retrieve mode, by the appropriate word DEPLOY, RETRIEVE or SERVICE; or if the word is blank, the mode is determined by the up/down weights in the cargo element table.

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.

The user may add cargo elements to the cargo element table as an afterthought in the mission data by entering the card:

ELEMENT

Field 1 contains the word "ELEMENT."

After this card, there should be any number of cargo element cards. These cargo elements will be added internally to the cargo element table.

The user may add items to the facility table as an afterthought in the mission data by entering the card:

FACILITY

Field 1 contains the word "FACILITY."

After this card there should be any number of facility cards. These facilities will be added internally to the facility table.

The facility table additions should precede the cargo element table additions to avoid error messages. The two additive capabilities may be used as many times as desired. The cargo elements so added are subsequently available for reference on CARGO cards.

The SCHEDULE card was implemented for inputting satellite data in which the launch schedule is scattered through a sequence of years. The format of the card is:

| SCHEDULE | Y1 ---------- Y7 |

Field 1 contains the word "SCHEDULE."

Fields 2 - 8 contain years in the form of 19XX; these are the years of a launch schedule.

Another card may follow with field 1 blank and 7 more year entries for a total of 14 years. The entries need not be in any specific order. After the SCHEDULE card appear the launch schedules of the form:

| NAME | LY1 --------- LY7 |

Field 1 contains the name of a cargo element.

Fields 2 - 8 contain the number of cargo elements to be shipped in the years entered on the SCHEDULE card.

Another card with field 1 blank should be next if there were over 7 years supplied via the preceding SCHEDULE card. Any number of cargo elements may be shipped by supplying them one by one after the SCHEDULE card.

The SATELLITE cards permits the user to be more exacting in the specification of how the satellite is to be handled. The first card of the group is:

SATELLITE	NAME

Field 1 contains the word "SATELLITE."

Field 2 contains the name of a satellite included in the cargo element table.

The remaining cards of the group comprise the launch schedule. The format for the other cards is:

YEAR	NUMBER	TYPE	VEHICLE	MAX OCCUP

Field 1 contains the year of shipment in the form 19XX.

Field 2 contains the number of satellites to be shipped that year.

Field 3 contains the type of delivery/retrieve mode by the appropriate word, DEPLOY, RETRIEVE or SERVICE; or if the entry is blank, the mode is determined by the up/down weights in the cargo element table.

Field 4 contains the name of the vehicle to be used on the furthest removed leg of the shipment. This entry is identical to the second field of the VEHICLE card.

Field 5 contains the maximum occupancy entry, either multiple (if blank) or single (if SINGLE).

After the SATELLITE card has been entered, the following cards combine the functions of the IOC card, the CARGO card and in part the VEHICLE card.

The user can create additional cargo elements by combining 2 or more existing cargo elements together via the COUPLE card. The new cargo element is considered a discrete payload, having an up weight, a down weight

and a volume obtained by simple summation of the cargo elements being coupled together. Anything may be coupled with anything else, even itself. Vehicles can couple with vehicles and/or payloads and/or crews and/or bulk cargo, etc. The user is responsible for the reasonableness of the arrangement. The format of the COUPLE card is:

| COUPLE | NAME |

Field 1 contains the word "COUPLE."

Field 2 contains the name being given to the new cargo element.

After this card is a list of up to 12 items to be packaged together one per card in the form:

| NAME | PROGRAM | MISSION |

Field 1 contains the name of the cargo element to be included.

Fields 2 and 3 contain the 18 letter program name to be charged for the delivery.

Fields 4 and 5 contain the 18 letter mission name to be charged for the delivery.

The end of the group is indicated by the card:

| END |

Field 1 contains the word "END."

The mission data is terminated by a request for a report as described in the next section.

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
```

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 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.

Invalid type.

Invalid max occupancy.

Too many items to be coupled.

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, COST80, TABLES, DEBUG, CALVEH, PRTCAL. Any other name or a misspelled name will be ignored. COST80 is an 80 column width version of COST for remote consoles.

Field 3 contains a length specification applicable to the reports VEHICLE, COST, and SPRINT. 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.

After the reports requests will occur either another mission data setup using the same basic tables or an END card to terminate the computer run.

The end of the computer run is indicated by putting the word "END" in field 1. Thus if only one case were being run, the next card after the REPORT cards would be the END card. However DORCA II can process several cases in succession, each being a different mission model. Then the data arangement would be tables, mission data, reports, mission data, etc. END.

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

COMMENT

PRINT

OPTION

VEHICLE PREFERENCE LIST

MISSION INPUT DATA

REPORTS

CONTAINER TABLE

- Describes bulk containers, propellant tanks and crew capsules.

- First card is:

TABLE	CONTAINER

- Each container is a card:

NAME	CAPACITY	EMPTY WT	CLASS	VOL FRACTION	EXPEND

- CLASSIFICATION is BULK, CREW or PROPELLANT.

- Default volume fraction is 1 full EOS cargo bay.

- If not EXPENDed, then every container is returned.

LEG TABLE

- Provides a list of leg and leg sequences.

- First card is:

TABLE	LEG

- Each leg is a card:

NAME	NEXT DOWN LEG	MAX OCCUP	DEFAULT VEH	ΔV	PROP VEH	LONGSHORE

- LONGSHORE is YES or NO.

- Last leg in sequence has NEXT DOWN LEG of NONE.

- MAX OCCUP is SINGLE, MULTIPLE or numeric.

SPREAD TABLE

- Provides spreading functions for costs.

- First card:

TABLE	SPREAD

- 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

- Each vehicle is a group of cards:

NAME	PROPELLANT	MAX/YEAR	LIFE FLT	LIFE YRS	VOL LIMIT	MAX OCCUP
NR DEV	DEV SPREAD	R PROD	PROD SPREAD	R FLT.	PROP TANK	

- Costs in millions.

- SPREAD is the name of a spreading function or value 0.

- Optional staging card:

	WET/DRY	STAGES	S1 - S6

- ISP card to compute performance and propellant

	ISP	ISP #	WSD	WNUP	WINT	WPBO	WNIE	WACP

- 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

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 or the value 0.

CARGO ELEMENT TABLE

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

- First card:

TABLE	CARGO

- Each cargo element is:

NAME	DESCRIPTOR	CONTAINER	CATEGORY	UP WT	DOWN WT	VOLUME

- CONTAINER is defined in container table or DISCRETE.

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

- VOLUME is 0 if no entry.

MISSION INPUT DATA

Describes overall plan.

Card formats are:

- | PROGRAM | NAME |

  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 |

  L-V1 = NONE (End of sequence), ANY (Capture), blank (Default) or vehicle name.

- | PHASE | TYPE |

  TYPE is INITIAL, SUSTAINING, TERMINAL or 1, 2, 3.

  | START | DATE |

  | STOP | DATE |

  | CARGO | NAME | NUMBER | MAX OCCUP | TYPE |

- MAX OCCUP is blank or SINGLE.

- TYPE is DEPLOY, RETRIEVE, SERVICE, or blank.

COUPLE	NAME	
ITEM1	Program X	Mission K
ITEM2	Program Y	Mission R

. . .

END

SCHEDULE	19XX 20XX	19XX 19XX	19XX	19XX	19XX	20XX	19XX	19XX
ITEMX	X	X	0	X	X	0	X	X
ITEMY	0	0	X	X	X	X	0	X

SATELLITE	NAME			
	NUMBER	TYPE	VEH	MAX OCCUP
19XX				
etc.				

See previous page.

VEHICLE PREFERENCE LIST

- Controls order of selection of vehicle.

- After vehicle table.

- First card:

PREFERENCE	LIST

- Each vehicle is entered as:

	VEH	D1	D2

- D1 is first available year (1970 if blank).

- Da is last available year (2470 if blank).

PRINT

- Permits the user to suppress printing.

PRINT	OFF

- Permits the user to resume printing.

PRINT	ON

- Standard is PRINT ON.

COMMENT

- Permits the user to put comments in deck.

- First card:

  COMMENT

- Followed by commentary.

- Field 1 is vacant

- Alternate first card for page eject:

  COMMENT1

OPTION

• Sets switches to enable/disable internal modes.

• Each is a card with OPTION in Field 1.

Switch	Default Setting	Alternative Setting
PROPELLANT	FULL TANK	OFF-LOAD
BASE	SPACE	GROUND
DEPLOY	MULTIPLE	SINGLE
CALVEH	MANUAL	AUTOMATIC
		PRINT
CONTAINER	RETURN	EXPEND
CARGO	ASSIGN	CAPTURE
- - - -	ENGLISH	METRIC

REQUESTS FOR REPORTS

• Provides requests for results.

• A report card is:

| REPORT | NAME | SHORT |

• NAME is: SPRINT, CONTAINER, FACILITY, TRAFFIC, VEHICLE, COST, COST80, TABLES, DEBUG.

• SHORT is effective only on VEHICLE, COST, COST80, and SPRINT.

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.
YYYYY	also an alphabetic ten letter entry in the data.

Errors in processing the container table:

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.

7) NO PROPELLANT TANK IN CONTAINER TABLE

   The entire container table has been read in and not one of the containers input via this table has the designation of propellant.

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 62 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) CARD NN OF LEG TABLE CONTAINS ILLEGAL LONGSHORING OPTION XXXXX.

In the longshoring entry in field 7, the permissible values are blank, "YES" or "NO". XXXXX is not any of these values.

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.

6) IN THE LEG TABLE ON CARD NN, THE FIELD - XXXXXX - CONTAINS A NON-NUMERIC.

The entry XXXXXX contains a non-numeric.

7) CARD NN OF LEG TABLE CONTAINS ILLEGAL OCCUPANCY LIMIT ENTRY XXXXXX.

The third entry of a leg card may be blank or contain - "SINGLE", "MULTIPLE", "YES" or "NO". Since this is not the case, the entry XXXXX must be numeric. The program has determined that the entry is not numeric either.

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 umambig-
uous 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) UNDER THE SPREAD NAME XXXXXX, THE SPREAD FACTORS
DO 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.

C-5

10) THE PROPELLANT VEHICLE XXXXXX IS NOT IN THE VEHICLE TABLE.

In the leg table the vehicle XXXXXX is specified to carry propellant on a particular leg. The vehicle XXXXXX was not found in the vehicle table.

11) IN THE VEHICLE TABLE, ISP CARD NN. THE FIELD - XXXXXX - CONTAINS A NON-NUMERIC.

The entry XXXXXX of card NN contains a non-numeric . The card is further identified as an ISP card.

12) NO FOLLOWING LEG XXXXXX YYYYYY.

A check is made on the leg table to identify the chain of vehicles to be used in a default option in the mission data. For leg XXXXXX the program could not find leg YYYYYY as following XXXXXX in the leg table. A careful check on the leg table will probably show a leg sequence that closes on itself.

13) VEHICLE XXXXXX HAS ILLEGAL ENTRY (YYYYYY) FOR PROPELLANT.

The vehicle XXXXXX has the entry YYYYYY for a propellant tank. Either YYYYYY is not in the container table or it is not available for propellant.

14) CARD NN OF VEHICLE TABLE CONTAINS ILLEGAL OCCUPANCY LIMIT (XXXXXX).

The entry XXXXXX does not conform to blank, "SINGLE" "MULTIPLE" or numeric value.

15) NO ISP VALUES IN THE DDB ARRAY FOR XXXXXX WHICH APPEARS IN THE WET STAGES CARD FOR VEHICLE NUMBER NN.

The program cannot find the ISP data for stage XXXXXX which is referred to as a propulsive stage on vehicle NN. Either add the ISP card or remove this vehicle from the wet stages card.

Errors in processing the facility table:

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) IN THE FACILITY TABLE ON CARD NN THE FIELD - XXXXXX - CONTAINS A NON-NUMERIC

The field XXXXXX 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 FACILITY
      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 CONTAIN-
      ER 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.

The program has a capacity of 62 program names and 62 mission names. The user is advised to review the data deck to determine if all the names are really required. Mission names may be reused several times.

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 XXXXX and mission YYYYY for the error.

9) VEHICLE CARD APPEARS BEFORE A LEG CARD.
    PROGRAM = XXXXX MISSION = YYYYY
    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 XXXXX and mission YYYYY for the error.

10) VEHICLE NAME XXXXXX IS NOT IN VEHICLE TABLE.
    PROGRAM = YYYYY 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 YYYYY.
    CARD IMAGE IN ERROR IS START ----

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

18) LEG UNDEFINED FOR SCHEDULING CARD
PROGRAM = XXXXXX
MISSION = YYYYYY

A SCHEDULE card has been encountered, but the program has no prior record of which leg the cargo is to be carried on. The user must supply the necessary LEG card preceding the SCHEDULE card. See program XXXXXX and mission YYYYY for the card in error.

19) AT LEAST ONE OF THE WEIGHTS IS WRONG IN COUPLED GROUP.
LAST PROGRAM ENTRY WAS XXXXXX
LAST MISSION ENTRY WAS YYYYYY
CARD IMAGE IN ERROR IS ----

On the basis of totals of weight up and weight down, the program has determined the potential directions of shipment.

However, the total weight upward does not have to match the total weight downward. The program has detected an item with zero weight in a possible direction. The coupled group has been rejected during processing of data under program XXXXXX and mission YYYYY. Should the user desire to force the issue, a very small weight ~.1 could be used for the invalid element.

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 YYYYY

    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.

3)   BAD CAPTURE - CARGO ELEMENT XXXXXX ON LEG YYYYY IN YEAR NN FORCED TO USE DEFAULT VEHICLE.

    In processing the preference list, the program could not find a vehicle of sufficient performance capability to deliver the cargo element XXXXXX on leg YYYYY in year NN. As a last resort the item is assigned to the default vehicle in the leg table. This assignment could create another error message from ASINER (number 6).

4)   *ERROR IN LEGPRO* COUPLE HAS NO ITEMS NN -----

    The user should check the input data for a bad data definition of a couple group with no items in it or, if that fails, have a programmer check for a program or computer error.

5) THE UPPER STAGE - XXXXXX - FOR GROUND BASE IS NOT
IN THE CARGO ELEMENT TABLE

The program is processing a ground based program and
has cargo assigned to fly on stage XXXXXX. The program is
attempting to couple the stage with the cargo for shipment on
a lower leg, but cannot find the stage in the cargo element
table. The user is advised to add the stage to the cargo element
table.

6) LEG - XXXXXX - DOES NOT EXIST FOR VEHICLE - YYYYYY

The program is attempting to provide ASINER with a list
of items to be shipped on leg XXXXXX via vehicle YYYYYY,
but finds that the vehicle has no performance capability to
deliver cargo on that leg. The user should add the leg XXXXXX
to the data already input for vehicle YYYYYY.

7) ***GROUND BASE MODE**** NO UPPER STAGE FOR VEHICLE
XXXXXX

The program is processing a ground based program and has
cargo assigned to fly on vehicle XXXXXX. The program is
attempting to couple the stage with the cargo for shipment on a
lower leg, but cannot find the upper stage of the vehicle. The
user is advised to add the stages card to the vehicle XXXXXX
or zero the propellant on said vehicle.

8) NLCE GT NBMISS

The user is advised to consult a programmer as this
application has exceeded certain internal constraints.

9) *** DDB ARRAY HAS OVERFLOWED ***

The user is advised to consult a programmer as this
application requires the dimension of the DDB array to be
increased.

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 computa-
      tions are correct except they lack the operating cost for shipping
      the vehicle.

4)   ***DDB ARRAY HAS OVERFLOWED IN TRAFIC***

      The user is advised to consult a programmer as this
      application requires the dimensions of the DDB array to be
      increased.

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 WEIGHT MUST EXCEED THE VALUE OF EEE FOR PROPER PROCESSING.

Currently, EEE is taken as 0.999. 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. YYYYY 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 YYYYY 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 XXXXX 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.

The user is advised to consult a programmer familiar with the DORCA program to interpret the information following this diagonastic.

12) REJECT CARGO ELEMENT XXXXXX FOR VEHICLE YYYYY
ON LEG XYXYXY
NEEDS EXPENDED VEHICLE BUT IS ALSO REQUIRED TO
MAKE ROUND TRIP ON SAME VEHICLE.

The cargo element XXXXXX is required to make a round trip on leg XYXYXY via vehicle YYYYY. However, the weight of the cargo element is just large enough so that an expended vehicle could make the delivery, which is inconsistent with the round trip requirement. Review the data and most likely provide an improved vehicle.

13) VEHICLE NUMBER = 0 FOR CARGO WITH ICF = NN, ICL = MM,
IF = LL, IL = KK

ASINER has a cargo element with no vehicle assigned in primary bins. This indicates a program or computer error. Consult a programmer.

Error messages from SPRINT:

1) SPRINT CANNOT FIND DATA FOR LEG XXXXXX ON
VEHICLE YYYYY

SPRINT needs the vehicle performance for vehicle YYYYY on leg XXXXXX as was used in ASINER for loading the vehicle. If a similar message was produced by ASINER, then provide the missing data in the vehicle table. If not, then something has gone wrong internally in the program and a programmer must be consulted.

2)   LEG/VEHICLE FLIGHT COMBINATIONS HAVE EXCEEDED NN
     CALCULATION OF SUMMARY TABLES ARE DISCONTINUED

     The capacity of the XLF array (used for weight and
volume summary printouts) is exceeded. Increase capacity
via the "55" and correspondingly increase the "69" for
JXMAX = 69 - NOVEH (check size of common).

Error messages from READER:

1)   TOO MANY ENTRIES IN VEHICLE PREFERENCE LIST

     The user has supplied a preference list of vehicles in
excess of the program limit of 20. Some of the less frequently
used vehicles could be removed from the list and a priori
assignments made.

2)   PRECEDING ENTRY IN VEHICLE PREFERENCE LIST CONTAINS
     ERROR IN ONE OR BOTH DATES

     One or both date entries on the vehicle in the preference
list contains a non-numeric.

3)   PRECEDING ENTRY IN VEHICLE PREFERENCE LIST CONTAINS
     ERROR IN VEHICLE NAME

     The vehicle table has been searched and the vehicle named
on the preference card was not in the vehicle table.

4)   PRECEDING OPTION CARD HAS ILLEGAL NAME

     The preceding option name has been checked against the
list of available options and a match was not found. The name
is probably misspelled.

5) PRECEDING OPTION CARD HAS ILLEGAL VALUE

The numeric value entry of the option card contains a non-numeric.

Error messages from PERLNK:

1) DESIGN ERROR: PROPELLANT INSUFFICIENT IN STAGE NN

The program has encountered an inconsistency in the performance computations. It would be wise to review the data for stage NN and all associated vehicles and stages.

2) ISP VALUES FOR VEHICLE NN NOT ENTERED

The PERLNK routine has found that a stage of a vehicle lacks an I_{sp} card providing the required information for performance calculations. Check vehicle number NN in the vehicle table.

Error message from PROLINK:

1) ***ERROR IN PROLINK*** VEHICLE = XXXXXX

The propellant computations have encountered a vehicle with a payload up, down or expended that requires more propellant than the vehicle can carry. In other words a flight has somehow been scheduled to fly more weight than the vehicle is capable. Recommend a programmer be consulted.

APPENDIX   D

SAMPLE   COMPUTER   RUN

TABLE   CONTAINER

			PROPELLANT	.49
CLPRM	30000	3500	BULK	.49
CLPRM-G/3	39000	3500	CREW	.39
TCC-25	33001	4198		

TABLE   LEG

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	ON	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		100.	50.	33.33	25.	20.
SPPROD2	2		50.	33.33	25.	20.	
SPPROD3	3		33.33	25.	20.	16.66	
SPPROD4	4		25.	20.	25.	25.	20.
SPPROD5	5	16.67	20.	20.	20.	20.	
SPPROD6	6		16.66	16.65	16.66	16.66	16.66
SPPROD7	7	14.3	14.3	14.3	14.3	14.3	14.3
	14.3						
SPPDEV3	3		20.99	56.38	22.64	11.82	6.99
SPPDEV4	4		10.64	38.31	39.23	26.29	18.12
SPPDEV5	5		5.13	25.23	35.36	23.41	
SPPDEV6	6	4.51	3.87	17.12	27.37		
SPPDEV7	7	3.11	2.61	12.06	21.55	25.57	22.16
SPPDEV8	8	9.56	1.85	8.79	16.65	21.67	21.92
	12.95		2.25				
SPPDEV9	9	13.67	1.37	5.60	13.01	18.00	19.99
	17.31		7.27				
SPPDEV10	10	15.36	1.04	1.70	10.32	14.90	17.60
	18.39		10.34				
SPPDEV11	11	15.53	0.82	5.09	1.32	12.38	15.27
	17.75		12.85	5.67	8.30	1.05	
SPPDEV12	12	14.30	0.65	4.01	4.52	10.34	13.18
	16.39		13.51	8.88	5.77	3.57	0.85
	14.79			3.22	7.30		
				10.82			

D-4

TABLE   VEHICLE

EOS-WOAB   0   20   105   10   SPPROD3
           10213   SPDEV9   600   SPPROD3   4.42   1.0
           ES-28/1   79000   9999999 79000   31600   360
           ES-55/2.7 51000   9999999 51000   20400
           ES-90/1   40000   9999999 40000   16300
           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   SPPROD2
           608.48   SPDEV3   13.15   SPPROD2   0   0
           LO-LS   0   0   0   0

TCC-25-CR 0   0   SPPROD2
           0   SPDEV3   SPPROD2   0   0
                      0   0   0

TCC-25-B/P NONE   0   SPPROD2
           0   SPDEV3   SPPROD2   0   0
           NONE   0   0   0

PADTUG-25K0 0   0   13.15   SPPROD2
           608.48   SPDEV3   13.15   SPPROD2   0   0
           LO-LS   0   0   0

TUS-25K   25000   10   20   5   SPPROD2
           0   SPDEV3   0   SPPROD2   .91   8.2
           STAGES   TUG-25K CRGTUG-25K
           28/1-P/12 2334   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 288389   18106   28989
           28/1-P/5.5 40997   27904   40997
           28/1-28/3 70480   54095   70480
           90/1-90/3 70480   54035   70480
           28/1-28/2 128774   109494   128774
           90/1-90/2 128774   109434   128774
           90/1-90/.7 269446   149097   169446

```
100/1-0/.7169446      149097            169446
28/1-28/19673         276               673
28/1-0/19    0        0        0        0
28/1-5/19    0        0        0        0
28/1-28/300           0        0        0
28/1-28/380           0        0        0
TOTUG-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
28/1-0/19       8486   2826     8486
28/1-28/309    9314    3141     9304
28/1-5/19      9519    3229     9519
28/1-28/3     10380    3579    10380
28/1-LO       11327    3841    11027
28/1-P/12     16596    6256    16596
28/1-P/11     21998    8867    21998
28/1-28/20    25673   10777    25673
90/1-90/20    25673   10777    25673
28/1-P/9      38285   17941    38285
LO-LS         46304   24535    46304
LO-LS2        46304   24535    46304
28/1-P/6.7657 55721   36412    55721
28/1-P/5.5890 89022   55525    89022
28/1-28/3    147060  107893   147060
90/1-90/3    147060  107893   147050
28/1-28/19    13669    4937    13669

TRTUG-25K  75000  10           20       5
0          SPDEV3      CRGTUG-25KCRGTUG-25KCRGTUG-25K   3.0   0
STAGES     TRTUG-25K   CRGTUG-25K   CRGTUG-25KCRGTUG-25K
28/1-0/19     19004    5730    19004
28/1-28/30    20144    6154    20144
28/1-5/19     20446    6271    20445
28/1-28/38    21654    6739    21654
28/1-LO       22560    7090    22560
28/1-P/12     30424   10332    30424
28/1-P/11     38156   13824    38156
28/1-28/20    43460   16374    43460
90/1-90/20    43460   16374    43460
28/1-P/9      61820   25920    61820
28/1-28/19    26272    8556    26272
```

TABLE FACILITY

NEO-2	100	C	SPDEV3	0	SPPROD2
NEO-2-R	100	J	SPDEV3	0	SPPROD2
NPL-10+AG	100	C	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

	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 ORA/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	0
TCC-25-R/P25K	TCC PROPELLANT	CLPRM-G/B	MATERIAL	25000	0	0

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+A5
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

```
REPORT    SPRINT
REPORT    VEHICLE
REPORT    CONTAINER
REPORT    FACILITY
REPORT    TRAFFIC
REPORT    COST
REPORT    COST80
REPORT    DEBUG
REPORT    TABLES
OPTION    CALVEH    AJTOMATIC
END
```

TABLES REPORT

NBSPD	2	NLSPD	138	NSPD	17	NWVEH	16
NBVEH	139	NLVEH	566	NVEH	8	NWFAC	8
NBFAC	567	NLFAC	598	NFAC	4	NWCE	9
NBCE	600	NLCE	743	NCE	16	NWMISS	3
NBMISS	2526	NLMISS	2684	LNGTH	53	NWDDB	3
NBDDB	744	NLDDB	977	NDDB	78		

I	NFTBL(I)	IFA(I)	IVA(I)
1	00010001100007	0204001320001	2602002000001
2	00070001100002	0204001323301	2602002000001
3	00010001200001	0205001411102	2602002000001
4	00010001300001	0306001511101	2610002000001
5	00010001400001	0306001512201	0000000000000
6	00010001500001	0306001513301	0000000000000
7	00010001600001	0306001514401	0000000000000
8	00010001700001	0306001515501	0000000000000
9	00010002000005	0306001516601	0000000000000
10	00010002000001	0306001517701	0000000000000
11	00010002100001	0306001520001	0000000000000
12	00010002200001	0306001521101	0000000000000
13	00010002300004	0306001522201	0000000000000
14	00010002300001	0306001523301	0000000000000
15	00010002400001	0306001524401	0000000000000
16	00000000000000	0306001611201	0000000000000
17	00000000000000	0306001613301	0000000000000
18	00000000000000	0306001614401	0000000000000
19	00000000000000	0306001615501	0000000000000
20	00000000000000	0306001616601	0000000000000
21	00000000000000	0306001617701	0000000000000
22	00000000000000	0306001620001	0000000000000
23	00000000000000	0306001621101	0000000000000
24	00000000000000	0306001622201	0000000000000
25	00000000000000	0306001623301	0000000000000
26	00000000000000	0306001624401	0000000000000

```
IFLAG =  1  1  1  1  1  1  1  1  1  1  1  1
         1  0  0  0  0  0  0  0  0  0  0  1

OPTIONS  0  0  3  1  0  0  0  0  0  0

CONTAINER TABLE-TBCONT
  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   4198.0   1.0   .4

LEG TABLE-TBLEG
  1   LO-LS        28/1-LO    1000.0   7777706100177    8    8   0.0   0.0
  2   LO-LS2       28/1-LO    1000.0   7777706100177    8   16   0.0   1.0
  3   28/1-28/3    ES-28/1       1.0   7777706017777   22   22   0.0   1.0
  4   28/1-28/19   ES-28/1       1.0   7777707017777   22   22   0.0   1.0
  5   28/1-28/2    ES-28/1       1.0   7777706017777   22   22   0.0   1.0
  6   28/1-5/19    ES-28/1       1.0   7777707017777   22   22   0.0   1.0
  7   28/1-0/19    ES-28/1       1.0   7777707017777   22   22   0.0   1.0
  8   28/1-LO      ES-28/1    1000.0   7777710017777   22   22   0.0   0.0
  9   28/1-28/20   ES-28/1       1.0   7777706017777   22   22   0.0   1.0
 10   28/1-28/30   ES-28/1       1.0   7777707017777   22   22   0.0   1.0
 11   28/1-P/12    ES-28/1       1.0   7777710017777   22   22   0.0   1.0
 12   28/1-P/11    ES-28/1       1.0   7777707017777   22   22   0.0   1.0
 13   28/1-P/9     ES-28/1       1.0   7777707017777   22   22   0.0   1.0
 14   28/1-P/6.7   ES-28/1       1.0   7777706017777   22   22   0.0   1.0
 15   28/1-28/38   ES-28/1       1.0   7777707017777   22   22   0.0   1.0
 16   28/1-P/5.5   ES-28/1       1.0   7777706017777   22   22   0.0   1.0
 17   90/1-90/.7   ES-90/1       1.0   7777706017777   27   27   0.0   1.0
 18   90/1-90/2    ES-90/1       1.0   7777706017777   27   27   0.0   1.0
 19   90/1-90/3    ES-90/1       1.0   7777706017777   27   27   0.0   1.0
 20   90/1-90/20   ES-90/1       1.0   7777706017777   28   28   0.0   1.0
 21   100/1-0/.7   ES-100/1      1.0   7777706017777   63   63   0.0   0.0
 22   ES-28/1      NONE       1000.0   7777701777777   63   63   0.0   0.0
 23   ES-28/3.5    NONE       1000.0   7777701777777   63   63   0.0   0.0
 24   ES-55/2.7    NONE       1000.0   7777701777777   63   63   0.0   0.0
 25   ES-90/.3     NONE       1000.0   7777701777777   63   63   0.0   0.0
 26   ES-90/.5     NONE       1000.0   7777701777777   63   63   0.0   0.0
 27   ES-90/1      NONE       1000.0   7777701777777   63   63   0.0   0.0
 28   ES-100/1     NONE       1000.0   7777701777777   63   63   0.0   0.0
 29   ES-103/.5    NONE       1000.0   7777701777777   63   63   0.0   0.0

SPREAD TABLE-TBSPD
```

```
 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.
```

SPREAD DATA

idx		1	2	3	4	5	6	7	8	9	10	11
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	.1667	.1667					
7.	7.	.1430	.1430	.1430	.1430	.1430	.1430	.1430				
3.	2.	.5638	.2264	.1182	.0699	.0451	.0311	.0225	.0170	.0132	.0105	.0085
4.	3.	.3831	.3923	.2629	.1812	.1295	.0956	.0727	.0567	.0452	.0367	
5.	4.	.2523	.3536	.2841	.2216	.1731	.1367	.1094	.0888	.0730		
6.	5.	.1712	.2797	.2557	.2192	.1839	.1536	.1285	.1082			
7.	6.	.1206	.2155	.2167	.1999	.1776	.1553	.1351				
8.	6.	.0879	.1665	.1800	.1760	.1639	.1490					
9.	7.	.0660	.1301	.1490	.1527	.1479						
10.	8.	.0509	.1032	.1238	.1318							
11.	9.	.0401	.0836	.1034								
12.	9.	.0322	.0677									

VEHICLE TABLE-TBVEH

```
1   EOS-WOAB     000070000213   000000000000   000000000000
2   CRGTUG-25K   000025000303   000000000000   000000000000
3   TCC-25-CR    000025000330   000000000000   000000000000
```

4   TCC-25-B/P   000025000355
5   PADTUG-25K   000025000402
6   TUG-25K   000164000427
7   TOTUG-25K   000145000613
8   TRTUG-25K   000107000760

VEHICLE DATA

```
1   EOS-MOAB        0.0     20.0    100.0   10.0    0000000000000   0.0     0.0       89.0
                    1.0     600.0   9.0     1000.0  0000000000000   4.4     10213.0   1.0
                                                    0602000000000           360.0
                                                    030403040000
                                                    1002020200000
        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     0000000000000   0.0     608.5     44.0
                    1.0     13.1    5.0     1000.0  0000000000000   0.0     0.0       1000.0
        LO-LS       0.0     0.0     0.0                             0602000000000
                                                                    030403040000
                                                                    1002020200000

3   TCC-25-CR       0.0     0.0     0.0     0.0                     0.0     0.0       44.0
                    1.0     0.0     5.0     1000.0                  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
                    1.0     0.0     5.0     1000.0                  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
                    1.0     13.1    5.0     1000.0                  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
                    1.0       0.0     5.0     1000.0                .9      8.2       1000.0
        28/1-P/12     2394.0    1017.0   2394.3
        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	18106.0	28989.0
28/1-P/5.5	40997.0	27904.0	40997.0
23/1-28/3	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
28/1-28/33	0.0	0.0	0.0
28/1-28/38	0.0	0.0	0.0

Header parameters: 44.0 / 1000.0 ; 0.0 / 0.0 ; 0.0 / 2.0 ; 5.0 / 1000.0

7   TOTUG-25K

28/1-0/19	50000.0 (1.0)	10.0 (0.0)	20.0 (5.0)
28/1-28/30	8486.0	2826.0	8486.0
28/1-5/19	9304.0	3141.0	9304.0
28/1-28/38	9519.0	3229.0	9519.0
28/1-LO	10380.0	3579.0	10380.0
28/1-P/12	11027.0	3841.0	11027.0
28/1-P/11	16596.0	6256.0	16596.0
28/1-28/20	21998.0	8867.0	21998.0
90/1-90/20	25673.0	10777.0	25673.0
28/1-P/9	25673.0	10777.0	25673.0
LO-LS	38285.0	17941.0	38285.0
LO-LS2	46304.0	24535.0	46304.0
28/1-P/6.7	46304.0	24535.0	46304.0
28/1-P/5.5	65721.0	36412.0	65721.0
28/1-28/3	89022.0	55525.0	89022.0
90/1-90/3	147060.0	107893.0	147060.0
28/1-28/13	147060.0	107893.0	147060.0
	13669.0	4937.0	13669.0

8   TRTUG-25K

28/1-0/19	75000.0 (1.0)	10.0 (0.0)	20.0 (5.0)
28/1-28/30	19004.0	5730.0	19004.0
28/1-5/19	20144.0	6154.0	20144.0
28/1-28/38	20446.0	6271.0	20446.0
28/1-LO	21654.0	6739.0	21654.0
28/1-P/12	22560.0	7090.0	22560.0
	30424.0	10332.0	30424.0

Header parameters: 44.0 / 1000.0 ; 0.0 / 0.0 ; 0.0 / 3.0 ; 5.0 / 1000.0

FACILITY DATA

#	Name	Schedule												
1	NPL-14+AG	28/1-P/11	38156.0	13824.0	38156.0	100.0	44.0	0.0	0.0	5.6	5.0	0.000
2	NPL-10+AG	28/1-28/20	43460.0	16374.0	43460.0	100.0	44.0	0.0	0.0	5.6	5.0	0.000
3	NEO-2	90/1-90/20	43460.0	16374.0	43460.0	100.0	44.0	0.0	0.0	0.0	5.0	0.000
4	NEO-2-R	28/1-P/9	61820.0	25920.0	61820.0	100.0	44.0	0.0	0.0	0.0	5.0	.390
		28/1-28/19	26272.0	8556.0	26272.0							

CARGO ELEMENT DATA

#	Name	Description	Code				
1	TUG-25K	SINGL 25K PROP TUG	0006000030004	1.0	1.0	0.0	0.000
2	TDTUG-25K	TANDM 25K PROP TUG	0007000030004	1.0	1.0	0.0	0.000
3	TRTUG-25K	TRIPL 25K PROP TUG	0010000030004	1.0	1.0	0.3	0.000
4	CRGTUG-25K	CARGO TUG-25K	0002000030004	4198.0		0.0	.390
5	PADTUG-25K	PROD+DEV TUG ONLY	0005000030004	1.0	1.0	0.0	0.000
6	TCC-25-CR	25K TCC CREW	0003000010002	1.0	1.0	1.0	0.030
7	TCC-25-B/P	25K TCC PROPELLANT	0002000020001	25000.0		0.3	0.000
8	CLPRM	CLPRM	0000000030001	33500.0	3500.0	3500.0	.490
9	CLPRM-G/B	CLPRM-G/B	0000000030001	3500.0	3500.0	3500.0	.490
10	TCC-25	TCC-25	0000000030001	4198.0	4198.0	4198.0	.390
11	NPL-14+AG	URANUS TOPS ORB/PR	0001000030003	18690.0	18690.0	0.0	.590
12	NPL-10+AG	GRAND TOUR	0002000030003	16502.0	16502.0	0.0	.540
13	NEO-2	POLAR EARTH OBS SA	0003000030003	5980.0	5980.0	0.0	.270
14	NEO-2-R	POLAR EARTH OBS SA	0004000030003	0.0	0.0	0.0	.270
15	NL BOX AA	NO LONGSHORING	0000000050001	18690.0	18690.0	18690.0	.590
16	NL BOX AC	NO LONGSHORING	0000000050001	16502.0	16502.0	16502.0	.540

PROGRAM NAME TABLE

1	OVERHEAD
2	PLANETRY SATELLITE
3	WTR AUTO SATELLITE

MISSION NAME TABLE

1	PROPELANTS
2	CONTAINERS

3   VEHICLES
4   URANS TOPS ORB/PRB
5   GRAND TOUR
6   POLAR EARTH OBSERV

CARGO MANIFEST

PROGRAM	MISSION	LEG	VEHICLE	YEAR	FLIGHT	CARGO	WT UP	WT DOWN	ELF	
PLANETRY SATELLITE	URANS TOPS ORB/PRB	28/1-P/12	TRTUG-25K	1986	1	NPL-14+AG	18690.	0.	1.0000	.6143
						TOTALS	18690.	0.	1.0000	.5900
PLANETRY SATELLITE	URANS TOPS ORB/PRB	28/1-P/12	TRTUG-25K	1989	1	NPL-14+AG	18690.	0.	1.0000	.6143
						TOTALS	18690.	0.	1.0000	.5900
PLANETRY SATELLITE	GRAND TOUR	28/1-P/11	TDTUG-25K	1979	1	NPL-10+AG	16502.	0.	1.0000	.7502
						TOTALS	16502.	0.	1.0000	.5400
PLANETRY SATELLITE	GRAND TOUR	28/1-P/11	TDTUG-25K	1979	2	NPL-10+AG	16502.	0.	1.0000	.7502
						TOTALS	16502.	0.	1.0000	.5400
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.	.0003	
OVERHEAD	PROPELANTS	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	PROPELANTS	ES-28/1	EOS-WOAB	1979	1	CLPRM	0.	3500.	.0000	
						TOTALS	67699.	7699.	1.0000	.8577 .8800
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	PROPELANTS	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	PROPELANTS	ES-28/1	EOS-WOAB	1979	2	CLPRM	0.	3500.	.0004	
						TOTALS	67699.	7699.	1.0000	.8577 .8800
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1979	3	TCC-25-B/P	25000.	0.	.3689	

OVERHEAD	VEHICLES	ES-28/1	EOS-MOAB	1979	3	TCC-25-B/P	5000.	0.	.0738
OVERHEAD	CONTAINERS	ES-28/1	EOS-MOAB	1979	3	TCC-25	4198.	0.	.0619
OVERHEAD	CONTAINERS	ES-28/1	EOS-MOAB	1979	3	TCC-25	0.	4198.	.0005
OVERHEAD	VEHICLES	ES-28/1	EOS-MOAB	1979	3	TCC-25-CR	1.	0.	.0000
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1979	3	CLPRM	33500.	0.	.4944
OVERHEAD	VEHICLES	ES-28/1	EOS-MOAB	1979	3	TCC-25-CR	0.	1.	0.0000
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1979	3	CLPRM	0.	3500.	.0004
						TOTALS	67699.	7699.	1.0000 .8577
									.8800
OVERHEAD	VEHICLES	ES-28/1	EOS-MOAB	1979	4	TCC-25-B/P	10000.	0.	.2094
OVERHEAD	CONTAINERS	ES-28/1	EOS-MOAB	1979	4	TCC-25	4198.	0.	.0879
OVERHEAD	CONTAINERS	ES-28/1	EOS-MOAB	1979	4	TCC-25	0.	4198.	.0007
OVERHEAD	VEHICLES	ES-28/1	EOS-MOAB	1979	4	TCC-25-CR	1.	0.	.0000
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1979	4	CLPRM	33500.	0.	.7014
OVERHEAD	VEHICLES	ES-28/1	EOS-MOAB	1979	4	TCC-25-CR	0.	1.	0.0000
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1979	4	CLPRM	0.	3500.	.0006
						TOTALS	47699.	7699.	1.0000 .6046
									.8800
PLANETRY SATELLITE GRAND TOUR		ES-28/1	EOS-MOAB	1979	5	NPL-10+AG	16502.	0.	1.0000 .2089
						TOTALS	16502.	0.	1.0000 .5400
PLANETRY SATELLITE GRAND TOUR		ES-28/1	EOS-MOAB	1979	6	NPL-10+AG	16502.	0.	1.0000 .2089
						TOTALS	16502.	0.	1.0000 .5400
OVERHEAD	VEHICLES	ES-28/1	EOS-MOAB	1986	1	TRTUG-25K	1.	0.	.0000
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1986	1	CLPRM	33500.	0.	.4996
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1986	1	CLPRM	33500.	0.	.4996
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1986	1	CLPRM	0.	3500.	.0004
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1986	1	CLPRM	0.	3500.	.0004
						TOTALS	67001.	7000.	1.0000 .8488
									.9800
OVERHEAD	VEHICLES	ES-28/1	EOS-MOAB	1986	2	CRGTUG-25K	4198.	0.	.1113
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1986	2	CLPRM	33500.	0.	.8880
OVERHEAD	PROPELANTS	ES-28/1	EOS-MOAB	1986	2	CLPRM	0.	3500.	.0007
						TOTALS	37698.	3500.	1.0000 .4775
									.8800
PLANETRY SATELLITE URANS TOPS ORB/PRB		ES-28/1	EOS-MOAB	1986	3	NPL-14+AG	18690.	0.	.8166

OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1986	3	CRGTUG-25K	4198.	0.	.1834	.2697
						TOTALS	22868.	0.	1.0000	.9800
OVERHEAD	VEHICLES	ES-28/1	EOS-WOAB	1986	4	CRGTUG-25K	4198.	0.	1.0000	.0531
						TOTALS	4198.	0.	1.0000	.3900
OVERHEAD	PROPELANTS	ES-28/1	EOS-WOAB	1989	1	CLPRM	33500.	0.	.4996	
OVERHEAD	PROPELANTS	ES-28/1	EOS-WOAB	1989	1	CLPRM	33500.	0.	.4996	
OVERHEAD	PROPELANTS	ES-28/1	EOS-WOAB	1989	1	CLPRM	0.	3500.	.0004	
OVERHEAD	PROPELANTS	ES-28/1	EOS-WOAB	1989	1	CLPRM	0.	3500.	.0004	
						TOTALS	67000.	7000.	1.0000	.8488 .9800
OVERHEAD	PROPELANTS	ES-28/1	EOS-WOAB	1989	2	CLPRM	33500.	0.	.9992	
OVERHEAD	PROPELANTS	ES-28/1	EOS-WOAB	1989	2	CLPRM	0.	3500.	.0008	
						TOTALS	33500.	3500.	1.0000	.4244 .4900
PLANETRY SATELLITE	URANS TOPS ORB/PRB	ES-28/1	EOS-WOAB	1989	3	NPL-14+AG	18690.	0.	1.0000	.2366
						TOTALS	18690.	0.	1.0000	.5900
MTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1979	1	NEO-2	5980.	0.	1.0000	.7205
						TOTALS	5980.	0.	1.0000	.2700
MTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1980	1	NEO-2	5980.	0.	.9992	
MTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1980	1	NEO-2-R	0.	5980.	.0008	
						TOTALS	5980.	5980.	1.0000	.7211 .2700
MTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1981	1	NEO-2	5980.	0.	.9992	
MTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1981	1	NEO-2-R	0.	5980.	.0008	
						TOTALS	5980.	5980.	1.0000	.7211 .2700
MTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1982	1	NEO-2	5980.	0.	.9992	
MTR AUTO SATELLITE	POLAR EARTH OBSERV	ES-90/.5	EOS-WOAB	1982	1	NEO-2-R	0.	5980.	.0008	
						TOTALS	5980.	5980.	1.0000	.7212 .2700

MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1983	1	NEO-2	5980.	0.	.9992
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1983	1	NEO-2-R	0.	5980.	.0008
					TOTALS	5980.	5980.	1.0000 .7211 .2700
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1984	1	NEO-2	5980.	0.	.9992
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1984	1	NEO-2-R	0.	5980.	.0008
					TOTALS	5980.	5980.	1.0000 .7211 .2700
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1985	1	NEO-2	5980.	0.	.9992
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1985	1	NEO-2-R	0.	5980.	.0008
					TOTALS	5980.	5980.	1.0000 .7211 .2700
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1986	1	NEO-2	5980.	0.	.9992
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1986	1	NEO-2-R	0.	5980.	.0008
					TOTALS	5980.	5980.	1.0000 .7211 .2700
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1987	1	NEO-2	5980.	0.	.9992
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1987	1	NEO-2-R	0.	5980.	.0008
					TOTALS	5980.	5980.	1.0000 .7211 .2700
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1988	1	NEO-2	5980.	0.	.9992
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1988	1	NEO-2-R	0.	5980.	.0008
					TOTALS	5980.	5980.	1.0000 .7211 .2700
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1989	1	NEO-2	5980.	0.	.9992
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1989	1	NEO-2-R	0.	5980.	.0008
					TOTALS	5980.	5980.	1.0000 .7211 .2700
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1990	1	NEO-2	5980.	0.	.9992
MTR AUTO SATELLITE POLAR EARTH OBSERV	ES-90/.5	EOS-NOAB	1990	1	NEO-2-R	0.	5980.	.0008
					TOTALS	5980.	5980.	1.0000 .7211 .2700

SUMMARY OF LOAD FACTORS

VEHICLE	LEG	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
EOS-MOAB	ES-28/1	.52	.60	0.00	0.00	0.00	0.00	0.00	0.00	.42	0.00	0.00	.50	0.00
EOS-MOAB	ES-90/.5	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72	.72
EOS-MOAB	SUB TOTAL	.62	.62	.72	.72	.72	.72	.72	.72	.48	.72	.72	.56	.72
TDTUG-25K	28/1-P/11	.75	.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TDTUG-25K	SUB TOTAL	.75	.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRTUG-25K	28/1-P/12	.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.61	0.00	0.00	.61	0.00
TRTUG-25K	SUB TOTAL	.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.61	0.00	0.00	.61	0.00
	GRAND TOTAL	.63	.65	.72	.72	.72	.72	.72	.72	.50	.72	.72	.57	.72

SUMMARY OF VOLUME FACTORS

VEHICLE	LEG	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
EOS-MOAB	ES-28/1	.76	.77	0.00	0.00	0.00	0.00	0.00	0.00	.81	0.00	0.00	.69	0.00
EOS-MOAB	ES-90/.5	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27
EOS-MOAB	SUB TOTAL	.53	.70	.27	.27	.27	.27	.27	.27	.70	.27	.27	.58	.27
TDTUG-25K	28/1-P/11	.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TDTUG-25K	SUB TOTAL	.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRTUG-25K	28/1-P/12	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TRTUG-25K	SUB TOTAL	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GRAND	TOTAL	.45	.54	.27	.27	.27	.27	.27	.27	.58	.27	.27	.47	.27

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CONTAINER SUMMARY

	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
CL-RM													
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
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

DISCRETE PAYLOADS 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
MTR 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
TOTAL DISCRETES	27.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	2.0	2.0	3.0	2.0

TRAFFIC TABLE FOR EOS-WOAB

	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
YEAR													
VEHICLE													
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	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	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	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													
PROPELANTS													
EOS-MOAB	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-MOAB	.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-MOAB	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-MOAB	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.3	.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-MOAB	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
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
MTR AUTO SATELLITE													
POLAR EARTH OBSERV													
EOS-MOAB	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
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

VEHICLE ACQUISITION SUMMARY REPORT

YEAR	TOTAL	79	80	81	82	83	84	85	86	87	88	89	90
VEHICLE													
EOS-MOAB	3	2	0	0	0	0	0	0	0	0	0	1	0
CRGTUG-25K	3	0	0	0	3	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	73	74	75	76	77	78	79	80	81	82	83	84
EOS-WOA3													
DEV.	10213.0	139.9	674.1	1328.7	1858.3	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	400.0	400.0	400.0	0.0	0.0	0.0	0.0	0.0
TOTAL	12013.0	139.9	674.1	1328.7	1858.3	2441.6	2278.2	1796.1	742.5	173.6	0.0	0.0	0.0
PRGTUG-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
PROD.	33.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	649.0	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.	12551.0	139.9	674.1	1328.7	1939.3	2441.6	2278.2	1796.1	742.5	173.6	0.0	0.0	0.0

COST REPORT

VEHICLE	TOTAL	85	86	87	88	89	90
EOS-WOAB							
DEV.	10213.0	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
TOTAL	12013.0	0.0	0.0	200.0	200.0	200.0	0.0
CRGTUG-25K							
DEV.	608.6	127.7	343.1	137.8	0.0	0.0	0.0
PROD.	39.4	19.7	19.7	0.0	0.0	0.0	0.0
TOTAL	648.0	147.4	362.8	137.8	0.0	0.0	0.0
TOTAL VEH.	12661.0	147.4	362.8	337.8	200.0	200.0	0.0

COST REPORT

DISCRETE PAYLOADS	TOTAL	73	74	75	76	77	78	79	80	81	82	83	84
OVERHEAD													
PROPELANTS													
CONTAINERS													
VEHICLES													
PLANETARY SATELLITE													
URANS TOPS OPB/PR3													
UPL-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
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
GRAND TOUR													
NOL-10+AG													
PROD.	11.2	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	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	5.6	5.6	0.0	0.0	0.0	0.0	0.0
WTR AUTO SATELLITE													
POLAR EARTH OBSERV													
GRAND TOT.	12593.4	139.9	674.1	1328.7	1838.3	2441.6	2283.8	1801.7	742.5	173.6			

COST REPORT

DISCRETE PAYLOADS	TOTAL	85	86	87	38	89	90
OVERHEAD							
PROPELANTS							
CONTAINERS							
VEHICLES							
PLANETRY SATELLITE							
URANS TOPS ORB/PR3							
NPL-14+AG							
PROD.	11.2	2.8	2.8	0.0	2.8	2.8	0.0
MISSION	11.2	2.8	2.8	0.0	2.8	2.8	0.0
GRAND TOUR							
NPL-10+AG							
PROD.	11.2	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
PROGRAM	22.4	2.8	2.8	0.0	2.8	2.8	0.0
WTR AUTO SATELLITE							
POLAR EARTH OBSERV				—			
GRAND TOT.	12683.4	150.2	365.6	337.8	202.8	202.8	0.0

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COST REPORT

OPERATIONS	TOTAL	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	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	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	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	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	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	6.8	0.0	0.0	0.0	0.0	0.0
PROGRAM	43.5	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 OKB/PKB													
EOS-WOAB	9.0	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	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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
GRAND TOUR													
EOS-WOAB	8.9	0.0	0.0	0.0	0.0	0.0	0.0	8.8	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	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	12.8	0.0	0.0	0.0	0.0	0.0
PROGRAM	25.8	0.0	0.0	0.0	0.0	0.0	0.0	12.8	0.0	0.0	0.0	0.0	0.0
MTR AUTC SATELLITE													
POLAR EARTH CBSERV													
EOS-WOAB	52.8	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	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	4.4	4.4	4.4	4.4	4.4	4.4
GRAND TOT.	12303.5	139.9	674.1	1328.7	1838.3	2441.6	2283.8	1836.6	746.9	178.0	4.4	4.4	4.4

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COST REPORT

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

CASE 1

0 FATAL ERRORS...A RUNNING TOTAL

53 PHASE I ITEMS

78 PHASE II ITEMS

8806 CELLS OF UNUSED BLANK COMMON

LOWCOR   PHASE I   PHASE II   SPRINT
12000   2684   977   1573

REPORT TITLE

DORCA II COMPUTER PROGRAM: Volume I User's Guide

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(NOTE: FOR OFF-SITE PERSONNEL, SHOW LOCATION SYMBOL, e.g. JOHN Q. PUBLIC/VAFB)

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APPROVED BY _Robert R Wolfe_   DATE 9/14/72

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