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USER'S MANUAL

SHUTTLE/PAYLOAD CONTAMINATION EVALUATION

(SPACE) PROGRAM

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Payload/Orbiter Contamination Control Requirement Study

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The Shuttle/Payload Contamination Evaluation computer model brings together contamination methodology into a practical systems analysis tool. The basic physical models for surface outgassing and deposition were first developed during the Skylab Program by Dr. Raymond O. Rantanen, Lyle E. Bareiss, Ernest B. Ress and others. Basic return flux mechanisms used in the model were formulated in part by Dr. Robert Naumann (MSFC) and S. J. Robertson (LMSC-HREC). Recent improvements have been made under NASA contracts directed by Charles M. Davis (MSFC) and Dr. Lubert Leger (JSC).

The program logic and computational techniques were integrated into the present computer model by Milton A. Hetrick. All mass transport factor data files used by the program were generated by Deborah Strange Jensen using the TRASYS thermal analysis program. Actual programming was performed by both Mr. Hetrick and Ms. Strange Jensen. Overall program management was under the direction of Ernest B. Ress.

FOREWORD

This User's Manual was prepared by the Contamination Analysis and Assessment Group of Martin Marietta Aerospace, Denver Division under Contract NAS8-31574, Exhibit B for the George C. Marshall Space Flight Center. This manual contains complete documentation for the MSFC version of the MMA VOLCAN program designated as the SPACE (Shuttle/Payload Contamination Evaluation) Program which predicts the on-orbit molecular contaminant induced environment for the Spacelab/Shuttle Orbiter vehicles.

The SPACE Program is an extension of computer programs developed under MSFC contracts NAS8-30452, NAS8-30755 - Exhibits A and B and NAS8-31574 - Exhibit A; and JSC contracts NAS9-14212 and NAS9-14767 - Exhibit A for the Spacelab/Shuttle Orbiter vehicles.

TABLE OF CONTENTS

		Page
Acknowledgements		i
Foreword		ii
Table of Contents		iii
List of Symbols		vi
1.	INTRODUCTION	1-1
2.	PROGRAM DESCRIPTION	2-1
2.1	PROGRAM PARAMETER DESCRIPTION	2-1
2.1.1	Spacecraft Configurations	2-2
2.1.2	Contaminant Sources and Source Functions	2-13
2.1.3	Contaminant Transport Functions	2-30
2.1.4	Contaminant Effects	2-39
2.2	PROGRAM MACHINE REQUIREMENTS	2-41
2.3	PROGRAM LOGIC FLOW AND OVERLAY STRUCTURE	2-42
2.4	SUBROUTINE DESCRIPTION	2-43
2.5	PERMANENT DATA FILES	2-46
2.5.1	Surface Thermal Profiles	2-46
2.5.2	Mass Transport Factors	2-46
2.6	FORTRAN VARIABLES LIST	2-52
3.	INPUT	3-1
3.1	EXECUTIVE INPUT	3-1
3.1.1	Type of Analysis	3-1
3.1.2	Sources of Contamination	3-3
3.1.3	Transport Mechanisms	3-3
3.1.4	Configurations	3-4
3.1.5	Surface Temperatures	3-4
3.1.6	New Data	3-5
3.1.7	Output Report Control	3-8
3.1.8	Mission Time Interval	3-9
3.1.9	Run Continuation Control Card	3-10
3.2	DETAILED INPUT DESCRIPTION	3-11
3.2.1	Source List Modification	3-11
3.2.2	Configuration Modification	3-16
3.2.3	Mass Loss Characteristics Modification	3-17
3.2.4	Surface Temperature Permanent File Update	3-22
3.2.5	Surface Temperature Modification Via Namelist	3-23
3.2.6	Mission Profile Data Bank Modification	3-23
3.2.7	Mass Transport Factor Permanent File	3-28
3.2.8	Run Termination	3-29
3.2.9	Additional Permanent Files	3-29

TABLE OF CONTENTS (cont'd)

		Page
4.	OUTPUT	4-1
4.1	OUTPUT NOMENCLATURE AND TERMS	4-1
4.2	MODEL INPUT DATA DISPLAY	4-4
4.3	MODEL OUTPUT PREDICTION DISPLAY	4-6
4.4	DEBUG OUTPUT	4-14
5.	SAMPLE PROBLEMS	5-1
5.1	SAMPLE CASE 1 - MINIMUM INPUT CASE	5-1
5.1.1	Input	5-1
5.1.2	Output	5-2
5.2	SAMPLE CASE 2 - SHUTTLE ORBITER -Y TRANSLATION MANEUVER	5-4
5.2.1	Input	5-4
5.2.2	Output	5-6
5.3	SAMPLE CASE 3 - SHUTTLE ORBITER 100 HOURS 60/90 LOS	5-10
5.3.1	Input	5-10
5.3.2	Output	5-11
5.4	SAMPLE CASE 4 - TWO BULK MASS LOSS RATES	5-20
5.4.1	Input	5-20
5.4.2	Output	5-22
5.5	SAMPLE CASE 5 - SURFACE TEMPERATURE CHANGE	5-28
5.5.1	Input	5-28
5.5.2	Output	5-29
5.6	SAMPLE CASE 6 - SL-1 PAYLOAD MISSION ANALYSIS	5-34
5.6.1	Input	5-35
5.6.2	Output	5-36
6.	MISSION SIMULATION APPROACH	6-1
7.	PROGRAM LIMITATIONS	7-1
8.	REFERENCES	8-1
Appendix		
A	Contamination Methodology Summary	A-1 to A-31
B	Surface Input to TRASYS	B-1 to B-72
C	SPACE Program Listing	C-1 to C-109

TABLE OF CONTENTS (cont'd)

Page

Figures

2-1	Modeled Shuttle Orbiter Configuration	2-4
2-2	Primary Shuttle Orbiter Nodal Surface Number Assignments	2-6
2-3	Schematic Drawings of the Modeled Spacelab Configurations	2-8
2-4	Primary LMOP Nodal Surface Number Assignments	2-10
2-5	Primary SMTP Nodal Surface Number Assignments	2-11
2-6	Primary FIVP Nodal Surface Number Assignments	2-12
2-7	External Nonmetallic Material Locations	2-16
2-8	Orbiter Engine/Vent Locations and Identification Numbers	2-23
2-9	Location of Precalculated Viewfactors in Hemispherical Cloud	2-31
2-10	Example of a Critical Surface Location, Orientation and Field-of-View	2-33
2-11	Second Surface Source Illustration	2-38
2-12	SPACE Program Overlay Structure	2-42
3-1	Minimum Input Data Deck for Program Execution	3-2
4-1	Example Placement Summary Report Output	4-9
4-2	Example Level I Model Prediction Output	4-10
4-3	Example Level II Model Prediction Output	4-13
4-4	Example of Model Plot Output	4-15
5-1	Illustration of Direction Cosine Input for Return Flux	5-5

Tables

1-I	SPACE Program Capability Summary	1-3
2-I	Major Modeled Spacelab Components	2-5
2-II	Spacelab Nodal Information	2-9
2-III	Sources Data Sheet - Outgassing	2-14
2-IV	Sources Data Sheet - Early Desorption	2-18
2-V	Sources Data Sheet - Leakage	2-20
2-VI	Sources Data Sheet - 25 lb. RCS Engines	2-21
2-VII	Sources Data Sheet - 870 lb. RCS Engines	2-24
2-VIII	Sources Data Sheet - Evaporator	2-27
2-IX	Code for Volume Element Midpoints	2-32
2-X	Sticking Coefficient Summary	2-40
2-XI	Maximum/Minimum Temperature Profile Permanent File	2-47
2-XII	List of Mass Transport Factors to Points Read In	2-51
3-I	Preset List of Surfaces, Engines and Vents	3-12
3-II	Preset List of Mass Loss Rate Characteristics	3-18
3-III	Preset List of Mission Profile Data Bank Parameters	3-27
6-I	User Checklist for Mission Contamination Analysis	6-2

LIST OF SYMBOLS

A_o	Nonmetallic materials outgassing rate constant.
a_o	Initial amount of active outgassing mass available.
CDC	Control Data Corporation.
$\mathbb{C}_L$	Centerline
cm^2	Square centimeters.
CRDG	Contamination Requirement Definition Group.
dA	Elemental unit of area.
D_i	Deposition on surface i.
$\dot{D}_i$	Deposition rate on surface i.
d_m	Elemental unit of mass.
E	Activation energy.
EDR	Early desorption rate.
F_{i2}	Second surface flux at location i.
F_i	Flux at location i.
FIVP	Five Pallet Spacelab Configuration.
FOV	Field-of-view.
FRSI	Flexible reusable surface insulation (same as Nomex).
g	Grams.
hr	Hours.
HRSI	High temperature reusable surface insulation tile.
Hz	Frequency.

i	Subscript denoting receiving surface or location of interest.
in	Inches.
ISP	Specific impulse.
j	Subscript denoting source.
JSC	Lyndon B. Johnson Space Center.
k	Subscript denoting material type k.
kg	Kilograms.
km	Kilometers.
k(T)	Rate constant as a function of temperature.
LKR	Leak rate.
LMOP	Long Module/One Pallet Spacelab configuration.
LOS	Line-of-sight.
LRSI	Low temperature reusable surface insulation tile.
M	Molecular weight; or integrated mass lost over time and temperature (Appendix A).
m	Meters; or active mass remaining in an outgassing source; or subscript denoting contaminant specie m.
max	Maximum.
$\dot{m}_{ej}$	Reevaporation rate of deposit j.
min	Minimum.
$\dot{m}_j$	Emission rate from j.
$\dot{m}(t,T)$	Mass loss rate as a function of time and temperature.
MCD	Mass column density in g/cm^2.
MMA	Martin Marietta Aerospace.

MMH	Monomethyl hydrazine.
MLR	Mass loss rate.
MSFC	George C. Marshall Space Flight Center
MTCS	Module thermal control surface.
n	Order of reaction; or subscript denoting contaminant specie n.
N_A	Ambient density in molecules/cm^3.
$N_m(P)$	Contaminant density of specie m in molecules/cm^3.
NASA	National Aeronautics and Space Administration.
NCD	Molecular number column density in molecules/cm^2.
NSS_N	Integral sum of all$(N_m(P) \cdot N_n(P)\ \Delta r)$ along line-of-sight N.
Nomex	Coated felt insulation (FRSI).
N_2O_4	Nitrogen tetroxide.
O/F	Oxidizer to fuel ratio.
OGR	Outgassing rate.
OMS	Orbital maneuvering system.
P	Point in the modeled hemispherical volume.
PLT	Spacelab pallet.
PMP	Prime measurement point.
PTCS	Pallet thermal control surface.
P_{vj}	Vapor pressure.
R	Distance from source to point (mean free path determination); or molar gas constant.
r	Distance.

RCC	Reinforced carbon-carbon insulation
RCS	Reaction control system 870 lb. thrusters.
$RFAS_i$	Return flux ambient scattering.
$RFSS_i$	Self-scattering return flux to i.
RI	Rockwell International.
s	Seconds.
S	Sticking coefficient.
S_{A-B}	Sticking coefficient between source A and surface B.
SL	Spacelab.
SMTP	Short Module/Three Pallet Spacelab configuration.
SO	Shuttle Orbiter.
SPACE	Shuttle/Payload Contamination Evaluation computer program.
sr	Steradians.
STS	Space Transportation System.
t	Time.
T	Temperature.
TAU	Decay constant in hours.
T_{CN}	Condensation temperature of specie N.
TF_{j-i}	Transport function from j to i.
TGA	Thermogravimetric analysis.
TRASYS	Thermal Radiation Analysis System.
UV	Ultraviolet radiation.
V_A	Velocity of ambient atmosphere (approximately equal to orbital velocity).

VCS	Vernier Control System 25 lb. thrusters.
VF	Viewfactor.
VF_{i-j}	Viewfactor between source j and receiver i.
V_m	Velocity of contaminant species.
X-IOP	X-axis in orbital plane attitude.
X_o	NASA station number along X-axis.
X-POP	X-axis perpendicular to orbital plane attitude.
Y_o	NASA station number along Y-axis.
Z-LV	Z-axis local vertical attitude.
Z_o	NASA station number along Z-axis.
^oA	Angstroms.
α	Angle between ambient flux and line-of-sight.
β	Angle between orbital plane and earth-sun line.
Γ_j	Source distribution function of j.
δ_A	Ambient molecular diameter (viscosity).
δ_m	Molecular diameter of specie m (viscosity).
$\Delta\alpha/\varepsilon$	Change in thermal absorptivity/emissivity.
Δr	Distance increment along line-of-sight.
Δt	Time increment.
θ	Volume element midpoint angle off +Z axis; or field-of-view definition angle off surface normal.
λ_m	Mean free path of specie m.
μ	Molecular diameter velocity factor.
σ_{Am}	Scattering or collision cross-section for ambient/specie m collision.

τ	Mass loss decay constant; time to reach 1/e of original value.
ϕ	Volume element midpoint angle off +X axis.
φ	Field-of-view definition angle in surface plane.
ψ_j	Source function of j.
Ω	Surface geometric acceptance angle in steradians.

SECTION 1
INTRODUCTION

The Shuttle/Payload Contamination Evaluation (SPACE) Computer Program was developed to provide the user with a flexible and consistent analytical tool with which to predict the external self induced molecular contaminant environment of a space vehicle during its on-orbit operations. The SPACE Program mathematically synthesizes the induced environment for the six major contaminant sources of three Spacelab configurations and the Space Shuttle Orbiter. It predicts surface deposition and return flux on surfaces with up to 2π steradian fields-of-view and molecular column densities for seventeen modeled lines-of-sight. The user has the options to modify configurations, input data blocks and physical relationships through proper program commands.

From its inception, the primary goals of the SPACE Program were to evaluate the molecular environments induced by the Space Transportation System (STS) Shuttle Orbiter and the various Spacelab configurations for compliance with program contamination control requirements and to support Spacelab design and development activities for compliance to these requirements. The external on-orbit contamination control requirements as set forth by the Contamination Requirements Definition Group (CRDG) and the Particle and Gases Working Group (PCWG) establish allowable limits for molecular contamination in the following areas:

a) Molecular Column Density - The total integrated density in molecules/cm^2 of molecular contaminant species along specific lines-of-sight.

b) Molecular Deposition - The total mass per unit area or thickness that will deposit upon a sensitive surface under specific time, temperature, acceptance angle and mission profile relationships.

c) Background Brightness - The total level of scattered or emitted radiant energy induced by the contaminant cloud in the vicinity of the spacecraft.

These requirements have in part dictated the format and the present capabilities of the SPACE Program. For example, the program's calculational capabilities are limited to a given instant in time where all parametric variables remain constant. This has proven quite sufficient for design and development and contamination

control criteria studies where the analyst is attempting to establish the worst and least case conditions for a particular spacecraft. For a total mission evaluation, multiple runs incorporating the necessary parametric variations must be made.

The SPACE Program as developed exceeds its initial objectives. Its current flexible design lends itself to easy modification through complete user option/model parameter control. Table 1-I presents an overview summary of the SPACE Program capabilities and user options available in the model. Definitions of the nomenclature and terms presented therein can be found in the ensuing sections of this manual.

This manual contains complete documentation of the SPACE Program. Section 2 contains a description of the SPACE Program including the modeled configurations, contaminant source and transport relationships, the program logic flow, subroutines and permanent data files. The last portion of Section 2 contains a list of program FORTRAN variables. Section 3 presents a description of the SPACE Program input requirements including input options available to the user and procedures for modifying model parameters and permanent file data. Basic model output format options are discussed in Section 4 along with sample printouts and descriptions of the various levels of detail available to the user. Debug and data plotting output options are also discussed. Sample problem test cases are presented in Section 5. These include a brief statement of the problem, complete model input listing, sample output and a discussion of the results. Section 6 summarizes an approach to expanding the modeling capabilities to simulate a complete mission profile and Section 7 presents the limitations of the current SPACE Program and potential future refinements. References are contained in Section 8. Three appendices are included for supplemental information. Appendix A presents a general summary of the physical approach, mathematical representations and assumptions employed in establishing the modeled parameters discussed in Section 2. Appendix B contains the geometrical breakdown/input data utilized to establish the modeled configurations currently in the model, and Appendix C presents a complete listing of the SPACE Program.

Table 1-I. SPACE Program Capability Summary

A. MODEL INPUT CAPABILITIES

- Preset Parameters
  - Geometry-Configurations
    - -Mass Transport Factors
  - Mission Profile Data
  - Ambient Atmosphere Data
  - Surface Temperature Profiles
  - Source Data
  - Transport Relationships
- Options (number available)
  - Configuration (4)
  - Line-of-Sight (17)
  - Source (6)
  - Transport (7)
  - Output Format (29)
- New Data
  - Configuration
    - -Mass Transport Factors
  - Sources
    - -Types
    - -Mass Loss/Emission Characteristics
  - Transport Relationships
  - Surface Temperature Profiles
  - Mission Profile Data

B. MODEL OUTPUT CAPABILITIES

- Surface Mass Loss Rates
- Line-of-Sight Mass Column Density } With and Without
- Line-of-Sight Number Column Density } Ambient Attenuation
- Return Flux (Ambient/Self-Scattering)
- Source-to-Surface Deposition
- Return Flux Deposition
- Debug

C. MODEL ANALYTICAL OPTIONS

- Configuration Options
  - Orbiter (On-Orbit)
  - Three Representative Spacelab Configurations
  - Seventeen Lines-of-Sight

Table 1-I. SPACE Program Capability Summary (cont'd)

C. MODEL ANALYTICAL OPTIONS (cont'd)

- Source Options
  - Outgassing
  - Early Desorption
  - Cabin Atmosphere Leakage
  - Evaporator Vents (2)
  - 870 lb. RCS Thrusters (38)
  - 25 lb. VCS Thrusters (6)

- Source Parametric Options
  - Distributed Sources
    - -Contributing Surface Selection
    - -Constituents
    - -Mass Loss/Emission Rate
    - -Time Dependence
    - -Temperature Dependence
    - -Molecular Weight
    - -Molecular Diameter
    - -Sticking Coefficient
    - -Sublimation Rate
    - -Velocity
  - Concentrated Sources
    - -Thruster/Vent Selection
    - -Source Duty Cycle
    - -Constituents
    - -Flowrate
    - -Plume Function
    - -Molecular Weight
    - -Molecular Diameter
    - -Sticking Coefficient
    - -Sublimation Rate
    - -Direct Flow/Structural Reflection
    - -Velocity

- Mission Options
  - Ambient Density
    - -Orbital Altitude (105 to 2500 km)
    - -Solar Activity (High, Medium, Low)
  - Thermal Profile (Max/Min)
  - Sensitive Surface Data
    - -Temperature
    - -Acceptance Angle (Up to 2π Steradians)
    - -Location
    - -Viewing Angle

Table 1-I. SPACE Program Capability Summary (cont'd)

C. MODEL ANALYTICAL OPTIONS (cont'd)

- Mission Options (cont'd)
  - Line-of-Sight
  - Orbital Velocity
  - Orbital Attitude
  - Mission Time Slice
  - Orbiter Age
  - Spacelab Age

- Transport Options
  - Direct Source-to-Surface or Point
  - Direct Source-to-Surface or Point with Ambient Attenuation
  - Mass/Number Column Density
  - Surface Reflection/Re-emission
  - Return Flux - Ambient Scattering
  - Return Flux - Self-Scattering
  - Surface Deposition

SECTION 2
PROGRAM DESCRIPTION

2.1 PROGRAM PARAMETER DESCRIPTION

This subsection presents a description of the major parameters employed in modeling the molecular contaminant induced environment of the Shuttle Orbiter (SO) and Spacelab (SL) vehicles. The methodology used in the contamination modeling is described in detail in Appendix A of this manual while only an abbreviated overview of the applicable parameters is presented in this subsection. For background information on the contamination analyses of the Spacelab carriers and Shuttle Orbiter, reference should be made to previous MMA contract reports MCR 76-387[1]* and MCR 75-13[2].

Due to the fact that the Shuttle/Payload Contamination Evaluation (SPACE) Program has been written specifically for the Orbiter and Spacelab configurations and contaminant sources, the methodology presented herein dwells primarily upon those areas determined significant in the contamination analysis of these vehicles. Where appropriate, however, a more generalized approach for an arbitrary spacecraft configuration and set of sources is presented to portray the potential flexibility of the model when the proper user manipulations are made. The basic physical relationships established in the model are inherently applicable to analyzing the contaminant environment of any space vehicle on-orbit although complete flexibility is somewhat limited through automatic program default to SO/SL unique parameters (i.e., sources, geometry, etc.).

Spacecraft contamination in general involves four primary phenomena which include: 1) the geometry of the spacecraft; 2) the emission process from a source; 3) the transport of emitted contaminants to a location of interest and ultimately 4) the induced effects of the contaminants upon critical surfaces and scientific objectives. The first three of these are handled analytically in the model through the empirical expression

$$F_i = \psi_j \cdot TF_{j-i}, \qquad (2\text{-}1)$$

*References designated by superscript numbers can be found in Section 8.

where;

F_i = flux at location i,

ψ_j = source function of j and

TF_{j-i} = transport function from j to i.

The above relationship for generalized sources can be applied to an overboard vent, an attitude control engine or an outgassing surface to predict the contaminant levels at any desired location (either at a point in free space or at a particular surface). Once the level of contamination has been established, existing computer programs and analytical techniques can be employed to determine the induced effects (item 4 above).

Referring to equation 2-1, the source function (ψ_j) is directly influenced by the type of source. If the source is concentrated into a confined area such as an engine or vent, flowrates and nozzle geometries are of prime importance. For diffuse or Lambertian surface sources, the thermal profiles, cure history and type of surface materials and leakage characteristics must be defined to evaluate their mass loss rates. The associated transport functions of equation 2-1 are strongly influenced by the spacecraft configuration which includes surface shadowing, source location and thrust direction of engines and vents, as well as items such as the collision frequency with structural surfaces or other molecules and the geometry of contaminant susceptible surfaces and instruments.

In the following subsections these influences and relationships and the methods and physics by which they are analytically simulated in the SPACE Program are described. Later sections of this manual will present in detail the program logic flow and the specific information required to initiate an on-orbit spacecraft contamination analysis.

2.1.1 Spacecraft Configurations

There are four configurations in the computer model that formulate the geometry for the model. These configurations are the Space Shuttle Orbiter and three Spacelab configurations. The Spacelab configurations are denoted as: 1) Long Module/One Pallet (LMOP); 2) Short Module/Three Pallet (SMTP) and 3) Five Pallet (FIVP). Any one of these can be evaluated separately or, at the user's option, the Shuttle Orbiter can be combined with a selected Spacelab configuration. These configurations have been geometrically synthesized

with the TRASYS II[3] Thermal Radiation Analysis Program utilizing basic geometrical surfaces and shapes (cones, cylinders, spheres, etc.). The level of detail employed was selected to assure accurate surface shadowing and to establish adequate surface resolution for compatibility with the different vehicle surface materials and available thermal profile data. The modeled SO/SL geometries are near duplicates of the actual configurations and in most cases are accurate to within a few inches. The standard NASA coordinate system and station numbers (X_O, Y_O and Z_O in terms of inches from the NASA origin) are utilized for all references to SO/SL surface and source locations in this manual. These are illustrated in Figure 2-1.

Appendix B contains the geometric breakdown and a listing of the data that was input to TRASYS to simulate the above configurations. These data can be modified to update the configuration and recompute the mass transport factor data blocks used by the contamination model provided the specially modified TRASYS model is available. These data blocks are discussed in subsection 2.5.2. Any equivalent thermal radiation program that computes viewfactors or shape factors could be used in place of TRASYS if the output is properly formatted. It is not necessary to run the TRASYS II program to exercise the SPACE Program because mass transport factor data for the SO/SL have been precalculated and form a portion of the SPACE Program. TRASYS operation is only necessary when new configurations are to be evaluated or existing configurations are to be modified.

Each major input surface has been assigned an identification number within the range of 1 to 7000. Identification numbers within the range of 7000 to 9999 have been reserved for concentrated sources such as engines or vents. The configurations currently available in the SPACE Program are discussed in the following subsections.

2.1.1.1 Shuttle Orbiter Modeled Configuration

The configuration of the Space Shuttle Orbiter shown pictorially in Figure 2-1 has been three-dimensionally synthesized in the on-orbit operational mode with the payload bay doors completely open and the wing elevons (trailing edge control surfaces) in their neutral positions. Surfaces representative of the payload bay liner have been included. Analysis has shown that the underside (-Z facing) Orbiter surfaces such as the fuselage and wing bottoms produce negligible contributions to the contaminant environment. Therefore, they have been deleted from the Orbiter model. By doing this, unnecessary additional complexity has been

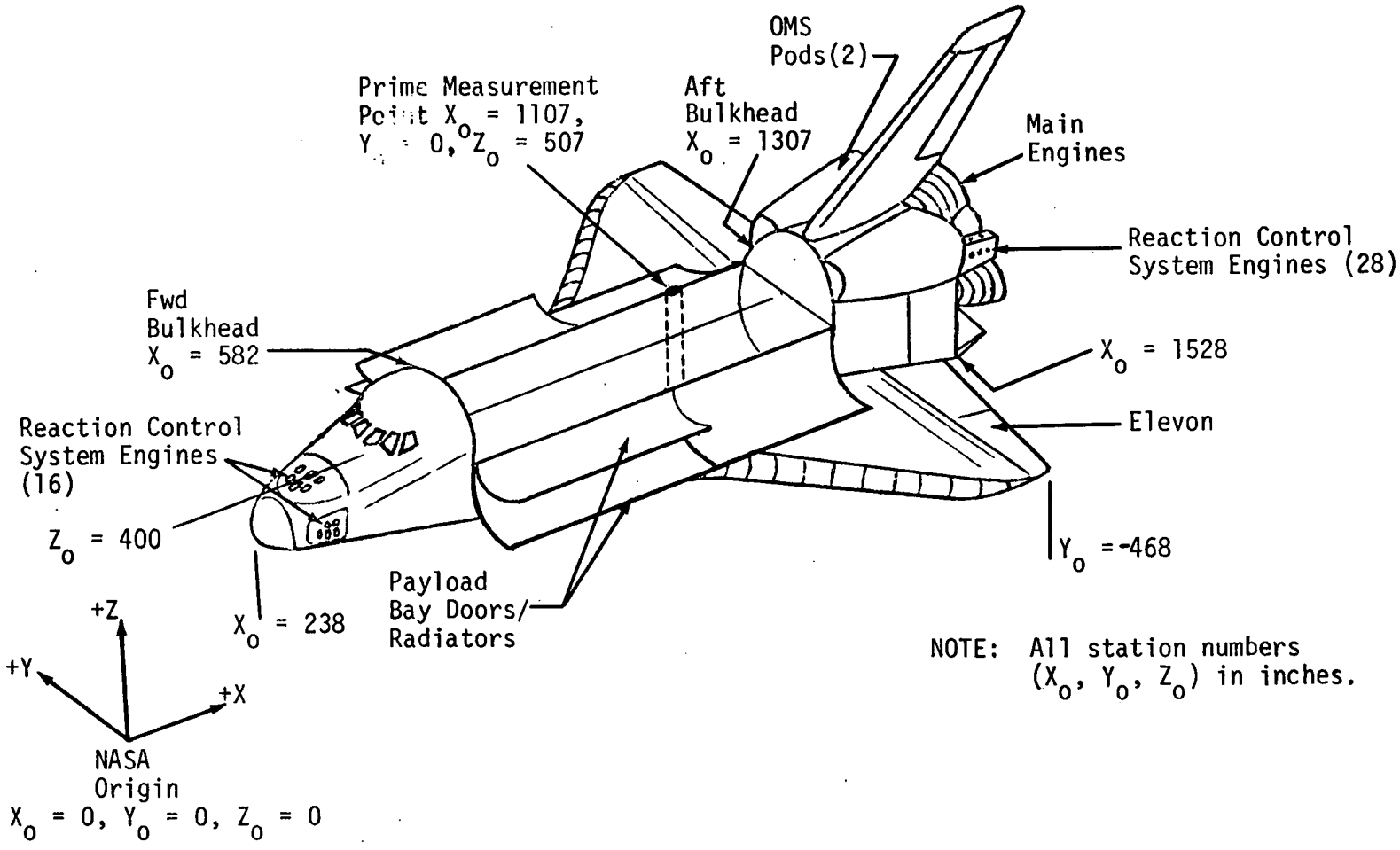


Figure 2-1. Modeled Shuttle Orbiter Configuration

eliminated without sacrificing model resolution. Point sources such as the Reaction Control System (RCS) engines and the flash evaporator vents have been geometrically synthesized as small discs representative of the nozzle exit planes perpendicular to their individual plume centerlines.

The Shuttle Orbiter is representated by a total of 106 major surfaces which have been further subdivided into 184 nodes for adequate resolution. The block of identification numbers reserved for the Orbiter ranges from 00001 to 00999. Figure 2-2 presents a TRASYS generated graphic display of the Shuttle Orbiter configuration along with the identification numbers assigned to each surface. The basic geometric shapes selected to construct the modeled Orbiter configuration are a function of not only the vehicle geometry but also the arrangement of external surface materials which are discussed in subsection 2.1.2. Figure 2-2 supplemented by the information contained in Appendix B will provide sufficient detail for the user to identify the modeled Orbiter input geometry.

2.1.1.2 Modeled Spacelab Configurations

There are three distinct Spacelab configurations addressable in the SPACE Program. These configurations denoted LMOP, SMTP and FIVP which are shown schematically in Figure 2-3 were selected because they are representative of the assorted potential module and pallet hardware combinations that will be utilized throughout the Spacelab Program. Graphical data utilized in establishing the necessary model input parameters was obtained from Reference 4. Table 2-I summarizes the major Spacelab modular components which comprise the three modeled configurations.

Table 2-I. Major Modeled Spacelab Components

CONFIGURATION / COMPONENT	LONG MODULE/ ONE PALLET (LMOP)	SHORT MODULE/ THREE PALLET (SMTP)	FIVE PALLET (FIVP)
TUNNEL	X	X	-
CORE SEGMENT	X	X	-
EXPERIMENT SEGMENT	X	-	-
THREE METER PALLETS	1	3	5
WINDOWS	3-(CORE, EXPT. & AFT VIEWING)	2-(CORE & AFT VIEWING)	-
CONDENSATE VENT	X	X	-
AFT AIRLOCK	X	X	-

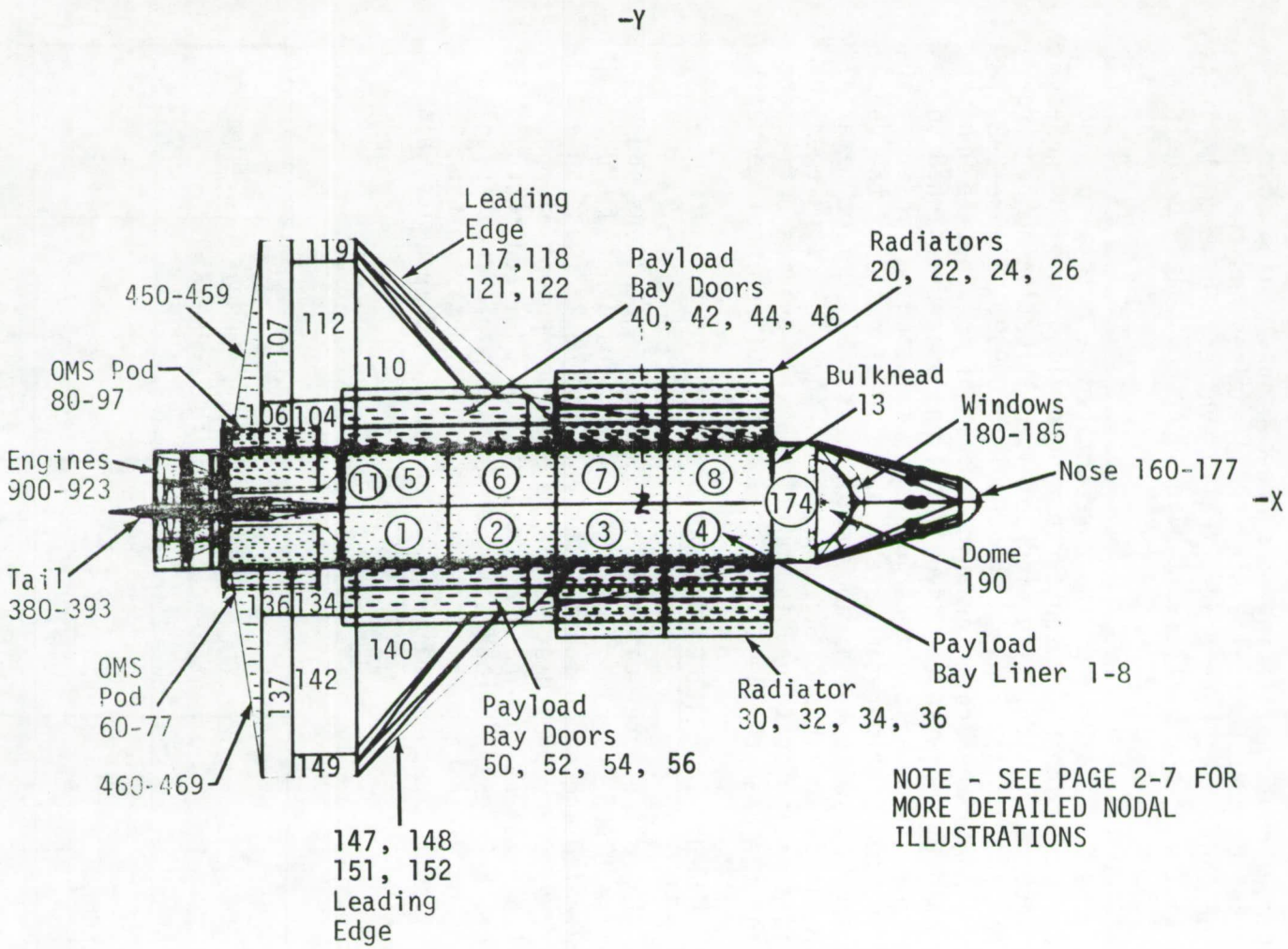


Figure 2-2. Primary Shuttle Orbiter Nodal Surface Number Assignments

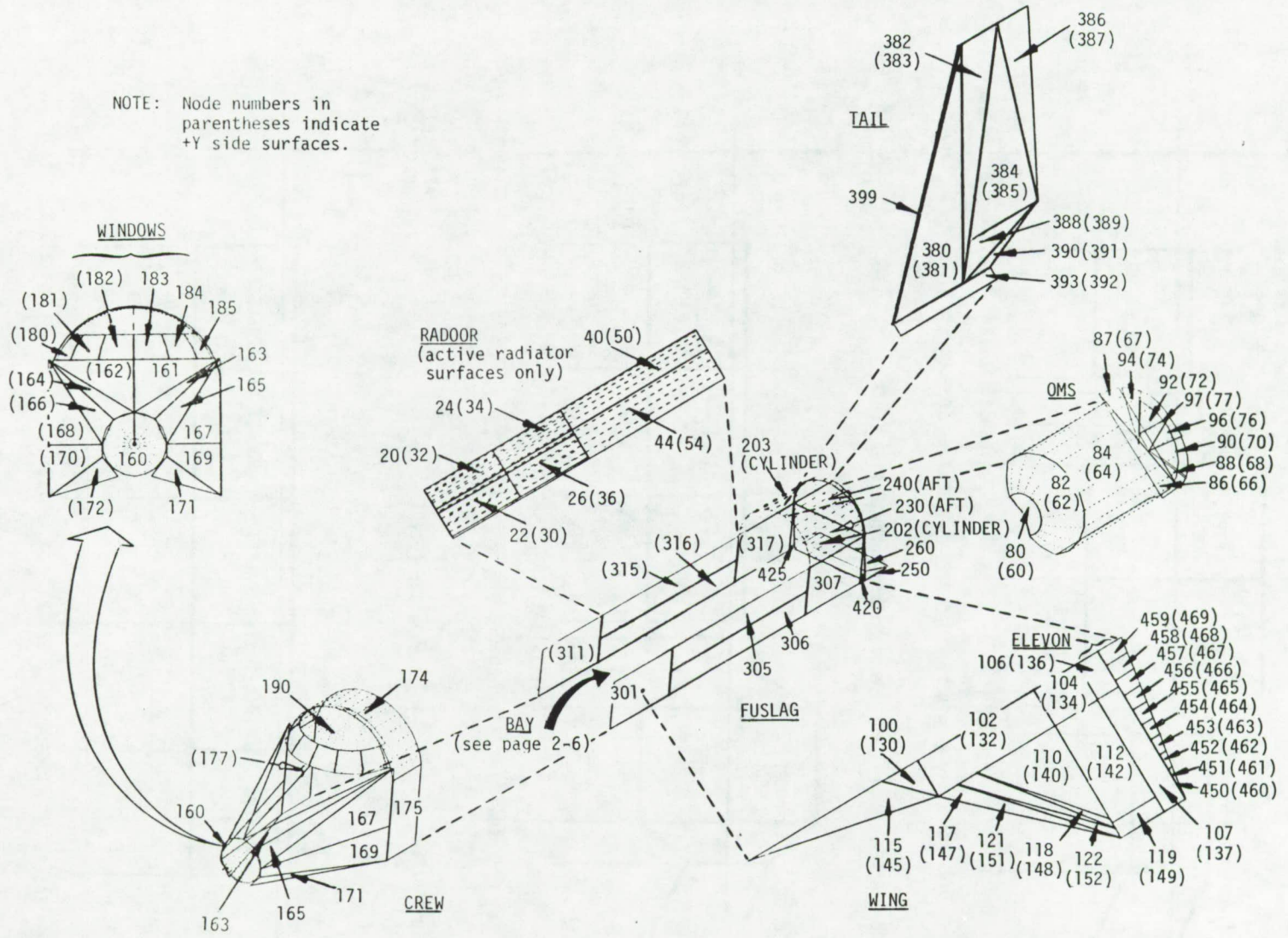


Figure 2-2. Primary Shuttle Orbiter Nodal Surface Number Assignments (cont'd)

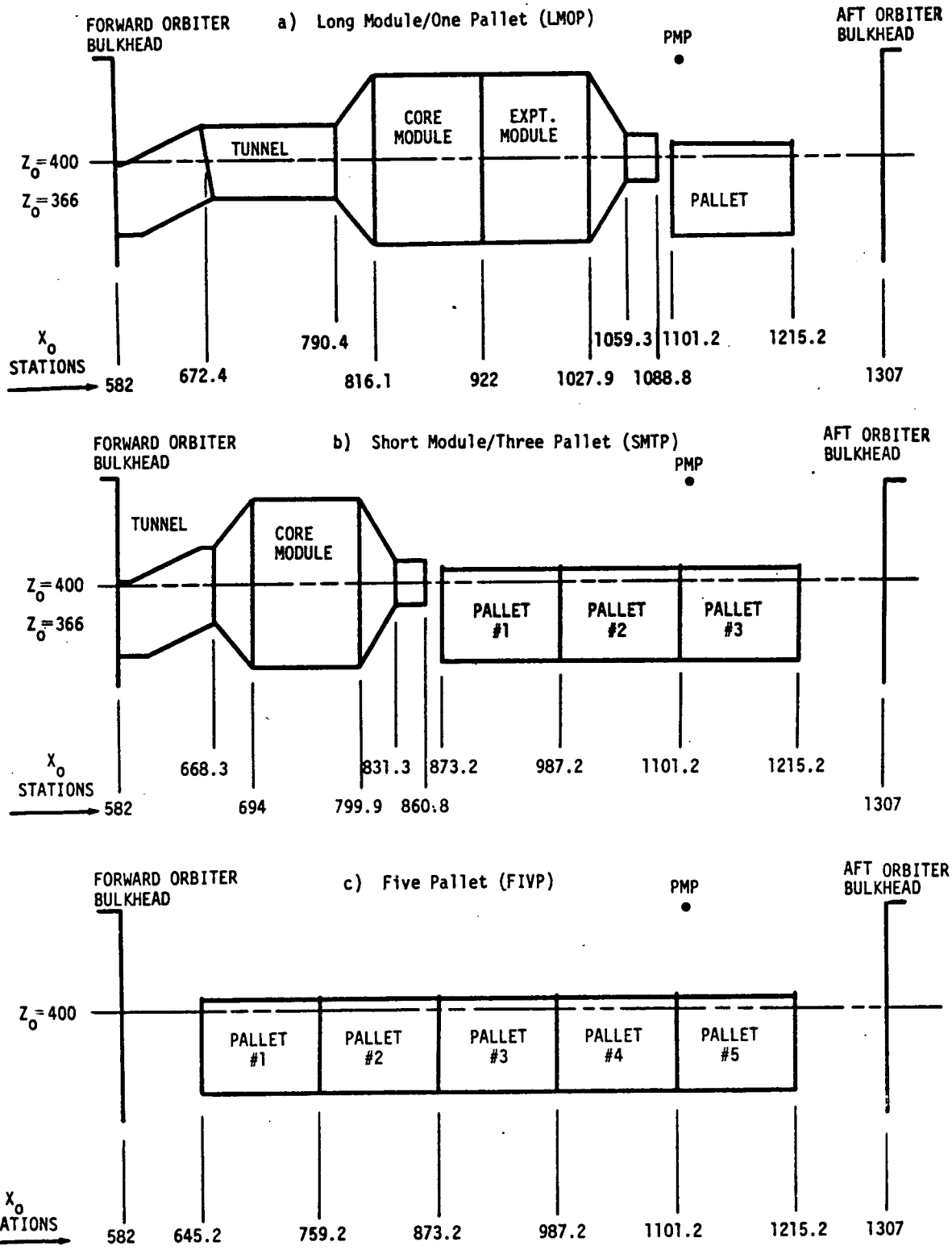


Figure 2-3. Schematic Drawings of the Modeled Spacelab Configurations

In order to maintain consistency between the three modeled configurations, their spacing and arrangements were established within the Orbiter payload bay envelope between X_0 = 582.0 and X_0 = 1215.2, as depicted in Figure 2-3. It is realized that hardware locations within the bay will vary depending upon center-of-gravity considerations, etc. but the envelope utilized establishes a consistent base and allows adequate volume between X_0 = 1215.2 and X_0 = 1307 for auxiliary Orbital Maneuvering System (OMS) propellant tanks required for certain Spacelab missions. The payload bay surfaces (representative of the Orbiter payload bay liner) are duplicated in each Spacelab configuration for surface shadowing characteristics. Therefore, when an integrated Spacelab/Orbiter configuration is being evaluated, the attached Spacelab liner surfaces mask or replace those in the Orbiter segment thus providing proper payload bay liner surface viewing/source relationships. When evaluating a Spacelab configuration detached from the Orbiter (i.e.; for Spacelab design and development studies), the payload bay liner surfaces are included for surface shadowing characteristics only and are not considered as active contaminant sources in the model predictions.

Table 2-II presents a summary of the surface number designators assigned to the three modeled Spacelab configurations. Reference should be made to Appendix B for specific surface input data to TRASYS and detailed location information. Major Spacelab nodal locations are mapped utilizing TRASYS generated graphic displays in Figures 2-4 through 2-6. Here, as with the Orbiter, the geometrical relationship block data for these configurations has been pregenerated (see subsection 2.5.2) and is addressable by the appropriate model subroutines.

Table 2-II. Spacelab Nodel Information

CONFIGURATION / PARAMETER	LMOP	SMTP	FIVP
RESERVED NODE NUMBER RANGE	01000 -01999	02000 -02999	03000 -03999
NUMBER OF SURFACES	33	48	55
NUMBER OF NODES	69	91	82

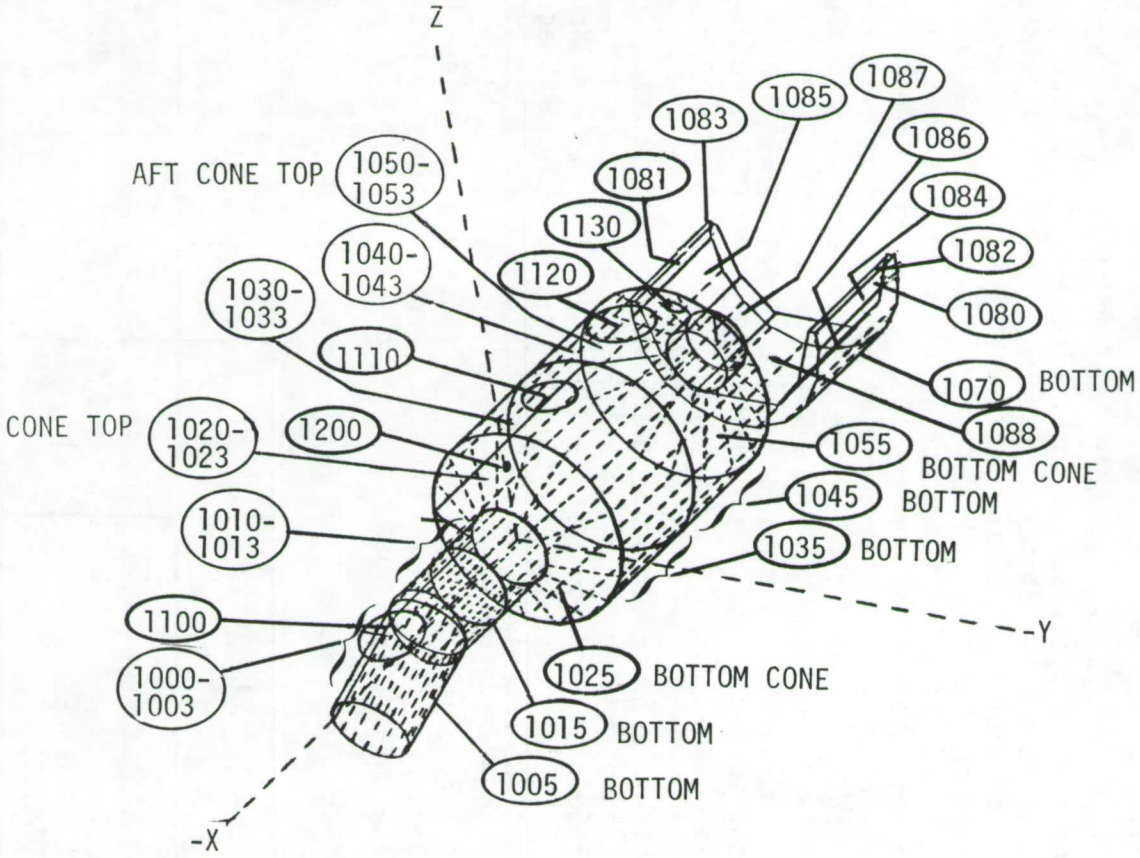


Figure 2-4. Primary LMOP Nodal Surface Number Assignments

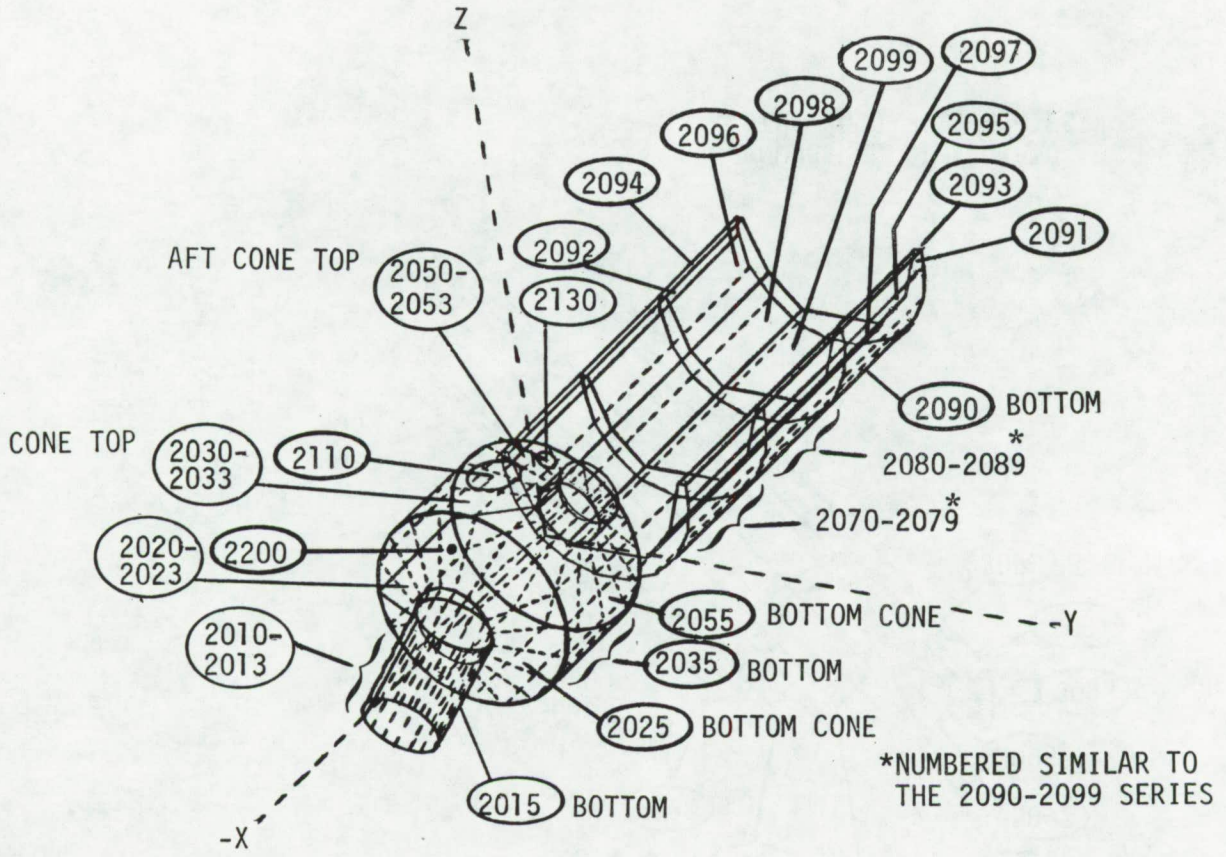


Figure 2-5. Primary SMTP Nodal Surface Number Assignments

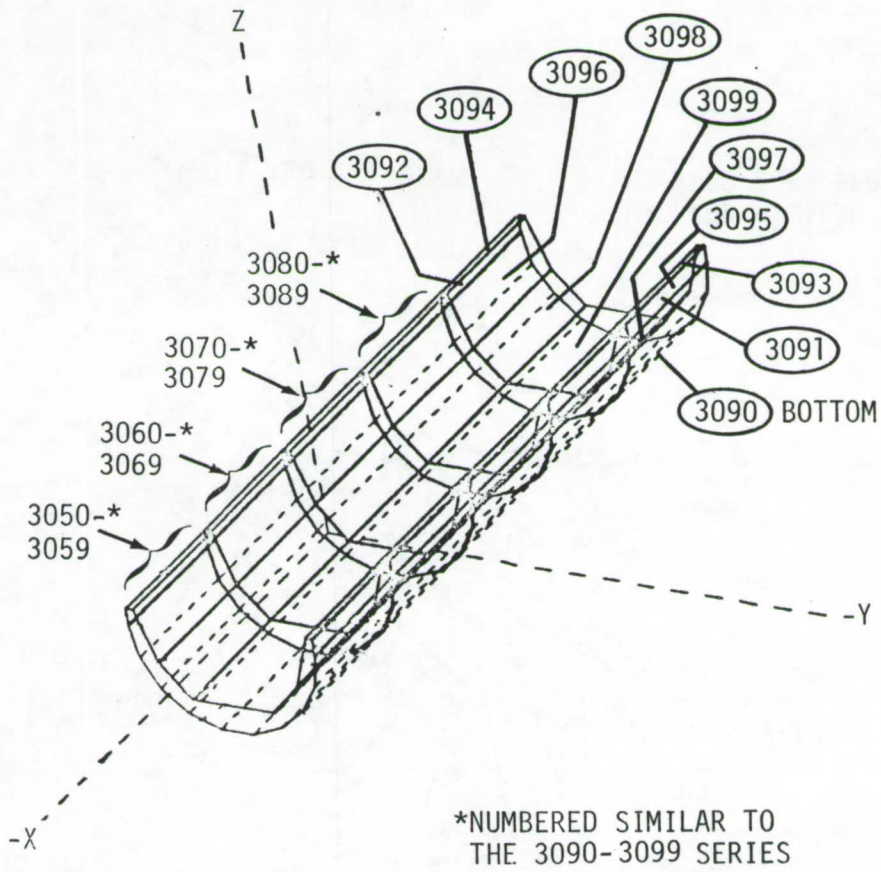


Figure 2-6. Primary FIVP Nodal Surface Number Assignments

2.1.1.3 Generalized Configurations

The model has the capability of analyzing configurations other than the four presented above. (This capability is beyond the scope of the current contract requirements and consequently has not been completely checked out.) In general, this procedure involves developing the necessary geometric relationships and mass transport factors for the particular configuration being analyzed. This can be accomplished analytically (see Appendix A) for simple configurations, but in most cases that approach can become tedious and cumbersome. A thermal radiation program such as TRASYS[3] is far more efficient for generating new mass transport factor input data for SPACE. User generated data must conform to the format presented in subsection 2.5.2. Through selection of the proper contamination model input options, a generalized spacecraft or laboratory configuration can then be evaluated. For more details see subsection 3.1.6.

2.1.2 Contaminant Sources and Source Functions

This subsection presents a summary of the SO/SL contaminant sources addressable in the model. There are two basic types of contaminant sources programmed into the model: 1) distributed sources which would include nonmetallic materials outgassing; early desorption from external surfaces; and leakage of cabin atmosphere; 2) concentrated sources which include the Orbiter 25 lb. vernier thrusters; the Orbiter 870 lb. Reaction Control System (RCS) thrusters; and the Orbiter evaporator vents.† For surface sources the mass loss rate is primarily dependent upon the type of material, its temperatures and its previous temperature history under vacuum exposure. Engine, vent and leakage source rates are functions of the spacecraft design and mission/operational timeline.

The mathematical models used to define each of these sources are summarized on the following data sheets (Tables 2-III through 2-VIII). These expressions are based upon current information, although, as additional test data become available, they can be easily modified by the user through input data (see subsection 3.2.3). Included in the data sheets are source descriptions, emission rates, constituent information, emission velocities and source duration/frequency.

Appendix A furnishes additional explanation of the mathematical characterization of each source. In a typical model run, the values presented in the data sheets will be employed automatically for each source unless the user provides override information. Currently 10 chemical species are considered - H_2O, N_2, CO_2, O_2, CO,

†The Spacelab condensate vent has been geometrically modeled, however, ψ_j is unknown. When determined, it can easily be added to the SPACE Program.

9/77

Table 2-III. Sources Data Sheet - Outgassing

SOURCE - External Nonmetallic Materials Outgassing

DESCRIPTIVE SUMMARY - Outgassing is the long term bulk mass loss of nonmetallic materials when exposed to the vacuum environment of space. Locations of all major Orbiter/ Spacelab nonmetallic materials are presented in Figure 2-7.

SOURCE EMISSION RATE [$MLR_{k,m}$ (T,t) = outgassing rate of material k and species m as f (temp. (^{o}C) and time (hrs)].

Basic Equation

$$MLR_{k,m}(T,t) = RATE_{k,m}\, e^{-t/TAU_{k,m}}\, e^{(T_j-100)/29},\ g/cm^2/s \quad [\text{see Appendix A}]$$

Material, k	Total Area (cm^2)	$Rate_{k,m}$ = Initial MLR @ 100°C ($g/cm^2/s$)	$TAU_{k,m}$ = Decay Constant (hrs)	T_j = Surface Temperature (^{o}C)
Orbiter				
Nomex	3.04E06	1.24E-09[5]	4100	Permanent File Input (see subsection 2.5.1)
RCC	3.80E05	1.00E-12*	4100	
HRSI	4.75E06	5.20E-10[6]	4100	
LRSI	2.82E06	5.10E-10[6]	4100	
Teflon	1.31E06	5.00E-10*	4100	
Liner	1.31E06	7.90E-10*	4100	
Bulkhead	3.28E05	1.00E-09*	4100	

*Estimates based upon previous tests of similar materials.

Table 2-III. Sources Data Sheet - Outgassing (cont'd)

Material	Total Area (cm^2)	$Rate_{k,m}$ = Initial MLR @ 100°C ($g/cm^2/s$)	$TAU_{k,m}$ = Decay Constant (hrs)	T_j = Surface Temperature (°C) Permanent File Input (see sub-section 2.5.1)
Spacelab (All Configurations)				
MODULE (MTCS)	1.25E06 Long	6.00E-09[1]	4100	
	7.84E05 Short	6.00E-09[1]	4100	
Pallet (PTCS)	1.16E05 Per Pallet	6.00E-09[1]	4100	

EMISSION PATTERN

cos θ/r^2 (Lambertian) $\longrightarrow \psi = MLR_{k,m}(T,t) \cdot VF_{i-j}$, $g/cm^2/s$

CONSTITUENTS

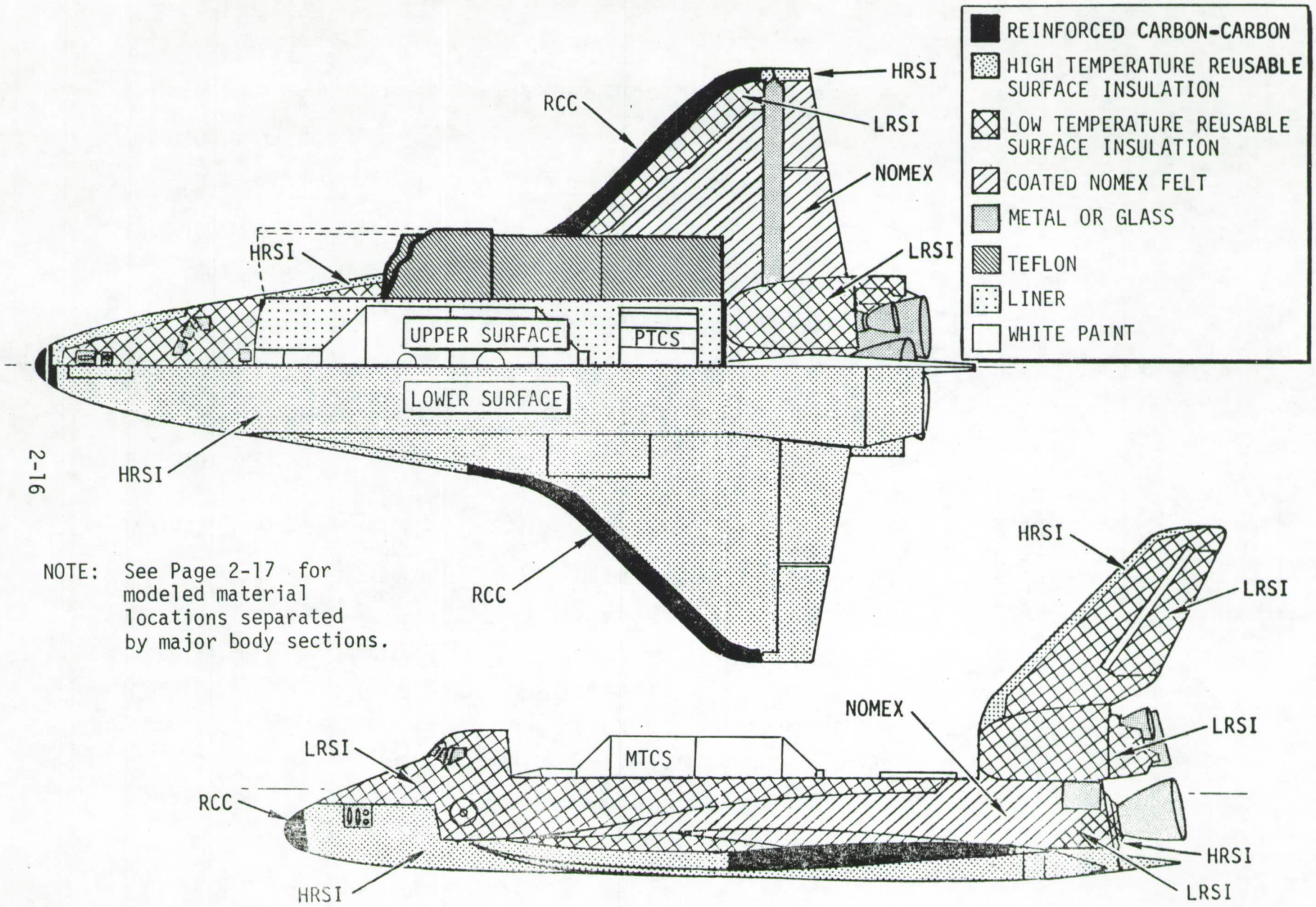
Specie, m	Mole Fraction	Molecular Weight (M)	Diameter (δ_m in cm)
Long Chain Polymers	1.00	100	9.967E-8

EMISSION VELOCITIES (V_m)

$V_m = 129\sqrt{T/M}$ m/s (T in °K = f (orbital attitude))

DURATION/FREQUENCY

Continuous on-orbit vacuum exposure time.



NOTE: See Page 2-17 for modeled material locations separated by major body sections.

Figure 2-7. External Nonmetallic Material Locations

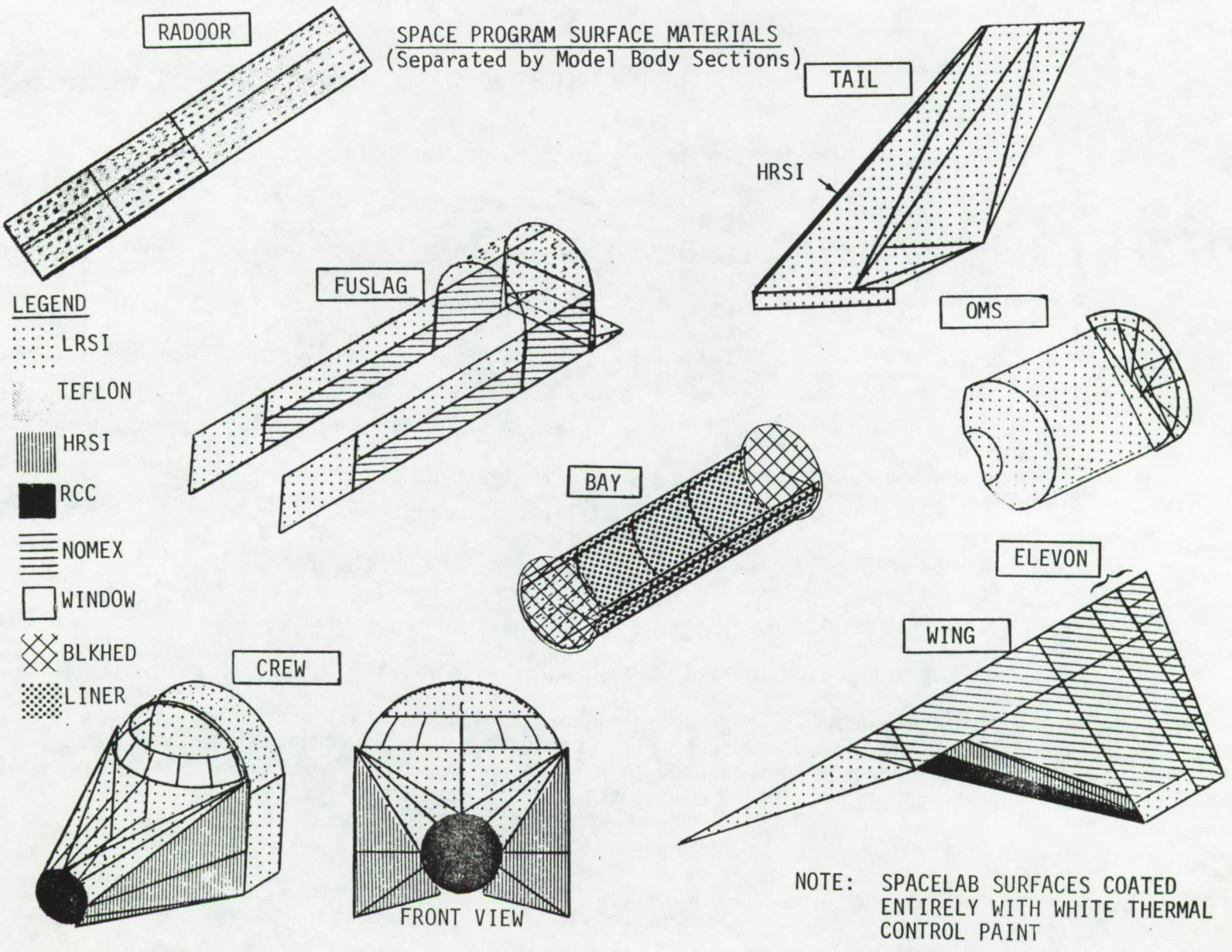


Figure 2-7. External Nonmetallic Material Locations (cont'd)

Table 2-IV. Sources Data Sheet - Early Desorption

SOURCE - External Surface Materials Early Desorption

DESCRIPTIVE SUMMARY - Early desorption is the short term rapidly decaying mass loss of external surfaces resulting from desorption of adsorbed and absorbed gases, volatiles and liquids upon exposure to space vacuum. Its combination with outgassing constitutes the total mass loss for a surface. Refer to Figure 2-7 for material locations.

SOURCE EMISSION RATE [$MLR_{k,m}$ (T,t) = Early Desorption Rate of material k and specie m as f (temp. (^{o}K) and time (hrs)].

Basic Equation

$$MLR_{k,m}(T,t) = RATE_{k,m} e^{-t/TAU_{k,m}} e^{\frac{E}{R}\left(\frac{1}{373} - \frac{1}{T_j}\right)}, \ g/cm^2/s \quad \text{[see Appendix A]}$$

Material, k	Total Area (cm^2)	$MLR_{k,m}$ = Initial MLR @ 100°C ($g/cm^2/s$)	$TAU_{k,m}$ = Decay Constant (hrs)	T_j = Surface Temperature (^{o}K)
Orbiter				
Nomex	3.04E06	1.24E-08[5]	18	Permanent File Input (see subsection 2.5.1)
RCC	3.80E05	1.00E-11*	18	
HRSI	4.75E06	5.20E-09[6]	18	
LRSI	2.82E06	5.10E-09[6]	18	
Teflon	1.31E06	5.00E-09*	18	
Liner	1.31E06	7.90E-10*	18	
Bulkhead	3.28E05	1.00E-08*	18	

*Estimates based upon previous tests of similar materials.

Table 2-IV. Sources Data Sheet - Early Desorption (cont'd)

Material	Total Area (cm^2)	$MLR_{k,m}$ = Initial MLR @ 100°C ($g/cm^2/s$)	$TAU_{k,m}$ = Decay Constant (hrs)	T_j = Surface Temperature (°K)
Spacelab (All Configurations)				Permanent File Input (see subsection 2.5.1)
Module (MTCS) Long	1.25E06	3.90E-07[1]	18	
Module (MTCS) Short	7.84E05	3.90E-07[1]	18	
Pallet (PTCS)	1.16E05 Per Pallet	3.90E-07[1]	18	

EMISSION PATTERN

$\cos \theta / r^2$ (Lambertian) $\longrightarrow$ $\psi = MLR_{k,m}(T,t) \cdot VF_{i-j}$, $g/cm^2/s$

CONSTITUENTS

Specie, m	Mole Fraction	Molecular Weight (M)	Diameter (δ_m in cm)	Activation Energy (E in Kcal/mole)
H_2O	0.57	18	3.245E-08	7.5 (Assumed for all species.)
N_2	0.23	28	4.132E-08	
CO_2	0.12	44	4.485E-08	
O_2	0.08	32	3.853E-08	

EMISSION VELOCITIES (V_m)

$V_m = 129 \sqrt{T/M}$, m/s (T in °K = f (orbital attitude)).

DURATION/FREQUENCY

Continuous for up to 100 hours of on-orbit vacuum exposure time.

Table 2-V. Sources Data Sheet - Leakage

SOURCE - Atmospheric Leakage from Pressurized Cabin Volumes

DESCRIPTIVE SUMMARY - Leakage constitutes the loss of atmospheric gases through seals and microscopic cracks in pressurized spacecraft modules. Orbiter leakage locations are considered concentrated at the forward payload bay bulkhead (Figure 2-1) and Spacelab leakage is confined to the (+Z) 1/2 of the module and tunnel sections (Figure 2-3). The maximum allowable specification leak rate for each volume[4,7] is assumed to be uniformly distributed over its corresponding external surface.

SOURCE EMISSION RATE (MLR)

Configuration	Area (A in cm^2)	Surface(s)	MLR (g/day)
Orbiter	2.11E+05	Fwd. Bulkhead	3180
LMOP	6.25E+05	Module/Tunnel	1350
SMTP	3.92E+05	Module/Tunnel	1350
FIVP	0	N/A	0

EMISSION PATTERN

$\cos \theta / r^2$ (Lambertian) $\longrightarrow \psi = MLR_{k,m} \cdot VF$

CONSTITUENTS

Specie	Mole Fraction	Molecular Weight (M)	Diameter (δ_m in cm)
H_2O	0.016	18	3.245E-08
N_2	0.758	28	4.132E-08
CO_2	0.007	44	4.485E-08
O_2	0.219	32	3.853E-08

EMISSION VELOCITIES (V_m)

$V_m = 129 \sqrt{T/M}$, m/s (T = ambient (297^oK)).

DURATION/FREQUENCY

Continuous at constant rate.

Table 2-VI. Sources Data Sheet - 25 lb RCS Engines

SOURCE - Orbiter 25 lb Thrust RCS Vernier Engines

DESCRIPTIVE SUMMARY - The Orbiter vernier thruster system consists of six MMH/N_2O_4 hypergolic engines. (ISP = 228 s, O/F = 1/6). Combustion effluents are emitted to space symmetrically around each engine centerline. The steady-state plume flowfield was computed with the method of characteristics subprogram within CONTAM II[12] The results for the gaseous flowfield are summarized accurately by a closed-form source flow model such as that devised by Simons[8]. The generalized closed-form model used in the program requires 9 coefficients defined below. The VCS engines, their firing directions and Orbiter station numbers are described in the table below and illustrated in Figure 2-8.

Engine No.	Location/ Firing Direction	Exit Plane Station Numbers X_o	Y_o	Z_o	Orbiter Wing Impingement
8116	FLD-Z*	324	- 46	374	No
8136	FRD-Z	324	46	374	No
8257	ALD-Z	1565	-144	459	Yes
8258	ALS+Y	1565	-118	457	Yes
8357	ARD-Z	1565	144	459	Yes
8358	ARS+Y	1565	-118	457	Yes

SOURCE EMISSION RATE ($\dot{m}$)

$\dot{m}$ = 40.8 g/s/engine

EMISSION PATTERN (r in cm, θ in degrees off $\mathcal{L}$)[8,9]

$$\psi_1 = \frac{23.2}{r^2}\left[\cos\left(.0137\ \theta\right)\right]^{8.65},\ g/cm^2/s \qquad \left[0 \leq \theta < 40^o\right]$$

$$\psi_2 = \frac{5.81}{r^2}\ e^{-0.0467\ (\theta - 40^o)},\ g/cm^2/s \qquad \left[40^o \leq \theta \leq 140^o\right]$$

$$\psi_3 = \frac{5.81}{r^2}\ e^{-4.67} = \frac{.054}{r^2},\ g/cm^2/s \qquad \left[140^o < \theta \leq 180^o\right]$$

*F = Forward; A = Aft; R = Right; L = Left; S = Side ($\pm$Y) Firing; D = Downward (-Z) Firing

Table 2-VI. Sources Data Sheet - 25 lb RCS Engines (cont'd)

EMISSION PATTERN PLUME COEFFICIENTS (PLUMEC (L,2) subsection 3.2.3)

PLUMEC(1,2)	= 23.2	PLUMEC(6,2)	= -0.0467
PLUMEC(2,2)	= 8.65	PLUMEC(7,2)	= 140.0
PLUMEC(3,2)	= 0.0137	PLUMEC(8,2)	= 0.054
PLUMEC(4,2)	= 40.0	PLUMEC(9,2)	= 3505.0
PLUMEC(5,2)	= 5.81		

PLUME TYPE

LTYPE = 2
NPLUME(2) = VCS

CONSTITUENTS

Major Specie	Mole Fraction	Molecular Weight	Diameter (δ_m in cm)
H_2O	0.328	18	3.245E-08
N_2	0.306	28	4.132E-08
CO_2	0.036	44	4.485E-08
O_2	0.0004	32	3.853E-08
CO	0.134	28	4.029E-08
H_2	0.17	2	3.331E-08
H	0.015	1	2.640E-08
$MMH\text{-}NO_3$	0.002	46	4.500E-08

EMISSION VELOCITY (V_m)

V_m = 3505 m/s

DURATION/FREQUENCY - Operates as required in 40 millisecond pulses at 12.5 Hz maximum frequency (i.e.; one of six engines on 49.9% of time at 110 kg/orbit system consumption). The time an engine is actually thrusting during the time interval being analysed must be input as ONTIME (K) in seconds (see subsection 3.2.1).

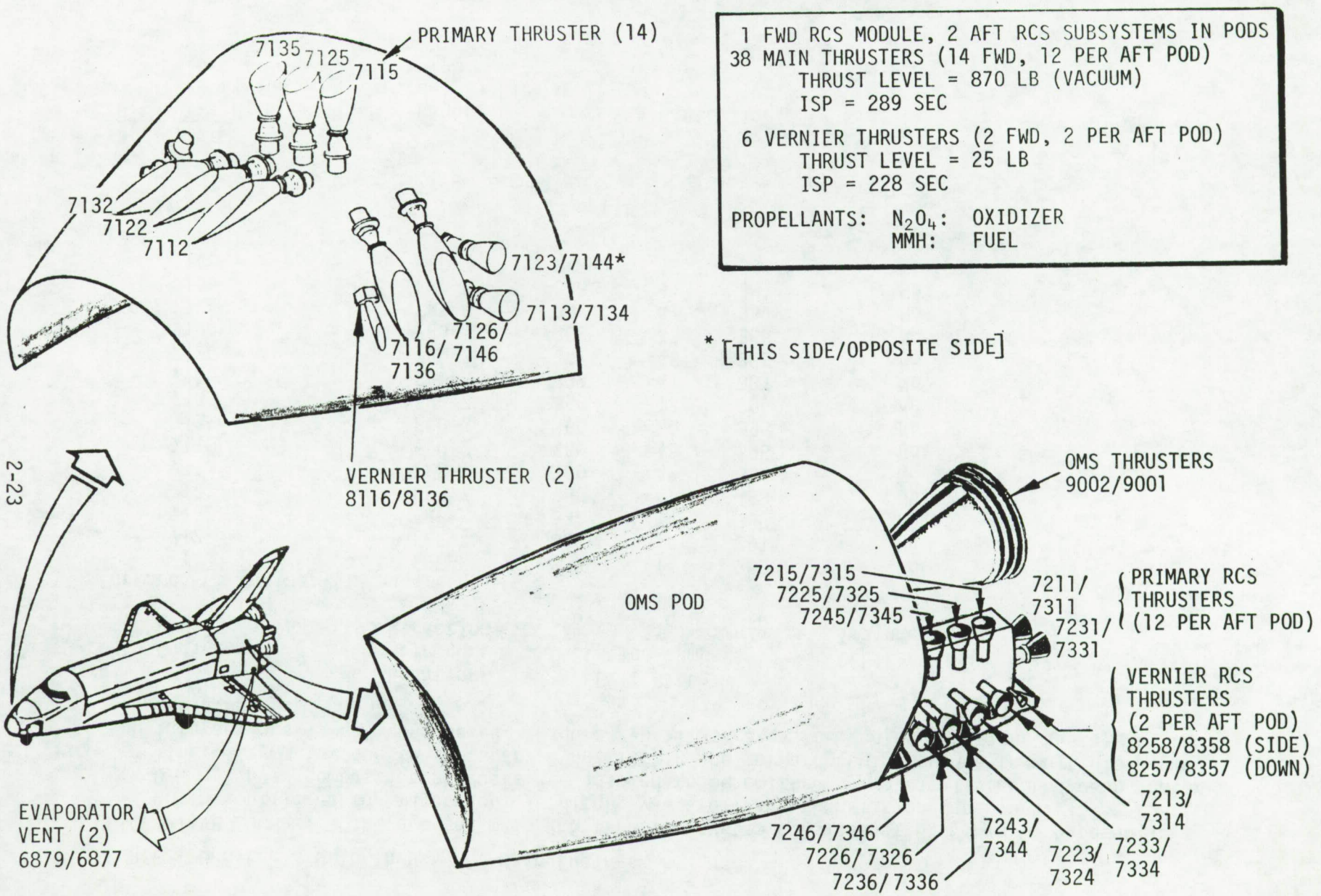


Figure 2-8. Orbiter Engine/Vent Locations and Identification Numbers

Table 2-VII. Sources Data Sheet - 870 lb RCS Engines

SOURCE - Orbiter 870 lb Thrust RCS Main Engines

DESCRIPTIVE SUMMARY - The Orbiter main RCS thruster system consists of 38 MMH/N_2O_4 hypergolic engines utilized for major vehicle pitch, yaw, roll and translation maneuvers (ISP = 289 s, O/F = 1.6). Combustion products are assumed to be emitted symmetrically around each centerline. Asymmetry due to the scarfed nozzles in the forward region or due to multiple plume interactions is not considered. Figure 2-8 illustrates the engine locations listed in the table below.

Engine No.	Location/ Firing Direction	Exit Plane Station Numbers X_o	Y_o	Z_o	Orbiter Wing Impingement
Forward RCS Engines					
7112	FLF-X*	332	-14	389	No
7122	FCF-X	332	0	391	No
7132	FRF-X	332	14	389	No
7123	FLS+Y	360	-47	368	No
7113	FLS+Y	360	-47	354	No
7115	FLU+Z	350	-13	395	No
7125	FCU+Z	350	0	395	No
7135	FRU+Z	350	13	395	No
7116	FLD-Z	333	-41	381	No
7126	FLD-Z	347	-45	386	No
7144	FRS-Y	362	47	368	No
7134	FRS-Y	362	47	354	No
7136	FRD-Z	333	41	381	No
7146	FRD-Z	347	45	386	No

*F = Forward; A = Aft; R = Right; L = Left; C = Centerline; S = Side (±Y) Firing, D = Downward (-Z) Firing; U = Upward (+Z) Firing

Table 2-VII. Sources Data Sheet - 870 lb RCS Engines (cont'd)

Engine No.	Location/ Firing Direction	Exit Plane Station Numbers X_o	Y_o	Z_o	Orbiter Wing Impingement
Aft RCS Engines Left Side of Orbiter					
7211	ALA+X	1557	-119	473	No
7231	ALA+X	1557	-132	473	No
7243	ALS+Y	1516	-123	459	Yes
7223	ALS+Y	1529	-123	459	Yes
7233	ALS+Y	1542	-122	459	Yes
7213	ALS+Y	1555	-122	459	Yes
7245	ALU+Z	1516	-132	481	No
7225	ALU+Z	1529	-132	481	No
7215	ALU+Z	1542	-132	481	No
7246	ALD-Z	1516	-112	437	Yes
7226	ALD-Z	1529	-111	440	Yes
7236	ALD-Z	1542	-110	443	Yes
Aft RCS Engines Right Side of Orbiter					
7311	ARA+X	1557	119	473	No
7331	ARA+X	1557	132	473	No
7344	ARS-Y	1516	123	459	Yes
7324	ARS-Y	1529	123	459	Yes
7334	ARS-Y	1542	123	459	Yes
7314	ARS-Y	1555	123	459	Yes
7345	ARU+Z	1516	132	481	No
7325	ARU+Z	1529	132	481	No
7315	ARU+Z	1542	132	481	No
7346	ARD-Z	1516	112	437	Yes
7326	ARD-Z	1529	111	440	Yes
7336	ARD-Z	1542	110	443	Yes

EMISSION RATE ($\dot{m}$)

$\dot{m}$ = 1419.8 g/s/engine

Table 2-VII. Sources Data Sheet - 870 lb RCS Engines (cont'd)

EMISSION PATTERN (r in cm, θ in degrees off ℄)[8,9]

$$\psi_1 = \frac{1351.0}{r^2} [\cos (.0126\ \theta)]^{10},\ g/cm^2/s \qquad [0 \leq \theta < 64^o]$$

$$\psi_2 = \frac{35.0}{r^2} e^{-0.035\ (\theta - 64^o)},\ g/cm^2/s \qquad [64^o \leq 0 \leq 180^o]$$

EMISSION PATTERN PLUME COEFFICIENTS (PLUMEC (L,1) subsection 3.2.3)

PLUMEC(1,1)	= 1351.0	PLUMEC(6,1)	= -0.0350
PLUMEC(2,1)	= 10.0	PLUMEC(7,1)	= 180.0
PLUMEC(3,1)	= 0.0126	PLUMEC(8,1)	= 0.0
PLUMEC(4,1)	= 64.0	PLUMEC(9,1)	= 3505.0
PLUMEC(5,1)	= 35.0		

PLUME TYPE

LTYPE = 1
NPLUME(1) = RCS

CONSTITUENTS

Major Specie	Mole Fraction	Molecular Weight	Diameter (δ_m in cm)
H_2O	0.328	18	3.245E-08
N_2	0.306	28	4.132E-08
CO_2	0.036	44	4.485E-08
O_2	0.0004	32	3.853E-08
CO	0.134	28	4.029E-08
H_2	0.17	2	3.331E-08
H	0.015	1	2.640E-08
$MMH\text{-}NO_3$	0.002	46	4.500E-08

EMISSION VELOCITY (V_m)

V_m = 3694.2 m/s

DURATION/FREQUENCY - Operates on an as required basis with pulsing or steady-state burns from 40 milliseconds to 150 seconds. The total time an engine is actually thrusting during the time interval being analyzed must be input as ONTIME(K) in seconds (see subsection 3.2.1).

Table 2-VIII. Sources Data Sheet - Evaporator

SOURCE - Orbiter Supplemental Evaporator Vent (Sonic)

DESCRIPTIVE SUMMARY - The Orbiter evaporator vent system expells excess fuel cell generated water directly to space in vaporous form through two nonpropulsive vents located at X_o = 1505.6, Y_o = ±127.1 (mold line) and Z_o = 305 (see Figure 2-8). Evaporator vent plume centerlines are parallel to the ± Y axis, and portions of the emitted effluents impinge directly on the upper surfaces of the Orbiter wings.

Evaporator No.	Location/ Flow Direction	Exit Plane Station Numbers X_o	Y_o	Z_o	Orbiter Wing Impingement
6877	ARS+Y*	1506	127	305	Yes
6879	ALS-Y	1506	-127	305	Yes

SOURCE EMISSION RATE ($\dot{m}$)

$\dot{m}$ = 13.6 kg/hr Total Nominal Average (2 vents)
$\dot{m}$ = 31.7 kg/hr Total Maximum Instantaneous (2 vents)

EMISSION PATTERN (r in cm, θ in degrees off ℄)[10]

$$\psi_1 = \frac{1.963}{r^2} \cos\left[(.0106\ \theta)\right]^6, \text{ g/cm}^2\text{/s} \qquad \left[0^o \leq \theta \leq 148^o\right]$$

EMISSION PATTERN PLUME COEFFICIENTS (PLUMEC (L, 5) subsection 3.2.3)

PLUMEC(1,5) = 1.963
PLUMEC(2,5) = 6.0
PLUMEC(3,5) = 0.0106
PLUMEC(4,5) =148.0
PLUMEC(5,5) = 0.0
PLUMEC(6,5) = 0.0
PLUMEC(7,5) = 148.0
PLUMEC(8,5) = 0.0
PLUMEC(9,5) =1000.0

PLUME TYPE

LTYPE = 5
NPLUME(5) = EVAP1

*ARS = Aft Right Side Firing, ALS = Aft Left Side Firing

Table 2-VIII. Sources Data Sheet - Evaporator (cont'd)

CONSTITUENTS

Specie	Mole Fraction	Molecular Weight	Diameter (δ_m in cm)
H_2O	1.0	18	3.245E-08

EMISSION VELOCITY (V_m)

V_m = 1012 m/s

DURATION/FREQUENCY - Operates in 100 millisecond pulses with a design goal nominal frequency of 4.3 Hz. Model currently considers instantaneous flow for 0.43 s ONTIME (subsection 3.2.1). If longer time intervals are to be evaluated, ONTIME = 0.43 s times the total system operation time.

H_2 (the predominant species during the early desorption period) plus two outgassing large molecular weight species and two additional species (H and MMH nitrate) unique to the RCS engines. (The number of species can be extended at a later date if found necessary.) Each surface can be assigned individual time dependent mass loss rates for each of the 10 species. This feature leads the available experimental data, however, recent test information from NASA-JSC on proposed Orbiter materials indicates that such a feature is required to correlate the mass loss rates of surfaces that have undergone different time/temperature cycling.

Outgassing from nonmetallic surfaces decreases with accumulated time on-orbit because the reservoir of available material is depleted. To account for this phenomenon, the user can input the age of the Orbiter (AGE ORB) or Spacelab (AGE SLB) in hours. If both the Orbiter and Spacelab vehicles are in a "first-launch" condition, no special input is required. However, if one or both vehicles have been on-orbit during previous missions, the appropriate time on-orbit for each should be defined as described in subsection 3.2.3.

An important relationship for modeling and evaluating each contaminant source is its specific source function (ψ_j). This expression describes the physics and the unabstructed emission patterns of the released contaminants. The source function can be interpreted as solely the mass emission rate from a particular source ($\dot{m}_j$). However, the unique characteristics of each source influence the ultimate mass distribution of contaminants as they are emitted from that source. Therefore, for a single source

$$\psi_j = \dot{m}_j \Gamma_j, \tag{2-2}$$

where Γ_j is the source distribution function.

Outgassing/early desorption are generally considered Lambertian or diffuse in nature, therefore, the mass transport analog to black body radiation can be employed to establish the mass transport factors (often referred to as "viewfactors", "form factors" or "shape factors"). The TRASYS II thermal radiation analysis program is used at MMA to generate the viewfactors (VF_{j-i}) for complex geometric configurations. In contrast, the transport of mass from concentrated sources such as engines or vents does not in general create a Lambertian or cosine distribution in space. Continuum flow gas dynamic models such as VOFMOC[11] or CONTAM II[12] are used to define the distribution of exhaust species. These predictions, together with test data from Chirivella[9] and Brook[13] are then

correlated with the closed form far-field plume model devised by Simons[8]. TRASYS II was also utilized to locate each surface relative to the plume centerline, in terms of distance r and angle θ.

2.1.3 Contaminant Transport Functions

The contaminant transport functions which are currently addressable in the model include: 1) direct line transport from a source to a receiving surface or point in space considering no collisions with the ambient; 2) direct transport with attenuation due to ambient scattering; 3) return flux of contaminants scattered by collisions with the ambient atmosphere; 4) Lambertian re-emission of contaminants from surfaces impinged upon directly by primary sources (second surface sources) and 5) self-scattering return flux resulting from contaminant/contaminant molecular collisions. The user can choose to employ any or all of these transport mechanisms through proper input options. Electrostatic or electromagnetic fields are not considered in the current transport functions.

2.1.3.1 Direct Transport Functions

In general, the mass flux arriving at a surface element i is proportional to the mass emission rate of each source j and the mass transport factor which is unique to i and j or

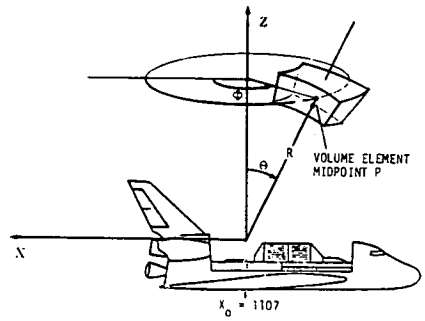
$$F_i = \sum_j \dot{m}_j \Gamma_j \qquad (2\text{-}3)$$

from all j sources. For point sources, equation 2-3 is equivalent to $\Sigma \psi_j$ and for Lambertain sources $\Gamma_j = VF_{j-i}$.

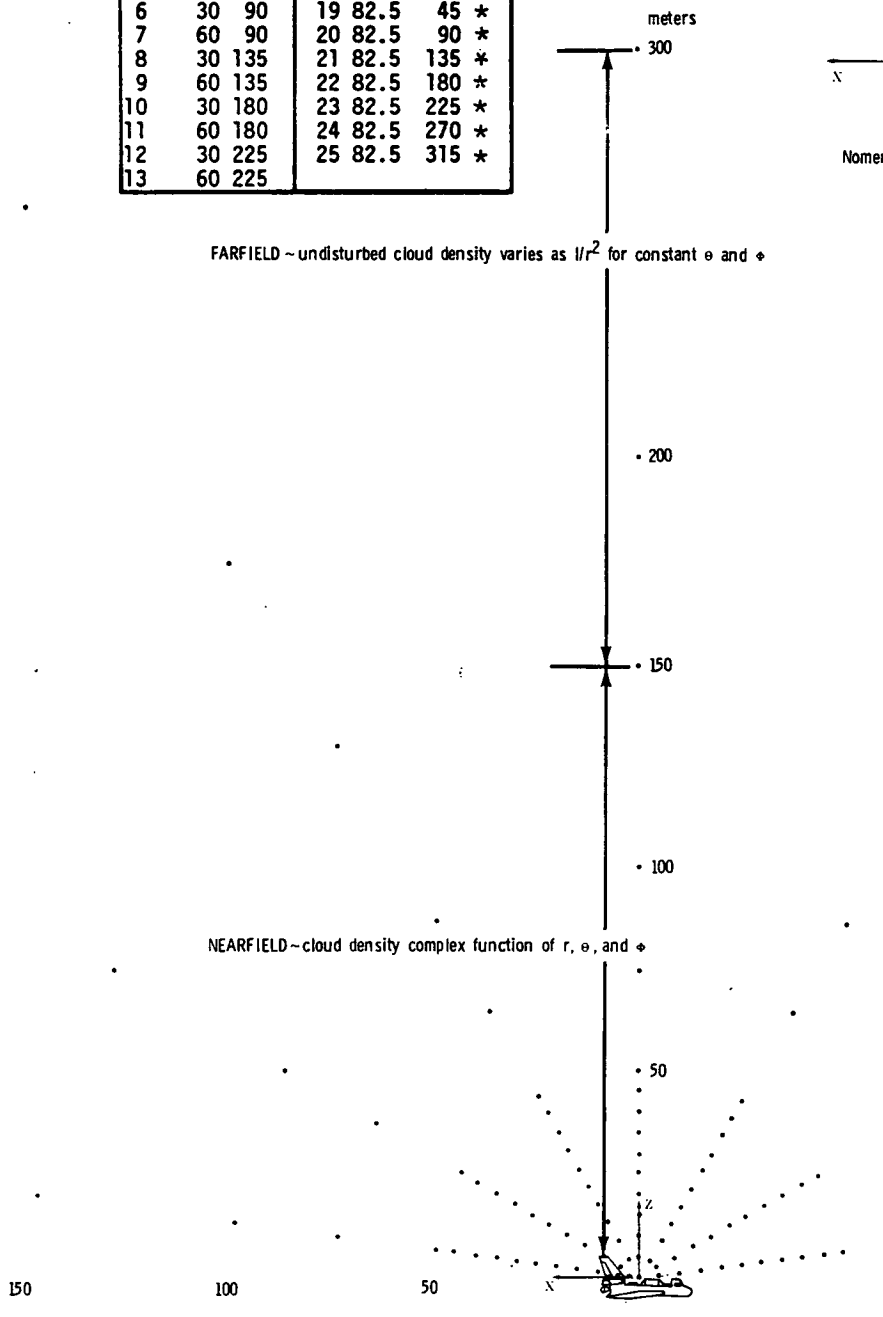
The model not only considers contaminant mass transport from a source to a receiving surface but it also evaluates the mass flux and density at points in the contaminant cloud above the Shuttle Orbiter and Spacelab. A major consequence of this induced environment is the column density or the integrated density along a line-of-sight passing through the cloud. To evaluate the column density, the model divides the hemispherical space above the Spacelab/Orbiter into a matrix of volume elements having midpoints strategically located along 25 predetermined lines-of-sight (see Figure 2-9). The mass transport factors from each surface source to each point in the cloud have been precalculated using the TRASYS II Program. Each point was assigned a 5 digit identification number which describes its spatial coordinates as illustrated in Table 2-IX.

Line-of-Sight Number Designators

No.	Θ	Φ	No.	Θ	Φ	
1	0	0	14	30	270	
2	30	0	15	60	270	
3	60	0	16	30	315	
4	30	45	17	60	315	
5	60	45	18	82.5	0	*
6	30	90	19	82.5	45	*
7	60	90	20	82.5	90	*
8	30	135	21	82.5	135	*
9	60	135	22	82.5	180	*
10	30	180	23	82.5	225	*
11	60	180	24	82.5	270	*
12	30	225	25	82.5	315	*
13	60	225				



Nomenclature for Points in the Hemispherical Cloud



*Not currently in data file 14 (see page 7-2).

Figure 2-9. Location of Precalculated Viewfactors in Hemispherical Cloud

Referring to the insert in Figure 2-9, the first digit describes the value of θ, the second the value of Φ and the last 3 digits define the radial distance from the origin in meters. Thus, a point numbered 22100 would be found on a line-of-sight 30° off the Z-axis, leaning over the right Orbiter wing, 100 meters from the origin. The use of this code to designate design points in the cloud places the numbers ranging from 10000 to 49999 on a reserved status and they should not be assigned to other surfaces.

Table 2-IX. Code for Volume Element Midpoints

θ (deg)	Code	Φ(deg)	Code	R (meters)	Code
				0	000
0	1	0	0 (aft)	5	005
30	2	45	1	10	010
60	3	90	2 (right)	15	015
82.5	4	135	3	20	020
		180	4 (forward)	25	025
		225	5	30	030
				35	035
		270	6 (left)	40	040
				45	045
		315	7	50	050
				75	075
				100	100
				150	150
				200	200
				300	300

The origin of the coordinate system used to define the points is located at the Prime Measurement Point (PMP) at station $X_0 = 1107$, $Y_0 = 0$ and $Z_0 = 507$ for ease in relating to current contamination control criteria[14]. The selection of this particular origin does not limit the calculation capability because a point selection subroutine was developed to select the proper points for interpolating along any line-of-sight originating at any desired location in the cloud (see Figure 2-10).

Although mass transport factors have been precalculated to points within the hemispherical volume to 300 meters from the vehicle, experience has shown that sufficient accuracy can be obtained beyond 150 meters along a line-of-sight with a constant θ and Φ, if the mass transport factor is assumed to decrease simply as $1/r^2$.*

*The percent error can be evaluated analytically.

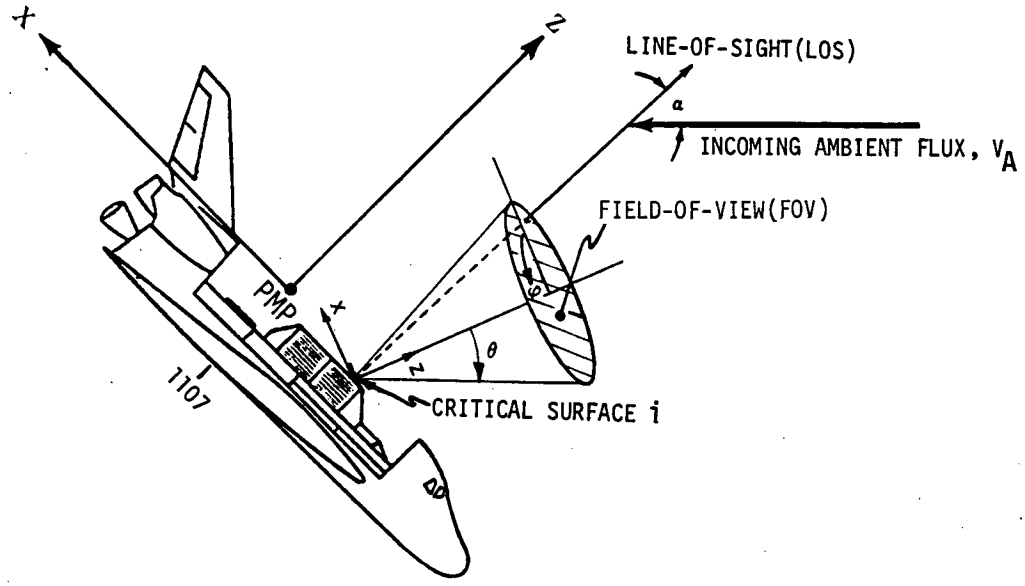


Figure 2-10. Example of a Critical Surface Location, Orientation and Field-of-View

The point selection routine contains an option to use a $1/r^2$ variation whenever the user desires which saves computational and peripheral processer time.

The amount of mass leaving each SO/SL surface or point source that can enter the volume element centered around point P (Figure 2-9) is computed by accessing precalculated "form factors" (or mass fraction data) between point P and each source. As a result, the contaminant cloud density ($N_m(P)$ in molecules/cm^3) at any point above the vehicle can be defined by summing over j sources

$$N_m(P) = \sum_j \frac{\dot{m}_j \, \Gamma_j}{V_j}, \qquad (2\text{-}4)$$

where V_j = emission velocity from source j in cm/s.

The molecular number column density (NCD in molecules/cm^2) is then determined by

$$NCD = \sum_{r=0}^{r_{max}} N_m(P) \, \Delta r, \qquad (2\text{-}5)$$

where r = the distance along a line-of-sight in centimeters from the LOS origin.

2.1.3.2 Direct Transport With Ambient Attenuation

After contaminant molecules are emitted from their source, they travel a finite distance before colliding with an ambient molecule. This distance traveled between collisions is a function of the mean free path. The interaction with the ambient can alter the distribution of contaminants along certain lines-of-sight particularly at low orbital altitudes (ALT < 400 km) where the mean free paths become increasingly smaller. Collisions with incoming ambient species can attenuate the molecular column density along a given line-of-sight by scattering contaminant molecules out of the line-of-sight or by not allowing them to reach it. Correspondingly, where the contaminant molecules are scattered out of a line-of-sight, one must also consider those molecules being swept from other locations into the line-of-sight in order to conserve mass.

The transport model with ambient interaction that is currently in the program is based upon a technique devised by Robertson[15]. It considers only ambient attenuation or molecules scattered out of the line-of-sight and does not include these scattered into it from other regions of the contaminant cloud. Although the mean free path option is supplied with the program, the user is cautioned to consider this limitation in interpreting the results.

The mean free path (λ) for contaminant specie m is determined by

$$\lambda_m = \frac{4\ V_m}{\pi[\mu\ (\delta_m + \delta_A)]^2\ N_A V_A}, \qquad (2\text{-}6)$$

where;

λ_m = mean free path (cm),

δ_m = molecular diameter of specie j (cm),

δ_A = molecular diameter of ambient (3.0E-08 cm),

V_m = emission velocity of specie j (cm/s),

μ = diameter velocity factor (3.0), (see page A-21 for further discussion),

N_A = ambient density (molecules/cm^3) and

V_A = ambient velocity.

If only scattering out of the line-of-sight is considered, the flux reaching a point p is attenuated as

$$F_p = \dot{m}_j \, r_j \, e^{-R/\lambda_m}, \qquad (2\text{-}7)$$

where R = distance traveled from source j to point p.

2.1.3.3 Return Flux Functions

Due to the geometries of the SO/SL carriers, the primary transport mechanism of contaminant species between sources and receivers is the return flux or backscattering of emitted molecules resulting from collisions with the ambient atmosphere. Direct line-of-sight source-to-surface transport and self scattering of contaminant molecules are considered in the model and are of concern to the SO/SL and its payloads under isolated conditions.

The return flux from the unit volume of space centered at the volume elemental midpoint P (Figure 2-9) is a direct function of the collision rate of the contaminant molecules with ambient species within that volume. A scattering model is assumed which defines the number of collisions that deflect molecules toward the critical surface. The scattering model currently used by most analysts[15,16] reduces to a cosine or Lambertian distribution from the scattering center. When and if on-orbit experimental data for this phenomena becomes available, the scattering model can be easily modified.

To calculate the return flux to a surface, the location and orientation of the critical surface i and the direction, α, of the incoming ambient flux vector, V_A, are defined with respect to SO/SL coordinates. In addition, the field-of-view (FOV) for this surface is specified in terms of θ and φ. The return flux to the surface is then computed by performing a volume integration over the defined region of space within the surface FOV. The relationship for modeling the return flux (RFAS) to a surface of interest for all lines-of-sight within the FOV along with the assumptions employed in the model is

$$RFAS_i = N_A V_A \, \frac{\pi}{4} \left[\mu \, (\delta_m + \delta_A)\right]^2 \sum_N \cos \alpha_N \, NCD_N \, VF_{i-N}, \qquad (2\text{-}8)$$

where;

$RFAS_i$ = return flux (molecules/cm^2/s),

NCD_N = molecular column density along line-of-sight N (molecules/cm^2),

α_N = angle drag vector makes with LOS N (degrees),

N_A = ambient density (molecules/cm^3),

V_A = ambient velocity (cm/s),

μ = diameter velocity factor (3.0),

δ_m = molecular diameter of specie m (cm),

δ_A = molecular diameter of ambient (3.0E-08 cm) and

VF_{i-N} = viewfactor from volume element coincident with LOS N to surface of interest i.

The ambient density term, N_A, in equation 2-8 is a function of orbital altitude, sunspot activity and position in orbit. The model has been configured with an ambient density array (AMBDEN) which allows the user to designate altitude (between 105 and 2500 km) and sun activity (either low-nighttime near sunspot minimum, medium or high-daytime near sunspot maximum) in the return flux calculations. Data in the AMBDEN array was obtained from Reference 17. This array can be expanded for more variables if the requirement exists in the future.

The return flux from self-scattering is the result of collisions between two emitted contaminant molecules. Although this contribution to the total return flux appears to be 1 to 2 orders of magnitude less than the contribution due to scattering with ambient species (for altitudes between 200 and 700 km)[1], the analytical approach proposed by Robertson[18] has been reconfigured and integrated into the model for completeness.

Using the assumptions of Robertson, equation (2-8) is replaced by

$$RFSS_i = (V_m + V_n)\,\frac{\pi}{64}\left[\mu(\delta_m + \delta_n)\right]^2 \sum_N NSS_N \cdot VF_{i-N}, \quad (2\text{-}9)$$

where;

$RFSS_i$ = self-scattering return flux (molecules/cm^2/s),

V_m & V_n = velocities of contaminant species m and n (cm/s),

δ_m & δ_n = molecular diameters of species m and n (cm),

NSS_N = integral sum of all $(N_m(P) \cdot N_n(P)\ \Delta r)$ along LOS N and

$N_m(P)$ & $N_n(P)$ = density of species m and n (molecules/cm^3).

This relationship will result in the upper limit of the self-scattering contribution due to the simplifying assumptions employed. These include: 1) no attenuation of the returning molecular flux due to collisions with contaminants in the denser regions near the vehicle and 2) the linear addition of contaminant molecule velocity vectors approaches reality only at locations very close to the vehicle. Self-scattering is predominant at point locations within the volume of the payload bay (Z_O < 507). These locations have not been modeled in the SPACE design and development model.

2.1.3.4 Second Surface Source Transport Functions

Second surface sources are defined as those contaminant sources which re-emit contaminants originating from other sources (e.g.; RCS engine effluent impingement upon Orbiter wings reflecting into a line-of-sight). A certain amount of engineering judgement must be used when evaluating second surface sources. For example, any surface that has a direct line-of-sight to an Orbiter engine should be considered a potential second surface source because of the high mass flux that could be incident on the surface during engine firing and the fact that exhaust from bi-propellant engines can deposit upon the surface and later desorb or sublimate. The user has the option to flag the second surface source function in the model. When this is flagged the model does the following:

Given a critical surface (i) in terms of deposition, a search is made of all surfaces (j) that see the critical surface. If surface j was flagged as a potential second surface source, then another search is made for all surfaces and point sources (k) that can see surface j. Depending on the temperature of the reflecting/re-emitting surface, certain species may or may not condense. The total incident flux of a species is compared to the evaporation or sublimation rate of the surface. If the loss rate exceeds the incident rate it is assumed all the material is instantaneously reflected or re-emitted. The accommodation of energy at the surface is assumed complete and the material emerges

diffusely with a velocity dictated by the temperature of the surface. Either a specular or diffuse re-emission could be assigned, but until experimental data is available to warrant a change, only the diffuse emission is considered (see Appendix A).

A calculational series is established when the second surface flag (REFLCT) is .TRUE. and utilizes routines previously discussed (see Figure 2-11). Initially, flux to a surface from the primary source A is calculated using equation 2-3. This flux will either partially or totally stick to surface B or will be reflected and/or sublime as a function of temperature (Langmuier-Knudsen) depending on the species. Material that does not permanently accommodate is then added to the surface B mass loss rate and is modeled as a normal surface source as previously discussed to contribute to the NCD; or impinge upon another surface of interest(i) i.e.,

$$F_{i2} = \dot{m}_A \Gamma_A \, (1 - S_{A-B}) \, VF_{B-i} \cdot \qquad (2\text{-}10)$$

Therefore, total flux from B to i would be

$$F_{B-i} = \dot{m}_B \Gamma_B + \dot{m}_A \Gamma_A \, (1-S_{A-B}) \, VF_{B-i}, \qquad (2\text{-}11)$$

where;

S_{A-B} = sticking coefficient between source A and surface B (see subsection 2.1.3.5) and

F_{i2} = second surface flux to i.

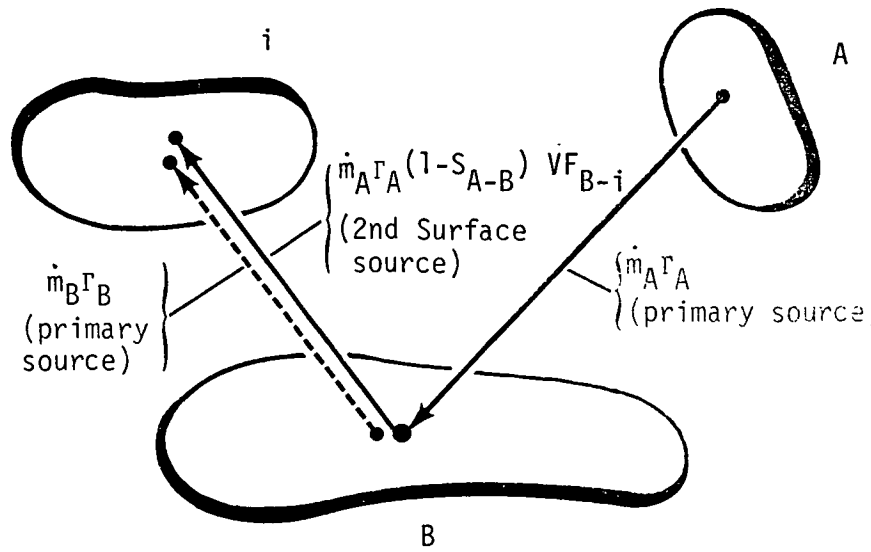


Figure 2-11. Second Surface Source Illustration

2.1.3.5 Surface Deposition Characteristics

The deposition of contaminants upon a surface of interest is a function of the surface sticking coefficient, S, and the contaminant flux on the surface. The sticking coefficient (discussed in more detail in Appendix A) is an extremely complex variable based upon such assorted physical phenomena as the characteristics of the contaminant source, temperatures of the source and surface of interest, source species, the transport phenomena incurred and surface phenomena such as UV photopolymerization and chemical reaction. In general, the deposition rate, $\dot{D}_i$, can be expressed as

$$\dot{D}_i = S \cdot F_i . \qquad (2\text{-}12)$$

Total deposition for any given time slice, Δt, is then found by

$$D_i = S \cdot F_i \, \Delta t . \qquad (2\text{-}13)$$

The units of D_i are expressed in g/cm^2 or $molecules/cm^2$ or if the density and uniformity of the surface deposit are known, deposition can be expressed in terms of thickness (micrometers or Å). The sticking coefficient relationships currently in the SPACE Program are summarized in Table 2-X. These are based upon available ground and flight test data applicable to the occurring phenomena. At present not all such data has been determined, and in those cases the user must select the appropriate input sticking coefficient dictated by the specific situation being evaluated.

2.1.4 Contamination Effects

Once the levels of contamination have been determined (deposition, NCD, etc.) it is sometimes necessary or desireable to predict their impacts upon sensitive surfaces and instruments. The SPACE Program was developed primarily for SO/SL design and development analyses related to program contamination control criteria, and therefore contains no contamination degradation effects routines. There are, however, several computer programs in existance which can predict the degradation effects resulting from the contaminant environment levels predicted by the SPACE Program. These programs can calculate the following contamination effects: 1) scattering, absorption and emission of radiant energy by deposited contaminant films on sensitive surfaces and 2) the scattering, absorption and emission of radiant energy by contaminant molecules within the field-of-view of a sensitive optical instrument. Other contamination related effects can be modeled. These effects consider the impacts

Table 2-X. Sticking Coefficient Summary

Transport Phenomena / Contaminant Source/Species	S Source-to-Surface	S Return Flux/ Self-Scattering
Outgassing		
• All Species	$(T_j - T_i)/200$*	$0 \leq S \leq 1$ - *User Input Required* - (If T_i = Cryogenic, $S \tilde{=} 1$; If $T_i \tilde{=} 25^oC$, $S \tilde{=} 0.25$; If $T_i > 50^oC$, $S \tilde{=} 0.10$)
Engines (VCS, RCS)		
• MMH-Nitrate	1 (i.e. $P_v \tilde{=} 0$)¶	1 (i.e. $P_v \tilde{=} 0$)
• All Other Species	1 if $T_i \leq T_{CN}$ †¶ 0 if $T_i > T_{CN}$	1 if $T_i \leq T_{CN}$ 0 if $T_i > T_{CN}$
Early Desorption		
• All Species		
Leakage		
• All Species	1 if $T_i \leq T_{CN}$ †¶ 0 if $T_i > T_{CN}$	1 if $T_i \leq T_{CN}$ 0 if $T_i > T_{CN}$
Evaporator		
• All Species		

*T_j = Source Temperature (^oC); T_i = Surface of Interest Temperature (^oC)

†T_{CN} = Condensation Temperature of Specie N

¶Langmuir - Knudsen relationship utilized to determine desorption rate of deposit (see Appendix A).

resulting from contaminant induced changes in thermal control surface characteristics ($\Delta\alpha/\epsilon$) and localized induced pressure phenomena such as corona arc-over and multipacting. Further discussion on the degradation effects of the induced contaminant environment can be found in Appendix A.

2.2 MACHINE REQUIREMENTS

The SPACE Program has been used on CDC 6500 and UNIVAC 1108 machines. The amount of core required depends, of course, on the machine and the efficiency of its compiler and loader. Typical estimates of core requirements are given below.

CDC 6500 FTN 4.5 SCOPE 3.4.3	UNIVAC 1108/1110 EXEC 8
~$125{,}000_8$ ~ $43{,}520_{10}$	~$116{,}100_8$ ~ $40{,}000_{10}$

Several files are required by the program and must be attached in the run stream to analyse the Orbiter configuration or the Spacelab configurations.

FILE NAME	FUNCTION	MODE	CONTENTS
TAPE 5	READS	MIXED	INPUT DATA
TAPE 6	WRITES	FMT	OUTPUT
TAPE 8	WRITES	FMT	DEBUG OUTPUT
TAPE 9	SCRATCH	FMT	CURRENTLY INACTIVE
TAPE 10†	WRITES/ READS	FMT	SURFACE TEMPS
TAPE 11	SCRATCH	FMT	SURFACE TEMPS
TAPE 12†	WRITES/ READS	FMT	MASS TRANSPORT FACTORS - SURFACE TO SURFACE
TAPE 13	WRITES/ READS	UNFMT RMS	MASS TRANSPORT FACTORS - SURFACE TO POINTS
TAPE 14*	READS	FMT	MASS TRANSPORT FACTORS - ORBITER SURFACES TO POINTS
TAPE 15*	READS	FMT	MASS TRANSPORT FACTORS - PAYLOAD SURFACES TO POINTS

†Can be attached or generated from card read from TAPE 6 = INPUT.
*Must be attached for Orbiter/LMOP/SMTP/FIVP column density or return flux analysis.

2.3 PROGRAM LOGIC FLOW AND OVERLAY STRUCTURE

Figure 2-12 illustrates the recommended overlay structure for the SPACE Program.

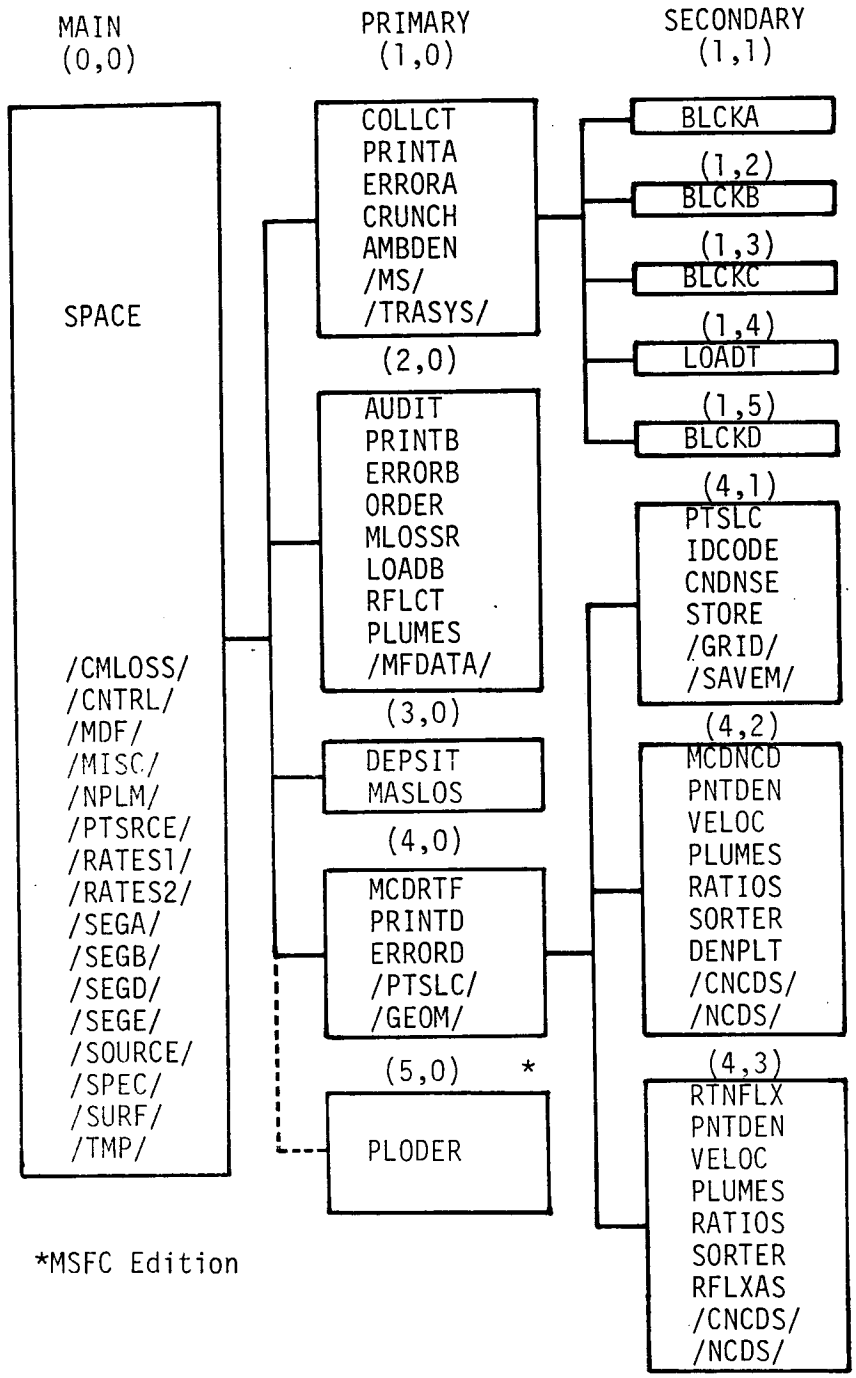


Figure 2-12 SPACE Program Overlay Structure

2.4 SUBROUTINE DESCRIPTION

In its present version, there are 33 separate subprograms called at various points in the analysis. Each routine is given a unique name as illustrated in Figure 2-12 and only single entry points are used. Several system routines are called which vary from machine to machine.

CDC (MMA)	UNIVAC (MSFC)	UNIVAC (JSC)
• CALL DATE (TODAY)	CALL FDATEX	CALL CDATE (TODAY)
• CALL TIME (HMS)	——	CALL CTIME (HMS)
• CALL OPENMS (13, INDEX, 51, 1)	DEFINE FILE 13 (50, 2101, U, IV)	DEFINE FILE 13 (50, 2101, U, IV)
• CALL WRITMS (13, NODEI, 2101, NODEI)	WRITE (13" NR)	WRITE (13" NR)
• CALL READMS (13, NODEI, 2101, IPNT)	READ (13" NR)	WRITE (13" NR)
• CALL CLOSMS (13)	——	——

The executive logic or main overlay is called SPACE and it controls the request for input data and calls the primary overlays or segments into core as required for the user's analysis.

SPACE - The executive portion of the program requests a definition of the problem from the user, i.e.,

a) TITLE CARD
b) CONTROL PARAMETERS

The control parameters are read in via NAMELIST CONTRL and can be accessed by all segments from named common /CNTRL/.

SPACE calls on the first primary overlay or segment to collect the detail input data from permanents that have been attached (see Section 2.2) or from user input cards depending on how the control flags were set.

SPACE then calls in segments to evaluate deposition, mass/number column density and return flux depending on user control flags and recycles for a new problem unless STOP is read on the TITLE card.

COLLCT - Collects the necessary data for the prescribed analysis by keying off control parameters. Data can be obtained from cards, block data or previously generated permanent files. If desired, new data can be read from cards to update the permanent files.

COLLCT reads NAMELIST INPUTA which allows the user to zero out or modify preset surface sources, activate preset engines/vents, identify critical surfaces that are susceptible to deposition (direct line-of-sight or return flux).

NAMELIST INPUTB is read to modify materials mass loss rates, plume coefficients and contaminant species.

NAMELIST MPDB is read to modify the mission profile data bank which contains information on spacecraft attitude, altitude and acceptance angles for critical surfaces, etc.

COLLCT calls AMBDEN, CLOSMS, CRUNCH, ERRORA, OPENMS, PRINTA, WRITMS, BLCKA, BLCKB, LOADT, BLCKC, BLCKD.

PRINTA - This routine is called to set up the various output reports that are requested by the user from Segment A.

ERRORA - When a problem is encountered within Segment A of the analysis, this routine is called to print out an error message for the user.

CRUNCH - This routine condenses the list of sources after the user was given the opportunity to eliminate or zero out certain sources through namelist INPUTA.

BLCKA - Sets up the STS Orbiter configuration.

BLCKB - Sets up the Spacelab LMOP, SMTP and FIVP configurations.

BLCKC - Sets up the types of spacecraft materials to be considered, with up to 10 species given off by the surfaces, and the mass loss characteristics of each species.

LOADT - Loads in surface temperatures from cards or from TAPE 10.

BLCKD - This routine sets up the mission profile data bank required for the prediction of mass column density and return flux.

AMBDEN - Finds the ambient number density given an attitude and level of sunspot activity.

AUDIT - The surface temperatures and mass loss characteristics are used to compute the actual mass lost from each of the surfaces.

PRINTB - Called to set up the various output reports printed from Segment B.

ERRORB - This routine is called with Segment B to print out an error message in the event of a problem in the computations.

ORDER - Arranges the surfaces in order of their potential impact on contamination based on total mass loss rate of the surface. Once arranged the parameter, JKEEP can be used to truncate the number of surfaces to be analysed.

MLOSSR - This routine assigns the rate at which species leave a particular surface. 10 species are currently monitored although only 6 are preset as original material lost from a surface.

LOADB - Reads TAPE 12 and pulls off the mass transport factor data between spacecraft surfaces that are required to define the contribution from secondary sources.

RFLCT - Computes the mass incident on a surface as a result of direct line-of-sight transport from another surface, engine or vent.

DEPSIT - Computes source to surface deposition of contaminants on critical surfaces. [currently inoperative]

MASLOS - Currently inoperative.

MCDRTF - Control logic for Segment D which calculates mass/number column density and estimates return flux.

PRINTD - Called to set up output reports generated within Segment D.

ERRORD - This routine is called from Segment D if problems are encountered in any computational procedure.

PTSELC - Given a definition of a line-of-sight through the contaminant cloud, this routine selects those points from the general matrix that are required to define mass column density and return flux.

CNDNSE - Condenses the contribution factors for points selected along a line-of-sight.

STORE - Stores points for a given field-of-view.

MCDNCD - Controls data manipulation required to calculate integrated mass/number column density along a line-of-sight.

PNTDEN - Calculates the density at points along a line-of-sight as well as a running integrated value for the number column density attributed to each source.

VELOC - This function calculates the most probable velocity of a molecule leaving a surface.

RTNFLX - Controls analysis for calculating return flux.

RFLXAS - Routine for computing return flux and deposition due to ambient scattering and self-scattering.

DENPLT - Routine for plotting density as a function of distance along chosen line-of-sight.

2.5 PERMANENT DATA FILES

Analysis of the STS Orbiter/Spacelab configurations requires three permanent data files. These files are attached as local files on CDC systems or built into the run stream with @ ASG, @ DATA and @ ADD control statements on the UNIVAC system.

2.5.1 Surface Thermal Profiles (TAPE 10)

Temperatures that are assigned to the Orbiter and Spacelab surfaces for two attitude/orbit cases which represent maximum and minimum temperature profiles are listed in Table 2-XI. Up to 5 additional sets of temperatures can be added to the file as described in Section 3.2.4. These data are inserted into the run stream as TAPE 10.

2.5.2 Mass Transport Factors (TAPE 12, TAPE 14 and TAPE 15)

Mass transport factors are precalculated outside the contamination analysis program. Source-to-point data for the STS Orbiter and three Spacelab configurations are stored as permanent files and inserted into the run stream as TAPE 14 and TAPE 15, respectively. Source-to-surface mass transport factors are inserted into the run stream as TAPE 12. An abbreviated representative

Table 2-XI. Maximum/Minimum Temperature Profile Permanent File

NODEJ	MAX °C*	MIN °C†	NODEJ	MAX °C	MIN °C
160	22.50	-58.76	26	-.94	-53.71
161	54.09	-124.66	20	-55.97	-26.81
163	65.56	-115.83	22	-5.31	-39.78
165	69.44	-108.33	40	32.78	-28.61
167	-14.03	-87.78	42	-37.22	-28.89
169	-66.11	-53.06	44	26.99	-39.74
171	-73.39	-39.44	46	-13.89	-38.89
174	29.39	-134.17	34	-37.22	-30.56
190	38.89	-153.89	36	-.19	-53.90
162	34.11	-85.61	32	-56.67	-27.08
164	65.14	-114.72	30	-5.13	-39.96
166	69.44	-108.89	52	-37.22	-28.89
168	-14.58	-87.78	56	-13.89	-38.89
170	-65.94	-53.28	21	-55.97	-26.81
172	-73.17	-39.44	23	-5.31	-39.78
175	-57.04	-70.13	25	-37.22	-30.00
177	-57.78	-70.13	27	-0.93	-53.71
180	21.11	-126.67	31	-5.13	-39.96
181	15.00	-100.56	33	-56.67	-27.08
182	-40.00	-81.67	35	-0.19	-53.90
183	24.44	-106.11	37	-37.22	-30.56
184	15.00	-100.56	41	-70.89	-27.22
185	21.11	-127.22	43	-76.67	-21.11
301	-2.56	-40.51	45	-70.89	-27.22
305	12.62	-50.49	47	-76.67	-21.11
306	32.67	-53.40	51	-70.89	-27.22
307	-2.93	-58.76	53	-76.67	-21.11
311	-2.01	-42.53	55	-70.89	-27.22
315	13.33	-50.76	57	-76.67	-21.11
316	33.28	-52.25	130	21.11	-41.67
317	-3.02	-58.76	145	7.33	-45.22
420	-2.93	-58.76	130	21.11	-41.67
425	-3.02	-58.76	132	44.22	-19.22
4	73.44	-144.00	140	44.17	-71.39
3	65.78	-158.44	148	51.67	-103.33
2	66.22	-145.00	152	51.67	-103.33
1	78.22	-144.56	147	44.17	-71.39
8	73.78	-143.33	151	44.17	-71.39
7	65.78	-157.78	115	7.22	-45.22
6	66.22	-144.78	100	20.56	-41.67
5	78.22	-145.22	102	44.00	-19.11
443	60.00	-124.44	110	44.17	-71.94
445	56.11	-131.11	118	51.67	-103.89
446	49.44	-145.00	122	51.67	-103.89
447	49.44	-127.22	117	44.17	-71.94
448	60.00	-123.33	121	44.17	-71.94
440	56.67	-130.55	149	53.89	-117.78
441	49.44	-143.88	142	54.56	-106.67
442	49.44	-126.66	134	55.56	-90.00
50	32.78	-28.61	137	54.78	-63.89
54	25.68	-39.37	136	56.11	-58.89
24	-37.22	-30.00	202	37.22	-80.00

*Max = 100% Solar Exposure, $\beta = 90^{o}$, +Z SI
†Min = +X SI, X-POP, $\beta = 90^{o}$

Table 2-XI. Maximum/Minimum Temperature Profile Permanent File (cont'd)

NODEJ	MAX °C	MIN °C
203	37.22	-80.00
230	18.33	102.22
240	3.89	89.44
241	18.33	102.22
250	-66.67	6.67
260	54.44	-58.89
459	56.11	-58.89
458	56.11	-58.89
457	56.11	-58.89
456	56.11	-58.89
455	56.11	-58.89
454	53.89	-67.22
453	53.89	-67.22
452	53.89	-67.22
451	53.89	-67.22
450	53.89	-67.22
119	53.89	-117.78
112	54.33	-106.67
104	55.00	-90.00
107	54.78	-63.89
106	56.11	-58.89
460	53.89	-67.22
461	53.89	-67.22
462	53.89	-67.22
463	53.89	-67.22
464	53.89	-67.22
465	56.11	-58.89
466	56.11	-58.89
467	56.11	-58.89
468	56.11	-58.89
469	56.11	-58.89
380	-31.94	-92.06
382	-35.78	-90.22
384	-61.67	-33.33
386	-57.11	-42.22
388	-26.11	-83.89
390	-26.11	-83.89
393	-26.11	-83.89
381	-31.11	-89.39
383	-35.78	-90.22
385	-61.11	-33.33
387	-56.67	-42.22
389	-23.33	-75.00
391	-23.33	-75.00
392	-26.11	-83.89
399	-34.44	-95.00
80	-71.11	-80.56
82	-71.11	-80.56
84	22.80	-120.53
60	-71.11	-12.22
62	-71.11	-13.50

NODEJ	MAX °C	MIN °C
64	22.76	-120.36
921	45.00	31.11
922	45.00	31.11
920	45.00	31.11
923	45.00	31.11
915	45.00	31.11
916	45.00	31.11
917	45.00	31.11
918	45.00	31.11
910	45.00	31.11
911	45.00	31.11
912	45.00	31.11
913	45.00	31.11
11	42.58	-152.76
13	-6.92	-27.80
66	-29.90	59.03
67	-30.00	71.67
68	-32.22	66.67
70	-36.94	64.72
72	-37.58	64.91
74	-30.00	71.67
76	-38.83	63.94
77	-34.46	66.19
86	-31.34	67.29
87	-30.00	71.11
88	-32.22	66.67
90	-38.33	64.72
92	-39.41	64.72
94	-30.00	71.11
96	-40.78	63.94
97	-35.38	66.01
1401	82.91	-137.64
1402	75.97	-129.30
1403	101.39	-108.47
1404	157.78	-124.03
1405	85.83	-137.64
1406	81.67	-129.30
1407	100.97	-108.47
1408	158.89	-124.03
1411	46.39	-147.78
1413	97.50	-130.83
1440	152.78	-125.56
1441	103.06	-111.67
1442	75.00	-132.22
1443	79.44	-140.83
1445	151.11	-125.56
1446	103.89	-111.67
1447	71.11	-132.22
1448	75.56	-140.83
1000	77.22	-155.00
1010	60.00	-158.33

Table 2-XI. Maximum/Minimum Temperature Profile Permanent File (cont'd)

NODEJ	MAX °C	MIN °C
1001	77.22	-155.00
1011	60.00	-158.33
1002	83.89	-99.44
1012	68.89	-158.33
1003	83.89	-99.44
1013	68.89	-158.33
1005	168.89	-121.67
1015	155.56	-120.00
1020	68.72	-131.67
1021	68.72	-131.67
1022	64.28	-131.67
1023	64.28	-131.67
1025	147.64	-110.00
1030	37.06	-130.17
1031	37.06	-130.17
1032	50.56	-130.17
1033	50.56	-130.17
1035	98.09	-98.31
1040	32.06	-138.50
1041	32.06	-138.50
1042	46.28	-138.50
1043	46.28	-138.50
1045	64.67	-86.67
1050	30.72	-130.17
1051	30.72	-130.17
1052	35.17	-130.39
1053	35.17	-130.39
1055	77.92	-112.78
1083	34.44	-145.00
1085	46.67	-152.22
1087	66.11	-151.11
1088	67.50	-152.78
1086	66.11	-151.11
1084	53.89	-152.22
1082	34.44	-145.00
1080	66.83	-145.17
1081	62.50	-145.00
1070	73.61	-138.61
1065	52.22	-158.33
1061	32.94	-130.28
1060	77.92	-112.78
1121	46.28	-138.50
1111	50.56	-130.17
1130	35.17	-130.39
2121	50.56	-130.17
2130	35.17	-130.19
2401	82.91	-137.64
2402	75.97	-129.30
2403	101.39	-108.47
2404	157.78	-124.03
2405	85.83	-137.64
2406	81.67	-129.30
2407	100.97	-108.47
2408	158.89	-124.03
2411	46.39	-147.78
2413	97.50	-130.83
2440	152.78	-125.56
2441	103.06	-111.67
2442	75.00	-132.22
2443	79.44	-140.83
2445	151.11	-125.56
2446	103.89	-111.67
2447	71.11	-132.22
2448	75.56	-140.83
2010	60.00	-158.33
2011	60.00	-158.33
2012	68.89	-158.33
2013	68.89	-158.33
2015	155.56	-120.00
2020	68.72	-131.67
2021	68.72	-131.67
2022	64.28	-131.67
2023	64.28	-131.67
2025	147.64	-110.00
2030	37.06	-130.17
2031	37.06	-130.17
2032	50.56	-130.17
2033	50.56	-130.17
2035	98.09	-98.31
2050	30.72	-130.17
2051	30.72	-130.17
2052	35.17	-130.39
2053	35.17	-130.39
2055	77.92	-112.78
2094	34.44	-145.00
2096	46.67	-152.22
2098	61.11	-151.11
2099	66.67	-152.78
2097	66.11	-151.11
2095	53.89	-152.22
2093	34.44	-145.00
2091	66.83	-145.17
2092	62.50	-145.00
2090	73.61	-138.61
2084	34.44	-145.00
2086	46.67	-152.22
2088	61.11	-151.11
2089	66.67	-152.78
2087	66.11	-151.11
2085	53.89	-152.22
2083	34.44	-145.00
2081	66.83	-145.17

Table 2-XI. Maximum/Minimum Temperature Profile Permanent File (cont'd)

NODEJ	MAX °C	MIN °C
2082	62.50	-145.00
2080	73.61	-138.61
2074	34.44	-145.00
2076	46.67	-152.22
2078	61.11	-151.11
2079	66.67	-152.78
2077	66.11	-151.11
2075	53.89	-152.22
2073	34.44	-145.00
2071	66.83	-145.17
2072	62.50	-145.00
2070	73.61	-138.61
2065	52.22	-158.33
2061	32.94	-130.28
2060	77.92	-112.78
3401	82.91	-137.64
3402	75.97	-129.30
3403	101.39	-108.47
3404	157.78	-124.03
3405	85.83	-137.64
3406	81.67	-129.30
3407	100.97	-108.47
3408	158.89	-124.03
3411	46.39	-147.78
3413	97.50	-130.83
3440	152.78	-125.56
3441	103.06	-111.67
3442	75.00	-132.22
3443	79.44	-140.83
3445	151.11	-125.56
3446	103.89	-111.67
3447	71.11	-132.22
3448	75.56	-140.83
3094	33.33	-138.33
3096	46.67	-153.33
3098	58.89	-156.11
3099	64.44	-158.33
3097	65.00	-155.56
3095	54.44	-153.33
3093	32.78	-137.78
3091	63.50	-147.50
3092	59.06	-147.94

NODEJ	MAX °C	MIN °C
3090	71.26	-145.65
3084	29.44	-138.33
3086	40.56	-153.89
3088	53.89	-155.83
3089	63.19	-157.78
3087	60.56	-155.56
3085	49.17	-153.61
3083	30.56	-137.78
3081	59.83	-147.78
3082	54.33	-148.22
3080	67.16	-144.80
3074	25.56	-138.33
3076	34.44	-154.44
3078	48.89	-155.56
3079	56.39	-157.22
3077	56.11	-155.56
3075	43.89	-153.89
3073	28.33	-137.78
3071	56.11	-148.06
3072	49.61	-148.50
3070	63.03	-143.93
3064	29.44	-133.89
3066	36.39	-150.56
3068	49.44	-151.11
3069	56.67	-152.64
3067	55.00	-151.11
3065	44.72	-150.00
3063	31.39	-132.78
3061	56.00	-144.06
3062	50.39	109.00
3060	59.72	-99.03
3054	33.33	-129.44
3056	38.33	-146.67
3058	50.00	-146.67
3059	56.94	-143.06
3057	55.56	-146.67
3055	45.56	-146.11
3053	34.44	-127.78
3051	55.83	-140.00
3052	51.11	-140.56
3050	56.36	-135.24

list of the mass transport factors in permanent file is contained in Table 2-XII. The nomenclature and terms presented in this table are discussed in detail in subsection 3.2.7.

Table 2-XII. List of Mass Transport Factors to Points Read In

NODEI	NODEJ	MFIJ	MFJI	AREAJ	THETAI	THETAJ	RADIUS
10100	1	.832E-04	.313E-08	.266E+05	.900E+02	.441E+02	.411E+04
10100	2	.833E-04	.313E-08	.266E+05	.900E+02	.441E+02	.411E+04
10100	3	.829E-04	.311E-08	.266E+05	.900E+02	.442E+02	.411E+04
10100	4	.820E-04	.308E-08	.266E+05	.900E+02	.444E+02	.413E+04
10100	5	.832E-04	.313E-08	.266E+05	.900E+02	.441E+02	.411E+04
10100	6	.833E-04	.313E-08	.266E+05	.900E+02	.441E+02	.411E+04
10100	7	.829E-04	.311E-08	.266E+05	.900E+02	.442E+02	.411E+04
10100	8	.820E-04	.308E-08	.266E+05	.900E+02	.444E+02	.413E+04
10100	440	.385E-06	.112E-09	.344E+04	.900E+02	.887E+02	.405E+04
10100	441	.389E-06	.113E-09	.344E+04	.900E+02	.887E+02	.404E+04
10100	442	.391E-06	.114E-09	.344E+04	.900E+02	.887E+02	.403E+04
10100	443	.391E-06	.114E-09	.344E+04	.900E+02	.887E+02	.403E+04
10100	445	.385E-06	.112E-09	.344E+04	.900E+02	.887E+02	.405E+04
10100	446	.389E-06	.113E-09	.344E+04	.900E+02	.887E+02	.404E+04
10100	447	.391E-06	.114E-09	.344E+04	.900E+02	.887E+02	.403E+04
10100	448	.391E-06	.114E-09	.344E+04	.900E+02	.887E+02	.403E+04
10100	13	.202E-04	.619E-09	.327E+05	.900E+02	.826E+02	.407E+04
10100	11	.787E-05	.241E-09	.327E+05	.900E+02	.872E+02	.404E+04
10100	20	.585E-04	.455E-08	.122E+05	.900E+02	.174E+02	.406E+04
10100	22	.562E-04	.460E-08	.122E+05	.900E+02	.167E+02	.404E-04
10100	24	.541E-04	.443E-08	.122E+05	.900E+02	.218E+02	.406E+04
10100	26	.547E-04	.448E-08	.122E+05	.900E+02	.213E+02	.404E+04
10100	30	.541E-04	.444E-08	.122E+05	.900E+02	.217E+02	.406E+04
10100	32	.547E-04	.449E-08	.122E+05	.900E+02	.212E+02	.404E+04
10100	34	.558E-04	.455E-08	.122E+05	.900E+02	.175E+02	.406E+04
10100	36	.562E-04	.460E-08	.122E+05	.900E+02	.168E+02	.404E-04
10100	40	.877E-04	.302E-08	.290E+05	.900E+02	.504E+02	.405E+04
10100	44	.135E-03	.463E-08	.290E+05	.900E+02	.632E+01	.409E+04
10100	50	.135E-03	.463E-08	.290E+05	.900E+02	.632E+01	.409E+04
10100	54	.877E-04	.302E-08	.290E+05	.900E+02	.504E+02	.406E+04
10100	305	.371E-05	.120E-09	.309E+05	.900E+02	.886E+02	.407E-04
10100	306	.355E-05	.115E-09	.309E+05	.900E+02	.886E+02	.413E+04
10100	315	.371E-05	.120E-09	.309E+05	.900E+02	.886E+02	.407E+04
10100	316	.355E-05	.115E-09	.309E+05	.900E+02	.886E+02	.413E+04

2.6 FORTRAN VARIABLES LIST

VARIABLE	DESCRIPTION	COMMON BLOCK
AGEORB	AGE OF THE ORBITER BASED ON HOURS ON ORBIT. USED TO CHARACTERIZE THE ORBITER LONG TERM OUTGASSING RATE(HR)	RATES2
AGESLB	AGE OF THE SPACELAB CONFIGURATION(HRS) USED TO CHARACTERIZE SPACELABS OUT GASSING RATE	RATES2
ALT	ALTITUDE(KILOMETERS).	MDF
AMBND	AMBIENT DENSITY,CALCULATED USING ALT AND THE SELECTION OF ONE OF THREE LEVELS OF SUNSPOT ACTIVITY	SEGD
AREA(J)	AREA OF EACH SURFACE J (SQ. IN.)	SURF
ATCODE	ATTITUDE CODE. DEFINES UP TO FIVE EXTRA SETS OF TEMPERATURES.	MDF
BELTA	NOT USED IN THIS MODEL	MDF
CNTRIB(I,K)	WEIGHTING FACTOR APPLIED TO DENSITY AT BASIC GRID POINTS NUMBER(I,K) TO OBTAIN DENSITY ALONG A LINE-OF-SIGHT	PTSLCT
COSXX(I)	COSINE OF THE ANGLE BETWEEN THE X-AXIS OF A CRITICAL SURFACE AND THE ORBITER X-AXIS.	MDF
COSXY(I)	COSINE OF THE ANGLE BETWEEN THE X-AXIS OF A CRITICAL SURFACE AND THE ORBITER Y-AXIS.	MDF
COSXZ(I)	COSINE OF THE ANGLE BETWEEN THE X-AXIS OF A CRITICAL SURFACE AND THE ORBITER Z-AXIS.	MDF
COSYX(I)	COSINE OF THE ANGLE BETWEEN THE Y-AXIS OF A CRITICAL SURFACE AND THE ORBITER X-AXIS.	MDF
COSYY(I)	COSINE OF THE ANGLE BETWEEN THE Y-AXIS OF A CRITICAL SURFACE AND THE ORBITER Y-AXIS.	MDF
COSYZ(I)	COSINE OF THE ANGLE BETWEEN THE Y-AXIS OF A CRITICAL SURFACE AND THE ORBITER Z-AXIS.	MDF
COSXZ(I)	COSINE OF THE ANGLE BETWEEN THE Z-AXIS OF A CRITICAL SURFACE AND THE ORBITER X-AXIS.	MDF
COSZY(I)	COSINE OF THE ANGLE BETWEEN THE Z-AXIS OF A CRITICAL SURFACE AND THE ORBITER Y-AXIS.	MDF
COSZZ(I)	COSINE OF THE ANGLE BETWEEN THE Z-AXIS OF A CRITICAL SURFACE AND THE ORBITER Z-AXIAS.	MDF
DA	EFFECTIVE DIAMETER OF AMBIENT SPECIES. CURRENTLY CONSTANT(3.0E-8 CM)	SEGD
DBUGA	DE-BUG AID(INDEPTH OUTPUT) FOR SEGMENT A (COLLECT)	CNTRL
DBUGB	DE-BUG AID(INDEPTH OUTPUT) FOR SEGMENT B(AUDIT)	CNTRL
DBUGC	DE-BUG AID(INDEPTH OUTPUT) FOR SEGMENT C(DEPOSITION)	CNTRL
DBUGD	DE-BUG AID(INDEPTH OUTPUT) FOR SEGMENT D(NCD/RTNFLX)	CNTRL
DBUGE	DE-BUG AID(INDEPTH OUTPUT) FOR SEGMENT E(RF DEPOS.)	CNTRL
DEPSIT	.TRUE./FALSE. FLAG TO INDICATE IF SURFACE DEPOSITION IS TO BE COMPUTED	RATES2
DIA(M)	DIAMETER OF CONTAMINANT SPECIES M (CM)	RAT
DOMEGA	SOLID ANGLE FIELD-OF-VIEW(STERADIANS)	GOMTRY
DL(L)	LENGTH OF SEGMENT ALONG LINE-OF-SIGHT (M)	PTSLC
DOMEG(I)	SOLID ANGLE FIELD-OF-VIEW(STERADIANS) FOR RETURN FLUX SURFACE I	MDF

VARIABLE	DESCRIPTION	COMMON BLOCK
DPHI	INCREMENT IN PHI TO BE USED FOR SUBDIVIDING FIELD-	GOMTRY
DPHII(I)	(SAME AS DPHI)	MDF
DS(L)	DISTANCE BETWEEN MIDPOINTS OF SEGMENTS USED FOR LINE-OF-SIGHT INTEGRATION (M)	GOMTRY
DSMCD(L)	(SAME AS DS) USED FOR MCD/NCD COMPUTATIONS	MDF
DSRTNF(L)	(SAME AS DS) USED FOR RETURN FLUX CALCULATIONS	MDF
DTHET(I)	INCREMENT IN THETA TO BE USED FOR SUBDIVIDING FIELD-OF-VIEW (DEG)	MDF
DTHETA	(SAME AS DTHET)	GOMTRY
ED	.TRUE./.FALSE. FLAG TO INDICATE IF EARLY DESORPTION SPECIES ARE TO BE CONSIDERED IN THIS ANALYSIS	CNTRL
ENG	.TRUE./.FALSE. FLAG TO INDICATE IF ANY ENGINES ARE TO BE CONSIDERED	CNTRL
EVAP	.TRUE./.FALSE. FLAG TO INDICATE IF THE EVAPORATOR IS TO BE CONSIDERED	CNTRL
FIVP	.TRUE./.FALSE. FLAG TO SELECT THE FIVE PALLET SPACELAB CONFIGURATION	CNTRL
GO	.TRUE./.FALSE. FLAG TO ALLOW ANALYSIS TO PROCEED TO NEXT GATE	CNTRL
ICSURF	INDEX USED FOR SURFACES IN DEPOSITION SEGMENT	SEGE
IDENT(J)	IDENTIFICATION NUMBER FOR EACH SURFACE THAT IS PART OF THE SPACECRAFT CONFIGURATION	SURF
ISURF	INDEX USED FOR SURFACES IN RETURN FLUX SEGMENT	SEGB
JKEEP	NUMBER OF LARGEST MASS LOSS CONTRIBUTERS TO BE RETAINED AFTER CONDUCTING THE MASS AUDIT	SEGA
JTOTAL	TOTAL NUMBER OF SURFACES TO BE USED IN THE ANALYSIS	SEGA
KIND(KK)	LIST OF SURFACE MATERIALS(TEFLON,NOMEX,LRSI,ECT)	RATES2
KINDS	TOTAL NUMBER OF SPACECRAFT MATERIALS CONSIDERED IN THE MODEL (15)	SEGA
LEAK	.TRUE./.FALSE. FLAG TO INDICATE LEAKAGE SPECIES ARE TO CONSIDERED IN THIS ANALYSIS	CNTRL
LMOP	.TRUE./.FALSE. FLAG TO SELECT LONG MODULE/ONE PALLET SPACE LAB CONFIGURATION	CNTRL
LOS	LINE OF SIGHT INDEX (RANGES FROM 1 TO 25)	SEGD
MATRL(J)	MATERIAL USED IN SURFACE COATINGS,I.E. NOMEX,LRSI, THIS DESIGHATES SPECIES RATES	SURF
MAXTMP	.TRUE./.FALSE. FLAG TO INDICATE USE OF MAXIMUM TEMPERATURES	CNTRL
MCD	.TRUE./.FALSE. FLAG TO INDICATE LOS MASS/NUMBER COLUMN DENSITY CALCULATIONS ARE TO BE MADE	CNTRL
MDOTJ(J)	TOTAL MASS LOSS RATE FROM A SURFACE (GM/SEC)	CMLOSS
MFPATH	.TRUE./.FALSE. FLAG TO INDICATE ATTENATION FOR MEAN FREE PATH	CNTRL
MINTMP	.TRUE./.FALSE. FLAG TO INDICATE USE OF MINIMUM TEMPERATURES	CNTRL
MLR(J,M)	MASS LOSS RATE PER UNIT AREA FOR 10 CHEMICAL SPECIES FROM UP TO 300 SURFACES (GM/CM**2/SEC)	CMLOSS
MNCD	.TRUE./.FALSE. FLAG USED WITHIN PTSLCT ROUTINE TO INDICATE IF ROUTINE IS BEING USED FOR MCD/NCD CALCULATIONS OR RETURN FLUX PREDITIONS.	SEGD
MED1	INDEX OF FIRST SPECIE THAT IS CONSIDERED AS AN EARLY DESORPTION CONTAMINANT	SPEC
MED2	INDEX OF LAST SPECIE CONSIDERED AS AN EARLY DESORPTION TYPE OF MOLECULE	SPEC
MOUT1	INDEX OF FIRST SPECIE THAT IS CONSIDERED AS AN OUTGASSING SPECIE	SPEC
MOUT2	INDEX OF LAST SPECIE THAT IS CONSIDERED AN OUTGASSING MOLECULE	SPEC

VARIABLE	DESCRIPTION	COMMON BLOCK
MOLWT(M)	MOLECULAR WEIGHT OF SPECIES M	RATES2
M1	INDEX TO INDICATE FIRST CHEMICAL SPECIES TO BE CONSIDERED	SPEC
M2	INDEX TO INDICATE LAST CHEMICAL SPECIES TO BE CONSIDERED	SPEC
NEWCON	.TRUE./.FALSE. FLAG TO INDICATE IF CARDS ARE TO BE READ THAT REVISE OR DEFINE THE CONFIGURATION	CNTRL
NEWMFP	.TRUE./.FALSE. FLAG TO INDICATE IF TAPE14 AND TAPE 15 ARE READ TO GENERATE A DIRECT ACCESS FILE (TAPE 13) WHICH CONTAIN MASS TRANSPORT FACTORS TO POINTS IN SPACE	CNTRL
NEWMFS	.TRUE./.FALSE.FLAG TO INDICATE IF NEW MASS TRANSPORT FACTORS ARE TO BE READ FROM CARDS.	CNTRL
NEWMLC	.TRUE./.FALSE. FLAG TO INDICATE IF NEW MASS LOSS CHARACTERISTICS ARE TO READ FROM CARDS	CNTRL
NEWTCD	.TRUE./FALSE. FLAG TO INDICATE IF NEW SURFACE TEMPERATURES ARE TO BE READ FROM FORMATTED CARDS	CNTRL
NEWTNL	.TRUE./.FALSE. FLAG TO INDICATE IF NEW SURFACE TEMPERATURES ARE TO BE READ FROM NAMELIST	CNTRL
NLOS	NUMBER OF LINES-OF-SIGHT EVALUATED	SEGD1
NUMBER(I,)	ARRAY USED TO STORE POINT IDENTIFICATION NUMBERS REQUIRED TO INTEGRATE ALONG A LINE-OF-SIGHT. USED WITH CNTRIB.	PTSLCT
ONTIME(I)	ONTIME OF POINT SOURCES IN SECONDS	SOURCE
ORBITR	.TRUE./.FALSE.FLAG TO SELECT SHUTTLE ORBITER CONFIGURATION	CNTRL
OUT	.TRUE./.FALSE. FLAG TO INDICATE OUTGASSING SPECIES ARE TO BE CONSIDERED IN THIS ANALYSIS	CNTRL
PHIF(I)	FINAL VALUE OF PHI USED TO DEFINE EDGE OF A FIELD-OF-VIEW (DEG)	GOMTRY
PHII	INITIAL VALUE OF PHI USED TO DEFINE BEGINNING OF THE FIELD-OF-VIEW (DEG)	GOMTRY
PHIL(I)	ANGLE LOS MAKES RELATIVE TO THE X-AXIS (DEG)	MDF
PHI1(I)	(SAME AS PHII)	MDF
PHI2(I)	(SAME AS PHIF)	MDF
PITCH	NOT USED IN THIS MODEL	MDF
PLACE(L)	LIST OF SURFACE LOCATIONS(WING,BAY,TAIL,ECT.)	RATES2
PLUMEC(L,N)	PLUME DISTRIBUTION COEFFICIENTS FOR POINT SOURCES	PTSRCE
PNTSC(I)	ARRAY CONTAINING IDENTIFICATION NUMBERS OF THE MODELED ORBITER ENGINES AND VENTS	SOURCE
RATE(K,M)	MASS LOSS RATE COEFFICIENTS OF SPECIES M FROM SPACECRAFT MATERIAL K	RATES1
RECEVR(I)	IDENTIFICATION NUMBER OF CRITICAL SURFACE THAT RECEIVES CONTAMINANT FLUX	MDF
REFLCT	.TRUE./.FALSE.FLAG TO INDICATE THAT REFLECTION/REEMISSION OF CONTAMINANTS FROM SURFACES IS TO BE ADDED INTO DEPOSITION/NCD ANALYSIS	CNTRL
REPORT(I)	.TRUE./.FALSE.FLAG TO INDICATE WHICH OUTPUT REPORTS THE USER WOULD LIKE WRITTEN	CNTRL
RFAS	.TRUE./.FALSE. FLAG TO INDICATE IF RETURN FLUX DUE TO AMBIENT SCATTERING IS TO BE CONSIDERED	CNTRL
RFSS	.TRUE./.FALSE. FLAG TO INDICATE IF RETURN FLUX DUE TO SELF SCATTERING IS TO BE CONSIDERED	CNTRL
RFSTK	STICKING COEFFICIENT FOR RFAS AND RFSS WHICH FALLS BETWEEN THE VALUES OF 0 AND 1.0	MDF
RFSURF(I)	IDENTIFICATION NUMBER FOR SURFACE SUSCEPTIBLE TO RETURN FLUX	MDF
RMAX	MAXIMUM DISTANCE FROM ORIGIN THAT PRECALCULATED MASS TRANSPORT FACTORS WILL BE USED (M)	GOMTRY

VARIABLE	DESCRIPTION	COMMON BLOCK
RMAXL	SAME AS RMAX-USED FOR MASS/NUMBER COLUMN DENSITY CALCULATIONS (M)	MDF
RMAXRF	SAME AS RMAX - USED FOR RETURN FLUX CALCULATIONS (M)	MDF
ROLL	NOT USED IN THIS MODEL	MDF
SECT	SECTION IDENTIFICATION I.E. WING, WINDOW, TAIL	SURF
SMAX	DISTANCE OF THE LAST SEGMENTS MIDPOINT FROM THE ORIGIN OF A LINE -OF-SIGHT	GOMTRY
SMTP	.TRUE./.FALSE. FLAG TO SELECT THE SHORT MODULE/ THREE PALLET SPACE LAB CONFIGURATION	CNTRL
SPECMF(M,N)	SPECIE M MASS FRACTION WITHIN THE PLUME OF TYPE N	PTSRCE
SPECIE	NAME OF THE CONTAMINANT	RATES2
SSURFS(I)	IDENTIFICATION NUMBERS OF SURFACES THAT CAN REEMIT CONTAMINANTS	SOURCE
SUNH	.TRUE./.FALSE. FLAG TO SELECT HIGH SUN SPOT ACTIVITY USED IN DETERMINATION OF AMBIENT DENSITY	CNTRL
SUNL	.TRUE./.FALSE. FLAG TO SELECT LOW SUN SPOT ACTIVITY	CNTRL
SUNM	.TRUE./.FALSE. FLAG TO SELECT MEDIUM SUN SPOT ACTIVITY	CNTRL
SURFSC(J)	IDENTIFICATION NUMBER OF SURFACE SOURCES	SOURCG
TAU (K,M)	MASS LOSS COEFFICIENT USED TO REPRESENT TIME HISTORY OF SPECIES M FROM MATERIAL K.	RATES2
TEMPOR	RECIEVING SURFACES TEMERATURES(DEGREES C)	TMP
TEMPOS	SURFACE TEMPERATURES(DEGREES C)	MP
THETAF	FINAL VALUE OF THETA USED TO DEFINE EDGE OF FIELD-OF-VIEW (DEGREES)	GOMTRY
THETAI	INITIAL VALUE OF THETA USED TO DEFINE EDGE OF FIELD-OF-VIEW (DEGREES)	GOMTRY
THETAL(LOS)	THETA OF LINE-OF-SIGHT WITH INDEX LOS (DEGREES)	MDF
THETA1	SAME AS THETAF (DEGREES)	MDF
THETA2	SAME AS THETAI (DEGREES)	MDF
TIME	CURRENTLY INACTIVE	MDF
TITLE	USER CHOSEN 72 CHARACTER TITLE FOR EACH RUN	CNTRL
TSTART(I)	START TIME FOR ANALYSIS (HR, MIN, S)	CNTRL
TSTOP(I)	STOP TIME FOR ANALYSIS HR, MIN, S)	CNTRL
ULX	DIRECTION COSINE BETWEEN X-AXIS OF SPACECRAFT AND X-AXIS OF CRITICAL SURFACE (SAME AS COSXX)	GOMTRY
ULY	SEE ULX - SAME AS COSXY	
ULZ	SEE ULX -SAME AS COSXZ	GOMTRY
VA	SPEED OF INCOMING AMBIENT SPECIES AS SEEN BY OBSERVER IN THE SPACECRAFT INERTIAL FRAME OF REFERENCE (ALSO ORBITAL VELOCITY) (M/SEC)	SEGD
VFACT2	FACTOR APPLIED TO VISCOSITY DERIVED COLLISION CROSS SECTIONS THAT CAN ACCOUNT FOR THE RELATIVE VELOCITY DEPENDENCE OF THE CROSS SECTION	SEGD
VLX	SEE VLX -SAME AS COSYX	GOMTRY
VLY	SEE ULX - SAME AS COSYY	GOMTRY
VLZ	SEE ULX - SAME AS COSYZ	GOMTRY
VVX	SAME AS VX	MDF
VVY	SAME AS VY	MDF
VVZ	SAME AS VZ	MDF
VX	X-COMPONENT OF INCOMING AMBIENT SPECIES - SEE VA (M/SEC)	GOMTRY
VY	Y-COMPONENT OF INCOMING ABMIENT SPECIES - SEE VA (M/SEC)	GOMTRY
VZ	Z-COMPONENT OF INCOMING AMBIENT SPECIES - SEE VA (M/SEC)	GOMTRY
WFAS	WEIGHTING FACTOR APPLIED TO COLUMN DENSITY TO ACCOUNT FOR SOLID ANGLE ENCOMPASSED BY LOS -USED FOR RETURN FLUX COMPUTATIONS	SEGD

VARIABLE	DESCRIPTION	COMMON BLOCK
WLX	SEE ULX - SAME AS COSZX	GOMTRY
WLY	SEE ULX - SAME AS COSZY	GOMTRY
WLZ	SEE ULX - SAME AS COSZZ	GOMTRY
XLOS(LOS)	X-LOCATION OF LOS ORIGIN IN SPACECRAFT COORDINATES (INCHES)	MDF
XO(ISURF)	X-LOCATION OF CRITICAL RETURN FLUX SURFACE,ISURF (INCHES)	MDF
XOOC	SAME AS XLOS OR XO DEPENDING ON APPLICATION (INCHES)	GOMTRY
YAW	NOT USED IN THIS MODEL	MDF
YLOS(LOS)	Y-LOCATION OF LOS ORIGIN (INCHES)	MDF
YO(ISURF)	Y-LOCATION OF CRITICAL RETURN FLUX SURFACE,ISURF	MDF
YOOC	SAME AS YLOS OR YO DEPENDING ON APPLICATION (INCHES)	GOMTRY
ZLOS	Z-LOCATION OF LOS ORIGIN (INCHES)	MDF
ZO	Z-LOCATION OF CRITICAL RETURN FLUX SURFACE,ISURF (INCHES)	MDF
ZOOC	SAME AS ZLOS OR ZO DEPENDING ON APPLICATION (INCHES)	GOMTRY

SECTION 3
INPUT

A comprehensive set of input instructions are contained in this section. The user options are described in subsection 3.1 followed by a detailed definition of variables that can be controlled through user input. This section also defines the units required for input variables and the permanent data files required for SO/SL contamination analysis. The minimum input data required to run the program is illustrated in Figure 3-1. With this deck all input parameters default to internally set values. To deviate from the default parameters, the user simply inserts cards (prior to the respective GO cards) which redefine the appropriate variables.

3.1 EXECUTIVE INPUT

The executive segment of the program requests a definition of the type of contamination analysis the user desires to conduct. Following the problem title card, logical (true or false) control parameters are read in via namelist format to set the stage for the analysis.

* * * TITLE CARD * * *

Format
(12A6)

Variable	Column	Contents
• TITLE	1-72	Title for the analysis. Each run in stacked data stream must begin with a title card. If STOP appears on the title card, execution terminates.

* * * NAMELIST CONTROL * * *

3.1.1 Type of Analysis

$CONTRL	
• DEPSIT = .T./.F. (FALSE)*	Computes deposition of contaminants on critical surfaces.

*Denotes the default value assumed by the program.

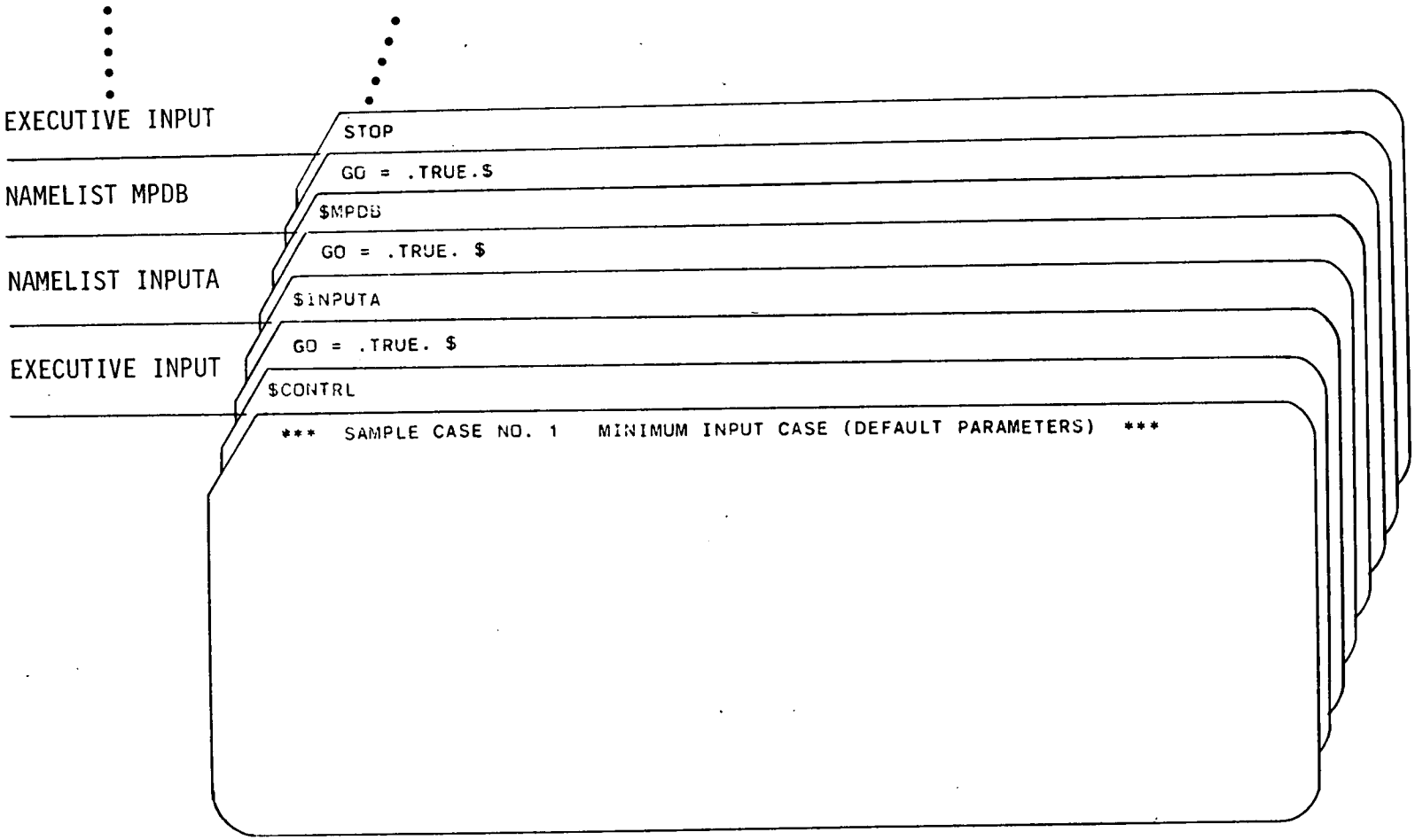


Figure 3-1. Minimum Input Data Deck for Program Execution

Variable	Column	Contents
• MCD = .T./.F. (TRUE)		Computes mass/number column density along a line-of-sight through the cloud of contaminants surrounding the configuration.

3.1.2 Sources of Contamination

• OUT = .T./.F. (TRUE)	Considers outgassing species generally large molecular weight substances.
• ED = .T./.F. (FALSE)	Considers gases usually defined as species that undergo early desorption from a surface placed in vacuum conditions (H_2O, N_2, CO_2, O_2).
• ENG = .T./.F. (FALSE)	Considers eight gases (H_2O, N_2, CO_2, O_2, CO, H_2, H, MMH Nitrate) which are the dominant species in the RCS engine exhaust plumes. Specific RCS/VCS engines can be "turned on" later via namelist INPUTA.
• EVAP = .T./.F. (FALSE)	Considers H_2O and allows a flash evaporator to be "turned on" through namelist INPUTA.
• LEAK = .T./.F. (FALSE)	Considers cabin atmospheric species (H_2O, N_2, O_2, CO_2) and allows the user to specify certain surfaces as areas which are diffuse leaks of the Shuttle Orbiter and Spacelab cabin gases.

3.1.3 Transport Mechanisms

• REFLCT = .T./.F. (FALSE)	Considers reflection/re-emission of contaminants originating from other surfaces or concentrated sources. Program will search TAPE 12 for the available mass transport factors.

Variable	Contents
• RFAS = .T./.F. (FALSE)	Considers the return flux of molecules scattered by collisions with ambient species.
• RFSS = .T./.F. (FALSE)	Considers the return flux of molecules scattered by collisions with contaminant species.
• MFPATH = .T./.F. (FALSE)	Attenuates the density of the contaminant cloud as a function of the mean free path of the contaminants. This option should be used with caution because it does not conserve mass flux within a given control volume. (Refer to subsection 2.1.3.2 for further discussion.)

3.1.4 Configurations

• ORBITR = .T./.F. (FALSE)	Considers the STS Orbiter configuration which consists of 184 surfaces, 44 RCS/VCS engines and 2 flash evaporators.
• LMOP = .T./.F. (TRUE)	Considers the Long Module/One Pallet configuration of Spacelab which consists of 69 surfaces and 1 condensate vent.
• SMTP = .T./.F. (FALSE)	Considers the Short Module/Three Pallet configuration of Spacelab which consists of 91 surfaces and 1 condensate vent.
• FIVP = .T./.F. (FALSE)	Considers the Five Pallet configurtion of Spacelab which consists of 82 surfaces.

3.1.5 Surface Temperatures

The temperature assigned to a surface determines the rate at which mass is lost from the surface, the most probable velocity of the species as they travel away from the surface and the condensation or sticking coefficient of the surface.

Average orbital surface temperatures have been computed by Teledyne Brown for Spacelab and by JSC for the Shuttle Orbiter configuration in several types of orbits. Data for a solar inertial, top (+Z) to sun, $\beta = 90^{o}$ orbit is used to provide the maximum temperature for the surfaces and a X-POP, -Z LV, tail to sun, $\beta = 90^{o}$ type of orbit is used to provide the minimum surface temperatures.

Variable	Contents
• MINTMP = .T./.F. (FALSE)	Uses the minimum temperatures for surfaces.
• MAXTMP = .T./.F. (TRUE)	Uses maximum temperatures for surfaces.

If the user desires another vehicle attitude or set of surface temperatures, the attitude code flag (ATCODE) can be set to a non-zero value and a new set of temperatures will be read from TAPE 10.

• ATCODE = 1, 2, 3, 4, 5	Uses surface temperature profiles corresponding to other vehicle attitudes. NOTE: At the present time, data have been inserted on TAPE 10 for only two vehicle attitudes. Provisions have been made to read new surface temperatures from cards and update or add to the permanent file - see NEWTNL and NEWTCD in subsection 3.1.6.

3.1.6 New Data

The computer model was designed to operate with a minimum amount of input from the user. Once the type of analysis has been defined, detailed input information is extracted from permanent files or block data. However, specific data can be overriden or supplied completely by the user if desired. The program was designed to be primarily an analysis tool for the Shuttle Orbiter and Spacelab configurations, however, it can also be used to evaluate generalized configurations if the user supplies the necessary data. These new data can be read from cards if certain executive control parameters are activated.

Variable	Contents
• NEWCON = .T./.F. (FALSE)	New Configuration Data - Configuration data consist of a definition of the sources of contamination and the surfaces critical to contaminant deposits. (Unverified option.) Each surface source is assigned an identification number (IDENT), a location code (SECT), a materials code (MATRL) and a surface area in square inches (AREA). To alter or add to this information, the user activates the flag NEWCON which allows formatted cards to be read (see subsection 3.2 for detailed data). These data can simply update a source in one of the existing Orbiter/Spacelab configurations or define an entirely new configuration if ORBITR, LMOP, SMTP and FIVP are set .FALSE.
• NEWMLC = .T./.F. (FALSE)	New Mass Loss Characteristics - Mass loss characteristics for 11 spacecraft materials are stored internally as block data. However, if NEWMLC is set .TRUE., new data can be read from cards via namelist INPUTB.
• NEWTCD - .T./.F. (FALSE)	New Temperatures From Formatted Cards - A permanent file is normally attached as TAPE 10 that contains a definition of the surface temperatures for various vehicle attitudes. If NEWTCD is set = .TRUE., TAPE 10 can be updated with information from cards. A supplemental program is available to translate MSFC and JSC thermal model surface numbers and temperatures to surface numbers and temperatures required for the SPACE

Variable	Contents
• NEWTCD = .T./.F. (cont'd) (FALSE)	Program. If NEWTCD is set .TRUE., the data stream must contain at least one formatted card and a blank terminator.
• NEWTNL = .T./.F. (FALSE)	New Temperatures Via Namelist Format - Individual surface temperatures can also be modified for a particular run without updating the permanent file. This can be accomplished if NEWTNL is set .TRUE. Namelist and INPUTC are read which allows the user to define individual surface temperatures.
• NEWMFS = .T./.F. (FALSE)	New Mass Transport Factors Between Surfaces - The transport of mass from one surface to another surface including all shadowing or blocking effects is precalculated as a mass transport factor (analogous to a radiation viewfactor). Normally, a permanent file is attached as TAPE 12 that contains this information for the SO/SL configurations. However, if a new configuration is desired, data can be read from cards if NEWMFS = .TRUE.
• NEWMFP = .T./.F. (FALSE)	New Mass Transport Factors to Points in Space - The transport of mass from the spacecraft surfaces to points in space surrounding the spacecraft is defined by mass transport factors to infinitesimal spheres located in a basic spatial array. This information has been precalculated for the SO/SL configurations and is normally attached as TAPE 14 and TAPE 15. TAPE 14 and 15 are then used to generate a name addressable random mass storage file called TAPE 13. After the random file is generated, NEWMFP is turned off so the random file is not regenerated for subsequent cases in the run stream.

3.1.7 Output Report Control

- REPORT (I) = .T./.F.

The executive segment requests a definition of the output reports to be generated during the analysis. The number of reports of course depends on the detail desired by the user. A list of sample output reports is given in the table below. Actual output report descriptions can be found in Section 4. Default assumes only the reports flagged with an asterick (*) are to be generated.

Report No. (I)[†]	Contents
*01	Listing of Input Control Parameters
02	Preset List of Surfaces, Engines and Vents
*03	List of Sources to be Evaluated
04	List of Changes to Preset Contaminant Sources
05	List of Mass Loss Rate Coefficients to be Used
06	Modified List of Mass Loss Rate Coefficients
07	List of Surface Temperatures That Will Be Used
*08	List of Mission Data That Will Be Used
09	List of Mass Transport Factor Data - Surface to Points
10	List of Mass Transport Factor Data - Surface to Surface
*11	Physical Characteristics of Surface Sources
12	Surface Characteristics Including Second Sources
13-30	(Currently Inoperative)
31	Output From Line-of-Sight Point Selector
*32	Summary Output From Line-of-Sight Point Selector
*33	Number Column Densities - Enumerated by Source - Highest to Lowest Contributor
34	Mass/Number Column Densities - Sorted by Materials
35	Summary: Mass/Number Column Densities - Listed by Materials
36	Mass/Number Column Densities - Sorted by Locations
37	Summary: Mass/Number Column Densities - Listed by Location
38	(Currently Inoperative)
39	Plot of Density Along Line-of-Sight

[†]If any of the MCD/NCD reports (Reports 33-39) is requested i.e., for return flux computations, a single line-of-sight will be used to estimate the properties within the field-of-view.

Report No. (I)	Contents
40	(Currently Inoperative)
41	Return Flux Enumerated by Source - Highest to Lowest Contributor
*42	Return Flux Enumerated by Source - Sorted by Type of Material
*43	Summary: Return Flux - Listed by Material Type
44	Return Flux Enumerated by Source - Sorted by Location
45	Summary: Return Flux - Listed by Location
46	Return Flux Due to Self-Scattering
*47	Return Flux Deposition
48-49	(Currently Inoperative)
*50	Final Prediction Summary (currently inoperative)

- DBUGA = .T./.F. (FALSE)
- DBUGB = .T./.F. (FALSE)
- DBUGC = .T./.F. (FALSE)
- DBUGD = .T./.F. (FALSE)
- DBUGE = .T./.F. (FALSE)

In addition to the nominal output reports, debug options exist for each of the primary overlays or segments. This allows the user to obtain additional printout on TAPE 8 for intermediate computational steps or to monitor complex data manipulations. Only the debug flag for the segment being examined should be activated to avoid excessive output.

3.1.8 Mission Time Interval

- TSTART = HR, MIN, S (10., 0., 0.)
- TSTOP = HR, MIN, S (10., 0., 1.)

This input establishes the mission time slice for which the evaluation is to be conducted. The maximum interval selected should encompass only those periods where all parameters (such as surface temperatures, orbital altitude, vehicle attitude, mass loss rates, etc.) remain essentially constant. As these parameters vary, additional time slices should be evaluated. Time is referenced from lift off and it is assumed that significant

Variable	Contents
• TSTOP = HR, MIN, S (cont'd) (10., 0., 1.)	outgassing does not occur until the vehicle has reached an altitude where the ambient pressure is on the order of 10^{-3} Torr. This condition exists around 3 - 4 minutes after liftoff. Three minutes are then subtracted from the mission time to arrive at an actual time "on-orbit" for outgassing/desorption. The rate at the beginning of the time slice is used throughout the time interval.

3.1.9 Run Continuation Control Card

• GO = .T./.F. $END	The user can terminate the analysis at several intermediate points to examine the preset input data before continuing. If GO is set = .TRUE.,the analysis will proceed to the next gate.

3.2 DETAILED INPUT DESCRIPTION

The function of collecting data and initializing parameters is carried out by the routine COLLCT. If the Shuttle Orbiter configuration is to be analyzed, the routine BLCKA will be called. If the Spacelab configurations are to be used, BLCKB will be called. At this point, the user can zero out or eliminate preset surfaces via namelist $INPUTA.

* * * NAMELIST INPUTA * * *

3.2.1 Source List Modification

$INPUTA

- SURFSC(I) = (all surfaces) — Surface Sources - This array contains a list of the identification numbers of surfaces to be considered as sources. Individual surfaces can be eliminated (see Table 3-I for the Shuttle/Orbiter listing) e.g. SURFSC (10) = 0, would eliminate radiator surface 42. SURFSC (74) = 0, would eliminate wing area 104. Additional listings of preset configurations can be obtained by initiating the analysis and not setting the run continuation .TRUE. in NAMELIST MPDB.

- SSURFS(I) = (all surfaces) — Second Surface Sources - This array contains a list of surfaces that will be allowed to reflect/re-emit material arriving from secondary sources. This array will be ignored if the reflection/re-emission transport mechanism flag, REFLCT, is set = .FALSE.

- PNTSC(I) = (all engines/vents) — Point Sources - This array contains the identification numbers of the Orbiter RCS main and Vernier engines, flash evaporators and OMS engines. In an attempt to retain identity with the existing three digit Rockwell International (RI) engine numbers and prevent confusion with Orbiter surface numbers, the RCS engines are denoted by a 7000 series of numbers where the last three-digits are the RI engine number - i.e., engine 115⟶7115. Correspondingly, the VCS are in the 8000 series, the OMS engines are in the 9000 series and the evaporators are in the 6000 series.

Table 3-I. Preset List of Surfaces, Engines and Vents

* * * SURFACES * * *

SEQUENCE NO.	IDENT NO.	SECTION	MATERIAL	AREA (SQ IN)
1	20	RADOOR	TEFLON	12200.
2	22	RADOOR	TEFLON	12200.
3	24	RADOOR	TEFLON	12200.
4	26	RADOOR	TEFLON	12200.
5	30	RADOOR	TEFLON	12200.
6	32	RADOOR	TEFLON	12200.
7	34	RADOOR	TEFLON	12200.
8	36	RADOOR	TEFLON	12200.
9	40	RADOOR	TEFLON	25580.
10	42	RADOOR	TEFLON	25580.
11	44	RADOOR	TEFLON	25580.
12	46	RADOOR	TEFLON	25580.
13	50	RADOOR	TEFLON	25580.
14	52	RADOOR	TEFLON	25580.
15	54	RADOOR	TEFLON	25580.
16	56	RADOOR	TEFLON	24990.
17	21	FUSLAG	LRSI	12200.
18	23	FUSLAG	LRSI	12200.
19	25	FUSLAG	LRSI	12200.
20	27	FUSLAG	LRSI	12200.
21	31	FUSLAG	LRSI	12200.
22	33	FUSLAG	LRSI	12200.
23	35	FUSLAG	LRSI	12200.
24	37	FUSLAG	LRSI	12200.
25	41	FUSLAG	LRSI	25580.
26	43	FUSLAG	LRSI	25580.
27	45	FUSLAG	LRSI	25580.
28	47	FUSLAG	LRSI	25580.
29	51	FUSLAG	LRSI	24990.
30	53	FUSLAG	LRSI	24990.
31	55	FUSLAG	LRSI	24990.
32	57	FUSLAG	LRSI	24990.
33	202	FUSLAG	LRSI	32520.
34	203	FUSLAG	LRSI	32520.
35	230	FUSLAG	LRSI	25730.
36	240	FUSLAG	LRSI	16340.
37	241	FUSLAG	LRSI	16340.
38	250	FUSLAG	LRSI	19580.
39	260	FUSLAG	LRSI	20240.
40	301	FUSLAG	LRSI	26600.
41	305	FUSLAG	LRSI	30930.
42	306	FUSLAG	NOMEX	30930.
43	307	FUSLAG	NOMEX	24770.
44	311	FUSLAG	LRSI	26600.
45	315	FUSLAG	LRSI	30930.
46	316	FUSLAG	NOMEX	30930.
47	317	FUSLAG	NOMEX	24770.
48	420	FUSLAG	LRSI	1312.
49	425	FUSLAG	LRSI	1312.
50	60	OMS	LRSI	1145.
51	62	OMS	LRSI	7850.

Table 3-I. Preset List of Surfaces, Engines and Vents (cont'd)

52	64	OMS	LRSI	37920.
53	66	OMS	LRSI	1991.
54	67	OMS	LRSI	2028.
55	68	OMS	LRSI	415.
56	70	OMS	LRSI	895.
57	72	OMS	LRSI	1406.
58	74	OMS	LRSI	1312.
59	76	OMS	LRSI	715.
60	77	OMS	LRSI	600.
61	80	OMS	LRSI	1145.
62	82	OMS	LRSI	7813.
63	84	OMS	LRSI	37740.
64	86	OMS	LRSI	1991.
65	87	OMS	LRSI	2028.
66	88	OMS	LRSI	415.
67	90	OMS	LRSI	895.
68	92	OMS	LRSI	1406.
69	94	OMS	LRSI	1312.
70	96	OMS	LRSI	715.
71	97	OMS	LRSI	601.
72	100	WING	NOMEX	6356.
73	102	WING	NOMEX	29590.
74	104	WING	NOMEX	9125.
75	110	WING	NOMEX	23340.
76	112	WING	NOMEX	19380.
77	115	WING	LRSI	19280.
78	117	WING	HRSI	5650.
79	118	WING	HRSI	2508.
80	119	WING	LRSI	3302.
81	121	WING	RCC	2251.
82	122	WING	RCC	3123.
83	130	WING	NOMEX	6356.
84	132	WING	NOMEX	29590.
85	134	WING	NOMEX	9125.
86	140	WING	NOMEX	23340.
87	142	WING	NOMEX	19380.
88	145	WING	LRSI	19280.
89	147	WING	HRSI	5650.
90	148	WING	HRSI	2508.
91	149	WING	LRSI	3302.
92	151	WING	RCC	2251.
93	152	WING	RCC	3123.
94	106	ELEVON	NOMEX	6499.
95	107	ELEVON	NOMEX	17210.
96	136	ELEVON	NOMEX	6499.
97	137	ELEVON	NOMEX	9125.
98	450	ELEVON	NOMEX	138.
99	451	ELEVON	NOMEX	415.
100	452	ELEVON	NOMEX	692.
101	453	ELEVON	NOMEX	960.
102	454	ELEVON	NOMEX	1246.
103	455	ELEVON	NOMEX	1523.
104	456	ELEVON	NOMEX	1800.
105	457	ELEVON	NOMEX	2076.
106	458	ELEVON	NOMEX	2353.
107	459	ELEVON	NOMEX	2630.

Table 3-I. Preset List of Surfaces, Engines and Vents (cont'd)

108	460	ELEVON	NOMEX	138.
109	461	ELEVON	NOMEX	415.
110	462	ELEVON	NOMEX	692.
111	463	ELEVON	NOMEX	969.
112	464	ELEVON	NOMEX	1246.
113	465	ELEVON	NOMEX	1523.
114	466	ELEVON	NOMEX	1800.
115	467	ELEVON	NOMEX	2076.
116	468	ELEVON	NOMEX	2353.
117	469	ELEVON	NOMEX	2630.
118	160	CREW	RCC	7191.
119	161	CREW	LRSI	9348.
120	162	CREW	LRSI	9348.
121	163	CREW	LRSI	3380.
122	164	CREW	LRSI	3380.
123	165	CREW	LRSI	4253.
124	166	CREW	LRSI	4253.
125	167	CREW	HRSI	12590.
126	168	CREW	HRSI	12590.
127	169	CREW	HRSI	9600.
128	170	CREW	HRSI	9600.
129	171	CREW	HRSI	3705.
130	172	CREW	HRSI	3705.
131	174	CREW	LRSI	20720.
132	175	CREW	LRSI	10150.
133	177	CREW	LRSI	10150.
134	180	CREW	WINDOW	1424.
135	181	CREW	WINDOW	1424.
136	182	CREW	WINDOW	1424.
137	183	CREW	WINDOW	1424.
138	184	CREW	WINDOW	1424.
139	185	CREW	WINDOW	1424.
140	190	CREW	LRSI	10250.
141	380	TAIL	LRSI	16920.
142	381	TAIL	LRSI	16920.
143	382	TAIL	LRSI	8833.
144	383	TAIL	LRSI	8833.
145	384	TAIL	LRSI	13940.
146	385	TAIL	LRSI	13940.
147	386	TAIL	LRSI	6116.
148	387	TAIL	LRSI	6116.
149	388	TAIL	LRSI	2744.
150	389	TAIL	LRSI	2744.
151	390	TAIL	LRSI	1160.
152	391	TAIL	LRSI	1160.
153	392	TAIL	LRSI	3081.
154	393	TAIL	LRSI	3081.
155	399	TAIL	HRSI	3823.
156	1	BAY	LINER	26620.
157	2	BAY	LINER	26620.
158	3	BAY	LINER	26620.
159	4	BAY	LINER	26620.
160	5	BAY	LINER	26620.
161	6	BAY	LINER	26620.
162	7	BAY	LINER	26620.
163	8	BAY	LINER	26620.
164	11	BAY	BLKHED	32690.
165	13	BAY	BLKHED	32690.
166	440	BAY	LINER	3444.

Table 3-I. Preset List of Surfaces, Engines and Vents (cont'd)

167	441	BAY	LINER	3444.
168	442	BAY	LINER	3444.
169	443	BAY	LINER	3444.
170	445	BAY	LINER	3444.
171	446	BAY	LINER	3444.
172	447	BAY	LINER	3444.
173	448	BAY	LINER	3444.

* * * ENGINE OPERATION * * *

SEQUENCE NO.	IDENT NO.	LOCATION	TYPE	ON-TIME (SEC)
1	7112	FLF -X	RCS	1.000
2	7122	FCF -X	RCS	1.000
3	7132	FRF -X	RCS	1.000
4	7123	FLS +Y	RCS	1.000
5	7113	FLS +Y	RCS	1.000
6	7115	FLU +Z	RCS	1.000
7	7125	FCU +Z	RCS	1.000
8	7135	FRU +Z	RCS	1.000
9	7116	FLD -Z	RCS	1.000
10	7126	FLD -Z	RCS	1.000
11	7144	FRS -Y	RCS	1.000
12	7134	FRS -Y	RCS	1.000
13	7136	FRD -Z	RCS	1.000
14	7146	FRD -Z	RCS	1.000
15	7211	ALA +X	RCS	1.000
16	7231	ALA +X	RCS	1.000
17	7243	ALS +Y	RCS	1.000
18	7223	ALS +Y	RCS	1.000
19	7233	ALS +Y	RCS	1.000
20	7213	ALS +Y	RCS	1.000
21	7245	ALU +Z	RCS	1.000
22	7225	ALU +Z	RCS	1.000
23	7215	ALU +Z	RCS	1.000
24	7246	ALD -Z	RCS	1.000
25	7226	ALD -Z	RCS	1.000
26	7236	ALD -Z	RCS	1.000
27	7311	ARA +X	RCS	1.000
28	7331	ARA +X	RCS	1.000
29	7344	ARS -Y	RCS	1.000
30	7324	ARS -Y	RCS	1.000
31	7334	ARS -Y	RCS	1.000
32	7314	ARS -Y	RCS	1.000
33	7345	ARU +Z	RCS	1.000
34	7325	ARU +Z	RCS	1.000
35	7315	ARU +Z	RCS	1.000
36	7346	ARD -Z	RCS	1.000
37	7326	ARD -Z	RCS	1.000
38	7336	ARD -Z	RCS	1.000
39	8116	FLD -Z	VCS	1.000
40	8136	FRD -Z	VCS	1.000
41	8257	ALD -Z	VCS	1.000
42	8258	ALS +Y	VCS	1.000
43	8357	ARD -Z	VCS	1.000
44	8358	ARS +Y	VCS	1.000
45	6877	ARS +Y	EVAP1	1.000
46	6879	ALS -Y	EVAP1	1.000

Variable	Content
• ONTIME(I) = (0.0 sec except for evaporators ONTIME(45) = .43 ONTIME(46) = .43)	"On Time" of Point Sources - This array defines the operation time in seconds of each concentrated source identified in the array PNTSC.
• RFSURF(I) = (none)	Return Flux Surfaces - This array contains the identification numbers of the surfaces that are susceptible to the return flux of contaminants. RFSURF(1) = 1120, would indicate surface number 1120 is to be the first surface examined for return flux. Up to a total of 10 surfaces can be flagged for return flux.
• GO = .T./.F. (FALSE)	Run continuation parameter. If set = .TRUE., the analysis will proceed to the next gate.

$END

* * * NEW CONFIGURATION CARDS * * *
(Ignore this section if NEWCØN = .FALSE.)

3.2.2 Configuration Modification

Format
(2I10, 2A10, F10.0)

Variable	Column	Contents
• I	1 - 10	Sequence number of this set of surface information. The variable, I, can relate to a sequence number of the preset configuration and subsequently override the preset information or if I is set to a number greater than the last sequence number of the preset configuration, surfaces can be added. If a new configuration is to be read in, start I at 1.

Variable	Column	Contents
• IDENT(I)	11-20	Identification number of the surface.
• SECT(I)	21-30	Location of surface.
• MATRL(I)	31-40	Name of surface material.
• AREA(I)	41-50	Area of the surface (in^2).

* * * NAMELIST INPUTB * * *
(Ignore this section if NEWMLC = .FALSE.)

3.2.3 Mass Loss Characteristics Modification

$INPUTB
(see Table 3-II)

- RATE(K,M) = (see Table 3-II) Data are automatically stored in this array when routine BLCKC is loaded into core. To modify the data simply specify K, the index for the appropriate surface material, M, the index for the appropriate species and the rate at which species M is lost from surface K.
- TAU(K,M) = (see Table 3-II) Time constant used in the mass loss rate expression.
- AGEORB = (0) The age of the STS Orbiter or time previously on orbit (hrs).
- AGELSB = (0) The age of the Spacelab (hrs).
- PLUMEC(L,N) = (see Table 3-II) Plume Distribution Coefficients - see the sources data sheets for an explanation of each of the coefficients L for each type of point source N (Section 2).
- SPECMF(M,N) = (see Table 3-II) Species M mass fraction within the plume of type N.

Table 3-II. Preset List of Mass Loss Rate Characteristics

KINDS

```
**************************
* * MATERIALS  LIST * *
 KINDS=15
 DATA(KKIND(K),K=1,15)
1    /6H LINER,
2     6HTEFLON,
3     6H NOMEX,
4     6H  LRSI,
5     6H  HRSI,
6     6H   RCC,
7     6HBLKHED,
8     6HWINDOW,
9     6H  MTCS,
*     6H  PTCS,
1     6HCRACKS,
2     6H LEAKL,
3     6H LEAKS,
4     6H  NONE,
5     6H  NONE/
```

PLACE

```
*******************************
* * LIST OF SURFACE LOCATIONS * *
 DATA(PLCE(K),K=1,10)
1    /6H   BAY,
2     6H  CREW,
3     6HFUSLAG,
4     6H   OMS,
5     6HRADOOR,
6     6H  TAIL,
7     6H  WING,
8     6HMODULE,
9     6H  PLT1,
*     6H  PLT2/
 DATA(PLCE(K),K=11,20)
1    /6H  PLT3,
2     6H  PLT4,
3     6H  PLT5,
4     6HWINDOW,
5     6HELEVON,
6     6H  BAYL,
7     6H  MODL,
8     6H WINDL,
9     6H  NONE,
*     6H  NONE/
```

SPECIE, MOLWT, DIA

```
*****************************************************************
* * LIST OF SPECIES,MOLECULAR WEIGHTS AND DIAMETERS(CENTIMETERS) * *
* * THAT WILL BE USED TO COMPUTE COLLISION CROSS SECTIONS         * *
* * REFERENCE HIRSCHFELDER,CURTISS AND BIRD
* *
 DATA(SDATA(K),K=1,30/
1    /6H OUTG1,   100.,  7.800E-8,
2     6H OUTG2,   100.,  7.800E-8,
3     6H   H2O,    18.,  3.245E-8,
4     6H    N2,    28.,  4.132E-8,
5     6H   CO2,    44.,  4.485E-8,
6     6H    O2,    32.,  3.853E-8,
7     6H    CO,    28.,  4.029E-8,
8     6H    H2,     2.,  3.331E-8,
9     6H     H,     1.,  2.640E-8,
*     6HMMHNO3,    46.,  4.500E-8/
```

9/77

Table 3-II. Preset List of Mass Loss Rate Characteristics (cont'd)

RATE, TAU

```
 ***  PAYLOAD BAY LINER  ***
 DATA(RTE(1,M),M=1,10)
1                    /8.00E-11,
2                     0.0,
3                     3.30E-10,
4                     2.07E-10,
5                     1.68E-10,
6                     8.00E-11,
7                        4*0.0/
 DATA(TAW(1,M),M=1,10)/2*4100.,8*18./

 ***  TEFLON  ***
 DATA(RTE(2,M),M=1,10)
1                    /5.00E-10,
2                     0.0,
3                     2.10E-09,
4                     1.31E-09,
5                     1.06E-09,
6                     5.00E-10,
7                        4*0.0/
 DATA(TAW(2,M),M=1,10)/2*4100.,8*18./

 ***  NOMEX  ***
 DATA(RTE(3,M),M=1,10)
1                    /1.24E-09,
2                     0.0,
3                     5.21E-09,
4                     3.25E-09,
5                     2.62E-09,
6                     1.24E-09,
7                       4*0.0/
 DATA(TAW(3,M),M=1,10)/2*4100.,8*18./

 ***  LRSI  ***
 DATA(RTE(4,M),M=1,10)
1                    /5.10E-10,
2                     0.0,
3                     2.14E-09,
4                     1.34E-09,
5                     1.08E-09,
6                     5.10E-10,
7                        4*0.0/
 DATA(TAW(4,M),M=1,10)/2*4100.,8*18./

 ***  HRSI  ***
 DATA(RTE(5,M),M=1,10)
1                    /5.20E-10,
2                     0.0,
3                     2.18E-09,
4                     1.36E-09,
5                     1.10E-09,
6                     5.20E-10,
7                        4*0.0/
 DATA(TAW(5,M),M=1,10)/2*4100.,8*18./

 ***  RCC  ***
 DATA(RTE(6,M),M=1,10)
1                    /1.00E-12,
2                     0.0,
3                     4.20E-12,
4                     2.62E-12,
5                     2.12E-12,
6                     1.00E-12,
7                        4*0.0/
 DATA(TAW(6,M),M=1,10)/2*4100.,8*18./

 ***  BULKHEAD  ***
 DATA(RTE(7,M),M=1,10)
1                    /1.00E-09,
2                     0.0,
3                     4.20E-09,
4                     2.62E-09,
5                     2.12E-09,
6                     1.00E-09,
7                        4*0.0/
 DATA(TAW(7,M),M=1,10)/2*4100.,8*18./

 ***  WINDOW  ***
 DATA(RTE(8,M),M=1,10)
1                    /0.0,
2                     0.0,
3                     0.0,
4                     0.0,
5                     0.0,
6                     0.0,
7                    4*0.0/
 DATA(TAW(8,M),M=1,10)/10*4100./

 ***  MTCS  ***
 DATA(RTE(9,M),M=1,10)
1                    /6.00E-09,
2                     0.0,
3                     1.64E-07,
4                     1.02E-07,
5                     8.27E-08,
6                     3.90E-08,
7                        4*0.0/
 DATA(TAW(9,M),M=1,10)/2*4100.,8*18./

 ***  PTCS  ***
 DATA(RTE(10,M),M=1,10)
1                    /6.01E-09,
2                     0.0,
3                     1.64E-07,
4                     1.02E-07,
5                     8.27E-08,
6                     3.90E-08,
7                        4*0.0/
 DATA(TAW(10,M),M=1,10)/2*4100.,8*18./
```

Table 3-II. Preset List of Mass Loss Rate Characteristics (cont'd)

RATE, TAU (cont'd)

```
***  CABIN ATMOSPHERE LEAKS (CRACKS) ***
AREA = 3.27E4 SQ INCHES
DATA(RTE(11,M),M=1,10)
1                    /0.0,
2                     0.0,
3                     1.745E-09,
4                     1.30SE-07,
5                     1.745E-09,
6                     4.014E-08,
7                        4*0.0/
DATA(TAW(11,M),M=1,10)/10*0.0/
```

```
***  LMDP LEAKAGE (LEAKL)***
AREA = 1.937E5 SQ INCHES
DATA(RTE(12,M),M=1,10)
1                    /0.0,
2                     0.0,
3                     2.50E-10,
4                     1.88E-08,
5                     2.50E-10,
6                     5.75E-09,
7                        4*0.0/
DATA(TAW(12,M),M=1,10)/10*0.0/
```

```
***  SMTP LEAKAGE (LEAKS)***
AREA = 1.215E5 SQ INCHES
DATA(RTE(13,M),M=1,10)
1                    /0.0,
2                     0.0,
3                     3.99E-10,
4                     2.99E-08,
5                     3.99E-10,
6                     9.18E-09,
7                        4*0.0/
DATA(TAW(13,M),M=1,10)/10*0.0/
```

PLUMEC

```
LOAD IN THE PLUME FUNCTION COEFICIENTS

  DATA(PFDATA(K),K=1,50)
    C1     C2      C3    THETA1 C5    C6    THETA2 MFLUX VELOC  TYPE
 1 /1351.,10.00,.0126,64.0, 35.0,-.0350,180.,  0.,3.5E+5,6H   RCS,
 2   23.2, 8.65,.0137,40.0,5.810,-.0467,140.,.054,3.5E+5,6H   VCS,
 3  9332.,10.65,.0126,64.0,235.5,-.0350,180.,  0.,3.5E+5,6H   OMS,
 4   4.47, 6.00,.0176,36.8, 1.14,-.0773,148.,.002,1.0E+5,6H EVAP2,
 5  1.963, 6.00,.0106,148.,   0.,    0.,148.,  0.,1.0E+5,6H EVAP1/
```

SPECMF

```
**************************************************************
   LOAD IN THE SPECIES MASS FRACTIONS TO BE USED FOR THE
   SHUTTLE ENGINES AND EVAPORATOR

     DATA(SPDATA(K),K=1,50)
 TYPE OUT1   OUT2  H2O   N2    CO2   O2    CO    H2    H     MMH HNO3
   1 /0.0,   0.0, .290, .420, .078, .001, .184, .017, .001, .002,
   2  0.0,   0.0, .290, .420, .078, .001, .184, .017, .001, .002,
   3  0.0,   0.0, .290, .420, .078, .001, .184, .017, .001, .002,
   4  0.0,   0.0,1.000,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,
   5  0.0,   0.0,1.000,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0/
```

Variable	Contents
• CHNGES = (0)	Number of changes to be made in preset contaminant species. If CHNGES ≠ 0, species names, molecular weights and diameters can be changed by reading the number of formatted cards indicated by CHNGES. These cards should be inserted directly after $END of NAMELIST INPUTB. FORMAT (I3, 1X, A6, E10.3, E10.3) MM = Species Index Number (1-10) SPECIE(MM) = Species Name MOLWT(MM) = Molecular Weight DIA(MM) = Molecular Diameter
• CHNGEK = (0)	Number of changes to preset inventory of kinds of spacecraft materials. If CHNGEK ≠ 0, names of spacecraft materials that will be recognized can be changed by reading the number of formatted cards indicated by CHNGEK. These cards should be inserted directly after species card if CHNGES ≠ 0 or directly after $END of NAMELIST INPUTB if CHNGES = 0. Up to 8 names can be placed on a card. FORMAT (8 (I3, 1X, A6)) KK = Index Number of Spacecraft Material KIND(KK) = Name of Spacecraft Material
• CHNGEP = (0)	Number of changes to preset basic locations or places on the spacecraft. If CHNGEP ≠ 0, new names can be read from formatted cards placed directly behind material cards (if CHNGEK ≠ 0) or behind species cards (if CHNGES ≠ 0) or directly behind $END of NAMELIST INPUTB if CHANGES = 0 and CHNGEK = 0. Up to 8 names can be placed on a card. FORMAT (8 (I3, 1X, A6)) LL = Index Number of Spacecraft Location PLACE(LL) = Name of Spacecraft Location
• MOUT1 = (1)	Index of first specie that is considered an outgassing specie.

Variable	Contents
• MOUT2 = (2)	Index of last specie that is considered on outgassing molecule.
• MED1 = (3)	Index of first specie considered as an early desorption type of contaminant.
• MED2 = (6)	Index of last specie considered as an early desorption type of molecule.
• M1 = (1)	Index of first specie considered.
• M2 = (10)	Index of last specie to be considered.

$END

* * * NEW TEMPERATURES FROM CARDS * * *
(Ignore this section if NEWTCD = .FALSE.)

3.2.4 Surface Temperature Permanent File Update - The temperature file is normally attached as TAPE 10. The following cards are read onto a scratch file (TAPE 11) and then used to update TAPE 10. (See subsection 2.5.1 for a listing of this permanent file.)

Format (I5, 7F10.2)	Column	Contents
• ISURF	1-5	Surface identification number.
• TMAX	6-15	Temperature of surface for hot orbit case (^{o}C).
• TMIN	16-25	Temperature for cold orbit case (^{o}C)
• T1	26-35	Temperature for orbit 1.
• T2	36-45	Temperature for orbit 2.
• T3	46-55	Temperature for orbit 3.
• T4	56-65	Temperature for orbit 4.
• T5	66-75	Temperature for orbit 5.

NOTE: Additional surfaces require additional cards. Terminate the temperature data with a blank card.

* * * NAMELIST INPUTC * * *
(Ignore this section if NEWTNL = .FALSE.)

3.2.5 Surface Temperature Modification Via Namelist

$INPUTC

- TEMP(ISURF) (see Table 2-XI) = Temperature of surface number ISURF. ISURF must be a number less than 2,000 due to core constraints. Therefore, if either SMTP or FIVP surface temperatures are to be modified via namelist, the program assumes the user will subtract 1,000 or 2,000 respectively from the original surface identification number and input result as ISURF.

* * * NAMELIST MPDB * * *

3.2.6 Mission Profile Data Bank Modification - A standard mission profile data bank is automatically set by block data. The user, however, can and should override these data for other analyses.

$MPDB

- ALT = (400.) — Altitude on-orbit (km).
- SUNL = .T./.F. (FALSE) — Selects low sunspot activity in determination of ambient atmosphere density. Note - set only one of three sun activity flags to .TRUE. for any calculation.
- SUNM = .T./.F. (TRUE) — Selects medium sunspot activity in determination of ambient atmosphere density.
- SUNH = .T./.F. (FALSE) — Selects high sunspot activity in ambient atmosphere density determination.
- VX = (0.) — Velocity component of incoming ambient species along the spacecraft X-axis (m/s).
- VY = (0.) — Velocity component in the Y-direction (m/s).

Variable	Contents
• VZ = (-7650.)	Velocity component in the Z-direction (m/s).
* * * PARAMETERS REQUIRED FOR MCD/NCD ANALYSIS * * *	
• NLOS = (1)	Number of lines-of-sight to be evaluated.
• XLOS(I) = (1107.)	X-location (in the spacecraft coordinate system) of the origin of LOS number I. Up to 25 lines-of-sight can be evaluated at a time (in).
• YLOS(I) = (0.)	Y-location of the LOS origin (in).
• ZLOS(I) = (507.)	Z-location of the LOS origin (in).
• THETAL(I) = (see Table 3-III)	The angle made by the LOS number I relative to the Z-axis using the usual spherical coordinate convention (deg). $0 \leq \theta \leq 90$.
• PHIL(I) = (see Table 3-III	The angle of the LOS number I relative to the X-axis as in spherical coordinates (deg). $0 \leq \phi \leq 360$.
• RMAXL = (150)	Maximum radius from spacecraft origin that precalculated mass transport factors to points in space will be used. Beyond RMAXL the MTF is assumed to vary as $1/r^2$ (meters).
• DSMCD (25) = (see Table 3-III)	Length of segments to be used along line-of-sight for integrating mass/number column density. For an accurate integration, it is suggested that small (approximately 5m) increments be used in the near vicinity of the spacecraft. Up to 25 segments can be defined (meters).

Variable	Contents
* * * PARAMETERS REQUIRED FOR RETURN FLUX ANALYSIS * * *	
• XØ(I) = (1107.)	X-location of surface I.
• YØ(I) = (0.)	Y-location of surface I.
• ZØ(I) = (507.)	Z-location of surface I
• COSXX(I)* = (1.)	Direction cosine between the X-axis of surface I and the X-axis of the spacecraft, i.e., if the two axis coincide, COSXX(I) = 1.0.
• COSXY(I) = (0.)	Direction cosine between the X-axis of surface I and the Y-axis of the spacecraft.
• COSXZ(I) = (0.)	Direction cosine between the X-axis of surface I and the Z-axis of the spacecraft.
• COSYX(I) = (0.)	Direction cosine between the Y-axis of surface I and the X-axis of the spacecraft.
• COSYY(I) = (1.)	Direction cosine between the Y-axis of surface I and the Y-axis of the spacecraft.
• COSYZ(I) = (0.)	Direction cosine between the Y-axis of surface I and the Z-axis of the spacecraft.
• COS ZX(I) = (0.)	Direction cosine between the Z-axis (assumed normal to the surface) of surface I and the X-axis of the spacecraft.

*See section 5.2 for further explanation of direction cosine inputs.

Variable	Contents
• COSZY(I) = (0.)	Direction cosine between the Z-axis (assumed normal to the surface) of surface I and the Y-axis of the spacecraft.
• COSZZ(I) = (1.)	Direction cosine between the Z-axis (assumed normal to the surface) of surface I and the Z-axis of the spacecraft.
• THETA1(I) = (0.)	Angle off surface Z-axis where surface field-of-view (FOV) begins (deg).
• THETA2(I) = (10.24)	Angle off Z-axis where FOV terminates (deg).
• PHI1(I) = (0.)	Angle measured from surface I X-axis moving toward Y-axis where FOV begins (deg).
• PHI2(I) = (360.)	Angle measured from surface I X-axis where FOV terminates.
• DTHETA(I) = (10.24)	Increment in THETA to be used to subdivide FOV for volume integration (deg).
• DPHI(I) = (45.)	Increment in PHI to be used to subdivide FOV (deg).
• DOMEGA(I) = (.1)	Increment in solid angle that will be used to perform volume integration. DOMEGA can override DPHI(sr).
• DS(L) = (see Table 3-III)	Radial distance between midpoints of volume elements used in integrating return flux contributions (meters).
• RMAXRF = (150.)	Maximum distance from spacecraft origin that precalculated mass transport factors will be used. Beyond RMAXRF, a $1/r^2$ variation will be assumed (meters).

Table 3-III. Preset List of Mission Profile Data Bank Parameters

```
 DATA(DSMCD(I),I=1,25)
1/2.5.9*5.,15.,25.,37.5.50.,124.,10*0./

 DATA(DSRTNF(I),I=1,12)
1/2.5.9*5.,15.,25.,37.5.50.,124.,10*0./

DATA(XLOS(I),I=1,25)/25*1107./
DATA(YLOS(I),I=1,25)/25*0./
DATA(ZLOS(I),I=1,25)/25*507./
DATA(THETAL(I),I=1,25)/0.,30.,60.,30.,60.,30.,60.,30.,60.,30.,60.,
.     30.,60.,30.,60.,30.,60.,8*82.5/
DATA(PHIL(I),I=1,25)/0.,0.,0.,45.,45.,90.,90.,135.,135.,180.,
.     180.,225.,225.,270.,270.,315.,315.,0.,45.,90.,135.,180.,225.,
.     270.,315./
DATA(X0(I),I=1,10)/10*1107./
DATA(Y0(I),I=1,10)/10*0./
DATA(Z0(I),I=1,10)/10*507./
DATA(THETA1(I),I=1,10)/10*0./
DATA(THETA2(I),I=1,10)/10*10.24/
DATA(PHI1(I),I=1,10)/10*0./
DATA(PHI2(I),I=1,10)/10*360./
RMAXL= 150
RMAXRF = 150
ALT    = 400.
VX = 0.0
VY = 0.0
VZ = -7650.
SUNL = .FALSE.
SUNM = .TRUE.
SUNH = .FALSE.
VFACTR = 3.
```

Variable	Contents
• VFACTR = (3.)	Factor that can be applied to all collision cross section computations to adjust viscosity derived data. Currently used as a constant but eventually will become a function of the center-of-mass velocity of the colliding particles.
• RFSTK = (1.0)	Sticking coefficient for RFAS and RFSS. Falls between 0 and 1 (see subsection 2.1.3.4).
• JKEEP = (300)	To minimize unnecessary computations, the user can select to evaluate only the dominant surfaces based upon their total mass loss rate. If only the 10 most significant surfaces are of interest, set JKEEP = 10.

Variable	Contents
• GO = .T./.F. (FALSE)	The user can opt to merely set up a configuration, insert temperatures, rate constants and compute mass loss rates and then terminate the run to check the input data before performing deposition, column density or return flux calculation by not giving a go-ahead. If GO is set = .TRUE. the analysis will proceed.

$END

* * * NEW MASS TRANSPORT FACTORS TO SURFACES * * *
(Ignore this section if NEWMFS = .FALSE.)

3.2.7 Mass Transport Factor Permanent File - Normally mass transport factors between SO/SL surfaces will be stored on a permanent file and attached as TAPE 12. However, if a new TAPE 12 is to be generated set NEWMFS = .TRUE.

Format
(2I10, 6E10.3)

• NODEI	1-10	Receiving surface identification number.
• NODEJ	11-20	Source identification number.
• MTFIJ	21-30	Mass transport factor that defines the fraction of mass leaving surface J that arrives at surface I.
• MTFJI	31-40	Mass transport factor that defines the fraction of mass leaving surface I that arrives at surface J.
• AREAJ	41-50	Area of surface J (in^2).
• THETAI	51-60	The angle between the normal to surface I and the vector drawn between surface I and source J (deg).

Variable	Column	Contents
• THETAJ	61-70	The angle between the normal to surface J and the vector connecting I and J (deg).
• R	71-80	Distance between I and J (in).

3.2.8 Run Termination - This completes the data stream for one run. Cases can be stacked by inserting a new TITLE card, NAMELIST CONTRL, etc. Only those parameters that change need to appear in the new data set.

The analysis terminates when STOP is placed on a title card.

3.2.9 Additional Permanent Files

* * * MASS TRANSPORT FACTORS TO POINTS IN SPACE * * *

These data do not appear in the normal input data stream (TAPE 5) but instead are attached as TAPE 14 and TAPE 15 for the Orbiter and Spacelab respectively.

Format
(2I10, 6E10.3)

• IPOINT	1-10	Identification number of the point in space. This is a 5 digit code as described in section 2.1.3.1.
• NODEJ	11-21	Source identification number.
• MTFIJ	21-30	Mass transport factor that defines the fraction of mass leaving surface J per unit area per second that arrives at a point in space.
• MTFJI	31-40	Not used.
• AREAJ	41-50	Area of surface J (in^2).
• THETAI	51-60	Not used.

Variable	Column	Contents
• THETAJ	61-70	Angle between the normal to source J and the vector connecting source J and the point IPOINT (deg).
• R	71-80	Distance between J and IPOINT (in).

The number of sources contributing mass to IPOINT can vary (up to 300), however, a blank card is required between blocks of data for different IPOINT values.

SECTION 4
OUTPUT

This section contains a discussion of the available model output options of the SPACE Program. The type and format of the model output are selected by the user through input commands in the executive segment of the program. By setting the desired output REPORT numbers to .TRUE., the user automatically establishes the level of detail and the output format displayed. Executive input requirements for this segment are discussed in subsection 3.1.7.

The SPACE Program output is categorized into three major groups which are: 1) model input data display; 2) model output prediction display and 3) debug output. These are discussed in the following subsections along with an explanation of the nomenclature and terms presented in the normal output.

4.1 OUTPUT NOMENCLATURE AND TERMS

Due to space limitations and computer printer capability constraints, certain abbreviations and symbols have been used in the standard model output. These terms are presented below along with an explanation of the meaning for each.

OUTPUT SYMBOL	INTERPRETATION
AGEORB	Accumulative Time On-Orbit of Orbiter Prior to This Mission In Hours
AGESLB	Accumulative Time On-Orbit of Spacelab Prior to This Mission In Hours
ALU	Engine Location/Firing Direction - Aft Left Upward +Z Firing
AMBND	Density of the Ambient Atmosphere in molecules/cm^3
ARA	Engine Location/Firing Direction - Aft Right - Aft Firing
AREA	Surface Area in in^2 or cm^2

OUTPUT SYMBOL	INTERPRETATION
BAYL	Location Designator for Bay Leakage Source
CM**2	cm^2
CO	Carbon Monoxide
CO2	Carbon Dioxide
DEG	Degrees
DEG C	^oC
DOMEGA	$d\Omega$ - Solid Angle Increment Used to Subdivide Surface Field-of-View
EARLY DESORPTION	Denotes Contribution From H_2O, N_2, CO_2 O_2 (MED1 $\leq$ M $\leq$ MED2)
FCU	Engine Location/Firing Direction - Forward Center-Firing Upward
FLS	Engine Location/Firing Direction - Forward Left-Side Firing
G or GM	Grams
H	Atomic Hydrogen
H2	Diatomic Hydrogen
H2O	Water
IDENT. NO.	Surface, Engine or Vent Identification Number
IN**2	in^2
KM	Kilometers
LEAKL	Surface Leakage Designator for LMOP
LEAKO	Surface Leakage Designator for Orbiter

OUTPUT SYMBOL	INTERPRETATION
LEAKS	Surface Leakage Designator for SMTP
LOS	Line-of-Sight
MATERIAL	Surface Material Descriptor
MCD	Mass Column Density in g/cm^2
MODL	Location Designator for Module Leakage Source
MODULE	Spacelab Module Section
MTCS	Module Thermal Control Surface
N2	Diatomic Nitrogen
NCD	Molecular Number Column Density in Molecules/cm^2
NO	Nitric Oxide
O2	Diatomic Oxygen
OUTGASSING	Denotes Contribution From Outgas1, Outgas2 (MOUT1 $\leq$ M $\leq$ MOUT2)
OUTG1	Outgassing Specie 1
OUTG2	Outgassing Specie 2
PTCS	Pallet Thermal Control Surface
RTNFLX	Return Flux of Contaminant Species
SECTION	Major Structural Section of a Given Configuration
SR	Steradians
SURFACE NUMBER	Node Number Identifier for Surface Sources

OUTPUT SYMBOL	INTERPRETATION
TYPE	Designates Type of Concentrated Source - RCS, VCS or Evaporator
WINDL	Location Designator for Window Leakage Source
% OF TOTAL	Indicates the Percentage That a Specific Source Contributes to the Total

4.2 MODEL INPUT DATA DISPLAY

This output segment allows the user to access the model input parameters and data utilized for a particular run. It includes not only the user input parameters, but also the program default values utilized and the accessed permanent file data. Summarized below are the model input data reports available to the user.

REPORT NO.	DESCRIPTION
01	Listing of Input Control Parameters - This report duplicates the user input executive commands used to initiate the program execution (see subsection 3.1). It is used to verify proper user input commands and can be displayed prior to run execution.
02	Preset List of Surfaces, Engines and Vents - This report contains a compilation of the surface and concentrated sources that are preset in the program from which the user can choose those to be included in the evaluation (see REPORT 03). It includes a listing of sequence number, identification number (node number), section, material and area (see Table 3-1 for example).
03	List of Sources to Be Evaluated - This report is a compilation of the surface and concentrated sources to be considered in the run stream (see Table 3-1). It includes a listing of sequence number, identification number (node number), section, material and area. This report can be used to verify that the desired sources are set to be evaluated prior to run execution.

REPORT NO.	DESCRIPTION
04	List of Changes to Preset Contaminant Sources - This report presents a compilation of only those surfaces for which the user has modified the surface material through NAMELIST INPUTA, subsection 3.2.2. It includes a listing of sequence number, identification number (node number), section, new material and area. This report can be used to verify that the desired surface material changes have been accepted by the model.
05	List of Mass Loss Rate Coefficients to Be Used - This report presents the input mass loss rate coefficients to be used in the run stream. These include values for RATE, TAU, AGEORB and AGESLB for the surface materials currently in the model (see Table 3-II for material sequence designators). Displayed for RATE and TAU are coefficients for OUTG1, OUTG2, H_2O, N_2, CO_2 and O_2 in that order. This report allows the user to verify proper mass loss rate input data prior to run commencement.
06	Modified List of Mass Loss Rate Coefficients - This report follows the same format as REPORT 05 but includes only those coefficients modified by the user via namelist INPUTB. It can be used to verify that the proper changes were made prior to execution.
07	List of Surface Temperatures That Will Be Used - This report contains a listing of the vehicle surface temperatures in ^{o}C that will be used in the analysis. It includes a listing of sequence number, identification number (node number), surface temperature, material and area. This report can be used to verify proper access of the surface thermal profile input data prior to execution.
08	List of Mission Data That Will Be Used - This report contains a listing of the NAMELIST MPDB as discussed in subsection 3.2.6 and should reflect any user modifications performed therein. It presents such data as orbital altitude, attitude, field-of-view and selected line-of-sight. Parameters not changed in NAMELIST MPDB will default to the values presented in subsection 3.2.6. If changes are made, the user can verify their accuracy through this report.

REPORT NO.	DESCRIPTION
09	List of Mass Transport Factor Data-Surface to Points - This report lists the mass transport factor data in the format presented in subsection 3.2.9. This data is necessary in determining MCD, NCD or RF. It contains the viewfactors, r's and θ's between the modeled sources/surfaces (REPORT 03) and the points along the line(s)-of-sight accessed from permanent file for the evaluation being conducted. The user should flag this report if he wishes to verify that the proper line-of-sight has been read in or that the mass transport factors are accurate.
10	List of Mass Transport Factor Data-Surface to Surface - This report lists the mass transport factor data between sources and surfaces in the format presented in subsection 3.2.8. This data is necessary in determining contaminant flux from one surface to another. It contains the viewfactors, r's and θ's between the modeled sources/surfaces (REPORT 03) and surfaces within their fields-of-view accessed from permanent file for the evaluation being conducted. The user should flag this report if he wishes to verify that the proper mass transport factors between surfaces have been read in.

4.3 MODEL OUTPUT PREDICTION DISPLAY

The model has been configured with an assortment of pre-established output report formats which allow for access of any level of detail desired for displaying the SPACE Program induced environment predictions. The user has the option in the executive segment of the program to select the format and level of detail of the final model output. The output reports include printouts of important intermediate predictions obtained in the model calculational stream, three groupings of final output which vary in the level of detail displayed, and data plot outputs. Summarized below are the model output prediction display reports available to the user. Sample printouts are included where appropriate.

- INTERMEDIATE PREDICTION OUTPUT

Report No.	Description
11	Physical Characteristics of Surface Sources - This report contains the predicted mass loss rate data for

Report No.	Description
11 (cont'd)	each modeled surface source contained in REPORT 03. It includes surface number, area, section, material, temperature and the following predicted mass loss rates for each surface: 1) total; 2) individual specie; 3) early desorption and 4) outgassing. This report allows the user to perform a mass loss audit prior to run execution.
12	Surface Characteristics Including Second Sources - This report is similar in format to REPORT 11 with the addition of second surface source contributions to the surface mass loss rate predictions. If REFLCT is set equal to .TRUE. (subsection 3.1.3), this report should be utilized in a mass loss audit.
31	Output From Line-of-Sight Point Selector - This report summarizes the intermediate steps involved in exercising the point selector routine in the SPACE Program. Point selector is operated any time the on-going evaluation involves mass transport to points along a line-of-sight. Data in this report includes a listing of the MPDB input parameters applicable to point select (see subsection 3.2.6) and a summary of the calculated point contributions to each segment along the line-of-sight in question (see DSMCD, subsection 3.2.6). Segment volume, length, midpoint and distance from line-of-sight origin are also included.
32	Summary Output From Line-of-Sight Point Selector - This report presents a compressed summary of the information available in REPORT 31. Data in this report includes a listing of the MPDB input parameters applicable to point select NCD or RF calculations and a compilation of the contribution of each matrix point to the line-of-sight MCD/NCD. By knowing the density (RHO) at each point in the above compilation, the MCD or NCD along the line-of-sight can be determined.

- FINAL PREDICTION OUTPUT - LEVEL I

33	Number Column Densities - Enumerated by Source - Highest to Lowest Contributor - This report presents the total MCD and NCD predictions for each modeled source/surface (REPORT 03) sorted in order of relative contribution to

Report No.	Description
33 (cont'd)	the total. It follows the format presented in Figure 4-1. Included in this report for each source node are the source identifiers (material, section, etc.), MCD, NCD, percent of the total and placement sequence number. Information on the line-of-sight being evaluated is included in the report header.
34	Mass/Number Column Densities - Sorted by Materials, Leakage Components or Engines/Vents - This report contains the total MCD and NCD predictions for each modeled source/surface (REPORT 03) sorted by surface materials, leakage components (LEAK0, etc.) or engines and vents whichever is applicable. It follows the general format presented in Figure 4-2. Included in this report for each source node are source identifiers (material, section, etc.); NCD for the 10 contaminant molecular species, MCD and NCD for each major source and the total predicted NCD. Totals for each major material, leak or engine grouping are also included. Slight variations will exist in the format of this report depending upon which source predictions are being displayed.
36	Mass/Number Column Densities - Sorted by Locations - This report presents the MCD and NCD predictions for each modeled source/surface (REPORT 03) sorted by section. It follows a format similar to the example Level I output presented in Figure 4-2. Included in this report for each source node are the source identifiers (material, section, etc.), NCD for the 10 contaminant molecular species, MCD and NCD for each major source and the total predicted NCD. Slight variations will exist in the format of this report depending on which source predictions are being displayed.
41	Return Flux Enumerated by Source - Highest to Lowest Contributor - This report presents the total RF predictions for each modeled source/surface (REPORT 03) sorted in order of relative contribution to the total. It follows the format presented in Figure 4-1. Included in this report for each source node are the source identifiers (material, section, etc.), RF, percent of the total and placement sequence number. The field-of-view of the surface experiencing the RF and

REPORT NO. 33 *** SAMPLE CASE NO. 1 MINIMUM INPUT CASE (DEFAULT PARAMETERS) ***

CONTENTS: NUMBER COLUMN DENSITIES - ENUMERATED BY SOURCE

LINE-OF-SIGHT NO. = 1
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** HIGHEST TO LOWEST CONTRIBUTOR *** (CONT)

SURFACE NUMBER	SECTION / MATERIAL	MASS LOSS (GM/SEC) / TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2)					EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD	% OF TOTAL	PLACE
			OUTG1 / O2	OUTG2 / CO	H2O / H2	N2 / H	CO2 / MMHNO3					
1043	MODULE	.208E-04	.74E+09	0.	0.	0.	0.	0.	.12E-12	.12E-12		
	MTCS	27.200	0.	0.	0.	0.	0.	0.	.74E+09	.74E+09	.6667	29
1000	MODULE	.530E-04	.66E+09	0.	0.	0.	0.	0.	.11E-12	.11E-12		
	MTCS	83.900	0.	0.	0.	0.	0.	0.	.66E+09	.66E+09	.5953	30
1013	MODULE	.284E-04	.58E+09	0.	0.	0.	0.	0.	.96E-13	.96E-13		
	MTCS	60.000	0.	0.	0.	0.	0.	0.	.58E+09	.58E+09	.5176	31
1003	MODULE	.420E-04	.53E+09	0.	0.	0.	0.	0.	.88E-13	.88E-13		
	MTCS	77.200	0.	0.	0.	0.	0.	0.	.53E+09	.53E+09	.4770	32
1130	WINDOW	.621E-06	.32E+09	0.	0.	0.	0.	0.	.53E-13	.53E-13		
	MTCS	27.800	0.	0.	0.	0.	0.	0.	.32E+09	.32E+09	.2849	33
1022	MODULE	.212E-04	.19E+09	0.	0.	0.	0.	0.	.31E-13	.31E-13		
	MTCS	57.200	0.	0.	0.	0.	0.	0.	.19E+09	.19E+09	.1669	34
1021	MODULE	.178E-04	.16E+09	0.	0.	0.	0.	0.	.26E-13	.26E-13		
	MTCS	52.200	0.	0.	0.	0.	0.	0.	.16E+09	.16E+09	.1415	35
1023	MODULE	.422E-04	.49E+08	0.	0.	0.	0.	0.	.81E-14	.81E-14		
	MTCS	77.200	0.	0.	0.	0.	0.	0.	.49E+08	.49E+08	.0438	36
1020	MODULE	.349E-04	.41E+08	0.	0.	0.	0.	0.	.68E-14	.68E-14		
	MTCS	71.700	0.	0.	0.	0.	0.	0.	.41E+08	.41E+08	.0365	37
TOTAL		.111E-02	.11E+12	0.	0.	0.	0.	0.	.19E-10	.19E-10		
			0.	0.	0.	0.	0.	0.	.11E+12	.11E+12	100.0000	

Figure 4-1. Example Placement Summary Report Output

REPORT NO. 34 *** SAMPLE CASE NO. 8A SHUTTLE ORBITER ALL ENGINE CHECK OUT ***

CONTENTS: MASS/NUMBER COLUMN DENSITIES

LINE-OF-SIGHT NO. = 8
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** SORTED BY MATERIALS ***

SURFACE NUMBER	SECTION / MATERIAL	MASS LOSS (GM/SEC) / TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1 / O2	OUTG2 / CO	H2O / H2	N2 / H	CO2 / MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD
6	BAY	.285E-04	.39E+09	0.	.22E+10	.11E+10	.72E+09	.19E-12	.65E-13	.26E-12
	LINER	66.220	.40E+09	0.	0.	0.	0.	.44E+10	.39E+09	.48E+10
5	BAY	.431E-04	.29E+09	0.	.16E+10	.83E+09	.54E+09	.14E-12	.49E-13	.19E-12
	LINER	78.220	.30E+09	0.	0.	0.	0.	.33E+10	.29E+09	.36E+10
7	BAY	.280E-04	.28E+09	0.	.16E+10	.79E+09	.51E+09	.14E-12	.46E-13	.18E-12
	LINER	65.780	.29E+09	0.	0.	0.	0.	.32E+10	.28E+09	.34E+10
8	BAY	.370E-04	.24E+09	0.	.13E+10	.67E+09	.44E+09	.12E-12	.40E-13	.16E-12
	LINER	73.780	.24E+09	0.	0.	0.	0.	.27E+10	.24E+09	.29E+10
1	BAY	.431E-04	.11E+09	0.	.62E+09	.31E+09	.20E+09	.54E-13	.18E-13	.72E-13
	LINER	78.220	.11E+09	0.	0.	0.	0.	.13E+10	.11E+09	.14E+10
2	BAY	.285E-04	.81E+08	0.	.46E+09	.23E+09	.15E+09	.40E-13	.14E-13	.53E-13
	LINER	66.220	.83E+08	0.	0.	0.	0.	.92E+09	.81E+08	.10E+10
443	BAY	.297E-05	.44E+08	0.	.25E+09	.12E+09	.80E+08	.21E-13	.73E-14	.29E-13
	LINER	60.000	.45E+08	0.	0.	0.	0.	.49E+09	.44E+08	.54E+09
3	BAY	.280E-04	.43E+08	0.	.24E+09	.12E+09	.78E+08	.21E-13	.71E-14	.28E-13
	LINER	65.780	.44E+08	0.	0.	0.	0.	.48E+09	.43E+08	.53E+09
442	BAY	.207E-05	.32E+08	0.	.18E+09	.91E+08	.59E+08	.16E-13	.54E-14	.21E-13
	LINER	49.440	.33E+08	0.	0.	0.	0.	.37E+09	.32E+08	.40E+09
4	BAY	.365E-04	.24E+08	0.	.13E+09	.67E+08	.44E+08	.12E-13	.40E-14	.16E-13
	LINER	73.440	.24E+08	0.	0.	0.	0.	.27E+09	.24E+08	.29E+09
441	BAY	.207E-05	.24E+08	0.	.13E+09	.67E+08	.44E+08	.12E-13	.40E-14	.16E-13
	LINER	49.440	.24E+08	0.	0.	0.	0.	.27E+09	.24E+08	.29E+09
440	BAY	.265E-05	.21E+08	0.	.12E+09	.59E+08	.38E+08	.10E-13	.35E-14	.14E-13
	LINER	56.670	.21E+08	0.	0.	0.	0.	.24E+09	.21E+08	.26E+09
TOTAL	LINER	.282E-03	.16E+10	0.	.89E+10	.45E+10	.29E+10	.77E-12	.26E-12	.10E-11
			.16E+10	0.	0.	0.	0.	.18E+11	.16E+10	.19E+11

Figure 4-2. Example Level I Model Prediction Output

Report No.	Description
41 (cont'd)	the orbital altitude of the evaluation are presented in the report header.
42	Return Flux Enumerated by Source - Sorted by Materials, Leakage Components or Engines/Vents - This report contains the total RF predictions for each modeled source/surface (REPORT 03) sorted by surface materials, leakage components (LEAK0, etc.) or engines and vents whichever is applicable. It follows the general format presented in Figure 4-2. Included in this report for each source node are source identifiers (material, section, etc.), total RF for the 10 contaminant molecular species and for each major source and the total predicted RF. Totals for each major material, leak or engine grouping are also included. Slight variations will exist in the format of this report depending upon which source predictions are being displayed.
44	Return Flux Enumerated by Source - Sorted by Location - This report presents the RF predictions for each modeled source/surface (REPORT 03) sorted by body section. Figure 4-2 is an example of this report for the sources of outgassing and early desorption. Included in this report for each source node are the source identifiers (material section, etc.), RF for the 10 contaminant molecular species and for each major source and the total predicted RF. The field-of-view of the surface experiencing the RF and the orbital altitude of the evaluation are presented in the contents header. Slight variatons will exist in the format of this report depending upon which source predictions are being displayed.
46	Return Flux Due to Self-Scattering - This report presents the self-scattering return flux predictions for each line-of-sight segment (see DSMCD subsection 3.2.6) opted by the user. For each elemental volume, it contains the total contaminant density, total flux, collision frequency and return flux for the 10 contaminant species. Information on the line-of-sight and surface of interest being evaluated is included in the report header. This report should be turned on if RFSS is set to .TRUE. as discussed in subsection 3.1.3.

Report No.	Description
47	This report presents the total RF deposition predictions for each modeled source/surface (REPORT 03) sorted in order of relative contribution to the total. It follows the format presented in Figure 4-1. Included in this report for each source node are the source identifiers (material, section, etc.), RF deposition, percent of the total and placement sequence number. The field-of-view of the surface experiencing RF deposition, its modeled temperature and the orbital altitude of the evaluation are presented in the report header.

- FINAL PREDICTION OUTPUT - LEVEL II

35	Summary Mass/Number Column Densities-Listed by Materials or Leakage Components - This report contains the MCD and NCD predictions for each major surface material or leakage component (LEAKO, etc.) whichever is applicable. It follows the general format presented in Figure 4-3. Included in this report for each surface material and leakage component are NCD for the 10 contaminant molecular species, NCD and MCD for each major source, total NCD and MCD and the percent contribution to the total from all sources. Information on the line-of-sight being evaluated is included in the report header.
37	Summary: Mass/Number Column Densities - Listed by Location - This report presents the MCD and NCD predictions for each major body section or leakage areas (BAYL, etc.) whichever is applicable. It follows the general format presented in Figure 4-3. Included in this report for each body section and leakage area are NCD for the 10 contaminant molecular species, NCD and MCD for each major source, total NCD and MCD and the percent contribution to the total from all sources. Information on the line-of-sight being evaluated is included in the report header.
43	Summary: Return Flux Listed by Materials or Leakage Components - This report presents the RF predictions for each major surface material or leakage component (LEAKO, etc.) whichever is applicable. It follows the general format presented in Figure 4-3. Included in this report for each surface material or leakage component are RF for the 10 contaminant molecular species, RF for each major source and RF total as well as the percent contribution

REPORT NO. 35 *** SAMPLE CASE NO. 8A SHUTTLE ORBITER ALL ENGINE CHECK OUT ***

CONTENTS: SUMMARY *** MASS/NUMBER COLUMN DENSITIES ***

*** LISTED BY MATERIALS *** (CONT)

LINE-OF-SIGHT NO. = 8
THETA (DEG) = 0.0
PHI (DEG) = 0.0

SECTION SUMMARY	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1 O2	OUTG2 CO	H2O H2	N2 H	CO2 MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL	% OF TOTAL
LINER	.16E+10	0.	.89E+10	.45E+10	.29E+10	.77E-12	.26E-12	.10E-11	
	.16E+10	0.	0.	0.	0.	.18E+11	.16E+10	.19E+11	5.2
TEFLON	.86E+10	0.	.49E+11	.24E+11	.16E+11	.42E-11	.14E-11	.56E-11	
	.87E+10	0.	0.	0.	0.	.98E+11	.86E+10	.11E+12	28.5
NOMEX	.13E+11	0.	.74E+11	.37E+11	.24E+11	.64E-11	.22E-11	.85E-11	
	.13E+11	0.	0.	0.	0.	.15E+12	.13E+11	.16E+12	43.1
LRSI	.36E+10	0.	.20E+11	.10E+11	.66E+10	.18E-11	.59E-12	.23E-11	
	.36E+10	0.	0.	0.	0.	.41E+11	.36E+10	.44E+11	11.8
HRSI	.14E+10	0.	.80E+10	.40E+10	.26E+10	.69E-12	.23E-12	.92E-12	
	.14E+10	0.	0.	0.	0.	.16E+11	.14E+10	.17E+11	4.6
RCC	.76E+06	0.	.43E+07	.22E+07	.14E+07	.37E-15	.13E-15	.50E-15	
	.76E+06	0.	0.	0.	0.	.87E+07	.76E+06	.95E+07	.0
BLKHED	.16E+10	0.	.91E+10	.45E+10	.29E+10	.78E-12	.26E-12	.10E-11	
	.16E+10	0.	0.	0.	0.	.18E+11	.16E+10	.20E+11	5.3
CRACKS	0.	0.	.37E+08	.22E+10	.24E+10	.31E-12	0.	.31E-12	
	.64E+09	0.	0.	0.	0.	.53E+10	0.	.53E+10	1.4
TOTAL	.30E+11	0.	.17E+12	.87E+11	.57E+11	.15E-10	.49E-11	.20E-10	
	.31E+11	0.	0.	0.	0.	.34E+12	.30E+11	.37E+12	100.0

Figure 4-3. Example Level II Model Prediction Output

Report No.	Description
43 (cont)	to the total from all sources. The field-of-view of the surface experiencing RF and the orbital altitude of the evaluation are presented in the report header.
45	Summary: Return Flux Listed by Location - This report presents the RF predictions for each major body section or leakage area (BAYL, etc.) whichever is applicable. It follows the general format presented in Figure 4-3. Included in this report for each body section and leakage area are RF for the 10 contaminant molecular species, RF for each major source and RF total as well as the percent contribution to the total from all sources. The field-of-view of the surface experiencing RF and the orbital altitude of the evaluation are presented in the report header.

- FINAL PREDICTION OUTPUT - LEVEL III

50	Final Prediction Summary - This report presents the final total induced environment predictions for a given model execution. Included therein for each of the 6 major contaminant sources are the NCD and RF predictions resulting from direct flux and second surface flux, the corresponding totals and the deposition rates resulting from RF, self-scattering and surface-to-surface flux. This report is annotated with assorted MPDB information such as configuration, thermal profile, line-of-sight, field-of-view, etc., to aid the user in understanding the output (currently inoperative).

- PLOT PREDICTION OUTPUT

39	Plot of Density Along Line-of-Sight - This report presents a graphical display of the variation of contaminant density along a selected line-of-sight (see Figure 4-4). Data presented is a function of the contaminant source(s) being evaluated and the line-of-sight selected for display. Integration under the curves presented in this report yields the line-of-sight MCD which has been previously discussed.

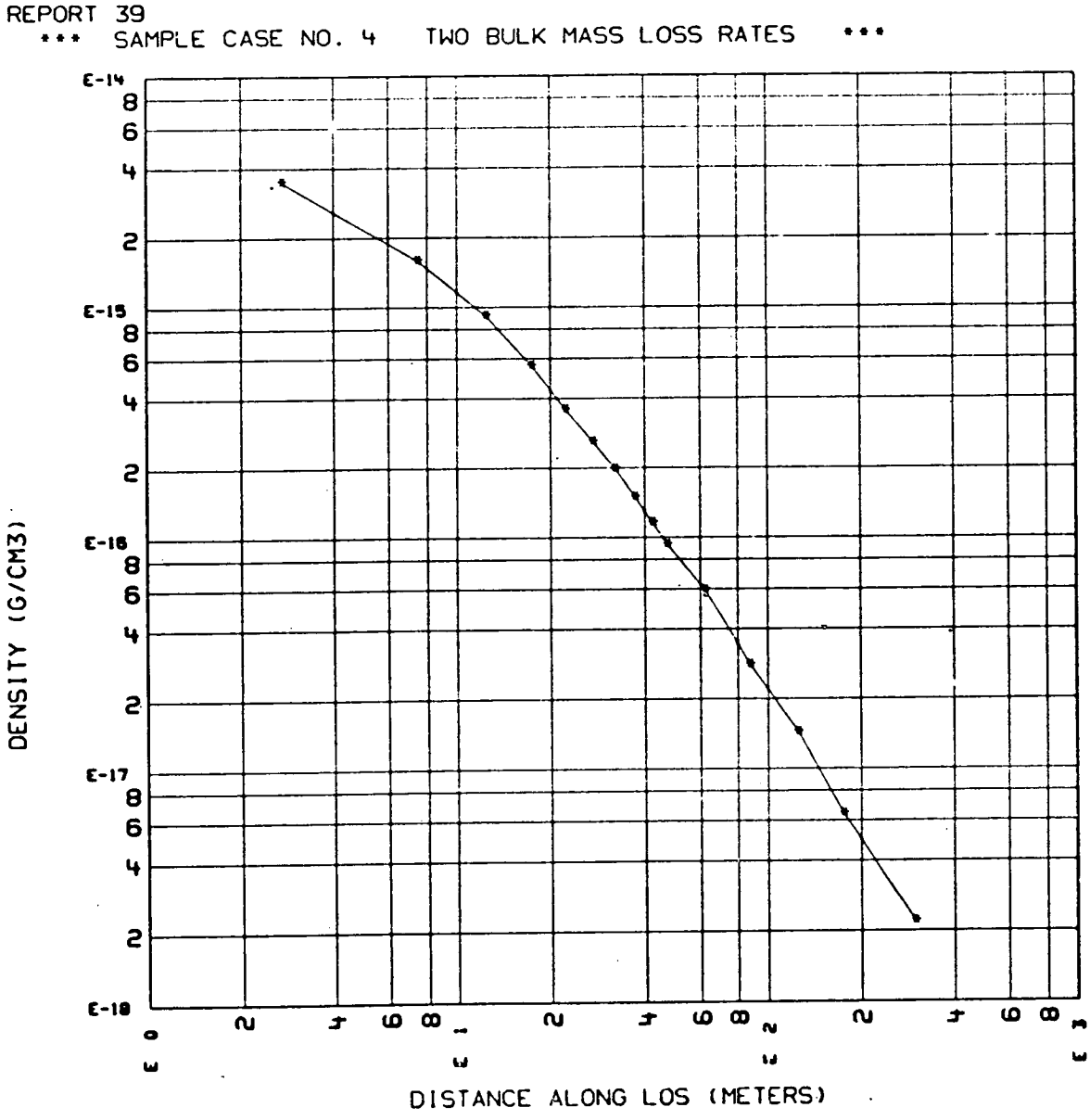


Figure 4-4. Example of Model Plot Output

4.4 DEBUG OUTPUT

An extensive debug output capability exists in the SPACE Program to facilitate model trouble-shooting if the need arises. The user should employ discretion in exercising the debug options due to the large amount of hardcopy generated with each option. To minimize this, the model debug segment has been designed with five debug options (see subsection 3.1.7 for input instructions) which allow the user to trouble-shoot the specific segment of the model where he feels an anomaly is centered. The options and corresponding model segments are summarized below.

Option	Model Segment
DBUGA	Collect Input Data
DBUGB	Mass Loss Audit
DBUGC	Deposition - Direct Transport
DBUGD	MCD/NCD
DBUGE	Return Flux Deposition

The model has also been configured with several error statements which are automatically called and printed if certain preset limits are exceeded during program execution. These will aid the user in diagnosing errors or omissions made in the model input data or logic errors internal to the program. If an error statement is incurred, the user should first verify the influencing input statements and then only if necessary access the applicable debug option(s).

SECTION 5
SAMPLE PROBLEMS

5.1 SAMPLE CASE 1 - MINIMUM INPUT CASE

This sample problem demonstrates the operation of the SPACE Program when all input parameters are assumed to be the pre-programmed default values (see Section 3). The problem involves outgassing of the Spacelab LMOP configuration at 10 hours into a mission. The mass and number column density of outgassing species along a line-of-sight parallel to the Z axis are computed.

A listing of the complete input and samples of the output reports are provided below.

5.1.1 Input

```
 ***  SAMPLE CASE NO. 1   MINIMUM INPUT CASE (DEFAULT PARAMETERS)  ***
$CONTRL
 GO = .TRUE. $
$INPUTA
 GO = .TRUE. $
$MPDB
 GO = .TRUE.$
STOP
```

5.1.2 Output

REPORT NO. 11 *** SAMPLE CASE NO. 1 MINIMUM INPUT CASE (DEFAULT PARAMETERS) *** 08/20/77 07.10.43. PAGE 4

CONTENTS: PHYSICAL CHARACTERISTICS OF SURFACE SOURCES AT TIME 10.HRS 0.MINS 0.SECS

SURFACE NUMBER	AREA (IN**2) (CM**2)	SECTION MATERIAL	MASS LOSS (GM/SEC) TEMP (DEG C)	SPECIES MASS LOSS RATES (GM/CM**2/SEC) OUTG1 O2	OUTG2 CO	H2O H2	N2 H	CO2 MMHNO3	EARLY DESORPTION	OUT GASSING
1005	.96E+04	MODULE	.397E-02	.64E-07	0.	0.	0.	0.		
	.62E+05	MTCS	169.	0.	0.	0.	0.	0.	0.	.644E-07
1015	.12E+05	MODULE	.306E-02	.41E-07	0.	0.	0.	0.		
	.75E+05	MTCS	156.	0.	0.	0.	0.	0.	0.	.407E-07
1025	.96E+04	MODULE	.191E-02	.31E-07	0.	0.	0.	0.		
	.62E+05	MTCS	148.	0.	0.	0.	0.	0.	0.	.309E-07
1070	.28E+05	PLT1	.439E-03	.24E-08	0.	0.	0.	0.		
	.18E+06	PTCS	74.	0.	0.	0.	0.	0.	0.	.241E-08
1045	.27E+05	MODULE	.304E-03	.18E-08	0.	0.	0.	0.		
	.17E+06	MTCS	65.	0.	0.	0.	0.	0.	0.	.177E-08
1055	.11E+05	MODULE	.190E-03	.28E-08	0.	0.	0.	0.		
	.68E+05	MTCS	78.	0.	0.	0.	0.	0.	0.	.280E-08
1088	.79E+04	PLT1	.992E-04	.20E-08	0.	0.	0.	0.		
	.51E+05	PTCS	68.	0.	0.	0.	0.	0.	0.	.195E-08
1035	.27E+04	MODULE	.961E-04	.56E-08	0.	0.	0.	0.		
	.17E+05	MTCS	98.	0.	0.	0.	0.	0.	0.	.560E-08
1002	.24E+04	MODULE	.529E-04	.34E-08	0.	0.	0.	0.		
	.15E+05	MTCS	84.	0.	0.	0.	0.	0.	0.	.343E-08
1003	.24E+04	MODULE	.529E-04	.34E-08	0.	0.	0.	0.		
	.15E+05	MTCS	84.	0.	0.	0.	0.	0.	0.	.343E-08
1087	.41E+04	PLT1	.492E-04	.19E-08	0.	0.	0.	0.		
•	.26E+05	PTCS	66.	0.	0.	0.	0.	0.	0.	.186E-08
•										
•										
•										
•										
TOTALS	.23E+06		.111E-01							
	.15E+07									
AVERAGE				.74E-08	0.	0.	0.	0.		
				0.	0.	0.	0.	0.	0.	.736E-08

5.1.2 Output (cont'd)

REPORT NO. 33 *** SAMPLE CASE NO. 1 MINIMUM INPUT CASE (DEFAULT PARAMETERS) *** 08/20/77 07.10.49. PAGE 6

CONTENTS: NUMBER COLUMN DENSITIES - ENUMERATED BY SOURCE

LINE-OF-SIGHT NO. = 1
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** HIGHEST TO LOWEST CONTRIBUTOR ***

SURFACE NUMBER	SECTION / MATERIAL	MASS LOSS (GM/SEC) / TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2)					EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD	% OF TOTAL	PLACE
			OUTG1 / O2	OUTG2 / CO	H2O / H2	N2 / H	CO2 / MMHNO3					
1088	PLT1	.992E-04	.22E+11	0.	0.	0.	0.	0.	.36E-11	.36E-11		
	PTCS	67.500	0.	0.	0.	0.	0.	0.	.22E+11	.22E+11	19.0592	1
1087	PLT1	.492E-04	.91E+10	0.	0.	0.	0.	0.	.15E-11	.15E-11		
	PTCS	66.110	0.	0.	0.	0.	0.	0.	.91E+10	.91E+10	7.9919	2
1086	PLT1	.492E-04	.91E+10	0.	0.	0.	0.	0.	.15E-11	.15E-11		
	PTCS	66.110	0.	0.	0.	0.	0.	0.	.91E+10	.91E+10	7.9919	3
1084	PLT1	.407E-04	.72E+10	0.	0.	0.	0.	0.	.12E-11	.12E-11		
	PTCS	53.890	0.	0.	0.	0.	0.	0.	.72E+10	.72E+10	6.3112	4
1042	MODULE	.403E-04	.66E+10	0.	0.	0.	0.	0.	.11E-11	.11E-11		
	MTCS	46.280	0.	0.	0.	0.	0.	0.	.66E+10	.66E+10	5.7799	5
1060	MODULE	.428E-04	.60E+10	0.	0.	0.	0.	0.	.10E-11	.10E-11		
	MTCS	77.920	0.	0.	0.	0.	0.	0.	.60E+10	.60E+10	5.3098	6
1085	PLT1	.318E-04	.56E+10	0.	0.	0.	0.	0.	.94E-12	.94E-12		
	PTCS	46.670	0.	0.	0.	0.	0.	0.	.56E+10	.56E+10	4.9755	7
1052	MODULE	.109E-04	.54E+10	0.	0.	0.	0.	0.	.89E-12	.89E-12		
	MTCS	35.170	0.	0.	0.	0.	0.	0.	.54E+10	.54E+10	4.7359	8
1032	MODULE	.467E-04	.50E+10	0.	0.	0.	0.	0.	.83E-12	.83E-12		
	MTCS	50.560	0.	0.	0.	0.	0.	0.	.50E+10	.50E+10	4.3817	9
1051	MODULE	.931E-05	.46E+10	0.	0.	0.	0.	0.	.77E-12	.77E-12		
	MTCS	30.720	0.	0.	0.	0.	0.	0.	.46E+10	.46E+10	4.0919	10
1041	MODULE	.247E-04	.41E+10	0.	0.	0.	0.	0.	.68E-12	.68E-12		
•	MTCS	32.060	0.	0.	0.	0.	0.	0.	.41E+10	.41E+10	3.6213	11
•												
•												
•												
•												
•												

5.2 SAMPLE CASE NO. 2 - SHUTTLE ORBITER -Y TRANSLATION MANEUVER

The sample problem illustrates the induced contaminant cloud that can be created when two of the Orbiter aft RCS engines and one forward engine are fired. A critical surface with a 0.19 steradian field-of-view is susceptible to backscattered contaminants that can return along a line-of-sight originating at the prime measurement point (PMP) directed 60^{o} off the +Z axis and 90^{o} from the Orbiter +X axis. Referring to Figure 5-1, the direction cosines of the surface coordinate system relative to the Orbiter coordinates are then

COSXX = 1.000
COSXY = 0.0
COSXZ = 0.0
COSYX = 0.0
COSYY = 0.500
COSYZ = -0.866
COSZX = 0.0
COSZY = 0.866
COSZZ = 0.500

The Orbiter is at an altitude of 400 km, with an attitude that places the Orbiter Z-axis 5^{o} below the local horizon, the Y-axis is perpendicular to the orbital plane (Y-POP), and the nose down toward the earth.

In the reference frame of the Orbiter, the velocity of the incoming atmosphere translates to the following components:

V_X = -7650 sin 20 = -667.

V_Y = 0.

V_Z = -7650 cos 20 = -7621.

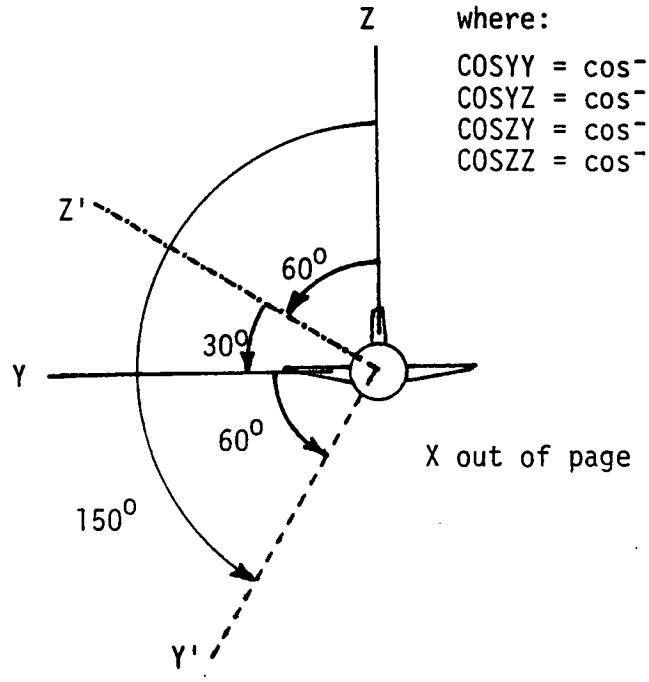
Side thrusting aft right RCS engines (7)344, (7)324 and forward engine (7) 144 will be activated.

5.2.1 Input

```
  *** SAMPLE CASE NO. 2   SHUTTLE ORBITER -Y TRANSLATION MANEUVER   ***
 $CONTRL
  ENG = .T.,      OUT = .F.,
  ORBITR =.T.,    LMOP = .F.,
  MCD = .F.,   RFAS = .T.,   RFSS = .T.,
  REPORT(31)=.T.,REPORT(41)=.T.,REPORT(43)=.F.,REPORT(46)=.T.,
  REPORT(33)=.T.,REPORT(47)=.T.,
  GO = .T.     $END
```

5.2.1 Input (cont'd)

```
$INPUTA
 ONTIME(11) = 1.0,  ONTIME(29)= 1.0,      ONTIME(30)= 1.0,
 ONTIME(31)= 19*0,
 RFSURF(1) = 8,9*0,
 GO = .T.    $END
$MPDB
 RMAXRF = 50.,
 THETA1(1) = 0.,    THETA2(1) = 14.,
 DTHETA(1) = 28.,   DPHI(1)   = 360.,
 DOMEGA     = .19,
 COSYY(1)   = .500,
 COSYZ(1)   =-.866,
 COSZY(1)   = .866,
 COSZZ(1)   = .500,
 VX = -667.
 VY =    0.
 VZ =-7621.
 GO = .T. $END
STOP
```



where:

COSYY = $\cos^{-1}$ (.500) = 60°, Y to Y'
COSYZ = $\cos^{-1}$ (-.866) = 150°, Y' to Z
COSZY = $\cos^{-1}$ (.866) = 30°, Z' to Y
COSZZ = $\cos^{-1}$ (.500) = 60°, Z to Z'

Z' is assumed to be the normal of RF surface.

Figure 5-1. Illustration of Direction Cosine Input for Return Flux

5.2.2 Output

REPORT NO. 3 *** SAMPLE CASE NO. 2 SHUTTLE ORBITER -Y TRANSLATION MANEUVER ***

CONTENTS: LIST OF SOURCES TO BE EVALUATED

* * * ENGINE OPERATION * * *

SEQUENCE NO.	IDENT NO.	LOCATION	TYPE	ON-TIME (SEC)
1	7144	FRS -Y	RCS	1.000
2	7344	ARS -Y	RCS	1.000
3	7324	ARS -Y	RCS	1.000

5.2.2 Output (cont'd)

REPORT NO. 33 *** SAMPLE CASE NO. 2 SHUTTLE ORBITER -Y TRANSLATION MANEUVER *** 09/19/77 10.35.39. PAGE 6

CONTENTS: NUMBER COLUMN DENSITIES - ENUMERATED BY SOURCE

LINE-OF-SIGHT NO. = 8
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** HIGHEST TO LOWEST CONTRIBUTOR ***

ENG/VENT NUMBER	TYPE	LOCATION	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1 / O2	OUTG2 / CO	H2O / H2	N2 / H	CO2 / MMHNO3	TOTAL MCD/NCD (GM/CM**2) (MOLECULES/CM**2)	% OF TOTAL	PLACE
7344	RCS	ARS -Y	0.	0.	.62E+16	.58E+16	.69E+15	.64E-06		
			.12E+14	.25E+16	.33E+16	.39E+15	.17E+14	.19E+17	35.2282	1
7324	RCS	ARS -Y	0.	0.	.61E+16	.57E+16	.67E+15	.62E-06		
			.12E+14	.25E+16	.32E+16	.38E+15	.16E+14	.18E+17	34.3385	2
7144	RCS	FRS -Y	0.	0.	.54E+16	.50E+16	.59E+15	.55E-06		
			.10E+14	.22E+16	.28E+16	.33E+15	.15E+14	.16E+17	30.4333	3
TOTAL			0.	0.	.18E+17	.16E+17	.19E+16	.18E-05		
			.34E+14	.72E+16	.93E+16	.11E+16	.48E+14	.54E+17	100.00	

REPORT NO. 41 *** SAMPLE CASE NO. 2 SHUTTLE ORBITER -Y TRANSLATION MANEUVER *** 09/19/77 10.35.39. PAGE 7

CONTENTS: RETURN FLUX AT 400.0 KM ALTITUDE - ENUMERATED BY SOURCE

CRITICAL SURFACE NO. = 8
FIELD-OF-VIEW (SR) = .390

*** HIGHEST TO LOWEST CONTRIBUTOR ***

ENG/VENT NUMBER	TYPE	LOCATION	SPECIES RETURN FLUX CONTRIBUTION (MOLECULES/CM**2) OUTG1 / OUTG2 / H2O / N2 / CO2					TOTAL RTN FLX (GM/CM**2/SEC) (MOLECULES/CM**2/SEC)	% OF TOTAL	PLACE
			O2	CO	H2	H	MMHNO3			
7344	RCS	ARS -Y	0.	0.	.81E+15	.99E+15	.13E+15	.10E-06		
			.19E+13	.42E+15	.44E+15	.41E+14	.32E+13	.28E+16	35.2282	1
7324	RCS	ARS -Y	0.	0.	.79E+15	.96E+15	.13E+15	.98E-07		
			.18E+13	.41E+15	.43E+15	.40E+14	.31E+13	.28E+16	34.3385	2
7144	RCS	FRS -Y	0.	0.	.70E+15	.85E+15	.11E+15	.87E-07		
			.16E+13	.36E+15	.38E+15	.36E+14	.27E+13	.24E+16	30.4333	3
TOTAL			0.	0.	.23E+16	.28E+16	.36E+15	.29E-06		
			.54E+13	.12E+16	.13E+16	.12E+15	.90E+13	.80E+16	100.00	

5.2.2 Output (cont'd)

REPORT NO. 46 *** SAMPLE CASE NO. 2 SHUTTLE ORBITER -Y TRANSLATION MANEUVER *** 09/19/77 10.35.39. PAGE 8

CONTENTS: RETURN FLUX DUE TO SELF SCATTERING 400.0 KM ALTITUDE CRITICAL SURFACE NO. = 8
FIELD-OF-VIEW (SR) = .90

*** LISTED BY LOS SEGMENT ***

SPECIES	COLLISION FREQUENCY (NO./SEC)	TOTAL DENSITY (GM/CM**3)	FLUX FROM SEGMENT (MOLECULES/ CM**2/SEC)	FLUX TO SEGMENT (GM/CM**2/ /SEC)	ACCUMULATED RETURN FLUX (MOLECULES/ CM**2/SEC)
SEGMENT = 2					
H2O	.183E+17	.300E-10	.136E+18	.105E-04	.136E+18
N2	.216E+17	.435E-10	.161E+18	.152E-04	.161E+18
CO2	.279E+16	.808E-11	.208E+17	.283E-05	.208E+17
O2	.419E+14	.104E-12	.313E+15	.363E-07	.313E+15
CO	.923E+16	.191E-10	.689E+17	.667E-05	.689E+17
H2	.988E+16	.176E-11	.737E+17	.616E-06	.737E+17
H	.945E+15	.104E-12	.705E+16	.363E-07	.705E+16
MMHNO3	.688E+14	.207E-12	.513E+15	.725E-07	.513E+15
SEGMENT = 3					
H2O	.110E+18	.736E-10	.819E+18	.258E-04	.955E+18
N2	.130E+18	.107E-09	.970E+18	.373E-04	.113E+19
CO2	.168E+17	.198E-10	.125E+18	.693E-05	.146E+18
O2	.252E+15	.254E-12	.188E+16	.899E-07	.219E+16
CO	.554E+17	.467E-10	.414E+18	.164E-04	.483E+18
H2	.593E+17	.432E-11	.443E+18	.151E-05	.517E+18
H	.568E+16	.254E-12	.424E+17	.889E-07	.494E+17
MMHNO3	.413E+15	.508E-12	.308E+16	.178E-06	.359E+16
SEGMENT = 4					
H2O	.184E+18	.954E-10	.137E+19	.334E-04	.233E+19
N2	.218E+18	.138E-09	.163E+19	.484E-04	.276E+19
CO2	.282E+17	.257E-10	.210E+18	.898E-05	.356E+18
O2	.423E+15	.329E-12	.315E+16	.115E-06	.535E+16
CO	.931E+17	.605E-10	.695E+18	.212E-04	.118E+19
H2	.996E+17	.559E-11	.743E+18	.196E-05	.126E+19
H	.953E+16	.329E-12	.711E+17	.115E-06	.121E+18
MMHNO3	.693E+15	.658E-12	.517E+16	.230E-06	.877E+16

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5.3 SAMPLE CASE NO. 3 - SHUTTLE ORBITER 100 HOURS 60/90 LOS

After the first day on-orbit, most of the low molecular weight gases have been desorbed from the spacecraft surfaces. Only the long term outgassing mass loss remains. To illustrate this, the timeline is set at 100 hours in the mission and the column density along a 60/90 line-of-sight ($\theta = 60^{o}$, $\phi = 90^{o}$) is computed (see case No. 2). Return flux into a 0.19 steradian field-of-view is also predicted.

5.3.1 Input

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 ***  SAMPLE CASE NO. 3   SHUTTLE ORBITER  100 HRS  60/90 LOS   ***
$CONTRL
 ED = .T.,
 ORBITR =.T.,   LMOP = .F.,
 MCD = .F.,  RFAS = .T.,  RFSS = .T.,
 REPORT(31)=.T.,REPORT(41)=.T.,REPORT(42)=.T.,REPORT(43)=.T.,
 REPORT(33)=.T.,REPORT(46)=.T.,REPORT(47)=.T.,
 TSTART(1) = 100.,0.,0.,
 TSTOP(1) = 100.,0.,1.,
 GO = .T.    $END
$INPUTA
 RFSURF(1) = 8,9*0,
 GO = .T.    $END
$MPDB
 RMAXRF = 50.,
 THETA1(1) = 0.,   THETA2(1) = 14.,
 DTHETA(1) = 28.,  DPHI(1)   = 360.,
 DOMEGA    = .19,
 COSYY(1)  = .500,
 COSYZ(1)  =-.866,
 COSZY(1)  = .866,
 COSZZ(1)  = .500,
 GO = .T. $END
STOP
```

5.3.2 Output

REPORT NO. 11 *** SAMPLE CASE NO. 3 SHUTTLE ORBITER 100 HRS 60/90 LOS *** 09/19/77 11.31.33. PAGE 4

CONTENTS: PHYSICAL CHARACTERISTICS OF SURFACE SOURCES AT TIME 100.HRS 0.MINS 0.SECS

SURFACE NUMBER	AREA (IN**2) (CM**2)	SECTION MATERIAL	MASS LOSS (GM/SEC) TEMP (DEG C)	SPECIES MASS LOSS RATES (GM/CM**2/SEC) OUTG1 OUTG2 H2O N2 CO2 O2 CO H2 H MMHNO3	EARLY DESORPTION	OUT GASSING
132	.30E+05 .19E+06	WING NOMEX	.351E-04 44.	.18E-09 0. .30E-11 .18E-11 .15E-11 .70E-12 0. 0. 0. 0.	.698E-11	.177E-09
102	.30E+05 .19E+06	WING NOMEX	.348E-04 44.	.18E-09 0. .29E-11 .18E-11 .15E-11 .70E-12 0. 0. 0. 0.	.693E-11	.175E-09
142	.19E+05 .13E+06	WING NOMEX	.328E-04 55.	.25E-09 0. .42E-11 .26E-11 .21E-11 .10E-11 0. 0. 0. 0.	.997E-11	.253E-09
112	.19E+05 .13E+06	WING NOMEX	.326E-04 54.	.25E-09 0. .42E-11 .26E-11 .21E-11 .10E-11 0. 0. 0. 0.	.989E-11	.251E-09
11	.33E+05 .21E+06	BAY BLKHED	.295E-04 43.	.13E-09 0. .22E-11 .14E-11 .11E-11 .54E-12 0. 0. 0. 0.	.532E-11	.135E-09
107	.17E+05 .11E+06	ELEVON NOMEX	.294E-04 55.	.25E-09 0. .42E-11 .26E-11 .21E-11 .10E-11 0. 0. 0. 0.	.100E-10	.254E-09
140	.23E+05 .15E+06	WING NOMEX	.276E-04 44.	.18E-09 0. .29E-11 .18E-11 .15E-11 .70E-12 0. 0. 0. 0.	.697E-11	.176E-09
110	.23E+05 .15E+06	WING NOMEX	.276E-04 44.	.18E-09 0. .29E-11 .18E-11 .15E-11 .70E-12 0. 0. 0. 0.	.697E-11	.176E-09
316	.31E+05 .20E+06	FUSLAG NOMEX	.251E-04 33.	.12E-09 0. .20E-11 .13E-11 .10E-11 .48E-12 0. 0. 0. 0.	.479E-11	.121E-09
306	.31E+05 .20E+06	FUSLAG NOMEX	.246E-04 33.	.12E-09 0. .20E-11 .12E-11 .10E-11 .47E-12 0. 0. 0. 0.	.469E-11	.119E-09
134	.91E+04 .59E+05	WING NOMEX	.160E-04 56.	.26E-09 0. .44E-11 .27E-11 .22E-11 .10E-11 0. 0. 0. 0.	.103E-10	.261E-09

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5.3.2 Output (cont'd)

CONTENTS: SUMMARY OUTPUT FROM LINE-OF-SIGHT POINT SELECTOR

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* * * * * *     LINE  OF  SIGHT  POINT  SELECTOR     * * * * * *
 * * * * * *           SUMMARY  FOR  LOS(   8)          * * * * * *

ORIGIN OF LINE OF SIGHT    8          (1107.0,   0.0, 507.0)

LOS ORIENTATION
    THETA(DEG)  =   0.0
    PHI  (DEG)  =   0.0
    DIRECTION COSINES
      S DOT XO  = 0.000
      S DOT YO  =  .866
      S DOT ZO  =  .500

INCOMING AMBIENT CHARACTERISTICS
    SPEED(M/SEC)  = .765E+04
    DIRECTION COSINES
     VA DOT XO  = 0.000
     VA DOT YO  = 0.000
     VA DOT ZO  =-1.000
    DENSITY(#/CC) = .209E+09
ANGLE BETWEEN VA AND LOS
     ALPHA    =  60.0

VOLUME CONSIDERATIONS
    HEMISPERICAL CLOUD (M**3)  = .132E+09
    VOL. ENCOMPASSED BY LOS    = .386E+07
    FRACTION OF TOTAL          =  .029


CLOUD CONTIBUTORS TO COLUMN DENSITY
    RHO(10000)  *   .23E+02
    RHO(32005)  *   .47E+02
    RHO(32010)  *   .47E+02
    RHO(32015)  *   .47E+02
    RHO(32020)  *   .47E+02
    RHO(32025)  *   .47E+02
    RHO(32030)  *   .47E+02
    RHO(32035)  *   .47E+02
    RHO(32040)  *   .47E+02
    RHO(32045)  *   .47E+02
    RHO(32050)  *   .41E+03
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5.3.2 Output (cont'd)

REPORT NO. 33 *** SAMPLE CASE NO. 3 SHUTTLE ORBITER 100 HRS 60/90 LOS *** 09/19/77 11.32.05. PAGE 7

CONTENTS: NUMBER COLUMN DENSITIES - ENUMERATED BY SOURCE

LINE-OF-SIGHT NO. = 8
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** HIGHEST TO LOWEST CONTRIBUTOR ***

SURFACE NUMBER	SECTION / MATERIAL	MASS LOSS (GM/SEC) / TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1	OUTG2	H2O	N2	CO2	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD	% OF TOTAL	PLACE
			O2	CO	H2	H	MMHNO3					
140	WING	.276E-04	.38E+10	0.	.15E+09	.74E+08	.48E+08	.13E-13	.63E-12	.64E-12		
	NOMEX	44.170	.27E+08	0.	0.	0.	0.	.30E+09	.38E+10	.41E+10	14.5340	1
142	WING	.328E-04	.32E+10	0.	.13E+09	.63E+08	.41E+08	.11E-13	.53E-12	.54E-12		
	NOMEX	54.560	.22E+08	0.	0.	0.	0.	.25E+09	.32E+10	.35E+10	12.2962	2
11	BAY	.295E-04	.31E+10	0.	.12E+09	.60E+08	.39E+08	.10E-13	.51E-12	.52E-12		
	BLKHED	42.580	.22E+08	0.	0.	0.	0.	.24E+09	.31E+10	.33E+10	11.8119	3
137	ELEVON	.156E-04	.19E+10	0.	.75E+08	.38E+08	.24E+08	.65E-14	.32E-12	.33E-12		
	NOMEX	54.780	.13E+08	0.	0.	0.	0.	.15E+09	.19E+10	.21E+10	7.3691	4
50	RADOOR	.824E-05	.18E+10	0.	.72E+08	.36E+08	.23E+08	.62E-14	.30E-12	.31E-12		
	TEFLON	32.780	.13E+08	0.	0.	0.	0.	.14E+09	.18E+10	.20E+10	7.0132	5
54	RADOOR	.645E-05	.12E+10	0.	.49E+08	.24E+08	.16E+08	.42E-14	.21E-12	.21E-12		
	TEFLON	25.680	.87E+07	0.	0.	0.	0.	.98E+08	.12E+10	.13E+10	4.7841	6
110	WING	.276E-04	.94E+09	0.	.37E+08	.19E+08	.12E+08	.32E-14	.16E-12	.16E-12		
	NOMEX	44.170	.66E+07	0.	0.	0.	0.	.74E+08	.94E+09	.10E+10	3.6158	7
134	WING	.160E-04	.81E+09	0.	.32E+08	.16E+08	.10E+08	.27E-14	.13E-12	.14E-12		
	NOMEX	55.560	.57E+07	0.	0.	0.	0.	.64E+08	.81E+09	.87E+09	3.1072	8
6	BAY	.435E-05	.67E+09	0.	.26E+08	.13E+08	.84E+07	.22E-14	.11E-12	.11E-12		
	LINER	66.220	.47E+07	0.	0.	0.	0.	.52E+08	.67E+09	.72E+09	2.5773	9
5	BAY	.657E-05	.64E+09	0.	.25E+08	.12E+08	.80E+07	.21E-14	.11E-12	.11E-12		
	LINER	78.220	.45E+07	0.	0.	0.	0.	.49E+08	.64E+09	.69E+09	2.4399	10
136	ELEVON	.116E-04	.62E+09	0.	.25E+08	.12E+08	.79E+07	.21E-14	.10E-12	.11E-12		
	NOMEX	56.110	.44E+07	0.	0.	0.	0.	.49E+08	.62E+09	.67E+09	2.3923	11

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5.3.2 Output (cont'd)

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REPORT NO. 33 *** SAMPLE CASE NO. 3 SHUTTLE ORBITER 100 HRS 60/90 LOS *** 09/19/77 11.32.07. PAGE 14

CONTENTS: NUMBER COLUMN DENSITIES - ENUMERATED BY SOURCE

LINE-OF-SIGHT NO. = 8
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** HIGHEST TO LOWEST CONTRIBUTOR *** (CONT)

SURFACE NUMBER	SECTION MATERIAL	MASS LOSS (GM/SEC) TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1 OUTG2 H2O N2 CO2 / O2 CO H2 H MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD	% OF TOTAL	PLACE
160	CREW	.320E-08	.69E+04 0. .27E+03 .14E+03 .87E+02	.23E-19	.11E-17	.12E-17		
	RCC	22.000	.48E+02 0. 0. 0. 0.	.54E+03	.69E+04	.74E+04	.0000	99
TOTAL		.423E-03	.26E+11 0. .10E+10 .51E+09 .33E+09	.88E-13	.43E-11	.44E-11		
			.18E+09 0. 0. 0. 0.	.20E+10	.26E+11	.28E+11	100.0000	

5.3.2 Output (cont'd)

REPORT NO. 41 *** SAMPLE CASE NO. 3 SHUTTLE ORBITER 100 HRS 60/90 LOS *** 09/19/77 11.32.07. PAGE 15

CONTENTS: RETURN FLUX AT 400.0 KM ALTITUDE - ENUMERATED BY SOURCE

CRITICAL SURFACE NO. = 8
FIELD-OF-VIEW (SR) = .190

*** HIGHEST TO LOWEST CONTRIBUTOR ***

SURFACE NUMBER	SECTION MATERIAL	MASS LOSS (GM/SEC) TEMP (DEG C)	SPECIES RETURN FLUX CONTRIBUTION (MOLECULES/CM**2) OUTG1 O2	OUTG2 CO	H2O H2	N2 H	CO2 MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL RTN FLX	% OF TOTAL	PLACE
140	WING	.276E-04	.15E+10	0.	.19E+08	.13E+08	.90E+07	.21E-14	.25E-12	.25E-12		
	NOMEX	44.170	.42E+07	0.	0.	0.	0.	.45E+08	.15E+10	.15E+10	14.5330	1
142	WING	.328E-04	.13E+10	0.	.16E+08	.11E+08	.76E+07	.17E-14	.21E-12	.21E-12		
	NOMEX	54.560	.35E+07	0.	0.	0.	0.	.38E+08	.13E+10	.13E+10	12.2953	2
11	BAY	.295E-04	.12E+10	0.	.16E+08	.10E+08	.73E+07	.17E-14	.20E-12	.20E-12		
	BLKHED	42.580	.34E+07	0.	0.	0.	0.	.37E+08	.12E+10	.12E+10	11.8110	3
137	ELEVON	.156E-04	.75E+09	0.	.99E+07	.64E+07	.46E+07	.10E-14	.12E-12	.13E-12		
	NOMEX	54.780	.21E+07	0.	0.	0.	0.	.23E+08	.75E+09	.77E+09	7.3686	4
50	RADOOR	.824E-05	.71E+09	0.	.94E+07	.61E+07	.44E+07	.99E-15	.12E-12	.12E-12		
	TEFLON	32.780	.20E+07	0.	0.	0.	0.	.22E+08	.71E+09	.74E+09	7.0126	5
54	RADOOR	.645E-05	.49E+09	0.	.64E+07	.42E+07	.30E+07	.68E-15	.81E-13	.82E-13		
	TEFLON	25.680	.14E+07	0.	0.	0.	0.	.15E+08	.49E+09	.50E+09	4.7837	6
110	WING	.276E-04	.37E+09	0.	.48E+07	.32E+07	.22E+07	.51E-15	.61E-13	.62E-13		
	NOMEX	44.170	.10E+07	0.	0.	0.	0.	.11E+08	.37E+09	.38E+09	3.6155	7
134	WING	.160E-04	.32E+09	0.	.42E+07	.27E+07	.19E+07	.44E-15	.53E-13	.53E-13		
	NOMEX	55.560	.90E+06	0.	0.	0.	0.	.97E+07	.32E+09	.33E+09	3.1070	8
6	BAY	.435E-05	.26E+09	0.	.34E+07	.22E+07	.16E+07	.36E-15	.44E-13	.44E-13		
	LINER	66.220	.74E+06	0.	0.	0.	0.	.80E+07	.26E+09	.27E+09	2.5786	9
5	BAY	.657E-05	.25E+09	0.	.32E+07	.21E+07	.15E+07	.34E-15	.41E-13	.42E-13		
	LINER	78.220	.70E+06	0.	0.	0.	0.	.75E+07	.25E+09	.26E+09	2.4411	10

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5.3.2 Output (cont'd)

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REPORT NO. 41 *** SAMPLE CASE NO. 3 SHUTTLE ORBITER 100 HRS 60/90 LOS *** 09/19/77 11.32.08. PAGE 22

CONTENTS: RETURN FLUX AT 400.0 KM ALTITUDE - ENUMERATED BY SOURCE

CRITICAL SURFACE NO. = 8
FIELD-OF-VIEW (SR) = .190

*** HIGHEST TO LOWEST CONTRIBUTOR ***(CONT)

SURFACE NUMBER	SECTION MATERIAL	MASS LOSS (GM/SEC) TEMP (DEG C)	SPECIES RETURN FLUX CONTRIBUTION (MOLECULES/CM**2) OUTG1 O2	OUTG2 CO	H2O H2	N2 H	CO2 MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL RTN FLX	% OF TOTAL	PLACE
160	CREW	.320E-08	.27E+04	0.	.35E+02	.23E+02	.16E+02	.37E-20	.45E-18	.45E-18		
	RCC	22.000	.76E+01	0.	0.	0.	0.	.83E+02	.27E+04	.28E+04	.0000	99
TOTAL		.423E-03	.10E+11	0.	.13E+09	.87E+08	.62E+08	.14E-13	.17E-11	.17E-11		
			.29E+08	0.	0.	0.	0.	.31E+09	.10E+11	.11E+11	100.0000	

5.3.2 Output (cont'd)

REPORT NO. 42 *** SAMPLE CASE NO. 3 SHUTTLE ORBITER 100 HRS 60/90 LOS *** 09/19/77 11.32.08. PAGE 23

CONTENTS: RETURN FLUX AT 400.0 KM ALTITUDE - ENUMERATED BY SOURCE

CRITICAL SURFACE NO. = 8
FIELD-OF-VIEW (SR) = .190

*** SORTED BY TYPE OF MATERIAL ***

SURFACE NUMBER	SECTION / MATERIAL	MASS LOSS (GM/SEC) TEMP (DEG C)	SPECIES RETURN FLUX CONTRIBUTIONS (MOLECULES/CM**2) OUTG1 O2	OUTG2 CO	H2O H2	N2 H	CO2 MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL RTNFLX
6	BAY	.435E-05	.26E+09	0.	.34E+07	.22E+07	.16E+07	.36E-15	.44E-13	.44E-13
	LINER	66.220	.74E+06	0.	0.	0.	0.	.80E+07	.26E+09	.27E+09
5	BAY	.657E-05	.25E+09	0.	.32E+07	.21E+07	.15E+07	.34E-15	.41E-13	.42E-13
	LINER	78.220	.70E+06	0.	0.	0.	0.	.75E+07	.25E+09	.26E+09
1	BAY	.657E-05	.18E+09	0.	.23E+07	.15E+07	.11E+07	.25E-15	.30E-13	.30E-13
	LINER	78.220	.51E+06	0.	0.	0.	0.	.54E+07	.18E+09	.18E+09
2	BAY	.435E-05	.14E+09	0.	.19E+07	.12E+07	.87E+06	.20E-15	.24E-13	.24E-13
	LINER	66.220	.41E+06	0.	0.	0.	0.	.43E+07	.14E+09	.15E+09
7	BAY	.428E-05	.14E+09	0.	.18E+07	.12E+07	.82E+06	.19E-15	.23E-13	.23E-13
	LINER	65.780	.39E+06	0.	0.	0.	0.	.41E+07	.14E+09	.14E+09
8	BAY	.564E-05	.10E+09	0.	.13E+07	.87E+06	.62E+06	.14E-15	.17E-13	.17E-13
	LINER	73.780	.29E+06	0.	0.	0.	0.	.31E+07	.10E+09	.11E+09
3	BAY	.428E-05	.46E+08	0.	.59E+06	.39E+06	.28E+06	.62E-16	.76E-14	.76E-14
	LINER	65.780	.13E+06	0.	0.	0.	0.	.14E+07	.46E+08	.47E+08
443	BAY	.454E-06	.28E+08	0.	.36E+06	.24E+06	.17E+06	.38E-16	.46E-14	.47E-14
	LINER	60.000	.79E+05	0.	0.	0.	0.	.85E+06	.28E+08	.29E+08
442	BAY	.315E-06	.23E+08	0.	.30E+06	.19E+06	.14E+06	.31E-16	.38E-14	.38E-14
	LINER	49.440	.65E+05	0.	0.	0.	0.	.69E+06	.23E+08	.24E+08
4	BAY	.557E-05	.20E+08	0.	.25E+06	.17E+06	.12E+06	.27E-16	.33E-14	.33E-14
	LINER	73.440	.56E+05	0.	0.	0.	0.	.59E+06	.20E+08	.20E+08
448	BAY	.454E-06	.11E+08	0.	.14E+06	.95E+05	.67E+05	.15E-16	.19E-14	.19E-14
	LINER	60.000	.32E+05	0.	0.	0.	0.	.34E+06	.11E+08	.12E+08
441	BAY	.315E-06	.11E+08	0.	.14E+06	.92E+05	.66E+05	.15E-16	.18E-14	.18E-14
	LINER	49.440	.31E+05	0.	0.	0.	0.	.33E+06	.11E+08	.11E+08
447	BAY	.315E-06	.10E+08	0.	.14E+06	.89E+05	.63E+05	.14E-16	.17E-14	.18E-14
	LINER	49.440	.30E+05	0.	0.	0.	0.	.32E+06	.10E+08	.11E+08

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5.3.2 Output (cont'd)

REPORT NO. 43 *** SAMPLE CASE NO. 3 SHUTTLE ORBITER 100 HRS 60/90 LOS *** 09/19/77 11.32.10. PAGE 31

CONTENTS: SUMMARY RETURN FLUX AT 400.0 KM ALTITUDE

CRITICAL SURFACE NO. = 8
FIELD-OF-VIEW (SR) = .190

*** LISTED BY MATERIAL TYPE ***(CONT)

SECTION SUMMARY	SPECIES RETURN FLUX (MOLECULES/CM**2) OUTG1 / OUTG2 / H2O / N2 / CO2					EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL	% OF TOTAL
	O2	CO	H2	H	MMHNO3				
LINER	.12E+10	0.	.16E+08	.10E+08	.74E+07	.17E-14	.20E-12	.21E-12	
	.35E+07	0.	0.	0.	0.	.37E+08	.12E+10	.13E+10	12.1
TEFLON	.15E+10	0.	.20E+08	.13E+08	.92E+07	.21E-14	.25E-12	.25E-12	
	.43E+07	0.	0.	0.	0.	.46E+08	.15E+10	.16E+10	14.8
NOMEX	.53E+10	0.	.70E+08	.46E+08	.32E+08	.74E-14	.88E-12	.89E-12	
	.15E+08	0.	0.	0.	0.	.16E+09	.53E+10	.55E+10	52.2
LRSI	.56E+09	0.	.73E+07	.48E+07	.34E+07	.77E-15	.92E-13	.93E-13	
	.16E+07	0.	0.	0.	0.	.17E+08	.56E+09	.57E+09	5.5
HRSI	.26E+09	0.	.35E+07	.23E+07	.16E+07	.37E-15	.44E-13	.44E-13	
	.75E+06	0.	0.	0.	0.	.81E+07	.26E+09	.27E+09	2.6
RCC	.28E+06	0.	.37E+04	.24E+04	.17E+04	.39E-18	.47E-16	.47E-16	
	.79E+03	0.	0.	0.	0.	.86E+04	.28E+06	.29E+06	.0
BLKHED	.13E+10	0.	.17E+08	.11E+08	.80E+07	.18E-14	.22E-12	.22E-12	
	.37E+07	0.	0.	0.	0.	.40E+08	.13E+10	.14E+10	12.9
TOTAL	.10E+11	0.	.13E+09	.87E+08	.62E+08	.14E-13	.17E-11	.17E-11	
	.29E+08	0.	0.	0.	0.	.31E+09	.10E+11	.11E+11	100.0

5.3.2 Output (cont'd)

REPORT NO. 46 *** SAMPLE CASE NO. 3 SHUTTLE ORBITER 100 HRS 60/90 LOS *** 09/19/77 11.32.10. PAGE 32

CONTENTS: RETURN FLUX DUE TO SELF SCATTERING 400.0 KM ALTITUDE CRITICAL SURFACE NO. = 8
FIELD-OF-VIEW (SR) = .190

*** LISTED BY LOS SEGMENT ***(CONT)

SPECIES	COLLISION FREQUENCY (NO./SEC)	TOTAL DENSITY (GM/CM**3)	FLUX FROM SEGMENT (MOLECULES/ CM**2/SEC)	FLUX TO SEGMENT (GM/CM**2/ /SEC)	ACCUMULATED RETURN FLUX (MOLECULES/ CM**2/SEC)
SEGMENT = 1					
OUTG1	.550E+06	.268E-14	.205E+07	.618E-10	.205E+07
OUTG2	0.	0.	0.	0.	0.
H2O	.177E+05	.189E-16	.661E+05	.103E-11	.661E+05
N2	.896E+04	.147E-16	.334E+05	.642E-12	.334E+05
CO2	.533E+04	.149E-16	.199E+05	.519E-12	.199E+05
O2	.293E+04	.601E-17	.109E+05	.246E-12	.109E+05
SEGMENT = 2					
OUTG1	.307E+06	.200E-14	.229E+07	.460E-10	.434E+07
OUTG2	0.	0.	0.	0.	0.
H2O	.990E+04	.142E-16	.739E+05	.767E-12	.140E+06
N2	.500E+04	.110E-16	.373E+05	.479E-12	.708E+05
CO2	.297E+04	.112E-16	.222E+05	.387E-12	.421E+05
O2	.163E+04	.450E-17	.122E+05	.183E-12	.231E+05
SEGMENT = 3					
OUTG1	.117E+06	.124E-14	.875E+06	.285E-10	.522E+07
OUTG2	0.	0.	0.	0.	0.
H2O	.379E+04	.876E-17	.283E+05	.475E-12	.168E+06
N2	.191E+04	.682E-17	.143E+05	.296E-12	.851E+05
CO2	.114E+04	.690E-17	.849E+04	.239E-12	.506E+05
O2	.624E+03	.278E-17	.466E+04	.113E-12	.278E+05
SEGMENT = 4					
OUTG1	.401E+05	.724E-15	.299E+06	.167E-10	.552E+07
OUTG2	0.	0.	0.	0.	0.
H2O	.130E+04	.512E-17	.967E+04	.278E-12	.178E+06
N2	.655E+03	.399E-17	.489E+04	.173E-12	.899E+05
CO2	.389E+03	.403E-17	.290E+04	.140E-12	.535E+05
O2	.213E+03	.163E-17	.159E+04	.662E-13	.294E+05

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5.4 SAMPLE CASE No. 4 - TWO BULK MASS LOSS RATES

The program is capable of monitoring up to 10 chemical species lost from spacecraft materials, leakage and rocket engines while on-orbit. The default list of contaminants includes two outgassing molecules, H_2O, N_2, CO_2, O_2, CO, H_2, H and monomethyl hydrazine nitrate. The type and number of contaminants can be changed by the user as demonstrated in this sample problem.

In this situation only two generic types of contaminants are desired. One will represent all outgassing large molecular weight species and be called OUTG1; the second (called OFF) will represent all low molecular weight gases (H_2O, N_2, CO_2, O_2) that desorb rapidly from a material once placed in a vacuum environment. For simplicity it will be assumed that all 15 spacecraft materials have an initial bulk mass loss rate for the early desorption species of 1.0×10^{-8} g/cm^2/s at 100°C.

Because mass loss rate coefficients are being altered in this run, reports (5) and (6) will be requested to document the new characteristics. The control flag NEWMLC must be set .TRUE. so that new information can be read in through namelist INPUTB. Plots that show the variation of density as a function of distance along the line-of-sight will be generated by requesting reports (39) and (40).

Only the top 50 surfaces based on total mass loss rates will be retained (JKEEP = 50) in computing the mass/number column density along a line-of-sight parallel to the Orbiter Z-axis.

5.4.1 Input

```
 *** SAMPLE CASE NO. 4   TWO BULK MASS LOSS RATES   ***
$CONTRL
 ORBITR = .T.,   LMOP = .F.,
 ED=.T.,
 NEWMLC = .T.,
 REPORT(5) = .T.,  REPORT(6) =.T.,  REPORT(39) =.T.,  REPORT(40) =.T.,
 GO = .T.$
$INPUTA
 GO = .T.$
$INPUTB
 CHNGES = 9,
 MOUT1 = 1.     MOUT2 = 1,   MED1 = 2,    MED2 = 2, M1=1, M2=2,
 RATE(1,2) = 15*1.0E-8,
 TAU(1,2)  = 15*18.0$
```

5.4.1 Input (cont'd)

```
  2     OFF        18.0     3.33E-8
  3                 .0          .0
  4                 .0          .0
  5                 .0          .0
  6                 .0          .0
  7                 .0          .0
  8                 .0          .0
  9                 .0          .0
 10                 .0          .0
 $MPDB
  RMAXL = 150.,
  NLOS = 1,
  JKEEP = 50,
  GO = .TRUE.$
STOP
```

5.4.2 Output

```
REPORT NO.  6  ***  SAMPLE CASE NO. 4   TWO BULK MASS LOSS RATES   ***

CONTENTS:  MODIFIED LIST OF MASS LOSS RATE COEFFICIENTS

$INPUTB

RATE   = .8E-10, .5E-09, .124E-08, .51E-09, .52E-09, .1E-11, .1E-08, 0.0,      .6E-08, .601E-08, 0.0, 0.0, 0.0, 0.0,
         0.0, .1E-07, .1E-07, .1E-07, .1E-07, .1E-07, .1E-07, .1E-07, .1E-07,  .1E-07, .1E-07, .1E-07, .1E-07, .1E-07,
         .1E-07, .1E-07, .33E-09, .21E-08, .521E-08, .214E-08, .218E-08,       .42E-11, .42E-08, 0.0, .164E-06, .164E-06,
         .1745E-11, .239E-12, .386E-12, 0.0, 0.0, .207E-09, .131E-08,         .325E-08, .134E-08, .136E-08, .262E-11,
         .262E-08, 0.0, .102E-06, .102E-06, .1308E-09, .179E-10, .29E-10, 0.0, 0.0, .168E-09, .106E-08, .262E-08,
         .108E-08, .11E-08, .212E-11, .212E-08, 0.0, .827E-07, .827E-07,      .1745E-09, .239E-12, .386E-12, 0.0,
         0.0, .8E-10, .5E-09, .124E-08, .51E-09, .52E-09, .1E-11, .1E-08, 0.0, .39E-07, .39E-07, .4014E-10, .55E-11,
         .889E-11, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0; 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
         0.0,

TAU    = .41E+04, .41E+04, .41E+04, .41E+04, .41E+04, .41E+04, .41E+04,      .41E+04, .41E+04, .41E+04, 0.0, 0.0,
         0.0, 0.0, 0.0, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02,  .18E+02, .18E+02, .18E+02, .18E+02,
         .18E+02, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02,        .18E+02, .18E+02, .18E+02, .18E+02,
         .18E+02, .41E+04, .18E+02, .18E+02, 0.0, 0.0, 0.0, 0.0, 0.0, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02,
         .18E+02, .18E+02, .41E+04, .18E+02, .18E+02, 0.0, 0.0, 0.0, 0.0, 0.0, .18E+02, .18E+02, .18E+02, .18E+02,
         .18E+02, .18E+02, .18E+02, .41E+04, .18E+02, .18E+02, .18E+02, 0.0, 0.0, 0.0, 0.0, .18E+02, .18E+02,
         .18E+02, .18E+02, .18E+02, .18E+02, .41E+04, .18E+02, .18E+02, 0.0,   0.0, 0.0, 0.0, 0.0, .18E+02, .18E+02,
         .18E+02, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02, .41E+04,        .18E+02, 0.0, 0.0, 0.0, 0.0, 0.0, .18E+02,
         0.0  .18E+02, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02,   .18E+02, .18E+02, 0.0, 0.0, 0.0, 0.0,
         0.0, 0.0, 0.0, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02, .18E+02,  .41E+04, .18E+02, .18E+02, 0.0, 0.0,
         0.0, 0.0, 0.0, 0.0, 0.0,                                              .18E+02, .41E+04, .18E+02, .18E+02,

AGEORB = 0.0,

AGESLB = 0.0,

CHNGES = 9,

CHNGEK = 0,

CHNGEP = 0,

MOUT1  = 1,

MOUT2  = 1,

MED1   = 2,

MED2   = 2,

M1     = 1,

M2     = 2,

$END
```

5.4.2 Output (cont'd)

REPORT NO. 33 *** SAMPLE CASE NO. 4 TWO BULK MASS LOSS RATES *** 08/20/77 07.03.43. PAGE 8

CONTENTS: NUMBER COLUMN DENSITIES - ENUMERATED BY SOURCE

LINE-OF-SIGHT NO. = 1
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** HIGHEST TO LOWEST CONTRIBUTOR ***

SURFACE NUMBER	SECTION / MATERIAL	MASS LOSS (GM/SEC) / TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1	OFF				EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD	% OF TOTAL	PLACE
1	BAY	.473E-03	.84E+09	.14E+12	0.	0.	0.	.43E-11	.14E-12	.44E-11		
	LINER	78.220	0.	0.	0.	0.	0.	.14E+12	.84E+09	.14E+12	13.7203	1
5	BAY	.473E-03	.84E+09	.14E+12	0.	0.	0.	.43E-11	.14E-12	.44E-11		
	LINER	78.220	0.	0.	0.	0.	0.	.14E+12	.84E+09	.14E+12	13.7203	2
6	BAY	.313E-03	.63E+09	.11E+12	0.	0.	0.	.32E-11	.10E-12	.33E-11		
	LINER	66.220	0.	0.	0.	0.	0.	.11E+12	.63E+09	.11E+12	10.3007	3
2	BAY	.313E-03	.63E+09	.11E+12	0.	0.	0.	.32E-11	.10E-12	.33E-11		
	LINER	66.220	0.	0.	0.	0.	0.	.11E+12	.63E+09	.11E+12	10.3007	4
7	BAY	.308E-03	.33E+09	.56E+11	0.	0.	0.	.17E-11	.55E-13	.17E-11		
	LINER	65.780	0.	0.	0.	0.	0.	.56E+11	.33E+09	.57E+11	5.4191	5
3	BAY	.308E-03	.33E+09	.56E+11	0.	0.	0.	.17E-11	.55E-13	.17E-11		
	LINER	65.780	0.	0.	0.	0.	0.	.56E+11	.33E+09	.57E+11	5.4191	6
8	BAY	.406E-03	.27E+09	.45E+11	0.	0.	0.	.13E-11	.44E-13	.14E-11		
	LINER	73.780	0.	0.	0.	0.	0.	.45E+11	.27E+09	.45E+11	4.3480	7
4	BAY	.401E-03	.26E+09	.45E+11	0.	0.	0.	.13E-11	.44E-13	.14E-11		
	LINER	73.440	0.	0.	0.	0.	0.	.45E+11	.26E+09	.45E+11	4.2994	8
11	BAY	.197E-03	.29E+10	.39E+11	0.	0.	0.	.12E-11	.48E-12	.16E-11		
	BLKHED	42.580	0.	0.	0.	0.	0.	.39E+11	.29E+10	.42E+11	4.0289	9
50	RADOOR	.102E-03	.10E+10	.27E+11	0.	0.	0.	.81E-12	.17E-12	.98E-12		
	TEFLON	32.780	0.	0.	0.	0.	0.	.27E+11	.10E+10	.28E+11	2.6981	10
142	WING	.182E-03	.21E+10	.23E+11	0.	0.	0.	.69E-12	.35E-12	.10E-11		
	NOMEX	54.560	0.	0.	0.	0.	0.	.23E+11	.21E+10	.25E+11	2.4252	11
112	WING	.181E-03	.21E+10	.23E+11	0.	0.	0.	.69E-12	.35E-12	.10E-11		
	NOMEX	54.330	0.	0.	0.	0.	0.	.23E+11	.21E+10	.25E+11	2.4068	12
44	RADOOR	.832E-04	.83E+09	.22E+11	0.	0.	0.	.67E-12	.14E-12	.81E-12		
	TEFLON	26.990	0.	0.	0.	0.	0.	.22E+11	.83E+09	.23E+11	2.2310	13
140	WING	.154E-03	.19E+10	.21E+11	0.	0.	0.	.63E-12	.32E-12	.95E-12		
	NOMEX	44.170	0.	0.	0.	0.	0.	.21E+11	.19E+10	.23E+11	2.1987	14

REPORT NO. 33 *** SAMPLE CASE NO. 4 TWO BULK MASS LOSS RATES *** 08/20/77 07.03.43. PAGE 9

CONTENTS: NUMBER COLUMN DENSITIES - ENUMERATED BY SOURCE

LINE-OF-SIGHT NO. = 1
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** HIGHEST TO LOWEST CONTRIBUTOR *** (CONT)

SURFACE NUMBER	SECTION MATERIAL	MASS LOSS (GM/SEC) TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1	OFF				EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD	% OF TOTAL	PLACE
110	WING	.154E-03	.19E+10	.21E+11	0.	0.	0.	.63E-12	.32E-12	.95E-12		
	NOMEX	44.170	0.	0.	0.	0.	0.	.21E+11	.19E+10	.23E+11	2.1987	15
137	ELEVON	.865E-04	.14E+10	.15E+11	0.	0.	0.	.45E-12	.23E-12	.68E-12		
	NOMEX	54.780	0.	0.	0.	0.	0.	.15E+11	.14E+10	.17E+11	1.5831	16
107	ELEVON	.163E-03	.14E+10	.15E+11	0.	0.	0.	.45E-12	.23E-12	.68E-12		
	NOMEX	54.780	0.	0.	0.	0.	0.	.15E+11	.14E+10	.17E+11	1.5831	17
40	RADOOR	.102E-03	.51E+09	.14E+11	0.	0.	0.	.42E-12	.85E-13	.50E-12		
	TEFLON	32.780	0.	0.	0.	0.	0.	.14E+11	.51E+09	.14E+11	1.3889	18
64	OMS	.107E-03	.42E+09	.11E+11	0.	0.	0.	.33E-12	.70E-13	.40E-12		
	LRSI	22.760	0.	0.	0.	0.	0.	.11E+11	.42E+09	.12E+11	1.1149	19
54	RADOOR	.795E-04	.41E+09	.11E+11	0.	0.	0.	.33E-12	.68E-13	.40E-12		
	TEFLON	25.680	0.	0.	0.	0.	0.	.11E+11	.41E+09	.11E+11	1.1002	20
84	OMS	.106E-03	.41E+09	.11E+11	0.	0.	0.	.33E-12	.69E-13	.40E-12		
	LRSI	22.800	0.	0.	0.	0.	0.	.11E+11	.41E+09	.11E+11	1.0970	21
134	WING	.889E-04	.66E+09	.72E+10	0.	0.	0.	.22E-12	.11E-12	.33E-12		
	NOMEX	55.560	0.	0.	0.	0.	0.	.72E+10	.66E+09	.79E+10	.7501	22
104	WING	.872E-04	.65E+09	.71E+10	0.	0.	0.	.21E-12	.11E-12	.32E-12		
	NOMEX	55.000	0.	0.	0.	0.	0.	.71E+10	.65E+09	.78E+10	.7413	23
443	BAY	.326E-04	.41E+08	.69E+10	0.	0.	0.	.21E-12	.68E-14	.21E-12		
	LINER	60.000	0.	0.	0.	0.	0.	.69E+10	.41E+08	.70E+10	.6667	24
448	BAY	.326E-04	.41E+08	.69E+10	0.	0.	0.	.21E-12	.68E-14	.21E-12		
	LINER	60.000	0.	0.	0.	0.	0.	.69E+10	.41E+08	.70E+10	.6667	25
174	CREW	.733E-04	.23E+09	.61E+10	0.	0.	0.	.18E-12	.38E-13	.22E-12		
	LRSI	29.390	0.	0.	0.	0.	0.	.61E+10	.23E+09	.63E+10	.6038	26
117	WING	.333E-04	.16E+09	.42E+10	0.	0.	0.	.13E-12	.27E-13	.15E-12		
	HRSI	44.170	0.	0.	0.	0.	0.	.42E+10	.16E+09	.43E+10	.4170	27
147	WING	.333E-04	.16E+09	.42E+10	0.	0.	0.	.13E-12	.27E-13	.15E-12		
	HRSI	44.170	0.	0.	0.	0.	0.	.42E+10	.16E+09	.43E+10	.4170	28

5.4.2 Output (cont'd)

REPORT NO. 33 *** SAMPLE CASE NO. 4 TWO BULK MASS LOSS RATES *** 08/20/77 07.03.43. PAGE 10

CONTENTS: NUMBER COLUMN DENSITIES - ENUMERATED BY SOURCE

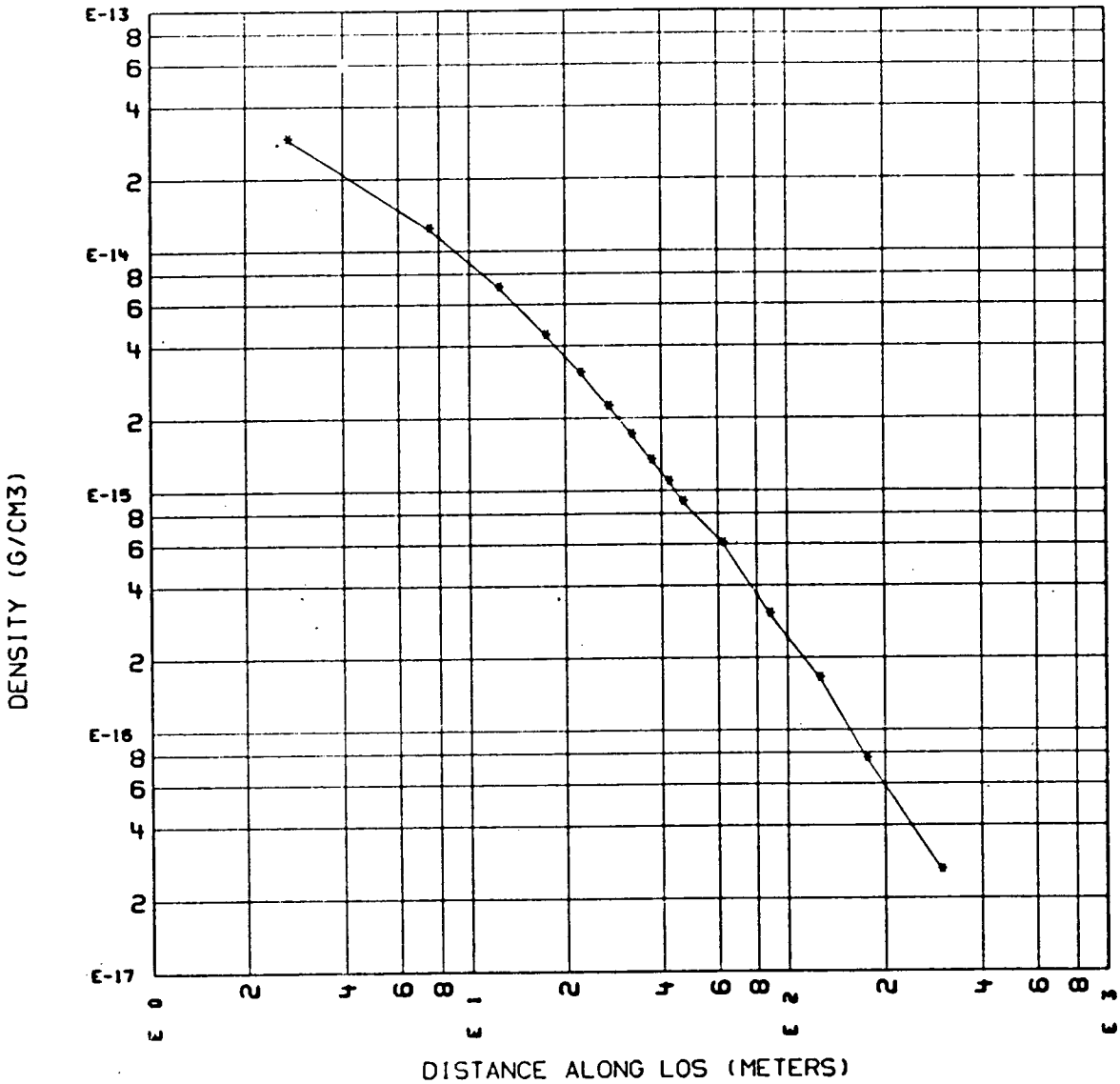
LINE-OF-SIGHT NO. = 1
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** HIGHEST TO LOWEST CONTRIBUTOR *** (CONT)

SURFACE NUMBER	SECTION / MATERIAL	MASS LOSS (GM/SEC) TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1	OFF				EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD	% OF TOTAL	PLACE
13	BAY	.357E-04	.29E+09	.40E+10	0.	0.	0.	.12E-12	.49E-13	.17E-12		
	BLKHED	-6.920	0.	0.	0.	0.	0.	.40E+10	.29E+09	.43E+10	.4119	29
190	CREW	.503E-04	.14E+09	.37E+10	0.	0.	0.	.11E-12	.23E-13	.13E-12		
	LRSI	38.890	0.	0.	0.	0.	0.	.37E+10	.14E+09	.39E+10	.3695	30
106	ELEVON	.645E-04	.30E+09	.33E+10	0.	0.	0.	.98E-13	.49E-13	.15E-12		
	NOMEX	56.110	0.	0.	0.	0.	0.	.33E+10	.30E+09	.36E+10	.3418	31
136	ELEVON	.645E-04	.30E+09	.33E+10	0.	0.	0.	.98E-13	.49E-13	.15E-12		
	NOMEX	56.110	0.	0.	0.	0.	0.	.33E+10	.30E+09	.36E+10	.3418	32
163	CREW	.416E-04	.73E+08	.20E+10	0.	0.	0.	.59E-13	.12E-13	.71E-13		
	LRSI	65.560	0.	0.	0.	0.	0.	.20E+10	.73E+08	.20E+10	.1948	33
164	CREW	.410E-04	.72E+08	.19E+10	0.	0.	0.	.58E-13	.12E-13	.70E-13		
	LRSI	65.140	0.	0.	0.	0.	0.	.19E+10	.72E+08	.20E+10	.1922	34
165	CREW	.599E-04	.22E+08	.60E+09	0.	0.	0.	.18E-13	.37E-14	.22E-13		
	LRSI	69.440	0.	0.	0.	0.	0.	.60E+09	.22E+08	.62E+09	.0595	35
166	CREW	.599E-04	.22E+08	.60E+09	0.	0.	0.	.18E-13	.37E-14	.22E-13		
	LRSI	69.440	0.	0.	0.	0.	0.	.60E+09	.22E+08	.62E+09	.0595	36
315	FUSLAG	.629E-04	.22E+08	.57E+09	0.	0.	0.	.17E-13	.36E-14	.21E-13		
	LRSI	13.330	0.	0.	0.	0.	0.	.57E+09	.22E+08	.60E+09	.0572	37
305	FUSLAG	.614E-04	.21E+08	.56E+09	0.	0.	0.	.17E-13	.35E-14	.20E-13		
	LRSI	12.620	0.	0.	0.	0.	0.	.56E+09	.21E+08	.58E+09	.0558	38
316	FUSLAG	.140E-03	.26E+08	.29E+09	0.	0.	0.	.87E-14	.44E-14	.13E-13		
	NOMEX	33.280	0.	0.	0.	0.	0.	.29E+09	.26E+08	.32E+09	.0304	39
306	FUSLAG	.137E-03	.26E+08	.28E+09	0.	0.	0.	.85E-14	.43E-14	.13E-13		
	NOMEX	32.670	0.	0.	0.	0.	0.	.28E+09	.26E+08	.31E+09	.0298	40
TOTAL		.589E-02	.25E+11	.10E+13	0.	0.	0.	.30E-10	.41E-11	.35E-10		
			0.	0.	0.	0.	0.	.10E+13	.25E+11	.10E+13	100.0000	

5.4.2 Output (cont'd)

REPORT 39
*** SAMPLE CASE NO. 4 TWO BULK MASS LOSS RATES ***

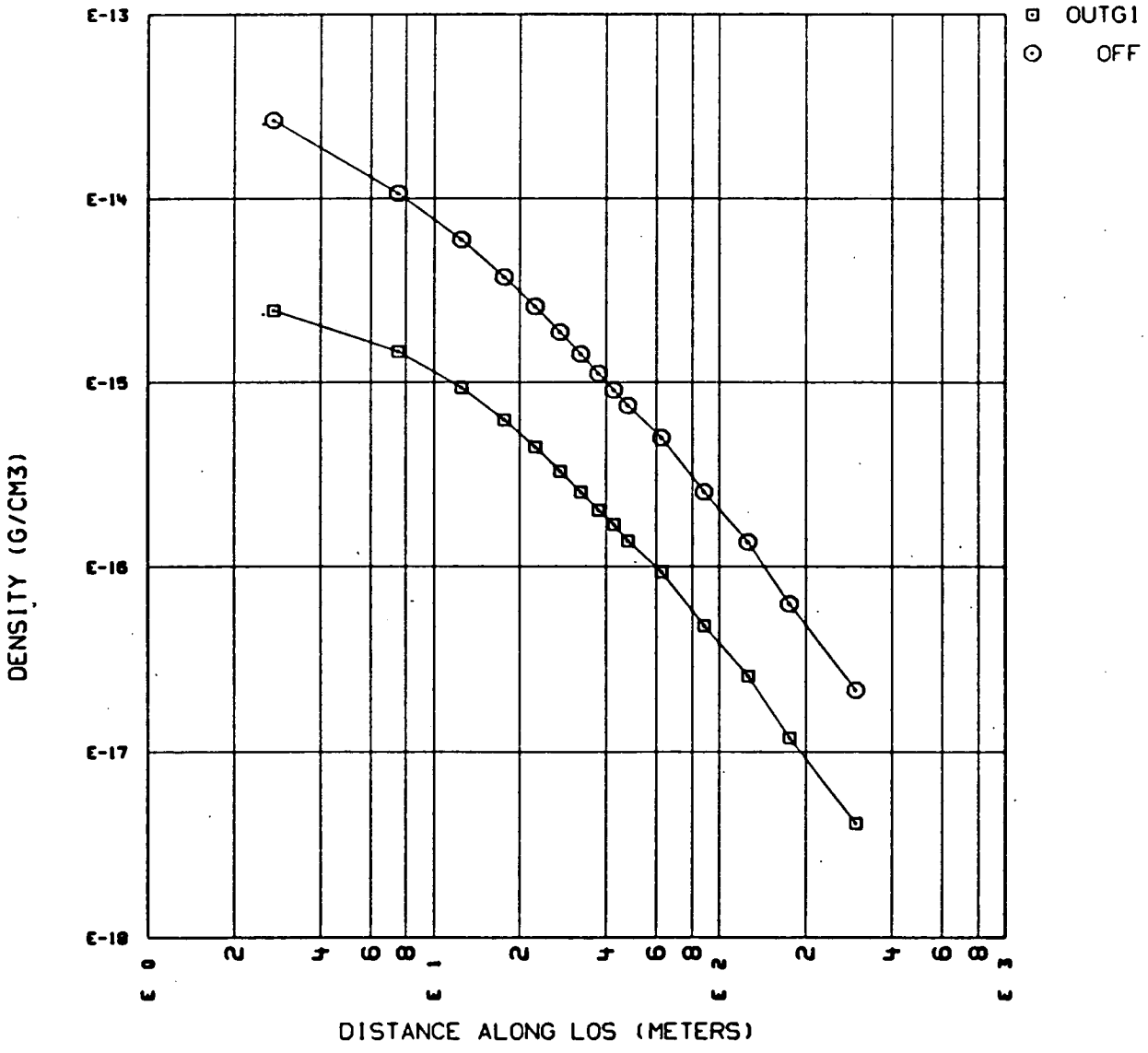


DENSITY ALONG LINE OF SIGHT 1

5.4.2 Output (cont'd)

REPORT 40

*** SAMPLE CASE NO. 4 TWO BULK MASS LOSS RATES ***



DENSITY VS DISTANCE (PER SPECIE) FOR LOS 1

5.5 SAMPLE CASE NO. 5 - SURFACE TEMPERATURE CHANGE

Surface temperatures for two different vehicle attitudes are currently stored on a permanent file that is read as TAPE10. In the event that the user wants to change a surface temperature, the following procedure can be used.

Set the NEWTCD = .TRUE. and then place a formatted card which contains the surface number and new temperature in the data stream as illustrated below. If there is some uncertainty about the mass loss rates this will create, the user can conduct the surface mass loss audit and forego a complete analysis by neglecting to set the run continuation flag .TRUE.

In this example LMOP surface 1010 was changed from 69°C to 101°C.

5.5.1 Input

```
  ***  SAMPLE CASE NO. 5   SURFACE TEMPERATURE CHANGE   ***
P$CONTRL
  NEWTCD =.T.,    REPORT(7) =.T.,    DBUGA=.T.,
  GO = .T.     $
P$INPUTA
  GO = .T.$
 1010      101.

P$MPDB
  GO = .TRUE.$
STOP
```

5.5.2 Output

REPORT NO. 7 *** SAMPLE CASE NO. 5 SURFACE TEMPERATURE CHANGE *** 04/21/77 13.40.12. PAGE 3

CONTENTS: LIST OF SURFACE TEMPERATURES THAT WILL BE USED

SEQUENCE NO.	IDENT NO.	TEMP (DEG C)	MATERIAL	AREA (SQ IN)
1	1000	84.	MTCS	2389.
2	1001	84.	MTCS	2389.
3	1002	77.	MTCS	2389.
4	1003	77.	MTCS	2389.
5	1005	169.	MTCS	9558.
→ 6	1010	101.	MTCS	2919.
7	1011	69.	MTCS	2919.
8	1012	60.	MTCS	2919.
9	1013	60.	MTCS	2919.
10	1015	150.	MTCS	11680.
11	1020	72.	MTCS	2397.
12	1021	52.	MTCS	2397.
13	1022	57.	MTCS	2397.
14	1023	77.	MTCS	2397.
15	1025	154.	MTCS	9589.
16	1030	51.	MTCS	6646.
17	1031	47.	MTCS	6646.
18	1032	33.	MTCS	6646.
19	1033	35.	MTCS	6646.
20	1035	102.	MTCS	2658.
21	1040	43.	MTCS	6646.
22	1041	46.	MTCS	6646.
23	1042	32.	MTCS	6646.
24	1043	27.	MTCS	6646.
25	1045	86.	MTCS	26580.
26	1050	35.	MTCS	2628.
27	1051	29.	MTCS	2628.
28	1052	27.	MTCS	2628.
29	1053	32.	MTCS	2628.
30	1055	84.	MTCS	10510.
31	1060	84.	MTCS	2373.
32	1061	28.	MTCS	2373.
33	1065	53.	MTCS	2059.
34	1070	88.	PTCS	28220.
35	1080	63.	PTCS	1596.
36	1081	67.	PTCS	1596.
37	1082	34.	PTCS	684.
38	1083	34.	PTCS	684.
39	1084	47.	PTCS	5166.
40	1085	54.	PTCS	5166.
41	1086	66.	PTCS	4093.
42	1087	66.	PTCS	4093.
43	1088	68.	PTCS	7866.
44	1110	46.	WINDOW	1219.
45	1111	46.	WINDOW	1219.
46	1120	46.	WINDOW	2059.
47	1121	46.	WINDOW	2059.
48	1130	28.	WINDOW	194.
49	1131	28.	WINDOW	194.

5.5.2 Output (cont'd)

REPORT NO. 34 *** SAMPLE CASE NO. 5 SURFACE TEMPERATURE CHANGE *** 04/21/77 13.40.41. PAGE 7

CONTENTS: MASS/NUMBER COLUMN DENSITIES

LINE-OF-SIGHT NO. = 1
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** SORTED BY MATERIALS ***

SURFACE NUMBER	SECTION / MATERIAL	MASS LOSS (GM/SEC) / TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1 / O2	OUTG2 / CO	H2O / H2	N2 / H	CO2 / MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD
1121	WINDOW	.122E-04	.25E+10	0.	0.	0.	0.	0.	.42E-12	.42E-12
	WINDOW	45.600	0.	0.	0.	0.	0.	0.	.25E+10	.25E+10
1111	WINDOW	.724E-05	.91E+09	0.	0.	0.	0.	0.	.15E-12	.15E-12
	WINDOW	45.600	0.	0.	0.	0.	0.	0.	.91E+09	.91E+09
1130	WINDOW	.623E-06	.32E+09	0.	0.	0.	0.	0.	.53E-13	.53E-13
	WINDOW	27.800	0.	0.	0.	0.	0.	0.	.32E+09	.32E+09
TOTAL	WINDOW	.201E-04	.38E+10	0.	0.	0.	0.	0.	.62E-12	.62E-12
			0.	0.	0.	0.	0.	0.	.38E+10	.38E+10
1010	MODULE	.117E-03	.22E+10	0.	0.	0.	0.	0.	.37E-12	.37E-12
	MTCS	101.000	0.	0.	0.	0.	0.	0.	.22E+10	.22E+10
1060	MODULE	.535E-04	.75E+10	0.	0.	0.	0.	0.	.12E-11	.12E-11
	MTCS	84.400	0.	0.	0.	0.	0.	0.	.75E+10	.75E+10
1000	MODULE	.530E-04	.66E+09	0.	0.	0.	0.	0.	.11E-12	.11E-12
	MTCS	83.900	0.	0.	0.	0.	0.	0.	.66E+09	.66E+09
1001	MODULE	.530E-04	.19E+10	0.	0.	0.	0.	0.	.31E-12	.31E-12
	MTCS	83.900	0.	0.	0.	0.	0.	0.	.19E+10	.19E+10
1030	MODULE	.475E-04	.13E+10	0.	0.	0.	0.	0.	.22E-12	.22E-12
	MTCS	51.100	0.	0.	0.	0.	0.	0.	.13E+10	.13E+10
1023	MODULE	.422E-04	.49E+08	0.	0.	0.	0.	0.	.81E-14	.81E-14
	MTCS	77.200	0.	0.	0.	0.	0.	0.	.49E+08	.49E+08
1002	MODULE	.420E-04	.15E+10	0.	0.	0.	0.	0.	.25E-12	.25E-12
	MTCS	77.200	0.	0.	0.	0.	0.	0.	.15E+10	.15E+10
1003	MODULE	.420E-04	.53E+09	0.	0.	0.	0.	0.	.88E-13	.88E-13
	MTCS	77.200	0.	0.	0.	0.	0.	0.	.53E+09	.53E+09
1031	MODULE	.408E-04	.44E+10	0.	0.	0.	0.	0.	.73E-12	.73E-12
	MTCS	46.700	0.	0.	0.	0.	0.	0.	.44E+10	.44E+10
1041	MODULE	.400E-04	.65E+10	0.	0.	0.	0.	0.	.11E-11	.11E-11
	MTCS	46.100	0.	0.	0.	0.	0.	0.	.65E+10	.65E+10

5.5.2 Output (cont'd)

REPORT NO. 34 *** SAMPLE CASE NO. 5 SURFACE TEMPERATURE CHANGE *** 04/21/77 13.40.41. PAGE 8

CONTENTS: MASS/NUMBER COLUMN DENSITIES

LINE-OF-SIGHT NO. = 1
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** SORTED BY MATERIALS *** (CONT)

SURFACE NUMBER	SECTION / MATERIAL	MASS LOSS (GM/SEC) / TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1 / O2	OUTG2 / CO	H2O / H2	N2 / H	CO2 / MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD
1011	MODULE	.386E-04	.24E+10	0.	0.	0.	0.	0.	.40E-12	.40E-12
	MTCS	69.900	0.	0.	0.	0.	0.	0.	.24E+10	.24E+10
1040	MODULE	.363E-04	.13E+10	0.	0.	0.	0.	0.	.21E-12	.21E-12
	MTCS	43.300	0.	0.	0.	0.	0.	0.	.13E+10	.13E+10
1020	MODULE	.349E-04	.41E+08	0.	0.	0.	0.	0.	.68E-14	.68E-14
	MTCS	71.700	0.	0.	0.	0.	0.	0.	.41E+08	.41E+08
1012	MODULE	.284E-04	.18E+10	0.	0.	0.	0.	0.	.30E-12	.30E-12
	MTCS	60.000	0.	0.	0.	0.	0.	0.	.18E+10	.18E+10
1013	MODULE	.284E-04	.58E+09	0.	0.	0.	0.	0.	.96E-13	.96E-13
	MTCS	60.000	0.	0.	0.	0.	0.	0.	.58E+09	.58E+09
1033	MODULE	.273E-04	.77E+09	0.	0.	0.	0.	0.	.13E-12	.13E-12
	MTCS	35.000	0.	0.	0.	0.	0.	0.	.77E+09	.77E+09
1032	MODULE	.253E-04	.28E+10	0.	0.	0.	0.	0.	.46E-12	.46E-12
	MTCS	32.800	0.	0.	0.	0.	0.	0.	.28E+10	.28E+10
1042	MODULE	.243E-04	.41E+10	0.	0.	0.	0.	0.	.67E-12	.67E-12
	MTCS	31.700	0.	0.	0.	0.	0.	0.	.41E+10	.41E+10
1022	MODULE	.212E-04	.19E+09	0.	0.	0.	0.	0.	.31E-13	.31E-13
	MTCS	57.200	0.	0.	0.	0.	0.	0.	.19E+09	.19E+09
1043	MODULE	.208E-04	.74E+09	0.	0.	0.	0.	0.	.12E-12	.12E-12
	MTCS	27.200	0.	0.	0.	0.	0.	0.	.74E+09	.74E+09
1021	MODULE	.178E-04	.16E+09	0.	0.	0.	0.	0.	.26E-13	.26E-13
	MTCS	52.200	0.	0.	0.	0.	0.	0.	.16E+09	.16E+09
1065	MODULE	.157E-04	.94E+09	0.	0.	0.	0.	0.	.16E-12	.16E-12
	MTCS	53.000	0.	0.	0.	0.	0.	0.	.94E+09	.94E+09
1050	MODULE	.108E-04	.10E+10	0.	0.	0.	0.	0.	.26E-12	.26E-12
	MTCS	35.000	0.	0.	0.	0.	0.	0.	.16E+10	.16E+10
1053	MODULE	.980E-05	.14E+10	0.	0.	0.	0.	0.	.24E-12	.24E-12
	MTCS	32.200	0.	0.	0.	0.	0.	0.	.14E+10	.14E+10

5.5.2 Output (cont'd)

REPORT NO. 34 *** SAMPLE CASE NO. 5 SURFACE TEMPERATURE CHANGE *** 04/21/77 13.40.41. PAGE 9

CONTENTS: MASS/NUMBER COLUMN DENSITIES

LINE-OF-SIGHT NO. = 1
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** SORTED BY MATERIALS *** (CONT)

SURFACE NUMBER	SECTION MATERIAL	MASS LOSS (GM/SEC) TEMP (DEG C)	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1 O2	OUTG2 CO	H2O H2	N2 H	CO2 MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL MCD/NCD
1051	MODULE	.874E-05	.44E+10	0.	0.	0.	0.	0.	.73E-12	.73E-12
	MTCS	28.900	0.	0.	0.	0.	0.	0.	.44E+10	.44E+10
1052	MODULE	.810E-05	.41E+10	0.	0.	0.	0.	0.	.68E-12	.68E-12
	MTCS	26.700	0.	0.	0.	0.	0.	0.	.41E+10	.41E+10
1061	MODULE	.760E-05	.12E+10	0.	0.	0.	0.	0.	.19E-12	.19E-12
	MTCS	27.800	0.	0.	0.	0.	0.	0.	.12E+10	.12E+10
TOTAL	MTCS	.895E-03	.55E+11	0.	0.	0.	0.	0.	.91E-11	.91E-11
			0.	0.	0.	0.	0.	0.	.55E+11	.55E+11
1088	PLT1	.100E-03	.22E+11	0.	0.	0.	0.	0.	.36E-11	.36E-11
	PTCS	67.800	0.	0.	0.	0.	0.	0.	.22E+11	.22E+11
1087	PLT1	.492E-04	.91E+10	0.	0.	0.	0.	0.	.15E-11	.15E-11
	PTCS	66.100	0.	0.	0.	0.	0.	0.	.91E+10	.91E+10
1086	PLT1	.492E-04	.91E+10	0.	0.	0.	0.	0.	.15E-11	.15E-11
	PTCS	66.100	0.	0.	0.	0.	0.	0.	.91E+10	.91E+10
1085	PLT1	.403E-04	.72E+10	0.	0.	0.	0.	0.	.12E-11	.12E-11
	PTCS	53.900	0.	0.	0.	0.	0.	0.	.72E+10	.72E+10
1084	PLT1	.316E-04	.56E+10	0.	0.	0.	0.	0.	.94E-12	.94E-12
	PTCS	46.700	0.	0.	0.	0.	0.	0.	.56E+10	.56E+10
1083	PLT1	.276E-05	.79E+09	0.	0.	0.	0.	0.	.13E-12	.13E-12
	PTCS	34.400	0.	0.	0.	0.	0.	0.	.79E+09	.79E+09
1082	PLT1	.276E-05	.79E+09	0.	0.	0.	0.	0.	.13E-12	.13E-12
	PTCS	34.400	0.	0.	0.	0.	0.	0.	.79E+09	.79E+09
TOTAL	PTCS	.277E-03	.54E+11	0.	0.	0.	0.	0.	.90E-11	.90E-11
			0.	0.	0.	0.	0.	0.	.54E+11	.54E+11

5.5.2 Output (cont'd)

REPORT NO. 35 *** SAMPLE CASE NO. 5 SURFACE TEMPERATURE CHANGE ***

04/21/77 13.40.42. PAGE 10

CONTENTS: SUMMARY *** MASS/NUMBER COLUMN DENSITIES ***

LINE-OF-SIGHT NO. = 1
THETA (DEG) = 0.0
PHI (DEG) = 0.0

*** LISTED BY MATERIALS *** (CONT)

SECTION SUMMARY	SPECIES NUMBER COLUMN DENSITY (MOLECULES/CM**2) OUTG1 O2	OUTG2 CO	H2O H2	N2 H	CO2 MMHNO3	EARLY DESORPTION (GM/CM**2) (MOLECULES/CM**2)	OUT GASSING	TOTAL	% OF TOTAL
WINDOW	.33E+10	0.	0.	0.	0.	0.	.62E-12	.62E-12	
	0.	0.	0.	0.	0.	0.	.38E+10	.38E+10	3.3
MTCS	.55E+11	0.	0.	0.	0.	0.	.91E-11	.91E-11	
	0.	0.	0.	0.	0.	0.	.55E+11	.55E+11	48.6
PTCS	.54E+11	0.	0.	0.	0.	0.	.90E-11	.90E-11	
	0.	0.	0.	0.	0.	0.	.54E+11	.54E+11	48.1
TOTAL	.11E+12	0.	0.	0.	0.	0.	.19E-10	.19E-10	
	0.	0.	0.	0.	0.	0.	.11E+12	.11E+12	100.0

5.6 SAMPLE CASE 6 - SL-1 PAYLOAD MISSION ANALYSIS

This problem briefly demonstrates the utility of the SPACE Program in evaluating the contaminant environment of a proposed Orbiter/Spacelab mission profile and payload manifest. The selected mission, designated SL-1, is based upon the NASA Spacelab 1 "Strawman" mission feasibility study activities. The payload mix for SL-1 consists of the following.

No.	Payload
AP-09-S	Electron Acceleration
AP-13-S	Low Light Level TV
ST-31-S	Drop Dynamics
EO-01-S	Zero-G Cloud Physics
LS-13-S	Minilab
APE-01	Lidar
SPE-80-85	Space Processing
SPE-01	Free Flow Electrophoresis
EOE-01	Metric Camera
APE-07	Infrared Radiometer
STE-10	Heat Pipe
ASE-01	Wide Field Galactic Camera

For simplicity, only one of the above payloads (ASE-01) known to be sensitive to outgassing deposition (based upon its detectable wavelength range) will be evaluated. Significant mission dependent parameters required for the modeling and evaluation include:

- configuration: Orbiter + LMOP,
- altitude: 250 km,
- sunspot activity: medium (assumed),
- attitude: random (assume $\alpha = 45^{o}$ continuously),
- contaminant sources: outgassing,
- Orbiter age/Spacelab age: 0/0 hours,
- deposition sensitive surface: ASE-01 hyperbolic collector,
- sensitive surface acceptance angle: 1.84 sr,
- sensitive surface temperature: 25°C,
- sticking coefficient: 0.25 solar side; 0.0 dark side,
- temperature profile: 60% hot; 40% cold,
- sensitive surface exposure time: 2.3 hours,
- location: Spacelab airlock (X_o = 975, Y_o = 0, Z_o = 480.9),
- line-of-signt; +Z (LOS1),
- wavelength of interest: 1500Å.

SPACE Program input parameters for this mission study are presented in subsection 5.6.1 and examples of the program output are included in subsection 5.6.2. As presented in the output subsection, the total deposition on the ASE-01 hyperbolic collector is 9.2×10^{15} mol/cm^2/orbit for the SL-1 mission profile. Assuming a density of the deposited outgassing material of 1.0 g/cm^3 results in a total deposition thickness of 233Å. At the 1500Å detectable wavelength of the ASE-01 payload this deposit will result in a reflectance loss of approximately 60.62%, based upon flight data obtained during the Gemini Program by Dr. J. Muscari of Martin Marietta Aerospace. Such a loss in reflectance could significantly hinder the ability of ASE-01 to meet its program objectives and contamination abatement procedures might be necessary.

5.6.1 Input

```
  ***  SAMPLE CASE NO. 6   SL-1 P/L MISSION ANALYSIS    ***
 $CONTRL
  ORBITR =.T..
  MCD = .F..    RFSS= .T..     RFAS = .T.. DEPSIT=.T..
  TSTART(1) = 0..3..0..
  TSTOP(1) = 0..57..0..
  REPORT(31) = .T.,   REPORT(33)=.F.,
  REPORT(46) = .T.,   REPORT(47)=.T.,
  GO = .T.    $END
 $INPUTA
  RFSURF(1) = 1120,9*0.
  GO =.T.     $END
 $MPDB
  ALT = 250.,
  THETA1(1) = 0..9*0..
  THETA2(1) = 45..9*0..
  VX= 5408.6.
  VZ=-5408.6.
  X0(1) = 975..  Y0(1) = 0..   Z0(1) = 480..
  DTHETA(1) = 22.5.
  DOMEGA(1) = .15.
  DPHI(1)   = 45..
  RFSTK = .25.
  GO = .TRUE.$
STOP
```

3.6.2 Output

```
 REPORT NO.  8  ***  SAMPLE CASE NO. 6   SL-1 P/L MISSION ANALYSIS    ***

 CONTENTS:  LIST OF MISSION DATA THAT WILL BE USED

$MPDB

BETA    = 0.0,

PITCH   = 0.0,

YAW     = 0.0,

ROLL    = 0.0,

ALT     = .25E+03,

SUNL    = F,

SUNM    = T,

SUNH    = F,

VX      = .54086E+04,

VY      = 0.0,

VZ      = -.54086E+04,

NLOS    = 1,

XLOS    = .1107E+04, .1107E+04, .1107E+04, .1107E+04, .1107E+04, .1107E+04,     .1107E+04, .1107E+04, .1107E+04, .1107E+04,
          .1107E+04, .1107E+04, .1107E+04, .1107E+04, .1107E+04, .1107E+04,     .1107E+04, .1107E+04, .1107E+04, .1107E+04,
          .1107E+04, .1107E+04, .1107E+04, .1107E+04, .1107E+04,

YLOS    = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0,

ZLOS    = .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03,
          .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03,
          .507E+03, .507E+03, .507E+03,

THETAL  = 0.0, .3E+02, .6E+02, .3E+02, .6E+02, .3E+02, .6E+02, .3E+02, .6E+02,  .3E+02, .6E+02, .3E+02, .6E+02, .3E+02,
          .6E+02, .3E+02, .6E+02, .825E+02, .825E+02, .825E+02, .825E+02,       .825E+02, .825E+02, .825E+02, .825E+02,

PHIL    = 0.0, 0.0, 0.0, .45E+02, .45E+02, .9E+02, .9E+02, .135E+03, .135E+03,  .18E+03, .18E+03, .225E+03, .225E+03,
          .27E+03, .27E+03, .315E+03, .315E+03, 0.0, .45E+02, .9E+02, .135E+03, .18E+03, .225E+03, .27E+03, .315E+03,

DSMCD   = .25E+01, .5E+01, .5E+01, .5E+01, .5E+01, .5E+01, .5E+01, .5E+01,     .5E+01, .5E+01, .15E+02, .25E+02, .375E+02,
          .5E+02, .124E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

RMAXL   = .3E+03,

RFSURF  = 1120, 0, 0, 0, 0, 0, 0, 0, 0, 0,
```

3.6.2 Output (cont'd)

```
COSXX  = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,      .1E+01, .1E+01,
COSXY  = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
COSXZ  = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
COSYX  = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
COSYY  = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,      .1E+01, .1E+01,
COSYZ  = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
COSZX  = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
COSZY  = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
COSZZ  = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,      .1E+01, .1E+01,
THETA1 = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
THETA2 = .45E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
PHI1   = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
PHI2   = .36E+03, .36E+03, .36E+03, .36E+03, .36E+03, .36E+03, .36E+03,      .36E+03, .36E+03, .36E+03,
DOMEGA = .15E+00, .1E+00, .1E+00, .1E+00, .1E+00, .1E+00, .1E+00, .1E+00,      .1E+00, .1E+00,
DSRTNF = .25E+01, .5E+01, .5E+01, .5E+01, .5E+01, .5E+01, .5E+01, .5E+01,      .5E+01, .5E+01, .15E+02, .25E+02, .375E+02,
         .5E+02, .124E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
DTHETA = .225E+02, .1024E+02, .1024E+02, .1024E+02, .1024E+02, .1024E+02,      .1024E+02, .1024E+02, .1024E+02, .1024E+02,
DPHI   = .45E+02, .1024E+02, .1024E+02, .1024E+02, .1024E+02, .1024E+02,      .1024E+02, .1024E+02, .1024E+02, .1024E+02,
RMAXRF = .3E+03,
RFSTK  = .25E+00,
VFACTR = .3E+01,
TIMEOO = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
JKEEP  = 300,
XO     = .975E+03, .1107E+04, .1107E+04, .1107E+04, .1107E+04, .1107E+04,      .1107E+04, .1107E+04, .1107E+04, .1107E+04,
YO     = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
ZO     = .48E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03, .507E+03,  .507E+03, .507E+03, .507E+03,
GO     = T,
```

3.6.2 Output (cont'd)

REPORT NO. 32 *** SAMPLE CASE NO. 6 SL-1 P/L MISSION ANALYSIS *** 08/20/77 06.45.51. PAGE 6

CONTENTS: SUMMARY OUTPUT FROM LINE-OF-SIGHT POINT SELECTOR

```
* * * * * *      LINE  OF  SIGHT  POINT  SELECTOR      * * * * * *
 * * * * * *            SUMMARY  FOR  LOS(1120)          * * * * * *

ORIGIN OF LINE OF SIGHT 1120          ( 975.0,   0.0, 480.0)

LOS ORIENTATION
    THETA(DEG)  =   0.0
    PHI  (DEG)  =   0.0
    DIRECTION COSINES
      S DOT XO  = 0.000
      S DOT YO  = 0.000
      S DOT ZO  = 1.000

INCOMING AMBIENT CHARACTERISTICS
    SPEED(M/SEC)  = .765E+04
    DIRECTION COSINES
     VA DOT XO  =  .707
     VA DOT YO  = 0.000
     VA DOT ZO  = -.707
    DENSITY(#/CC) = .245E+10
ANGLE BETWEEN VA AND LOS
     ALPHA     =  45.0

VOLUME CONSIDERATIONS
    HEMISPERICAL CLOUD (M**3)  = .132E+09
    VOL. ENCOMPASSED BY LOS    = .251E+07
    FRACTION OF TOTAL          =  .019


CLOUD CONTIBUTORS TO COLUMN DENSITY
    RHO(10000)  *   .10E+02
    RHO(10005)  *   .26E+01
    RHO(10010)  *   .14E+02
    RHO(10015)  *   .24E+02
    RHO(10020)  *   .29E+02
    RHO(10025)  *   .32E+02
```

3.6.2 Output (cont'd)

```
    RHO(10030)  *    .34E+02
    RHO(10035)  *    .35E+02
    RHO(10040)  *    .36E+02
    RHO(10045)  *    .37E+02
    RHO(10050)  *    .11E+03
    RHO(10075)  *    .19E+03
    RHO(10100)  *    .30E+03
    RHO(10150)  *    .42E+03
    RHO(10200)  *    .21E+03
    RHO(10300)  *    .17E+04
    RHO(24005)  *    .18E+02
    RHO(24010)  *    .32E+02
    RHO(24015)  *    .19E+02
    RHO(24020)  *    .14E+02
    RHO(24025)  *    .11E+02
    RHO(24030)  *    .93E+01
    RHO(24035)  *    .79E+01
    RHO(24040)  *    .69E+01
    RHO(24045)  *    .61E+01
    RHO(24050)  *    .14E+02
    RHO(24075)  *    .19E+02
    RHO(24100)  *    .19E+02
    RHO(24150)  *    .11E+02
    RHO(34005)  *    .30E+02
    RHO(44005)  *    .23E+01

VOLUME CONSIDERATIONS
    HEMISPERICAL CLOUD (M**3)  = .132E+09
    VOL. ENCOMPASSED BY LOS    = .251E+07
    FRACTION OF TOTAL          =  .019


WEIGHTING FACTORS FOR RETURN FLUX
    NCD * AMBND * SIGMA * VA *      .085
                  •
                  •
                  •
                  •
```

3.6.2 Output (cont'd)

```
 * * *  SUMMARY  FOR  FIELD  OF  VIEW  OF  SURFACE( 1120)  * * *


SURFACE NORMAL ORIENTATION
    DIRECTION COSINES
     N DOT X0 = 0.000
     N DOT Y0 = 0.000
     N DOT Z0 = 1.000
    ANGLE WRT AMBIENT
     ALPHA    =45.000
FIELD OF VIEW (STERADIANS)
     FOV      = 1.848
VOLUME OF CLOUD CONSIDERED
 TOTAL VOLUME =  .132E+09
 VOLUME OF FOV=  .386E+08
CLOUD CONTRIBUTORS
          10000        .90E+02
          10005        .28E+02
          10010        .54E+02
          10015        .66E+02
          10020        .73E+02
          10025        .77E+02
          10030        .82E+02
          10035        .89E+02
          10040        .93E+02
          10045        .95E+02
          10050        .30E+03
          10075        .51E+03
          10100        .80E+03
          10150        .11E+04
          10200        .54E+03
          10300        .44E+04
          20005        .24E+01
          20010        .94E+01
          20015        .14E+02
          20020        .16E+02
          20025        .17E+02
          20030        .18E+02
          20035        .18E+02
          20040        .19E+02
          20045        .19E+02
          20050        .59E+02
          20075        .99E+02
          20100        .15E+03
          20150        .21E+03
          20200        .95E+02
            .
            .
            .
            .
```

3.6.2 Output (cont'd)

REPORT NO. 47 *** SAMPLE CASE NO. 6 SL-1 P/L MISSION ANALYSIS *** 08/20/77 06.47.34. PAGE 50

CONTENTS: SUMMARY RETURN FLUX AT 250.0 KM ALTITUDE

CRITICAL SURFACE NO. = 1120
FIELD-OF-VIEW (SR) = 1.840
SURFACE TEMP(ISURF) = 100.0

*** INCIDENT FLUX - AMBIENT/SELF SCATTERING ***

SPECIES CONTRIBUTIONS
(MOLECULES/CM**2/SEC)

	OUTG1	OUTG2	H2O	N2	CO2	O2	CO	H2	H	MMHNO3
SURFACE CONTRIB	.114E+14	0.	0.	0.	0.	0.	0.	0.	0.	0.
ENG/VENT CONTRIB	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SELF SCATTERING	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

*** DEPOSITION RATES ***

SURFACE CONTRIB	.284E+13	0.	0.	0.	0.	0.	0.	0.	0.	0.
ENG/VENT CONTRIB	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SELF SCATTERING	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

*** DEPOSITION LEVELS ***

SURFACE CONTRIB	.922E+16	0.	0.	0.	0.	0.	0.	0.	0.	0.
ENG/VENT CONTRIB	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SELF SCATTERING	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

SECTION 6
MISSION SIMULATION APPROACH

As has been previously discussed, the SPACE Program is configured to evaluate unique time slices during a mission when all pertinent parameters such as configuration, thermal profile, vehicle attitude and source operations remain unchanged. This is accomplished by setting TSTART and TSTOP to the desired time interval as described in subsection 3.1.8. For a very simple static mission profile where all parameters remain constant, the model predictions can be extrapolated over the entire mission by multiplying the time-varying predictions such as total deposition rate by the appropriate mission time periods where each contributing source is active. This approach is an approximation in itself due to inherent time-varying source functions such as those of outgassing or early desorption. Such situations are the exception rather than the rule, however, and for a typical SO/SL mission, multiple computer runs are required to account for the assorted parametric variations. This can be accomplished through stacking runs by use of new TITLE cards discussed in subsections 3.1 and 3.2.8 or by multiple individual runs. In the stack mode, only those parameters that change from the previous run cycle must be input.

To evaluate a given mission, the three main segments of the SPACE Program (i.e., geometry, sources and transport) in conjunction with a detailed profile of the mission being evaluated must be considered. Table 6-I presents a summary checklist of items that the user should scrutinize prior to initiating a comprehensive mission contamination analysis. Detailed evaluation of the complete mission profile is required to determine the parametric variation/time dependencies dictated by the specific mission operational timelines. In most cases, if one or more of the parametric variations itemized in Table 6-I occur, a new SPACE Program run will be required. Configuration changes usually require new viewfactors to be calculated as well.

The user should evaluate each mission profile and mission payload mix and develop a contamination evaluation matrix which establishes the number of computer runs required, the parametric variations to be utilized and any peripheral analysis necessary to complete the mission evaluation. In developing the matrix, the user should consider what output parameters are necessary (i.e., NCD, deposition, etc.) and what analysis can be performed outside of the program thus minimizing not only the number of computer runs required but also the computer time required for each run. For example, if only NCD is of concern for a particular payload, the return flux and deposition segments of the program need not be

Table 6-I. User Checklist for Mission Contamination Analysis

INFLUENCING PARAMETERS	SPACE PROGRAM VARIABLES
INFLUENCING GEOMETRY/CONFIGURATION PARAMETERS	
• Change of sensitive surface location, orientation, acceptance angle or new surface (i.e. cover removal or airlock deployment) - usually requires new VF calculations.	XO(I), YO(I), ZO(I), COSXX(I), COSXY(I), COSXZ(I), etc., THETA1(I), THETA2(I), PHI1(I), PHI2(I), NEWCON, NEWMFS
• Change of source locations - moveable surfaces or exposure of new surfaces (elevons, doors, deployable radiators, etc.) - usually requires new VF calculations.	NEWCON, NEWMFS
• Change in surface pointing or viewing direction - new line-of-sight evaluation required.	XLOS(I), YLOS(I), ZLOS(I), THETL(I), PHIL(I)
INFLUENCING SOURCE PARAMETERS	
• Outgassing/Early Desorption	
- Change in exposed materials.	NEWCON, MATRL(I)
- Change in surface temperatures.	MINTMP, MAXTMP or ATCODE
- Time exposure decay characteristics.	NEWMLC, TAU(K,M)
- Change in emission constituents with time and temperature.	NEWMLC, CHNGES
• Leakage	
- Change in leak rate.	RATE(K,M)
• Evaporator	
- Vent duty cycles (function of environmental control system heat loads)	PNTSC(I), ONTIME(I)
- Change in flowrate (function of environmental control system heat loads)	NEWMLC, PLUMEC(L,N)
- Change in reflecting surface temperatures.	MINTMP, MAXTMP or ATCODE

Table 6-I. User Checklist for Mission Contamination Analysis (cont'd)

INFLUENCING PARAMETERS	SPACE PROGRAM VARIABLES
• 25 lb. Thrust RCS Vernier Engines	
- Engine duty cycles (function of altitude and attitude hold requirements) and engine firing sequence.	PNTSC(I), ONTIME(I)
- Change in reflecting surface temperatures.	MINTMP, MAXTMP or ATCODE
• 870 lb. Thrust RCS Engines	
- Firing sequence and ONTIME for specific maneuvers.	PNTSC(I), ONTIME(I)
- Change in reflecting surface temperatures.	MINTMP, MAXTMP or ATCODE
• NEW SOURCES	
- Constituents (type, M, δ_j, etc.)	NEWMLC, CHNGES, SPECIE(MM) MOLWT(MM), DIA(MM)
- Plume functions.	NEWMLC, PLUMEC(L,N)
- Emission rate time/temperature dependence.	NEWMLC, CHNGES, RATE(K,M), TAU(K,M)
- Duty cycle.	PNTSC(I), ONTIME(I)
- Sticking coefficient.	RFSTK
INFLUENCING TRANSPORT PARAMETERS	
• Change in orbital altitude (return flux variation with ambient density).	ALT
• Change in orbital attitude (variation of return flux with ambient drag vector).	VX, VY, VZ
• Changes in orbit position (sunlit/dark) or sunspot activity (variation of ambient density influence on return flux).	SUNL, SUNM, SUNH
• Sources operating simultaneously (self-scattering return flux influence).	RFSS, ONTIME(I)
• Change in sticking coefficient (UV exposure, temperature, etc. variations).	RFSTK

Table 6-I. User Checklist for Mission Contamination Analysis (cont'd)

INFLUENCING PARAMETERS	SPACE PROGRAM VARIABLES
• Critical surface exposure timeline.	TSTART, TSTOP
• Active sources considered (reflection/ re-emission routines required?)	OUT, ED, ENG, EVAP, LEAK, REFLCT, RFAS, RFSS, ONTIME(I)
• Change in critical surface acceptance angle (deployed sunshade, etc. influence on ambient and self-scatter return flux).	THETA1(I), THETA2(I), PHI1(I), PHI2(I)
• Surface temperature changes (influence on reflection/re-emission).	MINTMP, MAXTMP or ATCODE
• Changes in configuration (e.g. deployable systems may see one transport mechanism primarily in one position and another one at a different position).	NEWCON, NEWMFS

activated. It should be obvious that each situation will be somewhat unique and will require a certain amount of engineering judgement to minimize the number of runs while maximizing the final prediction resolution.

When a mission dependent parametric variation is incurred, the user has the option of stacking as many runs as are necessary by employing the multiple TITLE cards and inserting the appropriate parameter modification input cards previously discussed. For time varying parameters, there are additional simplifying approaches which may be utilized to minimize the stacking requirements. A few examples of these are discussed below for the contaminant sources and transport mechanisms currently in the SPACE Program. These examples pertain primarily to surface deposition predictions since deposition is the only model output parameter which accumulates with time and must be tracked as such throughout a mission. In many cases, deposition predictions can be made on a per second or per orbit basis and extrapolated over the surface exposure time without inducing significant errors.

- Outgassing/Early Desorption Variation With Time Approach

  If all other influencing parameters are considered to be held constant or if they vary in a repetative manner

(i.e., from orbit-to-orbit), the user can account for this variation or for the $e^{-t/\tau}$ relationship by modeling outgassing/early desorption at selected time intervals throughout the mission or a particular orbit and plotting the resulting NCD, $\dot{D}$ or RF predictions vs time. NCD and RF at any point in time can be estimated by picking points on the connecting lines between the predicted levels. Deposition at any point in time can be determined by integrating under the $\dot{D}$ vs time curve up to the time period of interest. Accumulative deposition can also be estimated by determining the deposition rate during the initial orbit (accounting for variations in T, S, α, etc. through multiple runs), applying the $e^{-t/\tau}$ relationship and developing the corresponding $\dot{D}$/orbit vs time curve.

- VCS/RCS Engine Duty Cycle Approach

  The VCS and RCS engines operate on a demand basis under the control of the Shuttle Orbiter autopilot system and their duty cycles/firing sequences can, therefore, become quite complex. Ideally, for a mission contamination analysis, duty cycle data should be read into the contamination model directly from the autopilot output. For premission evaluations where such data is not readily available, more simplified approaches can be utilized.

  If, for example, available engine data is in the form of fuel/oxidizer usage per mission or maneuver, the user can estimate engine deposition levels by averaging the fuel usage over the number of engines involved (e.g., XX kg/RCS maneuver $\div$ 38 engines would equate to the mass/engine average for a typical RCS maneuver). By knowing the engine flowrate (RCS = 1419.8 g/s), the total average firing time per engine can be determined. The user would then run the SPACE Program engine routine utilizing the determined firing time as the input ONTIME (see subsection 3.2.1). Due to the extreme variations in engine firing times and frequencies, the program was configured with no default values for ONTIME and user inputs to NAMELIST INPUTA are required to initiate an engine run.

A similar approach can be used for VCS engine predictions, however, in both cases the user should be cognizant of the other influencing parameters which must be considered. These include variances in drag vector angle (α), surface temperatures and self-scattering influences for specific engine firing combinations.

- Evaporator Vent Duty Cycle Approach

The evaporator vent system can be handled in a similar manner to the RCS/VCS. This system also operates on a demand pulse mode basis, however, during operation its nominal ONTIME is fixed. For this reason, the model has been configured with the nominal default ONTIME of 0.43 s of f operation. If all other influencing parameters are held constant, the user can determine accumulative deposition by simply multiplying the evaporator total operating time in seconds by the deposition rate determined by the model for a single ONTIME time interval (i.e., 1 s).

- Variable Attitude Approach

In evaluating return flux or return flux deposition for a mission where the vehicle attitude dictates a continuous variation of α (e.g., solar inertial), analytical approaches can be developed which will minimize the number of required computer runs. For example, considering a solar inertial attitude the return flux deposition can be determined by the simple integral

$$D_o = N \cos\beta \int_0^{t/2} S \cdot RF_m \sin\theta \, d\theta \qquad (6\text{-}1)$$

$$= \frac{t}{\pi} RF_m \cdot S \cos\beta,$$

where;

D_o = deposition (g/cm^2),

RF_m = maximum ram return flux ($g/cm^2/s$),

S = sticking coefficient,

t = orbit period (s),

β = angle between orbital plane and earth-sun line (deg) and

N = number of orbits where RF_m and S remain constant.

By using relationships such as equation 6-1, the user need only run the model at times when the major parameters such as RF_m and S undergo change and keep a running total of the predicted time slice deposition levels.

The above examples represent only a sample of the approaches that can be employed to minimize the number of required model runs in performing a complete mission contamination analysis. A future extension of the SPACE Program should be to incorporate the ability to input a complete mission profile/operational timeline and allow the model to internally handle the manipulations currently necessary with the existing SPACE Program to simulate a complete mission.

SECTION 7
PROGRAM LIMITATIONS

This section presents a summary of the limitations of the current SPACE Computer Program. As with any analytical technique or computer program, the SPACE Program is limited by the availability of sufficient applicable input data. Because spacecraft contamination has only recently become recognized as an important analytical discipline in spacecraft design and development, testing to determine the required SPACE Program input parameters has been minimal. Areas where further parametric testing are required to refine the prediction resolution of the SPACE Program include:

a) nonmetallic materials testing as discussed in Appendix A to determine the time and temperature variations of mass loss rate, emitted species, molecular weight, activation energies, sticking coefficients and deposit re-evaporation rates. Such testing should be conducted under UV, proton and electron radiation;

b) insitu testing of all potential molecular specie collision combinations to determine molecular diameters and collision cross-sections for relative velocities up to approximately 8 km/s;

c) insitu testing to determine sticking coefficient relationships as a function of velocity, temperature and contaminant species for molecules transported to a surface through ambient scattering and self-scattering return flux; and

d) comprehensive testing of the Shuttle Orbiter VCS and RCS engines to determine effluent deposition and sublimation characteristics of the deposits.

Such limitations are not unique to the SPACE Program but are inherent to any analytical approach applied to the phenomena of spacecraft contamination. However, certain additional limitations do exist within the SPACE Program due to its current design, architecture and permanent file data. These program unique limitations are itemized below.

- Due to its primary use as a design and development support tool, the SPACE Program has been designed to analyze individual time slices where all major influencing parameters remain constant. Therefore, to analyze a complete SO/SL mission, multiple runs and/or peripheral analyses are required.

- The SPACE Program currently contains four fixed SO/SL configurations. To modify existing configurations or develop new ones, the program requires the use of an outside configuration/thermal radiation program such as TRASYS II to develop the required mass transport factor input data. To generate the necessary mass transport factors to points within the hemispherical volume above the space vehicle, the configuration program must have the capability to treat dimensionless points in the mass transport factor calculations.

- Only mass transport factors to points within the upper hemisphere of the SO/SL vehicles have been calculated and placed in permanent file. For this reason, MCD/NCD calculations can be made only in the upper hemisphere. In addition, the user is limited in return flux calculations to surfaces having acceptance angles encompassed within the upper hemisphere volume. If additional mass transport factors to points within the lower hemisphere are to be calculated, the lower (-Z) surfaces of the Shuttle Orbiter must input as new sources in the SPACE Program. These were eliminated to minimize computer run times and core requirements.

- The SPACE Program mass transport factors-to-points permanent files currently contain seventeen lines-of-sight encompassing a 120^{o} conical viewing volume centered around the +Z axis. The 82.5^{o} lines-of-sight necessary to complete the upper hemisphere viewing volume (see subsection 2.1.3.1) have not been modeled for mass transport factors. However, the model has been configured to access mass transport factors from adjacent lines-of-sight to perform 2π steradian surface analyses. This induces finite errors in return flux calculations to large field-of-view surfaces, but under most conditions the errors are small due to the strong dependence on the cosine of these large off-axis angles. At a future date, the mass transport factor permanent files should be expanded to include the 82.5^{o} lines-of-sight.

- Currently the SPACE Program is configured with representative source-to-surface mass transport factors primarily for the purpose of verifying proper operation of the source-to-surface and reflect program subroutines. The source-to-surface mass transport factor permanent files

include mass transport factors from all surfaces to LMOP surface 1088 and from all modeled engines and vents to the SO/SL surfaces. At a future date all surface-to-surface mass transport factors should be calculated, although for the basic SO/SL configuration, surface-to-surface contaminant transport has been determined to be second order under most conditions.

- Return flux calculations are constrained to orbital altitudes between 105 km and 2500 km and to low, medium and high solar activity options. The ambient atmosphere is considered to be composed of a single specie representative of the predominant molecules present in this altitude range. If deemed necessary in the future, the ambient atmosphere density data file can be expanded to include a wider range of altitudes, different solar activity variations and ambient molecular specie characteristics.

- The SPACE Program currently contains temperature profile permanent file data for two orbital attitudes and has the capability to accept up to a total of five different profiles concurrently. The SPACE Program relies upon external thermal programs or user generated input to develop the permanent file data. An external node/temperature conversion subprogram (not included in the SPACE Program) has been developed which facilitates the conversion of Spacelab and Orbiter thermal model nodes and temperatures to be compatible with the nodal structure of the SPACE Program. This could be integrated into the program at a later date to allow direct thermal model input to the SPACE Program.

- The current program design establishes the following capability constraints for a single program run:

  - maximum number of surfaces = 300,
  - maximum kinds of surface sources = 15,
  - maximum number of contaminant species = 10,
  - maximum number of return flux receivers = 10,
  - maximum number of second surface sources = 300,
  - maximum drag vector angle with the +Z axis = 90^{o}.

  These can each be expanded if the need arises, however, consideration must be given to the increase in computer run time and core requirements which may result.

- Contamination degradation effects routines and influences of spacecraft charging upon contamination are not included in the SPACE Program. Nor has the phenomena of pressure induced corona arc-over been included. Effects such as deposition induced surface transmission/reflection loss; emission, absorption and scattering of radiant energy by the molecular cloud and changes in the thermal surface α/ε can be determined through use of existing computer programs, analytical techniques and limited flight/ground test data.

- Three minutes are automatically subtracted internally from the TSTART and TSTOP times input by the user to account for elapsed mission time between launch and on-orbit. The user should be aware of this fact in determining the above input parameters.

- It is possible that problems incurred in running the SPACE Program may be the result of internal difficulties stemming from the interplay of the vast number of model options. The SPACE Program has been checked out to the degree considered practical, however, not all possible optional combinations have been exercised. For this reason, an elaborate system of debug write statements has been retained in the program (see subsection 3.1.7). Debug output is obtained by setting the proper output reports to .TRUE. as discussed therein.

SECTION 8
REFERENCES

The following references are presented to support the technical material contained in the text of this manual..

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APPENDIX A

CONTAMINATION METHODOLOGY SUMMARY

TABLE OF CONTENTS

		Page
Table of Contents.		A-2
1.	INTRODUCTION.	A-3
2.	GEOMETRIC CONSIDERATIONS.	A-4
3.	CONTAMINANT SOURCE FUNCTIONS.	A-6
3.1	Outgassing/Early Desorption Source Kinetics	A-6
3.2	Leakage Source Kinetics	A-12
3.3	Point Source Kinetics	A-13
4.	CONTAMINANT TRANSPORT FUNCTIONS	A-13
4.1	Source-to-Surface Transport	A-14
4.2	Mass and Molecular Number Column Density.	A-15
4.3	Return Flux Transport Determination	A-16
4.4	Second Surface Transport.	A-21
4.5	Contaminant Self-Scattering	A-24
4.6	Plume Intermolecular Interference	A-26
4.7	Surface Deposition Determination.	A-26
5.	CONTAMINATION DEGRADATION EFFECTS	A-30
5.1	Deposited Films	A-30
5.2	Cloud Degradation	A-31
5.3	Other Effects	A-31

Figures

A-1	Geometry for Viewfactor Between Finite Areas.	A-5
A-2	Temperature Dependence of Outgassing Rate Upon Activation Energy.	A-8
A-3	Elemental Volume Definition	A-17
A-4	Elemental Volume Geometry (Line-of-Sight Location). . .	A-18
A-5	Critical Surface Location, Orientation and Field-of-View	A-18
A-6	Comparison of Model Sticking Coefficient Predictions to Testing	A-28

APPENDIX A
CONTAMINATION METHODOLOGY SUMMARY

1. INTRODUCTION

The modeling of spacecraft contamination involves many phases of spacecraft design and operations. These phases include manufacturing, assembly, test, ground handling, launch environments and the on-orbit conditions. The contamination analysis methodology summary presented herein deals only with the on-orbit induced environment experienced by a space vehicle.

The modeling and analysis of on-orbit molecular contamination is the study of the physics involved in the release and transport of an undesireable molecule from one location to another and the impact that this relocation will impart upon the operation of surfaces, experiments, sensors and systems. The release of molecular contaminants can be induced through propulsive means such as the chemical combustion of spacecraft engines or the expulsion of molecules to space through overboard vents. It can also be induced by surface phenomena such as releasing adsorbed/absorbed volatiles, liquids and gases (denoted early desorption) or through decomposition of external nonmetallic materials by the severing of their polymeric chemical bonds (outgassing). Contaminant molecules can also be released by leakage through microscopic cracks and seams of pressurized compartments. All of these mechanisms can be categorized under contaminant source functions which dictate the process by which contaminant molecules are relocated.

Once emitted, there are several mechanisms by which contaminant molecules can be transported to a location of interest. These include such phenomena as: 1) direct line-of-sight, source-to-surface transport; 2) second surface source transport (contaminant reflection and/or sublimation); 3) return flux transport resulting from collisions with the ambient atmosphere and 4) other phenomena such as contaminant self-scattering and plume intermolecular interference.

The relocation of molecular contaminants can be described in terms of surface deposition or mass residing within an experiment field-of-view. The deposition of contaminants is usually expressed in terms of mass per unit area or thickness (if density and uniformity of the deposit are known) and the material within an experiment or instrument field-of-view is usually expressed as molecular number column density (NCD) in molecules/cm^2 or mass column density (MCD) in g/cm^2. To determine these, a comprehensive molecular contamination model must consist of four major elements which are: geometry; source kinetics; transport mechanisms and degradation effects.

The following subsections present a brief summary of the physics and methodology currently employed in describing each of the four elements which constitute such a model. The descriptions are written in general terms to allow the user to not only understand the relationships in the contamination model but to also present the general approach and state-of-the-art relationships upon which further analysis and refinements can be based. Supportive information on this subject can be obtained from previous contract reports MCR-76-387[1] and MCR-75-13[2].

2. GEOMETRIC CONSIDERATIONS

All contaminant source functions are dependent upon the geometrical parameters of distance (r) from the source and the angle (θ) off of the centerline of the specific contaminant source plume where a region of investigation is located. In the case of surface sources the "plume" centerline is the normal vector of the emitting surface. These geometric "configuration factors" f (r, θ) are the foundation of the contamination modeling methodology. Because surface sources such as outgassing, early desorption and cabin leakage are characteristically Lambertian[3], line-of-sight transport for these sources can be considered analogous to black body thermal radiation. Therefore, for such sources, the geometric viewfactor is determined which establishes the percentage of mass emitted by a Lambertian source that is capable of impinging upon another surface of interest or a point in space. Referring to Figure A-1, the viewfactor between two finite areas can be determined from

$$VF_{i-j} = \frac{1}{A_i} \int_{A_i} \int_{A_j} \frac{\cos \theta_i \cos \theta_j}{\pi r^2} \, dA_j \, dA_i. \qquad \text{(A-1)}$$

The reciprocity relationship can be utilized to show that

$$VF_{i-j} \, A_i = VF_{j-i} \, A_j. \qquad \text{(A-2)}$$

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[1] "Payload/Orbiter Contamination Control Requirement Study", Interim Report, MSFC NAS8-31574 Exhibit A, MCR 76-387, Martin Marietta Aerospace, Denver Division, September 1976.

[2] "Payload/Orbiter Contamination Control Assessment Support", JSC NAS9-14212, MCR 75-13, Martin Marietta Aerospace, Denver Division, June 1975.

[3] The Lambertian distribution assumption for surface sources has been verified by experimental data obtained through numerous ground test programs.

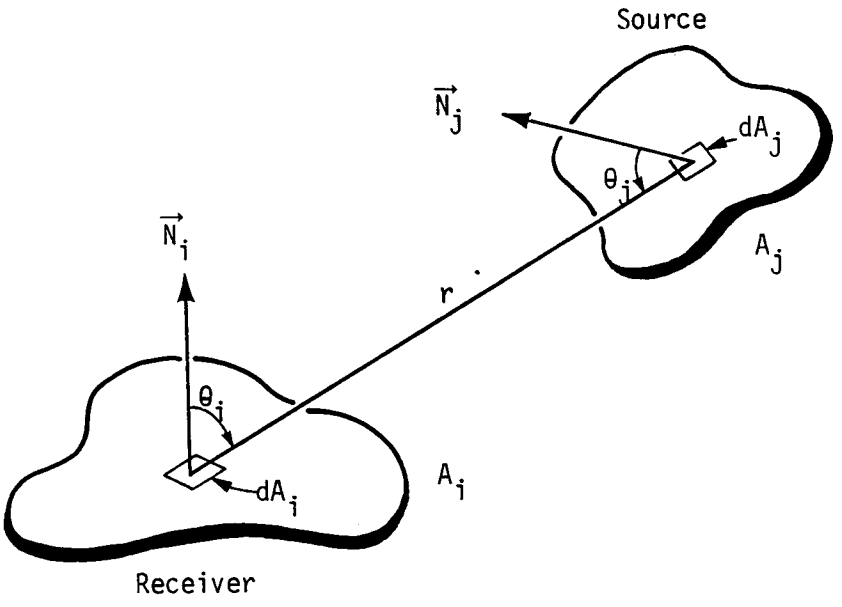


Figure A-1. Geometry for Viewfactor Between Finite Areas

The viewfactor in conjunction with the appropriate Lambertian contaminant source function, ψ_j, can then be used to determine the unattenuated contaminant flux at any location of interest, i, by:

$$\text{Flux}_i = \psi_j \cdot VF_{j-i} \quad \frac{A_j}{A_i} = \psi_j \, VF_{i-j}. \tag{A-3}$$

Determination of geometric viewfactors for complex space vehicle configurations is extremely difficult to accomplish manually due to the complicated surface integrations involved and the enormous number of calculations required. Among the additional complicating factors which must be considered in determining viewfactors between sources and locations of interest is the influence of shadowing by intervening structural surfaces. To alleviate the calculational requirements and to insure consistancy and accuracy, a configuration/black body thermal radiation program such as TRASYS II[1] is normally employed to establish the contamination model viewfactor files. This allows the user to establish the entire spacecraft configuration by evaluating all surfaces simultaneously, considering all shadowing characteristics automatically and calculating the required viewfactors with a minimum expenditure of

[1]"Thermal Radiation Analysis System (TRASYS)", JSC NAS9-14318, MCR 713-105, Rev. 1, Martin Marietta Aerospace, Denver Division, May 1975.

manpower.

In determining the flux from a Lambertian source and ultimately the contaminant density at a point, P, in space in the vicinity of a spacecraft, the viewfactor between vehicle surfaces and dimensionless points must be employed. For this case, the viewfactor is simply the solid angle subtended by surface j at distance r normalized by $1/\pi$, or $VF_{j-p} = A_j \cos \theta_j / \pi r^2$. When a point is input to TRASYS II, it can only be treated as a point emitter (i.e., radiating into 4π steradians) and therefore the TRASYS calculated viewfactors are equal to $A_j \cos \theta_j / 4\pi r^2$. The result is that if TRASYS generated viewfactors to points are utilized (as they are in the contamination model) they must be multiplied by a factor of 4 to yield the proper contaminant flux to point predictions. This operation is done internal to the contamination model.

For contaminant sources that are other than Lambertian in nature such as vents or engines, the viewfactors are not utilized. Rather, these sources are described by closed form functions of r and θ_j characteristic of their unique contamination emission patterns.

3. CONTAMINANT SOURCE FUNCTIONS

3.1 Outgassing/Early Desorption Source Kinetics - One of the most difficult sources to characterize is the mass loss behavior of nonmetallic materials such as paints, adhesives, insulation, etc. under vacuum exposure. Other sources such as attitude control systems and vents are more classical in their characterizations because their mass flow is usually well known.

During Skylab, an initial approach used to determine source rates was based on kinetic theory which employed molecular weight and vapor pressure. This approach used the Langmuir-Knudsen relationship equating mass loss rate to vapor pressure, molecular weight, temperature and desorption coefficient. This relationship could be used on well known substances such as water, but for polymeric spacecraft materials where the abundance of each molecular weight varies with temperature and time, the problem was intractable. A more practical macroscopic approach was adopted for the characteristics of polymeric nonmetallic materials on Skylab which involved a direct measurement of the mass loss characteristics. Although these measurements were limited, they formed the basis of the current approach. The resulting relationship for mass loss rate as a function of temperature is expressed as

$$\dot{m} = M_o \, e^{(T-100)/29}, \qquad \text{(A-4)}$$

where;

M_o = initial steady state outgassing rate at 100°C and

T = surface temperature (°C).

This exponential function form when compared to the expression $k = A_o \, e^{-E/RT}$ has the characteristics of an activation energy near 10 to 12 Kcal/mole. Similar values have been observed during limited testing of nonmetallics at MSFC[1].

Figure A-2 shows this relationship normalized to 100°C for outgassing rate as a function of temperature for several activation energies of desorption (curves A, C and D for 8, 10 and 15 Kcal/mole respectively) and the relation derived from Skylab flight data (curve B).

At the lower temperatures, the Skylab derived equation appears to follow an equivalent activation energy near 8 Kcal/mole. While at higher temperatures, the equation falls between 10 and 15 Kcal/mole. The use of an equation of the form $e^{-E/RT}$ is only good for a narrow temperature range because of the many activation energies involved in a complex nonmetallic surface. The temperature relation of the form $e^{-E/RT}$ is good for substances whose behavior is more thoroughly understood by testing. This is discussed later in this subsection.

The mass loss rate time dependency is expressed as $e^{-t/\tau}$ where τ is the decay constant (i.e., the time for the mass loss rate to fall to 1/e of its original value). The value of τ depends strongly on the thermal conditioning and the percent sunlight exposure of the vehicle. On Skylab, it was determined to be 4100 hours for an approximate solar exposure of 60%. A τ of 1000 hours has been observed on other satellite systems having nearly 100% solar exposure.

Therefore, based upon the above discussions, the outgassing mass loss rate in the model is expressed as

$$\dot{m}_j = M_o \, e^{(T_j - 100)/29} \, e^{-t/\tau}. \qquad \text{(A-5)}$$

[1]Jex, D. W. and Shriver, E.L.: "The Outgassing Rate for a Shuttle Thermal Protective Surface Using RTV 560 Adhesive", Eighth Conference on Space Simulation, NASA SP-379, No. 28, November 1975.

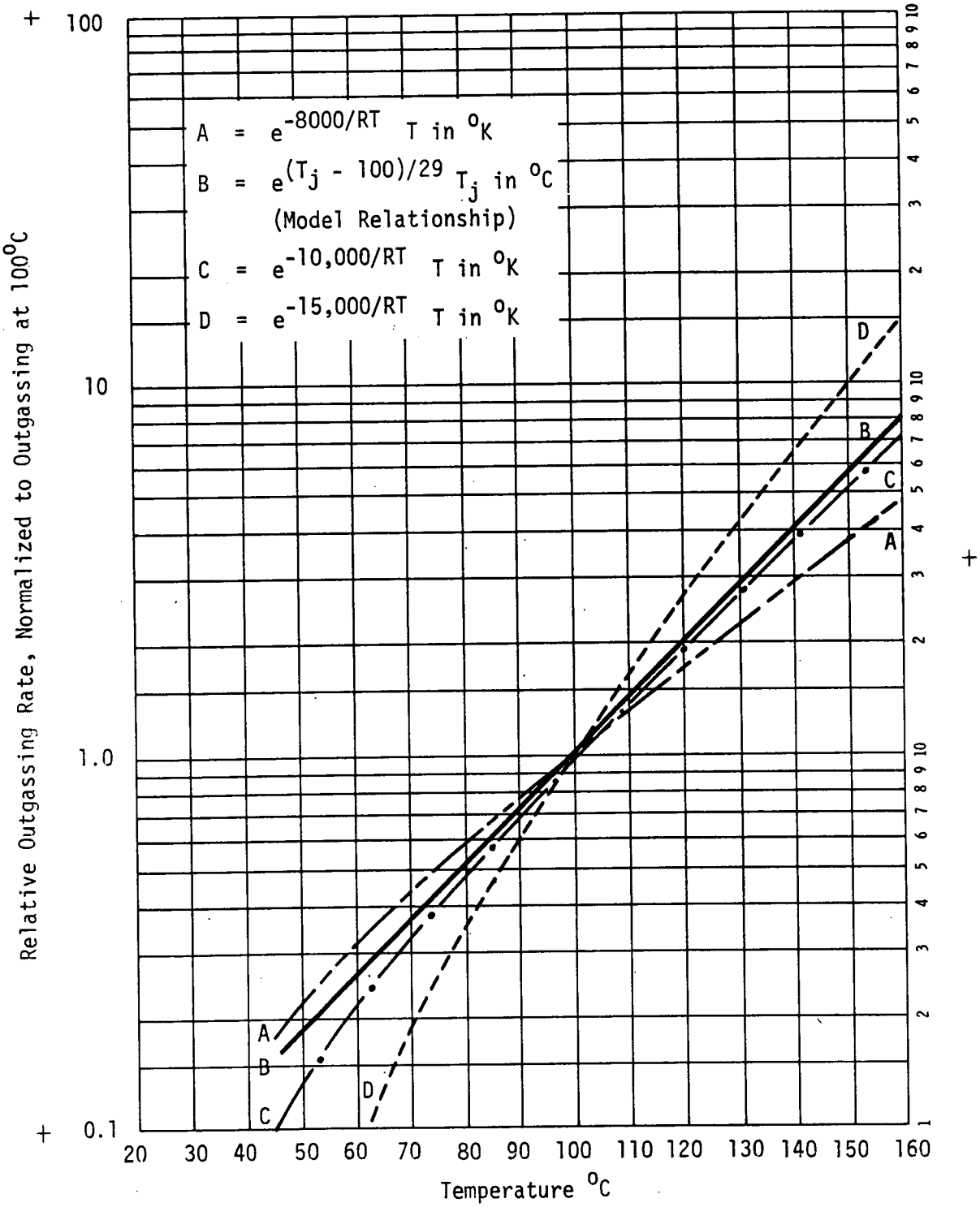


Figure A-2. Temperature Dependence of Outgassing Rate Upon Activation Energy

This expression is currently used primarily due to the lack of good comprehensive test data and has been found to fit the only extensive spacecraft flight data available to date.

The constituents of early desorption as opposed to those of outgassing are basically simple gases (H_2O, N_2, etc.) and can be assumed to exhibit zero order source kinetics. Their mass loss rates as a function of surface temperature can therefore be expressed by the classical Arrhenius relationship

$$\dot{m} = A_o \, e^{-E/RT},$$

where E can be obtained from published literature for most simple gases (e.g., E = 12.2 Kcal/mole for H_2O) and T is in ^oK. A_o which is a constant characteristic of the early desorbing material can be cancelled out by knowing the $\dot{m}$ at a given T. For example, if from materials testing a certain nonmetallic material demonstrates an initial mass loss rate of $\dot{m}$ g/cm^2/s at 100^{o}C, then by assuming that the emitted mass is primarily simple gases with an activation energy of desorption, E in Kcal/mole, the rate at any other temperature, T_j, can be determined from

$$\frac{\dot{m}_{T_j}}{\dot{m}_{100^oC}} = \frac{A_o \, e^{-E/RT_j}}{A_o \, e^{-E/R \cdot 373}} = e^{\frac{E}{R}\left(\frac{1}{373} - \frac{1}{T_j}\right)},$$

or

$$\dot{m}_{T_j} = \dot{m}_{100^oC} \, e^{\frac{E}{R}\left(\frac{1}{373} - \frac{1}{T_j}\right)} \quad g/cm^2/s. \qquad (A\text{-}6)$$

The time dependence function for early desorption is similar to that for outgassing ($e^{-t/\tau}$). Evaluation of available ground test data for the initial high mass loss rates of early desorption indicates a τ of approximately 18 hours. It must be realized that this value is actually the result of the superposition of the decay rates of the individual molecular components of early desorption. To account for this, the model has been configured to accept varying values for τ for each specie. However, this data is also limited and a τ of 18 hours is currently assumed for all early desorption species. The reservoir of available early desorption constituents is replenished during each period that a spacecraft is reexposed to the earth's environment, therefore, the temperature/time history for

this source has minimal influence. The velocities of emission of both outgassing and early desorption are determined as a function of constituent molecular weight (M) and surface temperature (T in ^{o}K) by the relationship $V = (2RT/M)^{1/2}$.

Ideally, tests should be performed that would determine those parameters required to model the complex process of outgassing and early desorption as a function of temperature and time. The current source mass loss rate theory founded on thermochemical rate processes has resulted in simple, concise source equations. The rate theory applied to polymeric source kinetics results in the following expression for mass loss rate:

$$\dot{m}\ (t, T) = k\ (T)\ (a_o - X)^n = k\ (T)\ m^n, \qquad (A\text{-}7)$$

where;

$\dot{m}$ = mass loss rate,

$k\ (T)$ = rate constant,

X = active mass outgassed,

m = active mass remaining,

n = order of the reaction and

a_o = initial amount of active mass available.

The rate constant can be expressed as a function of temperature by

$$k\ (T) = A_o\ e^{-E/RT},$$

where;

A_o = constant,

E = activation energy of the process,

R = molar gas constant and

T = absolute temperature.

The values of A_o, E, a_o, $\dot{m}$, m and n can be determined from a test procedure known as thermogravimetric analysis (TGA). The

degree of testing depends on the configuration of the nonmetallic material, whether it is a uniform film such as a paint or a composite of several materials in a layered formation. Additionally, the quantity of each active component may require several tests with different mass samples so the required resolution can be obtained.

Many investigators assume zero order (n = 0) and first order (n = 1) kinetics when determining the activation energy, E. However, it is relatively easy to determine the order of reaction, n, uniquely from the TGA data.

Integration of equation (A-7) yields

$$\int \frac{dm}{(a_o - x)^n} = \int -k\,(T)\,dt, \text{ or}$$

$$\frac{(a_o - x)^{1-n}}{(1-n)} = -k\,(T)\,t + C \quad (\text{for } n \neq 1). \tag{A-8}$$

For a zero order reaction,

$$M = -kt,$$

and for a first order reaction the integrated form of equation (A-7) becomes

$$M = -e^{-kt}.$$

At t = 0, m = 0, C in equation (A-8) becomes

$$C = \frac{a_o^{1-n}}{1-n}.$$

Then equation (A-8) becomes

$$\frac{m^{1-n}}{(1-n)} = k\,(T) + \frac{a_o^{1-n}}{1-n},$$

where a_o = the initial amount of active mass of a given component and m is the active mass remaining.

The majority of nonmetallic materials used on the STS system exhibit 2 or more components available for outgassing. The mass loss rate for such a case can be expressed for each surface coating in the form

$$\dot{m} = \dot{m}_1 + \dot{m}_2 + \dot{m}_3 + \ldots = \sum_{i=1}^{K} \dot{m}_i, \text{or}$$

$$\dot{m} = \sum_{i=1}^{K} A_i \left(e^{-E_i/RT}\right) m_i{}^{n_i}. \qquad \text{(A-9)}$$

Therefore, to determine the mass loss characteristics of an outgassing surface, the temperature history versus time must be known. The above expressions in conjunction with the appropriate test data can eventually lead to a closed form analytical treatment of nonmetallic material mass loss where the emitted components change with time and temperature.

3.2 Leakage Source Kinetics - Leakage from the crew compartments of space vehicles will continuously emerge from structural seams, hatches, microscopic cracks and seals around support hardware such as instrumentation feed-throughs. The crew compartments are normally pressurized with O_2 and N_2 which in combination with CO_2 and H_2O comprise the predominant species of cabin leakage.

The analytical approach to establish the source kinetics of cabin atmosphere leakage is to assume that the specification maximum allowable leak rate (SLKR) for each pressurized compartment is uniformly distributed over the external surface area (A_j) of that compartment. Leakage is considered to be emitted in a Lambertian distribution. Therefore, the viewfactors previously discussed can be utilized to describe the leakage emission pattern, i.e.,

$$\text{Flux}_i = \frac{\text{SLKR}}{A_j} \cdot VF_{i-j}. \qquad \text{(A-10)}$$

In addition, leakage is assumed to be emitted with a most probable velocity based upon the molecular weight (M) of the individual constituents and a cabin atmosphere temperature (T) of 297°K where $V = (2RT/M)^{1/2}$ or 413 m/s assuming an average molecular weight of 29.

3.3 Point Source Kinetics - Point sources considered are modeled by closed form analytical relationships. Those point sources treated in this manner in the model are the supplemental flash evaporator and the VCS and RCS attitude control engines. These point sources are expressed by an analytical function describing the mass flow as a function of distance and angle off of the central axis of the source.

The flow fields of the engines and evaporator are expressed in the form of the analytical function developed by Simons.[1] For given engine physical dimensions, injector pressures and chamber pressures, the flow field is expressed as a function of these parameters. For example, the expression for a region of the VCS engine flowfield is expressed as

$$\psi_1 = \frac{K}{r^2}\left[\cos\left(\frac{\pi}{2}\cdot\frac{\theta}{\theta_i}\right)\right]^{8.65} \quad \text{for } 0^o \leq \theta \leq 40^o, \qquad \text{(A-11)}$$

where K is a constant and θ_i is a function of the engine design. Beyond the limiting angle from the centerline axis where the Simons approach is valid, another approach developed from the test data of Chirivella[2] is utilized. This data shows that the flux beyond the limiting angle is a constant and has been incorporated into the model for all engine backflow regions. Emission velocities are determined through classical gas dynamic analyses for each engine or vent system.

The flash evaporator plume distribution was measured in testing at JSC. The analytical function and emission velocity were supplied by JSC analysis personnel. Evaporator flow field functions have the same general Simons' approach format as the engine expressions.

4. CONTAMINANT TRANSPORT FUNCTIONS

Included in the following subsections are the analytical approaches currently employed to describe the transport of emitted

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[1]Simons, G. A.: "Effect of Nozzle Boundary Layers on Rocket Exhaust Plumes", AIAA Journal, Vol, IV, No. 11, 1972.

[2]Chirivella, J. E. and Simon, E., "Molecular Flux Measurements in the Back Flow Region of a Nozzle Plume", JANNAF 7th Plume Technology Meeting, April 19, 1973.

contaminant molecules to locations of interest. These transport functions in conjunction with the appropriate contaminant source functions comprise the basic expressions necessary to evaluate the induced environment of a space vehicle.

4.1 Source-to-Surface Transport - The mass flux on a surface (i) from another surface (j) can be expressed as

$$F_i = \dot{m}_j \, VF_{j-i} \frac{A_j}{A_i} = \dot{m}_j \, VF_{i-j}, \qquad \text{(A-12)}$$

where;

F_i = mass flux on i,

A_i = surface area of i,

A_j = surface area of j and

VF_{j-i} = viewfactor or the fraction of mass leaving j that impinges on i.

Because of the reciprocity theorem for a cosine emitter,

$$VF_{j-i} \frac{A_j}{A_i} = VF_{i-j},$$

which simplifies the above equation for mass flux on a surface.

For determination of densities at point locations in space, a source to point transport function must be defined. For this case, a viewfactor is calculated between each nodal surface and points at which the density is to be determined. The flux at the point is expressed in the same manner as for a surface except the reciprocity theorem does not hold for a point. The flux at a point is given by

$$F_p = \dot{m}_j \, VF_{j-p}, \qquad \text{(A-13)}$$

where;

F_p = flux at a point p,

m_j = mass loss rate of source j and

VF_{j-p} = viewfactor between a surface and a mathematical point.

The viewfactor VF_{j-p} is a factor of four larger than that calculated by a modified thermal program as discussed in Section 2 of this appendix.

4.2 Mass and Molecular Number Column Density - The mass and molecular number column density of contaminants along a given line-of-sight are determined by applying the source to point transfer relationships. The density at a point is expressed as

$$N_m(P) = \frac{\dot{m}_p}{V_j} = \frac{\dot{m}_j \, VF_{j-p}}{V_j}, \qquad \text{(A-14)}$$

where;

N_m = the density of specie m at p from source j and

V_j = the velocity of the source j molecules.

By determining the density at many points along a line-of-sight, the mass column density (g/cm^2) can be determined by integration where

$$MCD = \int_0^{r_{max}} N_m(P)\, dr \qquad \text{(A-15)}$$

and

r = distance along the line-of-sight.

Knowledge of the molecular constituents of each jth source allows conversion of the mass column density into molecular number column density ($molecules/cm^2$).

Molecules are assumed to leave a source and arrive at a surface or point in space without experiencing a collision with another molecule during transit. The flux of molecules at a point, however, can be attenuated by considering the interaction of the contaminant molecules and the subsequent scattering of the contaminant before it intercepts a line-of-sight. For this case, the density can be expressed as

$$N_m(P)' = \frac{\dot{m}_j \, VF_{j-p} \, e^{-R/\lambda}}{V_j} \quad \text{and} \quad MCD' = \int_0^{r_{max}} N_m(P)'\, dr, \qquad \text{(A-16)}$$

where;

R = the distance from j to point p and

λ = mean free path of the j molecules.

It should be cautioned that this is a least case determination of the mass column density since other molecules are scattered into the line-of-sight while these are being scattered out. To determine the quantity scattered into a line-of-sight versus those scattered out, a great deal of computational effort is required. It is a complicated process involving knowledge of all mass densities around the vehicle and the orientation of the velocity vectors and requires costly, extensive Monte Carlo techniques. Estimates have shown that the amount scattered into a field-of-view from adjacent fields-of-view is approximately equal to those scattered out for many situations. Therefore, baseline density calculations are made in the model without considering the mean free path. At high altitudes, the mean free path becomes large enough so that the influence is negligible or non-existent. For orientations where the Shuttle Orbiter essentially blocks the ambient from interacting with the contaminant molecules, the model approach is also accurate. This would occur, for example, when the Orbiter is flying belly first and the ambient impinges on its underside and thus does not interact with many of the contaminant molecules on the payload bay side.

4.3 Return Flux Transport Determination - Return flux is a term applied to contaminant molecules that are scattered back to the vehicle through gas-gas collisions with the ambient atmosphere. For most space vehicle configurations, the primary transport mechanism of contaminant species between sources and receivers is the phenomena of return flux. The approach for modeling the return flux (RF) to a surface of interest divides the hemispherical space above the Shuttle Orbiter into a matrix of volume elements that have midpoints strategically located along given (up to 25) lines-of-sight (see Figures A-3 and A-4). The origin of this matrix is located at station X_0 = 1107, Y_0 = 0 and Z_0 = 507 with respect to the Shuttle Orbiter.

This particular origin in no way limits the return flux or column density calculation capability to a surface located at X_0 = 1107. The point select subroutine in the model will automatically select the proper points for interpolating along any selected line-of-sight originating at any desired location as shown in Figure A-5.

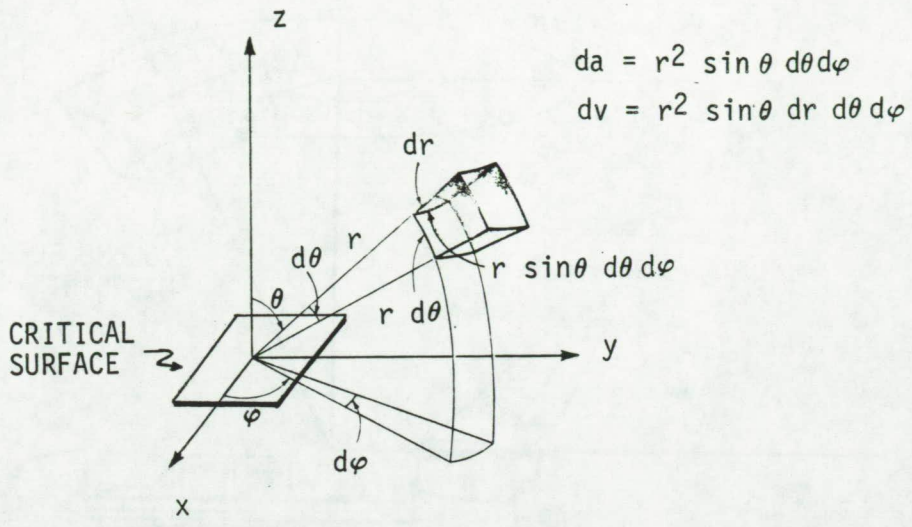


Figure A-3. Elemental Volume Definition

The amount of mass leaving each outgassing surface or other source that can enter the volume element centered around point P (Figure A-4) can be computed by accessing precalculated "form factors" (or mass transport factors) between point P and each of the outgassing surfaces or vent and engine sources. As a result, the contaminant cloud density at any point above the vehicle can be defined knowing the particular source emission characteristics. It should be noted that there are no restrictions on vehicle configuration such as assuming a spherical spacecraft.

To calculate the return flux to a surface, the location and orientation of the critical surface i (Figure A-5) is defined. In addition, the field-of-view (FOV) for this surface in terms of θ and ϕ and the direction of the incoming ambient flux vector, V_A, with respect to the line-of-sight (LOS) in terms of α must be defined. The return flux to the surface is then computed by performing a volume integration over the defined region of space within the surface field-of-view. (Note: abnormal fields-of-view such as rectangles can also be considered through special analytical manipulation).

The return flux per unit volume of space centered at point P is a direct function of the collision rate of the contaminant and ambient species within that volume. The collision rate can be defined by knowing the number density of both the contaminants ($N_m(P)$) and the ambient species (N_A) within that volume. This together with the

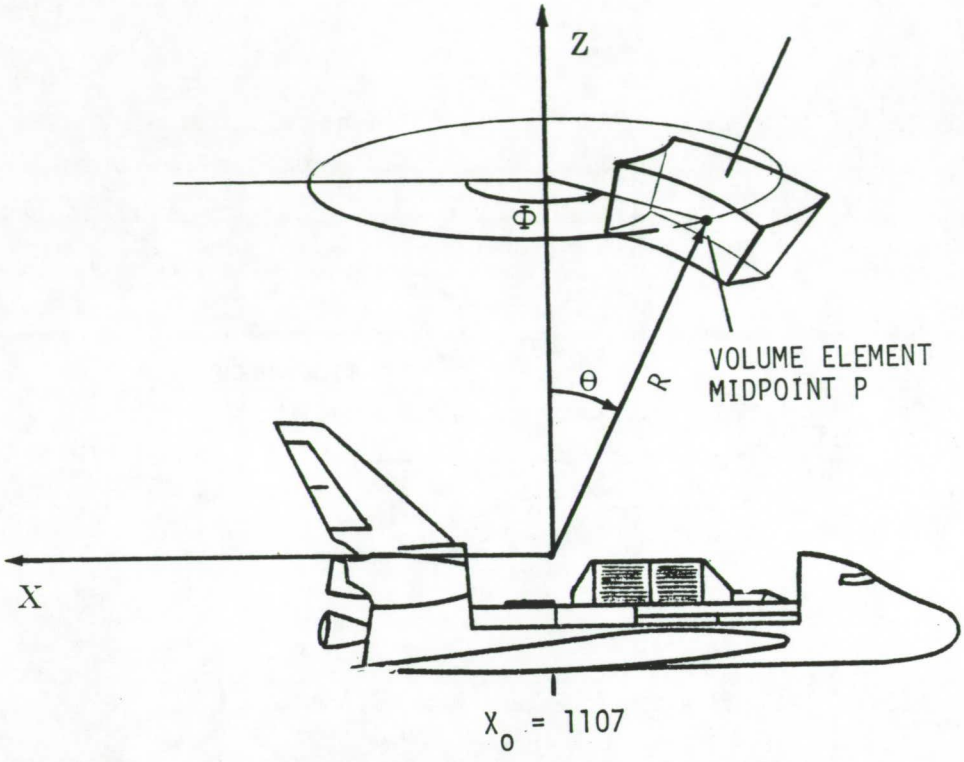


Figure A-4. Elemental Volume Geometry (Line-of-Sight Location)

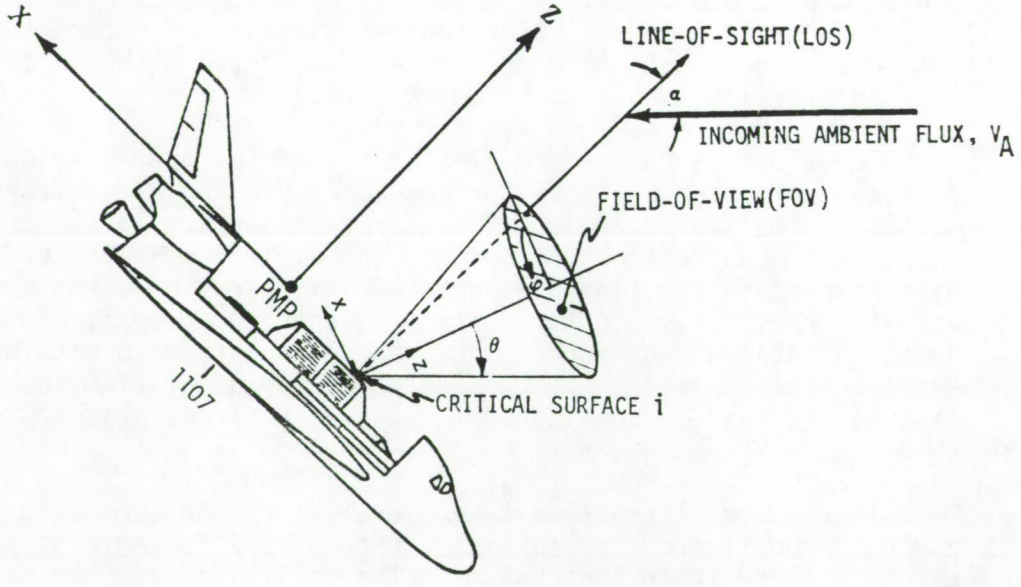


Figure A-5. Critical Surface Location, Orientation and Field-of-View

relative velocity (V_A) and the effective cross section of the collision process (σ_{Am}) is used to determine the collision rate within the volume element

$$\dot{n}_m(P) = N_A N_m(P) V_A \sigma_{Am}. \qquad \text{(A-17)}$$

It is assumed that there is no attenuation in the ambient density due to the perturbation by the contaminant environment and that the impact of the ambient flux upon the contaminant density is negligible at all altitudes above approximately 250 km. It is also assumed that densities induced by surface sources such as outgassing and leakage can be defined knowing the mass loss characteristics and utilizing a Lambertian distribution from each surface.

A scattering model is assumed which defines the number of collisions given in equation (A-17) that deflect molecules toward the critical surface. The scattering model currently used by most analysts (hard sphere) reduces to a cosine or Lambertian distribution from the scattering center. By integrating over all space within the geometric acceptance angle or the FOV of a critical surface, the total return flux ($g/cm^2/s$) to the surface can be determined. Using the hard sphere scattering model, the return flux of specie m can be expressed as

$$RFAS_m = \iiint_{\theta\phi 0}^{r_{max}} \frac{r^2 \, \dot{n}_m(P) \cos\alpha \cos\theta \sin\theta \, dr \, d\phi \, d\theta}{\pi r^2}, \text{ or} \qquad \text{(A-18)}$$

$$RFAS_m = N_A V_A \frac{\pi}{4} \left[\mu(\delta_C + \delta_A)\right]^2 \iint_{\theta\phi} \frac{\cos\alpha}{\pi} \underbrace{\int_0^{r_{max}} N_m \, dr}_{NCD} \sin\theta \cos\theta \, d\theta \, d\phi \qquad \text{(A-19)}$$

In performing the volume integration, observe that for a given θ and ϕ that a line-of-sight (LOS) has been defined emanating from the critical surface (Figure A-5). Since the scattering angle, α, is a constant along each LOS, integration is first performed over the variable r (along the LOS) to obtain the number column density (The NCD is often a useful piece of information if the surface is a

viewing optic and there is concern with not only the return flux deposition but also field-of-view interference through scattering, emission and/or absorption). The return flux is, therefore

$$RFAS_m = N_A V_A \frac{\pi}{4} \left[\mu \left(\delta_m + \delta_A\right)\right]^2 \sum_N \frac{\cos \alpha_N}{\pi r^2} NCD_N \, r^2 \sin \theta_N \cdot \cos \theta_N \, \Delta\theta \, \Delta\phi, \qquad \text{(A-20)}$$

where;

NCD_N = molecular column density along line-of-sight N (molecules/cm^2),

α_N = angle the incoming ambient species subtend with LOS N, degrees,

N_A = ambient density (molecules/cm^3),

V_A = ambient velocity (cm/s),

δ_m = contaminant diameter (cm),

δ_A = ambient diameter (cm) and

μ = velocity factor (3.0 assumed).

and the volume integration has reduced to LOS integration followed by summation of a series of lines-of-sight that encompass the desired field-of-view. This is the relationship currently being used to define the contaminant return flux.

Note that if equation (A-20) is further modified, the return flux becomes

$$RFAS_m = N_A V_A \frac{\pi}{4} \left[\mu \left(\delta_m + \delta_A\right)\right]^2 \sum_N \cos \alpha_N \, NCD_N \frac{\cos \theta_N}{\pi r^2} \cdot r^2 \sin \theta_N \, \Delta\theta \, \Delta\phi. \qquad \text{(A-21)}$$

Now

$$\frac{\cos \theta_N}{\pi r^2} \cdot r^2 \sin \theta_N \, \Delta\theta \, \Delta\phi = \frac{\Delta A_N \cos \theta_N}{\pi r^2} = VF_{I-N}.$$

Therefore,

$$RFAS_m = N_A V_A \frac{\pi}{4} \left[\mu \, (\delta_m + \delta_A)\right]^2 \sum_N \cos \alpha_N \, NCD_N \, VF_{I-N}, \qquad \text{(A-22)}$$

where;

VF_{I-N} = form factor from volume element coincident with line-of-sight N to surface of interest I.

An important factor in the calculation of the return flux of contaminant molecules through collisions with the ambient atmosphere is the collision cross section σ_A which is expressed in equation A-22 as $\pi/4[\mu \, (\delta_m + \delta_A)]^2$. Where available, experimental data has been used in determining an effective collision cross section. As a result, the velocity factor, μ, is included in the scattering cross-section expressions to account for the average differences between measured molecular diameters and their "effective" diameters during high speed collision processes[1,2]. The return flux expression is based on the assumption the scattered molecules are scattered in a cosine distribution with respect to the velocity vector. The assumption has also been made that the vehicle induced contaminant molecules are at rest with respect to the ambient molecules in the vehicle frame of reference.

The ambient density can vary significantly between sunlit and dark periods of the orbit and during different levels of sunspot activity. For a complete mission profile, this factor should be considered when calculating the return flux of contaminants.

4.4 Second Surface Transport - Impingement on a surface by a source results in possible deposition and reemission of contaminants that do not adhere. In addition, some of the deposited material can desorb with time under the influence of temperature variations of the surface deposited upon.

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[1]Kydd, P. H.: "Total Scattering Cross Sections of H_2O and NH_3", Journal of Chemical Physics, Vol. 37, Number 5, September 1962.

[2]Snow, W. R. et al: "Molecular Beam Measurements of Total Collision Cross Sections of H_2O", Journal of Chemical Physics, Vol. 58, Number 6, March 1973.

In most instances, the effluents from the RCS engines and flash evaporator will not deposit on surfaces because of their temperature and the relatively high vapor pressure of the effluents. For this case, the reflection rate is equal to the impingement rate on the surface. The emission distribution of the reflected components is considered to be a $\cos \theta / r^2$ distribution with respect to the normal of the surface. The reemission velocities are assumed to be the most probable velocity based upon the temperature of the emitting surface and the molecular weight of the impinging effluents. This is expressed as

$$V = \left(\frac{2RT}{M} \right)^{1/2}, \qquad \text{(A-23)}$$

where;

V = velocity (m/s),

T = temperature (^{o}K),

M = molecular weight and

R_o = ideal gas constant.

This treatment of surface reflected species was arrived at following a survey of experimental work and contacts with investigators in this field. The following observations are pertinent to the decision to model the scattered molecules as described above:

a) Molecules with large dipole moments (H_2O, CO_2, etc.) have long interaction times (i.e., a few milliseconds) with a surface, thus allowing for more complete thermal accommodation with a surface. That is, one or more vibrations occur before being reemitted. The result is diffuse emission patterns.

b) Molecules with incident energies less than 1 to 2 eV exhibit diffuse scattering with surfaces[1]. These energies correspond to velocities of 1000 to 3000 m/s for the molecules of interest. The engine molecular exhaust products are near 3500 m/s and the evaporator exhaust near 100 m/s and thus fall close to this energy range.

c) A rough surface causes diffuse scattering of impinging molecules. A rough surface can be categorized as one having any irregularities such as the seams, penetrations and tile cracks such as those on the Shuttle Orbiter wings.

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[1]Private communication, Dr. T. Dickinson, Washington State University.

d) Contamination on a surface (even fractions of a monolayer) tends to drive specular scattering to diffuse scattering due to the nonuniformity of contaminant deposits. Significant contamination results in total diffuse scattering.

e) For the previous conditions, the scattered molecules have velocities indicative of the surface temperature impinged upon which implies complete thermal accommodation.

f) Low incident impingement angles can introduce lobular scattering (approaching specular) for a very clean surface with none of the above conditions.

g) Specular scattering of molecules is very hard to obtain and requires ultra-high vacuum conditions, atomically smooth, well characterized surfaces, no contamination and a unique gas and surface combination.

h) The portion of the plumes impinging on the wing surfaces that can contribute to the lines-of-sight are in the near molecular and free molecular flow regime, thus approximating experimental conditions from which the results were obtained for the decision making process.

i) For regions of the orbiter that are in the plume continuum or transition flow regime, significant plume interference will occur[1]. However, once the engine/vent has been turned off, the reemission from those surfaces impinged upon will be diffuse.

The available data indicates that a first order model would be best using a cosine or diffuse scattering model from the Shuttle Orbiter surfaces (in particular the wings) for the conditions anticipated on orbit. Later versions of the model could extend this to include specular reflection as well.

For materials that do deposit and are subsequently desorbed, the desorption rate can be expressed by

$$\dot{m}_j = 5.83 \times 10^{-2} P_{vj} \left(\frac{M_j}{T_j} \right)^{1/2}, \qquad \text{(A-24)}$$

[1]Robertson, S. J.: "Molecular Scattering of Vernier and Flash Evaporator Plumes from Space Shuttle Orbiter Wings", LMSC-HREC TM D496810, April 1976, Lockheed Missiles and Space Company, Inc.

where;

$\dot{m}_j$ = mass loss rate of deposit j ($g/cm^2/s$),

P_{vj} = vapor pressure (Torr),

M_j = molecular weight and

T_j = temperature (^oK).

The emission pattern of desorbed gases is known to be cosine dependent also. Therefore, if the vapor pressure and molecular weight of a gas is known, the desorption rate can be determined as a function of temperature and treated in a manner analogous to outgassing sources which utilizes viewfactors to a point or a surface in determining flux. This can be expressed as

$$\dot{m}_p = 5.83 \times 10^{-2} P_{vj} \left(\frac{M_j}{T_j}\right)^{1/2} VF_{j-p} , \qquad \text{(A-25)}$$

where;

$\dot{m}_p$ = mass flux at a point p,

P_{vj} = vapor pressure of source j at temperature T_j,

T_j = source j temperature,

M_j = molecular weight of source j and

VF_{j-p} = viewfactor between source j and point p.

4.5 Contaminant Self-Scattering - This situation occurs when the density of contaminant gases allows significant collisions among like molecules or combinations of other spacecraft induced molecules. In most instances, this effect is secondary when compared to other mechanisms already cited. Unique situations involving confined volumes and high source rates may require consideration of self-scattering. Self-scattering of a contaminant species is modeled using an approach as proposed by Robertson[1].

[1]Robertson, S. J.: "Spacecraft Self-Contamination Due to Back-Scattering of Outgas Products", LMSC-HREC TR D496676, January 1976, Lockheed Missiles and Space Company, Inc.

Using the assumptions of Robertson, equation (A-17) is replaced by

$$\dot{n}ss_m(P) = \frac{N_m(P)}{2}\sum\frac{N_n(P)}{2}(V_m + V_n) \bullet \frac{\pi}{4}\left[\mu\,(\delta_m + \delta_n)\right]^2 \qquad \text{(A-26)}$$

where;

m and n denote different contaminant species.

Using the assumption that the self scattered molecules emerge from the volume element with an equal probability in all directions and integrating over the hemispherical space above the vehicle,

$$RFSS_m = \iiint_{\theta\phi r} \frac{\dot{n}ss_m \cos\theta \sin\theta\, r^2\, dr\, d\theta\, d\phi}{4\pi r^2}, \qquad \text{(A-27)}$$

or

$$RFSS_m = \frac{\pi}{4}\iiint_{\theta\phi r} \frac{N_m(P)}{4\pi r^2}\sum_n N_n(P)\left[V_m + V_n\right]\bullet\frac{\pi}{4}\left[\mu(\delta_m + \delta_n)\right]^2\bullet$$

$$r^2\, dr \cos\theta \sin\theta\, d\theta\, d\phi$$

or

$$RFSS_m = \frac{\pi}{64}\sum_0\sum_\phi\sum_r N_m(P) \bullet \sum_n N_n(P)\left[V_m + V_n\right]\bullet$$

$$\left[\mu\,(\delta_m + \delta_n)\right]^2 \Delta r \cos\theta \sin\theta\, \Delta\theta\, \Delta\phi\,. \qquad \text{(A-28)}$$

4.6 Plume Intermolecular Interference - Situations can occur where the effluent reflected off of a surface can interfere with the incoming effluents. This occurs for large sources such as flash evaporators or attitude control engines. This in effect would reduce some of the surface reflection rates during operation of the source. However, once the source ceases there could be a larger burst of effluents from a surface that were held there (viscous layer) by the action of the incoming effluent plume. Because of the uncertainties in determining both these phenomena and their cancellation effect on each other with time, the impingement rate from a high volume source is allowed to be the reflected rate. For experiments that cannot tolerate high pulses over short periods of time, this effect should be investigated further.

4.7 Surface Deposition Determination - The direct source-to-surface outgassing sticking coefficient term

$$\frac{T_j - T_i}{200} = 0 \text{ for } T_i > T_j, \qquad \text{(A-29)}$$

where;

T_j = source temperature (^oC) and

T_i = surface temperature of receiver (^oC)

was estimated from percent weight loss and percent VCM comparisons from materials testing[1,2]. That is, if the % WT loss was 0.9% and the % VCM was 0.45% at standard VCM test temperatures of 125°C and 25°C, the sticking coefficient would be 0.5 as based upon equation (A-29), where

$$S = \frac{T_j - T_i}{200} = \frac{125 - 25}{200} = 0.5.$$

The relation also encompassed limited data[3] observed at other source temperatures. The deposits observed during these tests is of a

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[1]Miraca, R. F. and Whittick, J. S.: "Polymers for Spacecraft Applications", N67 40270, Stanford Research Institute, September 15, 1967.

[2]Campbell, W. A., et al: "A Compilation of Outgassing Data for Spacecraft Materials", NASA TND 7362.

[3]Poehlman, H. C.: "Vacuum Weight-Loss and Contamination Tests of Some Materials for Space Application", Proc. of the Fourth INTERNL. Vacuum Congress 1968.

permanent nature and of long duration. It was decided during the Skylab program that a desorption equation based on $e^{-E/RT}$ for the deposit would not suffice. This type of phenomena was also apparent in the Orbiter Thermal Protection System tile outgassing tests conducted at MSFC where heating the test QCM did not remove the deposit even though it should have if the E of 15 Kcal/mole ascertained at lower temperatures for the source was applied to the deposit.

The problem is that the source activation energies cannot be applied to VCM deposits on a surface because repolymerization or other chemical reactions can occur. In the presence of sunlight, photopolymerization can also occur thus changing the nature of the deposit. It was for these reasons that a simplified sticking coefficient based on a limited temperature range of materials testing was applied for the Skylab outgassing contaminants.

Figure A-6 shows the comparison of the $\frac{T_j - T_i}{200}$ expression to test data of RTV-602 outgassing onto a gold substrate. The lower curve corresponds to the $\frac{T_j - T_i}{200}$ expression while the upper predicted curve corresponds to $\frac{T_j - T_i}{150}$ which was preliminarily determined from testing of DC-92007 white paint at JSC.

Ideally, the condensation or sticking coefficient should be determined experimentally using the expression

$$\dot{D}_i = \dot{m}_j \, S_{j-i} \, VF_{i-j} - \dot{m}_{ej}, \qquad \text{(A-30)}$$

where;

$\dot{D}_i$ = the condensation rate on surface i,

$\dot{m}_j$ = mass loss rate of source j,

S_{j-i} = fraction of j condensing on i at the temperature T_i,

VF_{i-j} = viewfactor and

$\dot{m}_{ej}$ = reevaporation rate of j deposit from i at temperature T_i.

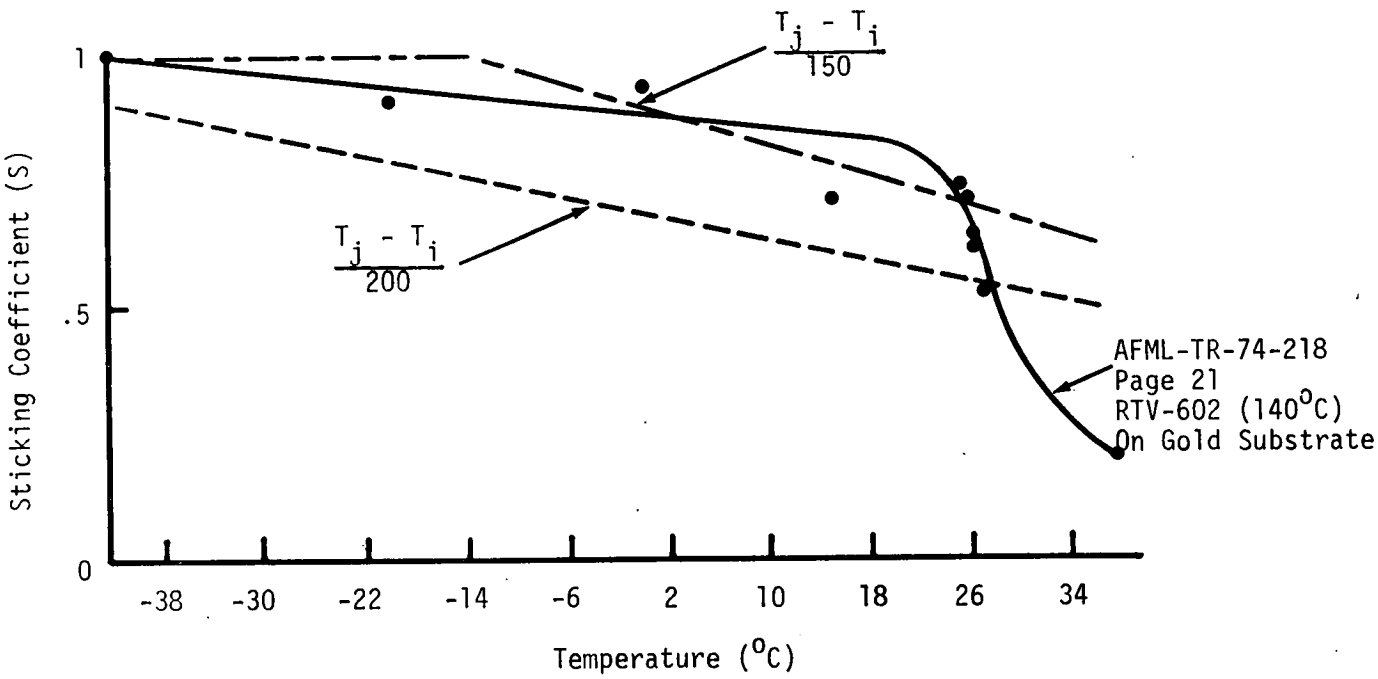


Figure A-6 Comparison of Model Sticking Coefficient Predictions to Testing

This test should be performed with and without vacuum ultraviolet radiation of the deposit during deposition to determine the change in $\dot{m}_{ej}$ and any possible influence on S_{j-i}, the condensation coefficient. Until adequate testing has been performed, the previous temperature difference expression for outgassing deposition will be used. Material testing currently being conducted at MMA has as a primary goal the determination of $\dot{m}_j$, S_{j-i} and $\dot{m}_{ej}$ for accurate modeling in the future.

The condensation coefficient for return flux (either from self-scattering or ambient collisions) could be calculated in a way similar to equation A-29. However, one must consider the molecular kinetic energy gained during the collision processes and its ultimate impact on the ability of a contaminant molecule to adhere to a surface. Existing ground test data of this phenomena is inadequate to establish a general condensation coefficient relationship. It is, therefore, necessary to select a value for this parameter (between 0 and 1) based upon engineering judgement of the analysis being conducted. This value could be estimated by averaging the temperatures of all j sources and utilizing equation A-29 knowing the temperature of the deposition sensitive surface, T_i. Additional items which should also be considered include:

a) If the deposition sensitive surface operates at cryogenic temperatures, the sticking coefficient for return flux will be near 1.

b) If the deposition sensitive surface operates at warm temperatures (>50°C), the sticking coefficient will probably be relatively low (i.e., $\tilde{=}$ 0.1).

c) If the deposition sensitive surface operates at nominal temperatures ($\tilde{=}$25°C), the sticking coefficient averaged over a typical orbit (60 - 70% sunlite exposure) will probably fall within the range of 0.25 to 0.30.

Each situation requires individual evaluation, and therefore, the model has been configured to accept user input of the return flux sticking coefficient for surface deposition analysis. When, and if the influence of this phenomena is accurately determined through ground testing or flight experimentation, the methodology can and should be refined.

For MMH/N_2O_4 bi-propellant engines, the condensation coefficient has been determined through limited engine testing at Lewis Research Center to be 0.002 of the total engine flux. This value

was established during engine testing with deposition collectors held near 0°C and was verified by the onboard deposition detectors of Skylab operating at an average temperature near 10°C. The deposits observed during the engine testing were determined to be MMH-Nitrate which is a small fraction of the total engine effluents. For the simple gases which comprise the majority of engine exhausts (H_2O, H_2, etc.), the desorption rate on a surface is compared to the corresponding engine flux rate to determine if a net deposit could result. Surface desorption rates are calculated utilizing the vapor pressure equation (A-24) knowing the temperature of the given surface.

5. CONTAMINATION DEGRADATION EFFECTS

Once the amount of a material on a surface or in a field-of-view is determined, the effect on experiments, sensors or thermal control surfaces must be ascertained. Since the current contamination model was developed primarily for SO/SL design and development studies for compliance with program contamination control criteria, there was basically no need to over-complicate the model with subroutines to predict the effects of the contaminant environment. In essence, compliance with the criteria implies compliance with the allowable contamination effects as cited by the technical community. If, in the future the model evolves into a mission analysis/payload evaluation tool, the area of effects must be expanded. The analyst should be familiar with the types of degradation effects that can be experienced. These are discussed in the following subsections.

5.1 Deposited Films - Associated with each contaminant specie or a known combination, a series of coefficients can be developed that relate the change in transmission of a particular wavelength through the deposited film; relate the change in reflectance of a particular wavelength that interacts with the deposited film; relate the change in conductivity of the surface or relate changes in solar absorptivity and emissivity. The net effect of a contaminant deposit is to reduce transmitted signal strength, change the reflectivity of a surface, change its electrical properties or discolor a thermal control surface. For integrated responses such as solar cells or eye response, the attenuation must be applied to all wavelengths of the detector response curve. The deposit characteristics can change significantly in the presence of ultraviolet, electron or proton radiation through chemical changes of the deposited film.

Normally, the shorter wavelengths (UV) are affected the most, even by relatively small levels of contaminant. The visible and infrared wavelengths are affected to a lesser degree.

It was noted that on Skylab the white thermal control surfaces experienced a solar absorptivity change from 0.18 to 0.25 due to surface deposits and their subsequent interaction with solar ultraviolet radiation.

By changing the electrical conductivity of surfaces, the deposit could cause a conductor to become a semiconductor thus changing the charge characteristics of the surface. This could lead to serious voltage breakdown problems for differentially charged areas and could also enhance the deposition of ionized molecules or charged particles.

5.2 Cloud Degradation - Particular experiments or instruments are sensitive to specific molecular or particulate species in their field-of-view. The degradation mechanisms are molecular scattering, absorption or emission and particulate scattering or emission. The net effect is an addition to or reduction of a signal for a particular wavelength of interest. Computer programs are in existence that can predict the above mentioned degradation effects.

5.3 Other Effects - Other degradation phenomena that can occur and cause irrepairable damage or unsatisfactory operation are corona and multipacting.

Corona occurs when the induced contaminant gas density in the vicinity of high voltages is sufficient to cause electrical breakdown through the gas cloud. This is likely to occur in poorly vented areas and/or where contaminant effluent levels are high.

Multipacting occurs when the gas density in the vicinity of an antenna is high enough to allow ionized contaminants (by photoionization) to impinge on the antenna thus releasing secondary electrons which develop into an interference cloud around the antenna rendering it inoperable for periods.

APPENDIX B

SURFACE INPUT TO TRASYS

TABLE OF CONTENTS

		Page
Table of Contents		B-2
I. INTRODUCTION		B-3
Tables		
B-I	Shuttle Orbiter Geometry Breakdown	B-5
	Shuttle Orbiter TRASYS Input Listing	B-19
	Line-of-Sight TRASYS Input Listing	B-35
B-II	Spacelab LMOP Geometry Breakdown	B-38
	Spacelab LMOP TRASYS Input Listing	B-41
B-III	Spacelab SMTP Geometry Breakdown	B-47
	Spacelab SMTP TRASYS Input Listing	B-52
B-IV	Spacelab FIVP Geometry Breakdown	B-59
	Spacelab FIVP TRASYS Input Listing	B-65

APPENDIX B
SURFACE INPUT TO TRASYS

I. INTRODUCTION

This appendix contains the input parameters to the TRASYS II thermal program that were utilized to establish the geometric relationship permanent files (viewfactors, r's and θ's) discussed in Appendix A. Information contained herein can be divided into two categories: 1) modeled surface geometry for the four fixed configurations and 2) the listings of the actual surface input data to TRASYS for the developed configurations and one line-of-sight representative of the seventeen included in the model.

Tables B-I through B-IV contain the geometric breakdowns for the Shuttle Orbiter and the Spacelab Long Module/One Pallet (LMOP), Short Module/Three Pallet (SMTP) and Five Pallet (FIVP), respectively. Included in the tables are the general area of each specific surface, a descriptive name, the type of surface, its assigned number, the number of nodes that it is subdivided into and the node numbers of which it is composed. Following each table is a listing of the TRASYS surface input deck which can be duplicated and/or modified if the user desires to recalculate or change the geometric relationship permanent files in the contamination model.

Included in the Orbiter geometry section is a listing of the point/surface input deck utilized to construct one of the 17 modeled lines-of-sight. This line-of-sight which originates at Orbiter station $X_0 = 1107$, $Y_0 = 0$ and $Z_0 = 507$ and is parallel to the +Z axis can be rotated through internal TRASYS II commands to any desired angle off of the +Z axis and point viewfactors can be calculated. Reference should be made to the TRASYS II User's Manual[1] if any of these activities are to be conducted.

Descriptive comments are included with each input surface in the TRASYS input listings to aid the user in understanding the type and function of the surface. From the specific TRASYS input parameters; the user can determine exact shape, location, orientation, size and shadowing properties of individual surfaces. All input parameters are in units of inches from an arbitrarily selected coordinate system origin for each configuration. Reference should be made to the TRASYS II User's Manual[1] if mass transport factor data block modification is desired or if clarification is required. The user should use caution when performing major modifications to

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[1] "Thermal Radiation Analysis System (TRASYS II) User's Manual", MCR-73-105 (Revision 1), Contract NAS9-14318, Martin Marietta Aerospace, Denver Division, May 1975.

the mass transport factor data. If configuration changes are extensive, all form factors should be recalculated due to potential changes in surface shadowing characteristics, impacts upon surface subdivisions and resolution of calculations, etc. The surface input data to TRASYS for the Orbiter is based upon a coordinate system compatible with the standard NASA STS axis/station number identification system. To facilitate programming, however, variances between the two systems do exist. The differences involve transformation of the coordinate system origin to NASA station X_0 = 800, Y_0 = 0 and Z_0 = 400 (see Figure 2-1 of main report), and reversing the right-handed system from +X aft to +X forward. This was done solely to allow for proper sizing and maximum visibility of the TRASYS generated graphic displays of the Orbiter configuration and is unique only to the Orbiter TRASYS input data. In contrast, surface input data for the three modeled Spacelab configurations is based upon the standard NASA coordinate and station number identification system. Any other references to the Shuttle Orbiter/Spacelab coordinate system or station number identifiers in this manual will be based upon the NASA designations.

Table B-I. Shuttle Orbiter Geometry Breakdown

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
BODY	BAY AREA BOTTOM CYLINDER	CYLINDER	1	8	1, 2, 3, 4, 5, 6, 7, 8
	INSIDE -Y LINER STRIP	RECTANGLE	440	4	440, 441, 442, 443
	INSIDE +Y LINER STRIP	RECTANGLE	445	4	445, 446, 447, 448
	FRONT BAY AREA DISK	DISK	13	1	13
	END BAY AREA DISK	DISK	11	1	11
	-Y RADIATOR	CYLINDER	20	8	20, 21, 22, 23, 24, 25, 26, 27
	+Y RADIATOR	CYLINDER	30	8	30, 31, 32, 33, 34, 35, 36, 37
	-Y SIDE DOOR	CYLINDER	40	8	40, 41, 42, 43, 44, 45, 46, 47
	+Y SIDE DOOR	CYLINDER	50	8	50, 51, 52, 53, 54, 55, 56, 57
	BACK BODY TOP	CYLINDER	202	2	202, 203
	BACK RECTANGLE @ 7.35 DEGREES	RECTANGLE	230	1	230

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
BODY	REAR FLAT PLATE OUT BACK	RECTANGLE	250	1	250
	SLOPING REAR FLAT PLATE	RECTANGLE	260	1	260
	-Y SIDE FRONT TRAPEZOID	RECTANGLE	301	1	301
	+Y SIDE FRONT TRAPEZOID	RECTANGLE	311	1	311
	-Y SIDE PANEL	RECTANGLE	305	2	305, 306
	+Y SIDE PANEL	RECTANGLE	315	2	315, 316
	REAR PORT BACK, SIDE	RECTANGLE	307	1	307
	REAR STARBOARD BACK, SIDE	RECTANGLE	317	1	317
	-Y REAR SIDE TAPER	TRAPEZOID	420	1	420
	+Y REAR SIDE TAPER	TRAPEZOID	425	1	425
BODY:	TOTAL SURFACES = 21	TOTAL NODES = 65			
CREW	NOSE	PARABOLOID	160	1	160

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
CREW	+Y TOP NOSE TRIANGLE	POLYGON	162	1	162
	-Y TOP NOSE TRIANGLE	POLYGON	161	1	161
	FIRST -Y SIDE NOSE TRIANGLE	POLYGON	163	1	163
	FIRST +Y SIDE NOSE TRIANGLE	POLYGON	164	1	164
	SECOND -Y SIDE NOSE TRIANGLE	POLYGON	165	1	165
	SECOND +Y SIDE NOSE TRIANGLE	POLYGON	166	1	166
	THIRD -Y SIDE NOSE TRIANGLE	POLYGON	167	1	167
	THIRD +Y SIDE NOSE TRIANGLE	POLYGON	168	1	168
	-Y SIDE NOSE TRAPEZOID	TRAPEZOID	169	1	169
	+Y SIDE NOSE TRAPEZOID	TRAPEZOID	170	1	170
	-Y SIDE BOTTOM NOSE TRIANGLE	POLYGON	171	1	171
	+Y SIDE BOTTOM NOSE TRIANGLE	POLYGON	172	1	172

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER
CREW	NOSE CYLINDER HOOD	CYLINDER	174	1	174
	-Y RECTANGLE BELOW SURFACE 174 NOSE HOOD	RECTANGLE	175	1	175
	+Y RECTANGLE BELOW SURFACE 174 NOSE HOOD	RECTANGLE	177	1	177
	WINDOW SPHERE SECTION	SPHERE	180	6	180, 181, 182, 183, 184, 185
	DOME SPHERE SECTION ABOVE WINDOW	SPHERE	190	1	190
CREW:	TOTAL SURFACES = 18		TOTAL NODES = 23		
TAIL	LEADING EDGE TAIL FIN	CYLINDER	399	1	399
	FIRST POLYGON -Y SIDE	POLYGON	380	1	380
	SECOND POLYGON -Y SIDE	POLYGON	382	1	382
	THIRD POLYGON -Y SIDE	POLYGON	384	1	384
	FOURTH POLYGON -Y SIDE	POLYGON	386	1	386

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER
TAIL	FIFTH POLYGON BENEATH SURFACE 386 (-Y)	POLYGON	388	1	388
	SIXTH POLYGON BENEATH SURFACE 388 (-Y)	POLYGON	390	1	390
	BOTTOM TAIL RECTANGLE	RECTANGLE	392	2	392, 393
	FIRST POLYGON +Y SIDE	POLYGON	381	1	381
	SECOND POLYGON +Y SIDE	POLYGON	383	1	383
	THIRD POLYGON +Y SIDE	POLYGON	385	1	385
	FOURTH POLYGON +Y SIDE	POLYGON	387	1	387
	FIFTH POLYGON BENEATH SURFACE 387 (+Y)	POLYGON	389	1	389
	SIXTH POLYGON BENEATH SURFACE 389 (+Y)	POLYGON	391	1	391
TAIL:	TOTAL SURFACES = 14		TOTAL NODES = 15		

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER
WING	FIRST TRIANGLE NOMEX WING (-Y)	TRAPEZOID	100	1	100
	FIRST RECTANGLE NOMEX WING (-Y)	RECTANGLE	102	1	102
	SECOND RECTANGLE (TOWARD X) NOMEX WING (-Y)	RECTANGLE	104	1	104
	TRIANGLE ABOVE SURFACE 102 NOMEX WING (-Y)	TRAPEZOID	110	1	110
	INSERT IN WING TILE WING (-Y)	POLYGON	117	1	117
	OUTER WING STRIP CARBON WING (-Y)	POLYGON	121	1	121
	LONG BACK RECTANGLE NOMEX WING (-Y)	RECTANGLE	112	1	112
	SHORT BACK RECTANGLE ON BOTTOM OF 112 TILE WING (-Y)	RECTANGLE	119	1	119
	FORWARD TRIANGLE TILE WING (-Y)	TRAPEZOID	115	1	115

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER
WING	FIRST TRIANGLE NOMEX WING (+Y)	TRAPEZOID	130	1	130
	FIRST RECTANGLE NOMEX WING (+Y)	RECTANGLE	132	1	132
	SECOND RECTANGLE (TOWARD X) NOMEX WING (+Y)	RECTANGLE	134	1	134
	TRIANGLE ABOVE SURFACE 132 NOMEX WING (+Y)	TRAPEZOID	140	1	140
	INSERT IN WING TILE WING (+Y)	POLYGON	147	1	147
	OUTER WING STRIP CARBON WING (+Y)	POLYGON	151	1	151
	LONG BACK RECTANGLE NOMEX WING (+Y)	RECTANGLE	142	1	142
	SHORT BACK RECTANGLE ON TOP OF 142 TILE WING (+Y)	RECTANGLE	149	1	149
	FORWARD TRIANGLE TILE WING (+Y)	TRAPEZOID	145	1	145
WING:	TOTAL SURFACES = 18		TOTAL NODES = 18		

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER
ELEVON	THIRD RECTANGLE (INNER AILERON) NOMEX WING (-Y)	RECTANGLE	106	1	106
	THIRD RECTANGLE (OUTER AILERON) NOMEX WING (-Y)	RECTANGLE	107	1	107
	TAIL EDGE NOMEX WING (-Y)	POLYGON	450	10	450, 451, 452, 453, 454, 455, 456, 457, 458, 459
	THIRD RECTANGLE (INNER AILERON) NOMEX WING (+Y)	RECTANGLE	136	1	136
	THIRD RECTANGLE (OUTER AILERON) NOMEX WING (+Y)	RECTANGLE	137	1	137
	TAIL EDGE NOMEX WING (+Y)	POLYGON	460	10	460, 461, 462, 463, 464, 465, 466, 467, 468, 469
ELEVON:	TOTAL SURFACES = 6		TOTAL NODES = 24		
OMS	+Y OMS SEALER	DISK	60	1	60
	FIRST PARABOLOID +Y OMS	PARABOLOID	62	1	62
	OMS END CYLINDER RADIUS = 65	CYLINDER	64	1	64

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER
OMS	TRAPEZOID BOTTOM OF OMS END SEALER (+Y)	POLYGON	66	1	66
	FIRST TRIANGLE LEFT SIDE LOOKING BACK (+Y)	DISK	68	1	68
	LAST TRIANGLE RIGHT SIDE +Y OMS	DISK	70	1	70
	SECOND TRIANGLE LEFT SIDE	DISK	72	1	72
	THIRD TRIANGLE MIDDLE RIGHT SIDE +Y OMS	DISK	74	1	74
	TOP INSIDE TRAPEZOID +Y OMS	POLYGON	76	1	76
	-Y OMS SEALER	DISK	79	1	79
	FIRST PARABOLOID -Y OMS	PARABOLOID	82	1	82
	-Y OMS END CYLINDER	CYLINDER	84	1	84
	TRAPEZOID BOTTOM OMS END SEALER	POLYGON	86	1	86

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER
OMS	FIRST TRIANGLE LEFT SIDE LOOKING BACK -Y OMS	DISK	88	1	88
	LAST TRIANGLE RIGHT SIDE -Y OMS	DISK	90	1	90
	SECOND TRIANGLE LEFT SIDE -Y OMS	DISK	92	1	92
	THIRD TRIANGLE MIDDLE RIGHT SIDE -Y OMS	DISK	94	1	94
	TOP INSIDE TRAPEZOID	POLYGON	96	1	96
OMS:	TOTAL SURFACES = 18		TOTAL NODES = 18		
EVAP	REAR SONIC EVAPORATOR (-Y)	DISK	879	1	879
	REAR SONIC EVAPORATOR (+Y)	DISK	877	1	877
EVAP:	TOTAL SURFACES = 2		TOTAL NODES = 2		

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER	EQUIVALENT RI ENGINE NUMBERS
ENGINES	AFT RCS (-Z) (-Y SIDE) 712 - FFLOW 713 - BFLOW	DISK	712	2	712, 713	226
	AFT RCS (-Y) (-Y SIDE) 722 - FFLOW 723 - BFLOW	DISK	722	2	722, 723	223
	AFT RCS (+Z) (-Y SIDE) 733 - FFLOW 732 - BFLOW	DISK	732	2	732, 733	225
	FRONT SCARFED RCS LOOKING 45° OFF -Z → -Y 736 - FFLOW 737 - BFLOW	DISK	736	2	736, 737	116, 126
	FRONT RCS LOOKING +Z 740 - FFLOW 741 - BFLOW	DISK	740	2	740, 741	115, 125, 135
	FRONT RCS LOOKING -X 743 - FFLOW 742 - BFLOW	DISK	742	2	742, 743	112, 122, 132
	FRONT RCS LOOKING -Y (-Y SIDE) 745 - FFLOW 744 - BFLOW	DISK	744	2	744, 745	113, 123

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER	EQUIVALENT RI ENGINE NUMBERS
ENGINES	FRONT SCARFED RCS LOOKING 45° OFF -Z → +Y 739 - FFLOW 738 - BFLOW	DISK	738	2	738, 739	136, 146
	FRONT RCS LOOKING +/-Y (+Y SIDE) 746 - FFLOW 747 - BFLOW	DISK	746	2	746, 747	134, 144
	AFT RCS (-Z) (-Y SIDE) 710 - FFLOW 711 - BFLOW	DISK	710	2	710, 711	246
	AFT RCS (-Z) (-Y SIDE) 714 - FFLOW 715 - BFLOW	DISK	714	2	714, 715	236
	AFT RCS (-Y) (-Y SIDE) 720 - FFLOW 721 - BFLOW	DISK	720	2	720, 721	243
	AFT RCS (-Y) (-Y SIDE) 724 - FFLOW 725 - BFLOW	DISK	724	2	724, 725	233
	AFT RCS (-Y) (-Y SIDE) 726 - FFLOW 727 - BFLOW	DISK	726	2	726, 727	213

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER	EQUIVALENT RI ENGINE NUMBERS
ENGINES	AFT RCS (+Z) (-Y SIDE) 731 - FFLOW 730 - BFLOW	DISK	730	2	730, 731	245
	AFT RCS (+Z) (-Y SIDE) 735 - FFLOW 734 - BFLOW	DISK	734	2	734, 735	215
	AFT RCS (-Z) (+Y SIDE) 748 - FFLOW 749 - BFLOW	DISK	748		748, 749	326, 336, 346
	AFT RCS (+Y) (+Y SIDE) 751 - FFLOW 750 - BFLOW	DISK	750	2	750, 751	314, 324, 334, 344
	AFT RCS (+Z) (+Y SIDE) 753 - FFLOW 752 - BFLOW	DISK	752	2	752, 753	315, 325, 345
	AFT VCS (-Y) (-Y SIDE) 800 - FFLOW 801 - BFLOW	DISK	800	2	800, 801	258
	AFT VCS (-Z) (-Y SIDE) 806 - FFLOW 805 - BFLOW	DISK	805	2	805, 806	257

Table B-I. Shuttle Orbiter Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBER	EQUIVALENT RI ENGINE NUMBERS
ENGINES	FRONT SCARFED VCS (-Y SIDE) 837 - FFLOW 836 - BFLOW	DISK	836	2	836, 837	116
	AFT VCS (+Y) (+Y SIDE) 810 - FFLOW 811 - BFLOW	DISK	810	2	810, 811	358
	AFT VCS (-Z) (+Y SIDE) 815 - FFLOW 816 - BFLOW	DISK	815	2	815, 816	357
	FRONT SCARFED VCS (+Y SIDE) 839 - FFLOW 838 - BFLOW	DISK	838	2	838, 839	136
ENGINES:	TOTAL SURFACES = 27		TOTAL NODES = 54			TOTAL ENGINES = 40
	SUPER ENGINES (OMS LOCATION) -Y 900 - FFLOW 901 - BFLOW	DISK	900	2	900, 901	
	SUPER ENGINES (OMS LOCATION) +Y 903 - FFLOW 902 - BFLOW	DISK	902	2	902, 903	
	TOTAL SURFACES = 4		TOTAL NODES = 4			

ORBITER TRASYS INPUT LISTING

```
BCS         BODY
D          1.
S         SURFN=1,SHADE=BOTH,BSHADE=BOTH,ALPHA=0.,EMISS=0.
          TRANS=-0.    ,TRANI=-0.    ,COM=*BAY AREA CYLINDER                *
          TYPE=CYLINDER  ,ACTIVE=INSIDE ,ALPH= 93.5
          BMIN= 0.          ,BMAX= 7.25000E+02,GMIN= 0.
          GMAX= 1.60000E+02,NNX=     2,NNY=     4,ICSN=    -0
          POSITION=-5.07000E+02. 0.          , 0.
          ROTZ     =    -0.     , ROTY     =    90.0000, ROTX     =     0.
S         SURF=440,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
          P1=218.,93.5,0.
          P2=218.,93.5,19.
          P3=-507.,93.5,19.
          PROP=0.,0.
          NNX=4
          COM=* INSIDE +Y LINER STRIP*
S         SURF=445,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
          P1=218.,-93.5,0.
          P2=218.,-93.5,19.
          P3=-507.,-93.5,19.
          PROP=0.,0.
          NNX=4
          COM=* INSIDE -Y LINER STRIP*
S         SURFN=   13,SHADE=BOTH,BSHADE=BOTH,ALPHA=-0.    ,EMISS=-0.
          TRANS=-0.    ,TRANI=-0.    ,COM=* FRONT BAY AREA DISK             *
          TYPE=DISC       ,ACTIVE=TOP     ,ALPH= 0.
          BMIN= 0.          ,BMAX= 1.02000E+02,GMIN= 0.
          GMAX= 3.60000E+02,NNX=     1,NNY=     1,ICSN=    -0
          POSITION= 2.18000E+02. 0.          , 0.
          ROTZ     =    -0.     , ROTY     =   -90.0000, ROTX     =     0.
S         SURFN=   11,SHADE=BOTH,BSHADE=BOTH,ALPHA=-0.    ,EMISS=-0.
          TRANS=-0.    ,TRANI=-0.    ,COM=*  END  BAY AREA DISK             *
          TYPE=DISC       ,ACTIVE=TOP      ,ALPH= 0.
          BMIN= 0.          ,BMAX= 1.02000E+02,GMIN= 0.
          GMAX= 3.60000E+02,NNX=     1,NNY=     1,ICSN=    -0
          POSITION=-507.,0.,0.
          ROTZ     =    -0.     , ROTY     =    90.0000, ROTX     =     0.
S         SURF=20,SHADE=BOTH,BSHADE=BOTH,ALPHA=0.,EMISS=0.
          TRANS=0.,TRANI=0.,COM=*  +Y   RADIATOR   *
          TYPE=CYLINDER,ACTIVE=BOTH,ALPH=101.
          BMIN=0.,BMAX=362.5,GMIN=00.00,GMAX=76.38
          NNX=2,NNY=2,ICSN=3
          POSITION=-165.1,104.2,570.
          ROTZ=-141.8,ROTY=0.,ROTX=0.
S         SURF=30,SHADE=BOTH,BSHADE=BOTH,ALPHA=0.,EMISS=0.
          TRANS=0.,TRANI=0.,COM=*  -Y   RADIATOR   *
          TYPE=CYLINDER,ACTIVE=BOTH,ALPH=101.
          BMIN=0.,BMAX=362.5,GMIN=13.62,GMAX=90.
          NNX=2,NNY=2,ICSN=3
          POSITION=165.1,104.2,570.
          ROTZ=-128.1,ROTY=0.,ROTX=0.
S         SURFN=   40,TYPE=CYL,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
          P1=218.,198.51,52.00
          P2=218.,102.,19.
          P3=218.,231.51,-44.51
          P4=-507.,231.51,-44.51
          PROP=0.,0.
          NNX=2,NNY=2
          COM=*.....+Y SIDE DOOR.....*
S         SURFN=   50,TYPE=CYL,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
          P1=218.,-198.51,52.00
          P2=218.,-231.51,-44.51
          P3=218.,-102.,19.
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```
      P4=-507.,-102.,19.
      PROP=0.0,0.
      NNX=2,NNY=2
      COM=*... -Y SIDE DOOR....*
S     SURF=202,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
      P1=1307.,0.,0.
      P2=1307.,-102.,0.
      P3=1307.,102.,0.
      P4=1510.,102.,0.
     ICS=34
      NNAX=2,PROP=0.,0.
      COM=* BACK BODY TOP     *
S       SURF=230,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
       P1=-728.,-102.,-125.
       P2=-728.,102.,-125.
        P3=-711.,102.,0.0
        PROP=0.,0.
        COM=*  BACK RECT   7.35DEG*
S       SURF=240,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
       DIMENSIONS=0.0,0.0,102.,90.,270.
       PROP=0.,0.
       ICSN=15
       COM=* REAR END HALF DISK*
S     SURF=250,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
     P1=-728.,-102.,-125.
     P2=-728.,102.,-125.
     P3=-824.,102.,-125.
      PROP=0.,0.
      COM=* REAR FLAT PLATE OUT BACK  *
S     SURF=260,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
     P1=-728.,-102.,-100.
     P2=-728.,102.,-100.
     P3=-824.,102.,-125.
      PROP=0.,0.
      COM=*   SLOPING REAR FLAT PLATE *
S      SURFN=  301,TYPE=RECT,BSHADE=BOTH,SHADE=BOTH,ACTIVE=TOP
       P1=218.,102.,-122.
       P2=0.,102.,-122.
       P3=0.,102.,0.
       COM=* +Y SIDE FRONT TRAPOZOID*
       PROP=0.,0.
S      SURFN=  311,TYPE=RECT,BSHADE=BOTH,SHADE=BOTH,ACTIVE=BOTTOM
       P1=218.,-102.,-122.
       P2=0.,-102.,-122.
       P3=0.,-102.,0.
       COM=* -Y SIDE FRONT TRAPOZOID*
       PROP=0.,0.
S      SURF=305,TYPE=RECT,SHADE=BOTH,BSHADE=BOTH,ACTIVE=BOTTOM
     P1=800.,102.,0.
     P2=1307.,102.,0.
     P3=1307.,102.,-122.
     PROP=0.,0.,ICS=34,NNX=2
     COM=* +Y SIDE PANNEL*
S     SURF=315,TYPE=RECT,SHADE=BOTH,BSHADE=BOTH,ACTIVE=TOP
     P1=800.,-102.,0.
     P2=1307.,-102.,0.
     P3=1307.,-102.,-122.
     PROP=0.,0.,ICS=34,NNX=2
     COM=* -Y SIDE PANNEL*
S    SURF=307,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
     P1=1307.,-102.,0.
     P2=1510.,-102.,0.
     P3=1510.,-102.,-122.
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```
      ICSN=34
      PROP=0.,0.
      COM=* REAR PORT BACK,SIDE*
S      SURF=317,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
       P1=1307.,102.,0.
      P2=1510.,102.,0.
      P3=1510.,102.,-122.
      PROP=0.,0.
      ICSN=34
      COM=*REAR STBD BACK,SIDE*
S     SURF=420,TYPE=TRAP,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-709.,102.,0.
      P2=-709.,102.,-125.
      P3=-728.,102.,-125.
      P4=-711.,102.,0.
       PROP=0.,0.
       COM=*+ Y REAR TAPER*
S     SURF=425,TYPE=TRAP,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=-709.,-102.,0.
      P2=-709.,-102.,-125.
      P3=-728.,-102.,-125.
      P4=-711.,-102..0.
      PROP=0.,0.
      COM= * - Y. REAR SIDE TAPER...*
BCS   CREW
S     SURF=160,TYPE=PARAB,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
      P1=269.,0.0,-60.
      P2=269.,0.0,-22.
      P3=269.,0.0,-22.
      P4=235.,0.0,-60.  SAPEX OF PARABOLA,MAJOR RADIUS=38IN.
      PROP=0.,0.
      ICSN=34
      COM=* NOSE *
S     SURF=162,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=269.,0.,-22.
      P2=437.0,0.,41.
      P3=510.,-101.,41.
      PROP=0.,0.
      ICSN=34
      COM=* -Y TOP TRIANGLE NOSE *
S     SURF=161,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=269.,0.,-22.
      P2=437.0,0.,41.
      P3=510.,+101.,41.
      PROP=0.,0.
      COM=* +Y TOP  TRIANGLE NOSE *
      ICS=34
S     SURF=163,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=269.,0.,-22.
      P2=269.,-25.,-30.
      P3=510.,-101.,41.
      PROP=0.,0.
      ICSN=34
      COM=* -Y SIDE TRI(1ST) NOSE *
S     SURF=164,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=269.,0.,-22.
      P2=269.,+25.,-30.
      P3=510.,+101.,41.
      PROP=0.,0.
      ICSN=34
      COM=*+Y SIDE TRI(1ST) NOSE *
S     SURF=165,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=269.,-25.,-30.
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      P2=269.,-38.,-60.
      P3=510.,-101.,41.
      PROP=0.,0.
      COM=*-Y SIDE TRI(2ND)(DOWN) NOSE *
      ICSN=34
S     SURF=166,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=269.,+25.,-30.
      P2=269.,+38.,-60.
      P3=510.,+101.,41.
      PROP=0.,0.
      ICSN=34
      COM=* +Y SIDE TRI(2ND) NOSE *
S     SURF=167,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=269.,-38.,-60.
      P2=510.,-102.,-60.
      P3=510.,-102.,41.
      PROP=0.,0.
      ICSN=34
      COM=* -Y SIDE TRI(3RD) NOSE *
S     SURF=168,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=269.,38.,-60.
      P2=510.,102.,-60.
      P3=510.,101.,41.
      PROP=0.,0.
      ICSN=34
      COM=* +Y SIDE TRI(3RD) NOSE *
S     SURF=169,TYPE=TRAP,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=269.,-38.,-60.
      P2=510.,-102.,-60.
      P3=510.,-102.,-122.
      P4=269.,-38.,-75.
      PROP=0.,0.
      ICSN=34
      COM=* -Y SIDE TRAP NOSE *
S     SURF=171,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=510.,-102.,-122.
      P2=269.,-38.,-75.
      P3=269.,-20.,-98.
      PROP=0.,0.
      ICSN=34
      COM=* -Y SIDE TRI NOSE  BOTTOM*
S     SURF=170,TYPE=TRAP,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=269.,38.,-60.
      P2=510.,+102.,-60.
      P3=510.,+102.,-122.
      P4=269.,38.,-75.
      PROP=0.,0.
      ICSN=34
      COM=*+Y SIDE TRAP NOSE *
S     SURF=172,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=510.,+102.,-122.
      P2=269.,38.,-75.
      P3=269.,20.,-98.
      PROP=0.,0.
      ICSN=34
      COM=*+Y SIDE TRI NOSE  BOTTOM    *
S     SURF=174,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
      P1=510.,0.,0.
      P2=510.,-102.,19.
      P3=510.,102.,19.
      P4=582.,102.,19.
      PROP=0.,0.
      ICSN=34
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      COM=* CYLINDER HOOD NOSE *
S     SURF=175,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=510.,-102.,19.
      P2=510.,-102.,-122.
      P3=582.,-102.,-122.
      PROP=0.,0.
      ICSN=34
      COM=* RECT BELOW SURF 174 SIDE(-Y) HOOD NOSE *
S     SURF=177,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=510.,102.,19.
      P2=510.,102.,-122.
      P3=582.,102.,-122.
      PROP=0.,0.
      ICSN=34
      COM=* RECT BELOW SURF 174 SIDE(+Y) HOOD NOSE *
S     SURF=180,TYPE=SPHERE,ACTIVE=OUTSIDE,BSHADE=BOTH,SHADE=BOTH
      DIMENSIONS=102.,40.,70.,10.,170.
      TX=522.2,TY=0.,TZ=0.0
      ROTX=0.,ROTY=0.,ROTZ=-270.
      PROP=0.,0.
      NNAX=6
      ICSN=34
      COM=*   WINDOW   SPHERE SECITON ORIGIN=TX,TY,TZ*
S     SURF=190,TYPE=SPHERE,ACTIVE=OUTSIDE,BSHADE=BOTH,SHADE=BOTH
      DIMENSIONS=102.,70.,102.,0.,180.
      ICSN=34
      TX=522.2,TY=0.,TZ=0.
      ROTX=0.,ROTY=0.,ROTZ=-270.
      PROP=0.,0.
      COM=*     LID    SPHERE SECITON ORIGIN=TX,TY,TZ*
BCS   TAIL
S     SURF=399,TYPE=CYL,ACTIVE=OUTSIDE,BSHADE=BOTH,SHADE=BOTH
      P1=1312.,0.0,121.5
      P2=1312.,-3.0,121.5
      P3=1312.,3.0,121.5
      P4=1591.,3.0,416.0
      ICSN=34
      PROP=0.,0.
      COM=*LEADING EDGE TAIL FIN  X=1312,1594,HGT=316*
S     SURF=380,TYPE=POLY,ACTIVE=TOP,BSHADE=BOTH,SHADE=BOTH
      P1=1594.,00.,416.
      P2=1312.,-3.,121.5
      P3=1425.,-17.5,121.5
      PROP=0.,0.
      ICSN=34
      COM=* FROM BEG TO REAR 1ST PLOY -Y SIDE*
S     SURF=382,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=1594.,0.0,416.
      P2=1425.,-17.5,121.5
      P3=1653.,-7.5,416.
      PROP=0.,0.
      ICSN=34
      COM=* 2ND POLY -Y SIDE  *
S     SURF=384,TYPE=POLY,ACTIVE=TOP ,BSHADE=BOTH,SHADE=BOTH
      P1=1653.,-7.5,416.
      P2=1463.,-15.,170.
      P3=1575.,0.0,170.
      PROP=0.,0.
      ICSN=34
      COM=* 3RD POLY -Y SIDE TAIL *
S     SURF=386,TYPE=POLY,ACTIVE=TOP,BSADE=BOTH,SHADE=BOTH
      P1=1653.,-7.5,416.
      P2=1575.,0.0,170.
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      P3=1702.,0.0,416.
      PROP=0.,0.
      ICSN=34
      COM=*4TH POLY -Y SIDE  TAIL *
S     SURF=388,TYPE=POLY,ACTIVE=TOP,BSHADE=BOTH,SHADE=BOTH
      P1=1425.,-17.5,121.5
      P2=1575.,0.0,170.
      P3=1463.,-15.,170.
      PROP=0.,0.
      ICSN=34
      COM=* 5 POLY BENEATH 386 TAIL*
S     SURF=390,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=1425.,-17.5,121.5
      P2=1470.,-17.5,121.5
      P3=1575.,0.0,170.
      PROP=0.,0.
      ICSN=34
      COM=*  6TH  POLY BENEATH 388  TAIL*
S     SURF=392,TYPE=RECT,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
      P1=1312.,0.0,121.5
      P2=1312.,0.0,102.
      P3=1470.,0.0,102.
      PROP=0.,0.
      ICSN=34
      COM=* BOTTOM  RECT       TAIL *
S     SURF=381,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=1594.,00.,416.
      P2=1312.,+3.,121.5
      P3=1425.,+17.5,121.5
      PROP=0.,0.
      ICSN=34
      COM=* FROM BEG TO REAR 1ST POLY -Y SIDE)
S     SURF=383,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=1594.,0.0,416.
      P2=1425.,+17.5,121.5
      P3=1653.,7.5,416.
      PROP=0.,0.
      ICSN=34
      COM=* 2ND POLY -Y SIDE *
S     SURF=385,TYPE=POLY,ACTIVE=BOTTOM,BSHADE=BOTH,SHADE=BOTH
      P1=1653.,7.5,416.
      P2=1463.,+15.,170.
      P3=1575.,0.0,170.
      PROP=0.,0.
      ICSN=34
      COM=* 3RD POLY -Y SIDED TAIL *
S     SURF=387,TYPE=POLY,ACTIVE=BOTTOM,BSADE=BOTH,SHADE=BOTH
      P1=1653.,7.5,416.
      P2=1575.,+0.0,170.
      P3=1702.,0.0,416.
      PROP=0.,0.
      ICSN=34
      COM=*4TH POLY -Y SIDE  TAIL *
S     SURF=389,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=1425.,+17.5,121.5
      P2=1575.,0.0,170.
      P3=1463.,+15.,170.
      PROP=0.,0.
      ICSN=34
      COM=* 5 POLY BENEATH 386 TAIL*
S     SURF=391,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=1425.,17.5,121.5
      P2=1470.,17.5,121.5
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      P3=1575.,0.0,170.
      PROP=0.,0.
      ICSN=34
      COM=*  6TH  POLY  BENEATH 388  TAIL*
BCS   EVAP
S     SURF=877,TYPE=DISC,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-704.,103.,-109.
      P2=-704.,103.,-112.
      P3=-707.,103.,-109.
      P4=-707.,103.,-109.
      PROP=0.,0.
      COM=* SONIC EVAP REAR (LUBERT) + 291 +*
S     SURF=879,TYPE=DISC,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-704.,103.,-95.
      P2=-704.,103.,-98.
      P3=-707.,103.,-95.
      P4=-707.,103.,-95.
      PROP=0.,0.
      COM=* SONIC EVAP REAR (LUBERT) + 305 +*
S     SURF=881,TYPE=DISC,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-704.,103.,-85.
      P2=-704.,103.,-88.
      P3=-707.,103.,-85.
      P4=-707.,103.,-85.
      PROP=0.,0.
      COM=* SONIC EVAP REAR (LUBERT) + 315 +*
BCS    WING
S     SURF=100,TYPE=TRAP,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=-103.,0.,-62.1
      P4=-103.,0.,-62.1
      P3=-224.,105.,-58.
      P2=-224.,0.,-58.0
      PROP=0.,0.
      ICSN=20
      COM=*+Y 1ST TRIANGLE  NOMEX  WING  *
S     SURF=102,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=-224.,0.,-58.
      P2=-504.,0.,-90.
      P3=-504.,105.,-90.
      PROP=0.,0.
      ICSN=20
      COM=* +Y 1ST RECT NOMEX WING  *
S     SURF=104,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=-590.34,0.,-99.9
      P2=-590.34,105.,-99.9
      P3=-504.,105.,-90.
      PROP=0.,0.
      COM=* +Y 2ND RECT(TWRD-X) NOMEX WING *
      ICSN=20
C
S     SURF=110,TYPE=TRAP,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=-504.,105.,-90.
      P4=-504.,105.,-90.
      P2=-504.,319.,-90.
      P3=-287.,105.,-68.16
      PROP=0.,0.
      ICSN=20
      COM= * +Y TRI ABOVE SURF102  NOMEX WING  *
S     SURF=117,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-287.,105.,-68.16
      P4=-504.,319.,-90.
      P3=-504.,342.,-90.
      P2=-239.5,105.,-64.03
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      PROP=0.,0.
      ICSN=20
      COM= * +Y       INSERT IN WING TILE WING *
S     SURF=121,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-239.5,105.,-64.03
      P4=-504.,342.5,-90.
      P3=-504.,366.,-90.
      P2=-224.,105.,-58.
      PROP=0.,0.
      ICSN=20
      COM=* +Y      OUTER WING STRIP  CARBON  WING *
S     SURF=112,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=-504.00,105.,-90.
      P2=-590.34,105.,-99.9
      P3=-590.34,328.,-99.9
      ICSN=20
      PROP=0.,0.
      COM=* +Y LONG BACK  RECT   NOMEX   WING *
S     SURF=119,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=-504.,328.,-90.
      P2=-590.34,328.,-99.9
      P3=-590.34,366.,-99.9
      ICSN=20
      PROP=0.,0.
      COM=*+Y  SHORT BACK RECT ON BOTTOM OF 112 TILE WING *
S     SURF=115,TYPE=TRAP,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=263.9,0.,-78.7
      P4=263.9,0.,-78.7
      P2=-103.,0.,-62.1
      P3=-224.,105.,-58.
      PROP=0.,0.
      ICSN=20
      COM=* +Y FORWARD  TRIANGLE     TILE   WING *
S     SURF=130,TYPE=TRAP,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-103.,0.,-62.1
      P4=-103.,0.,-62.1
      P3=-224.,-105.,-58.0
      P2=-224.,0.,-58.0
      PROP=0.,0.
      ICSN=21
      COM=*-Y 1ST TRIANGLE  NOMEX  WING  *
S     SURF=132,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-224.,0.,-58.
      P2=-504.,0.,-90.
      P3=-504.,-105.,-90.
      PROP=0.,0.
      ICSN=21
      COM=*-Y 1ST RECT NOMEX WING  *
S     SURF=134,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-590.34,0.,-99.9
      P2=-590.34,-105.,-99.9
      P3=-504.,-105.,-90.
      PROP=0.,0.
      COM=* -Y 2ND RECT(TWRD-X) NOMEX WING *
      ICSN=21
S     SURF=140,TYPE=TRAP,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-504.,-105.,-90.
      P4=-504.,-105.,-90.
      P2=-504.,-319.,-90.
      P3=-287.,-105.,-68.16
      PROP=0.,0.
      ICSN=21
      COM= * -Y TRI ABOVE SURF 132  NOMEX  WING *
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S       SURF=147,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
        P1=-287.,-105.,-68.16
        P4=-504.,-319.,-90.
        P3=-504.,-342.,-90.
        P2=-239.5,-105.,-64.03
        PROP=0.,0.
        ICSN=21
        COM=* -Y        INSERT IN WING  TILE WING *
S       SURF=151,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
        P1=-239.5,-105.,-64.03
        P4=-504.,-342.5,-90.
        P3=-504.,-366.,-90.
        P2=-224.,-105.,-58.
        PROP=0.,0.
        ICSN=21
        COM=* -Y      OUTER  WING STRIP  CARBON  WING *
S       SURF=142,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        P1=-504.00,-105.,-90.
        P2=-590.34,-105.,-99.9
        P3=-590.34,-328.,-99.9
        ICSN=21
        PROP=0.,0.
        COM=* -Y LONG BACK  RECT  NOMEX  WING *
S       SURF=149,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        P1=-504.,-328.,-90.
        P2=-590.34,-328.,-99.9
        P3=-590.34,-366.,-99.9
        PROP=0.,0.
        ICSN=21
        COM=* -Y  SHORT BACK RECT ON TOPE OF 142  TILE WING *
S       SURF=145,TYPE=TRAP,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        P1=263.9,0.,-78.7
        P4=263.9,0.,-78.7
        P2=-103.,0.,-62.1
        P3=-224.,-105.,-58.
        PROP=0.,0.
        ICSN=21
        COM=* -Y FORWARD  TRIANGLE      TILE  WING *
C
BCS     ELEVON
S       SURF=106,TYPE=RECT,ACTIVE=BOTTOM,BSHADE=BOTH,SHADE=BOTH
        P1=-644.,6.,-106.56
        P2=-644.,105.,-106.56
        P3=-590.34,105.,-99.9
        PROP=0.,0.
        ICSN=20
        COM=* +Y 3RD RECT(INNER ALERION) NOMEX WING *
S       SURF=107,TYPE=RECT,ACTIVE=TOP,BSHADE=BOTH,SHADE=BOTH
        P1=-644.,105.,-106.56
        P2=-590.,105.,-99.9
        P3=-590.34,366.,-99.9
        PROP=0.,0.
        ICSN=20
        COM=* +Y 3RD RECT(OUTER ALERION) NOMEX WING *
S       SURF=450,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
        P3=-707.,6.,-116.9
        P1=-644.,366.,-106.56
        P2=-644.,6.,-106.56
        PROP=0.,0.,NNY=10
        ICSN=20
        COM=* +Y WING TAIL  EDGE NOMEX  WING *
S       SURF=136,TYPE=RECT,ACTIVE=TOP,BSHADE=BOTH,SHADE=BOTH
        P1=-644.,-6.,-106.56
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      P2=-644.,-105.,-106.56
      P3=-590.34,-105.,-99.9
      PROP=0.,0.
      ICSN=21
      COM=* -Y 3RD RECT(INNER ALERION) NOMEX WING *
S     SURF=137,TYPE=RECT,ACTIVE=BOTTOM,BSHADE=BOTH,SHADE=BOTH
      P1=-644.,-105.,-106.56
      P2=-590.,-105.,-99.9
      P3=-590.,-366.,-99.9
      PROP=0.,0.
      ICSN=21
      COM=* -Y 3RD RECT(OUTER ALERION) NOMEX WING *
S     SURF=460,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P3=-707.,-6.,-116.0
      P1=-644.,-366.,-106.56
      P2=-644.,-6.,-106.56
      PROP=0.,0.,NNY=10
      ICSN=21
BCS   OMS
S     SURF=60,TYPE=DISC,ACTIVE=OUT,SHADE=BOTH,BSHADE=BOTH
        DIMENSIONS=0.0,0.0,.25.,125.,335.
      PROP=0.,0.
      ICSN=11
      COM = * ...-Y OWS SEALER ...*
S       SURF=62,TYPE=PARAB,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
        DIMENSIONS=22.5,7.,40.,25.,238.
        POSITION=-500.,-78.14,65.56
         ROTX=180.,ROTY=-90.,ROTZ=0.
        PROP=0.,0.
        ICS=25
        COM=* 1ST PARAB -Y OMS *
S       SURF=64,TYPE=CYLINDER,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
        DIMENSIONS=60.,40.,210.,25.,238.
        POSITION=-500.,-78.14,65.56
        ROTX=180.,ROTY=-90.,ROTZ=0.
        PROP=0.,0.
        COM=* OMS END CYLINDER RADIUS=65.*
        ICS=25
S       SURF=66,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        P1=-710.,-140.,40.
        P2=-710.,-50.,130.
        P3=-710.,-23.75,112.
        P4=-710.,-120.,17.5
        PROP=0.,0.
        COM=*TRAP BOTTOM OMS END SEALER -Y    *
        ICSN=25
S       SURF=68,TYPE=DISC,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
        P1=-710.,-111.88,67.5
        P2=-710.,-141.25,95.
        P3=-710.,-150.625,58.75
        P4=-710.,-140.,40.
        PROP=0.,0.
        COM=*1ST TRIANGLE LT SIDE LOOKING BACK  -Y    *
        ICSN=25
S       SURF=70,TYPE=DISC,ACTIVE=BOTTOM,BSHADE=BOTH,SHADE=BOTH
        P1=-710.,-82.5,71.25
        P2=-710.,-13.75,68.75
        P3=-710.,-50.,131.25
        P4=-710.,-78.75,138.13
        PROP=0.,0.
        COM=*LAST TRI RT SIDE -Y OMS *
        ICS=25
S       SURF=72,TYPE=DISC,ACTIVE=BOTTOM,BSHADE=BOTH,SHADE=BOTH
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      P1=-710.,-96.88,68.75
      P2=-710.,-135.,27.
      P3=-710.,-150.,56.88
      P4=-710.,-137.5,105.
      PROP=0.,0.
      ICSN=25
      COM=*2ND TRI LEFT SIDE*
S     SURF=74,TYPE=DISC,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-710.,-81.25,84.38
      P2=-710.,-43.13,124.375
      P3=-710.,-76.875,138.75
      P4=-710.,-120.625,121.875
      PROP=0.,0.
      ICSN=25
      COM=*3RD TRI MIDDLE RT SIDE -Y OMS    *
S     SURF=76,TYPE=POLY,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-710.,-96.88,68.75
      P2=-710.,-140.0,105.
      P3=-710.,-120.625,121.875
      P4=-710.,-81.25,84.38
      PROP=0.,0.
      ICSN=25
      COM=*TOP INSIDE TRAP -Y OMS     *
S     SURF=80,TYPE=DISC,ACTIVE=OUT,SHADE=BOTH,BSHADE=BOTH
        DIMENSIONS=0.0,0.0,25.,25.,235.
      PROP=0.,0.
      ICSN=12
      COM= * ..+Y OWS SEALER ...*
S       SURF=82,TYPE=PARAB,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
        DIMENSIONS=22.5,7.,40.,-56.,156.
        PROP=0.,0.
        POSITION=-500.,78.14,65.56
        ROTX=0.,ROTY=-90.,ROTZ=0.
        ICS=25
        COM=* 1ST PARAB +Y OMS*
S       SURF=84,TYPE=CYLINDER,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
        DIMENSIONS=60.,40.,210.,-56.,156.
        POSITION=-500.,78.14,35.56
        ROTX=0.,ROTY=-90.,ROTZ=0.
        PROP=0.,0.
        ICS=25
        COM=* +Y OMS END CYLINDER *
S       SURF=86,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
        P1=-710.,140.,40.
        P2=-710.,50.,130.
        P3=-710.,23.75,112.
        P4=-710.,120.,17.5
        PROP=0.,0.
        COM=*TRAP BOTTOM OMS END SEALER *
        ICSN=25
S       SURF=88,TYPE=DISC,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        P1=-710.,111.88,67.5
        P2=-710.,141.25,95.
        P3=-710.,150.625,58.75
        P4=-710.,140.,40.
        PROP=0.,0.
        COM=*1ST TRIANGLE LT SIDE LOOKING BACK +Y OMS *
        ICSN=25
S       SURF=90,TYPE=DISC,ACTIVE=TOP,BSHADE=BOTH,SHADE=BOTH
        P1=-710.,82.5,71.25
        P2=-710.,13.75,68.75
        P3=-710.,50.,131.25
        P4=-710.,78.75,138.13
```

```
          PROP=0.,0.
          COM=*LAST TRI RT SIDE +Y OMS    *
          ICS=25
S         SURF=92,TYPE=DISC,ACTIVE=TOP,BSHADE=BOTH,SHADE=BOTH
          P1=-710.,96.88,68.75
          P2=-710.,135.,27.
          P3=-710.,150.,56.88
          P4=-710.,137.5,105.
          PROP=0.,0.
          ICSN=25
          COM=*2ND TRI LEFT SIDE +Y OMS    *
S         SURF=94,TYPE=DISC,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
          P1=-710.,81.25,84.38
          P2=-710.,43.13,124.375
          P3=-710.,76.875,138.75
          P4=-710.,120.625,121.875
          PROP=0.,0.
          ICSN=25
          COM=*3RD TRI MIDDLE RT SIDE +Y OMS    *
S         SURF=96,TYPE=POLY,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
          P1=-710.,96.88,68.75
          P2=-710.,140.0,105.
          P3=-710.,120.625,121.875
          P4=-710.,81.25,84.38
          PROP=0.,0.
          ICSN=25
          COM=*TOP INSIDE TRAP *
BCS       ENDF
S         SURFN=736,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
          P1=467.0,60.5,-46.5
          P2=470.0,60.5,-46.5
          P3=467.0,62.62,-44.38
          P4=467.0,62.62,-44.38
          PROP=0.,0.
          COM=*...FRONT RCS..LOOKING +/-Y AT 45 DEG. (116) 2/26/76*
S         SURFN=739,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
          P1=467.0,-60.5,-46.5
          P2=470.0,-60.5,-46.5
          P3=467.0,-62.62,-44.38
          P4=467.0,-62.62,-44.38
          PROP=0.,0.
          COM=*...FRONT RCS..LOOKING +/-Y(-YSIDE) 45 DEG. (136)*
S         SURFN=740,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
          P1=450.0,0.,12.
          P2=450.0,3.,12.
          P3=453.0,0.,12.
          P4=453.0,0.,12.
          PROP=0.,0.
          COM=*...FRONT RCS..LOOKING +/-Z ...(125)    *
S         SURFN=742,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
          P1=468.,0.,6.
          P2=469.,0.,3.
          P3=468.,3.,6.
          P4=468.,3.,6.
          PROP=0.,0.
          COM=*...FRONT RCS..LOOKING +/-X ...(122) *
S         SURFN=744,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
          P1=440.,47.,-20.
          P2=437.,47.,-20.
          P3=440.,47.,-17.
          P4=440.,47.,-17.
          PROP=0.,0.
          COM=*...FRONT RCS..LOOKING +/-Y .+Y SIDE*
```

```
S       SURFN=746,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
        P1=440.,-47.,-20.
        P2=437.,-47.,-20.
        P3=440.,-47.,-17.
        P4=440.,-47.,-17.
        PROP=0.,0.
        COM=*...FRONT RCS..LOOKING +/-Y .-Y SIDE*
BCS     ENCR
S       SURF=710,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
            DIMENSIONS=0.,0.,3.,0.,360.
            PROP=0.,0.
            ICSN=26
            COM=* -Z 1ST RCS X=1519.75 *
S       SURF=712,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
            DIMENSIONS=0.,0.,3.,0.,360.
            ICSN=27
            PROP=0.,0.
            COM=* -Z 2ND RCS X=1532.875 *
S       SURF=714,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
            DIMENSIONS=0.,0.,3.,0.,360.
            ICSN=28
            PROP=0.,0.
            COM=* -Z 3RD RCS X=1545.375 *
S       SURF=720,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
            P1=-716.,148.75,59.000
            P2=-716.,148.75,62.000
            P3=-719.,148.75,59.000
            P4=-719.,148.75,59.000
            PROP=0.,0.
            COM=* +Y 1ST RCS X=1516. *
S       SURF=722,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
            P1=-729.,148.75,59.000
            P2=-729.,148.75,62.000
            P3=-732.,148.75,59.000
            P4=-732.,148.75,59.000
            PROP=0.,0.
            COM=* +Y 2ND RCS X=1529. *
S       SURF=724,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
            P1=-742.,148.75,59.000
            P2=-742.,148.75,62.000
            P3=-745.,148.75,59.000
            P4=-745.,148.75,59.000
            PROP=0.,0.
            COM=* +Y 3RD RCS X=1545. *
S       SURF=726,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
            P1=-755.,148.75,59.000
            P2=-755.,148.75,62.000
            P3=-758.,148.75,59.000
            P4=-758.,148.75,59.000
            PROP=0.,0.
            COM=* +Y 4TH RCS X=1555. *
S       SURF=730,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
            P1=-716.,132.50,96.5
            P2=-716.,135.50,96.5
            P3=-719.,132.50,96.5
            P4=-719.,132.50,96.5
            PROP=0.,0.
            COM=* +Z 1ST RCS X=1516. *
S       SURF=732,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
            P1=-729.,132.50,96.5
            P2=-729.,135.50,96.5
            P3=-732.,132.50,96.5
            P4=-732.,132.50,96.5
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      PROP=0.,0.
      COM=* +Z 2ND RCS X=1529. *
S     SURF=734,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
      P1=-742.,132.50,96.5
      P2=-742.,135.50,96.5
      P3=-745.,132.50,96.5
      P4=-745.,132.50,96.5
      PROP=0.,0.
      COM=* +Z 3RD RCS X=1542. *
S     SURF=748,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
      DIMENSIONS=0.,0.,3.,0.,360.
      ICSN=35
      PROP=0.,0.
      COM=* -Z 2ND RCS X=1532.875( -Y SIDE)*
S     SURF=750,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
      P1=-729.,-148.75,59.000
      P2=-729.,-148.75,62.000
      P3=-732.,-148.75,59.000
      P4=-732.,-148.75,59.000
      PROP=0.,0.
      COM=* -Y 2ND RCS X=1529. *
S     SURF=752,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
      P1=-729.,-132.50,96.5
      P2=-729.,-135.50,96.5
      P3=-732.,-132.50,96.5
      P4=-732.,-132.50,96.5
      PROP=0.,0.
      COM=* +Z(-Y SIDE)2ND RCS X=1529. *
S     SURF=800,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
      P1=-765.,149.37,59.
      P2=-765.,149.37,62.
      P3=-768.,149.37,59.
      P4=-768.,149.37,59.
      PROP=0.,0.
      ICSN=25
      COM=*REAR  Y VCS (Y WAS 134. ALL REST SAME)*
S     SURF=805,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
      P1=-765.,118.,51.
      P2=-765.,115.,51.
      P3=-768.,118.,51.
      P4=-768.,118.,51.
      PROP=0.,0.
      ICSN=25
      COM=*REAR Z VCS (Z WAS 57. ALL REST THE SAME)*
S     SURF=810,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
      P1=-765.,-149.37,59.
      P2=-765.,-149.37,62.
      P3=-768.,-149.37,59.
      P4=-768.,-149.37,59.
      PROP=0.,0.
      ICSN=25
      COM=*REAR -Y VCS (Y WAS 134. ALL REST SAME)*
S     SURF=815,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH
      P1=-765.,-118.,51.
      P2=-765.,-115.,51.
      P3=-768.,-118.,51.
      P4=-768.,-118.,51.
      ICSN=25
      PROP=0.,0.
      COM=*REAR Z VCS(-Y SIDE,Z WAS 57. ALL REST THE SAME)*
S     SURFN=855,TYPE=DISC,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      P1=-701.,103.,-95.
      P2=-701.,103.,-98.
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      P3=-704.,103.,-95.
      P4=-704.,103.,-95.
      PROP=0.,0.
      COM=*...650S UP= LUSERTS EVAPORATOR  +Y SONIC 2/22/76*
S     SURFN=856,TYPE=DISC,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
      P1=-706.,-103.,-95.
      P2=-706 ,-103.,-98.
      P3=-709.,-103.,-95.
      P4=-709.,-103.,-95.
      PROP=0.,0.
      COM=*...650S UP= LUSERTS EVAPORATOR  -Y SONIC 2/22/76*
S      SURF=866,TYPE=DISC,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE= BOTH
       P1=-592.0,-113.,-77.
       P2=-592.0,-113.,-80.
       P3=-595.0,-113.,-77.
       P4=-595.0,-113.,-77.
       PROP=0.,0.
       COM=*  BACK SIDE EVAPORAT, (-Y SIDE EVAP=1392)*
S      SURF=868,TYPE=DISC,ACTIVE=TOP,SHADE=BOTH,BSHADE= BOTH
       P1=-592.0,113.,-77.
       P2=-592.0,113.,-80.
       P3=-595.0,113.,-77.
       P4=-595.0,113.,-77.
       PROP=0.,0.
       COM=*  BACK SIDE EVAPORAT, (+Y SIDE EVAP=1392)*
S     SURFN=900,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
      DIMENSIONS=0.,0.,22.5,0.,360.
      ICSN=16,PROP=0.,0.
      COM=*.......SUPER ENGINS (OMS LOCATION)..+Y..*
S     SURFN=902,TYPE=DISC,ACTIVE=BOTH,BSHADE=BOTH,SHADE=BOTH
      DIMENSIONS=0.,0.,22.5,0.,360.
      ICSN=17,PROP=0.,0.
      COM=*.......SUPER ENGINS (OMS LOCATION)..-Y..*
BCS     ENDS
S     SURF=910,TYPE=PARAB,ACTIVE=OUT,SHADE=BOTH,BSHADE=BOTH
      DIMENSIONS=4.4,0.0,100.,0.,360.
      ICSN=13
      PROP=0.,0.
      NNX=2,NNY=2
      COM=* TOP  ENGIN *
S     SURF=915,TYPE=PARAB,ACTIVE= OUT,SHADE=BOTH,BSHADE=BOTH
      DIMENSIONS=4.4,0.0,100.,0.,360.
      ICSN=14,TY=+50.
         PROP=0.,0.
      NNX=2,NNY=2
      COM = * + Y ENGIN *
S     SURF=920,TYPE=PARAB,ACTIVE=OUT,SHADE=BOTH,BSHADE=BOTH
      DIMENSIONS=4.4,0.0,100.,0.,360.
      ICSN = 14, TY =-50.
         PROP=0.,0.
      NNX=2,NNY=2
      COM = * -Y ENGIN...*
```

LINE-OF-SIGHT TRASYS INPUT LISTING
(Typical One of Seventeen Parallel
to +Z Axis.)

```
BCS       LOS10N     $POINTS-NEAR FOR PLOT BREAK DOWN                    001710
D      39.37 $ MX39.37=IN, ORGIN(BCS)=X(1107),Y(0),Z(102).              001720
S        SURF=10000,TYPE=POINT                                          001730
       P1=0.,0.,0.                                                      001740
       POSIT=0.,0.,0.                                                   001750
       COM=* POINT 10000  *                                             001760
S        SURF=10005,TYPE=POINT                                          001770
       P1=0.,0.,0.                                                      001780
       POSIT=0.,0.,5.                                                   001790
       COM=* POINT 10005  *                                             001800
S        SURF=10010,TYPE=POINT                                          001810
       P1=0.,0.,0.                                                      001820
       POSIT=0.,0.,10.                                                  001830
       COM=* POINT 10010  *                                             001840
S        SURF=10015,TYPE=POINT                                          001850
       P1=0.,0.,0.                                                      001860
       POSIT=0.,0.,15.                                                  001870
       COM=*  POINT 10015  *                                            001880
S        SURF=10020,TYPE=POINT                                          001890
       P1=0.,0.,0.                                                      001900
       POSIT=0.,0.,20.                                                  001910
       COM=* POINT 10020  *                                             001920
S        SURF=10025,TYPE=POINT                                          001930
       P1=0.,0.,0.                                                      001940
       POSIT=0.,0.,25.                                                  001950
       COM=*  POINT 10025  *                                            001960
S        SURF=10030,TYPE=POINT                                          001970
       P1=0.,0.,0.                                                      001980
       POSIT=0.,0.,30.                                                  001990
       COM=* POINT 10030  *                                             002000
BCS       LOS10F  $POINTS-FAR PLOT BREAK DOWN                           002010
S        SURF=10035,TYPE=POINT                                          002020
       P1=0.,0.,0.                                                      002030
       POSIT=0.,0.,35.                                                  002040
       COM=*  POINT 10035  *                                            002050
S        SURF=10040,TYPE=POINT                                          002060
       P1=0.,0.,0.                                                      002070
       POSIT=0.,0.,40.                                                  002080
       COM=*  POINT 10040  *                                            002090
S        SURF=10045,TYPE=POINT                                          002100
       P1=0.,0.,0.                                                      002110
       POSIT=0.,0.,45.                                                  002120
       COM=* POINT 10045  *                                             002130
S        SURF=10050,TYPE=POINT                                          002140
       P1=0.,0.,0.                                                      002150
       POSIT=0.,0.,50.                                                  002160
       COM=*  POINT 10050  *                                            002170
S        SURF=10075,TYPE=POINT                                          002180
       P1=0.,0.,0.                                                      002190
       POSIT=0.,0.,75.                                                  002200
       COM=* POINT 10075  *                                             002210
S        SURF=10100,TYPE=POINT                                          002220
       P1=0.,0.,0.                                                      002230
       POSIT=0.,0.,100.                                                 002240
       COM=*  POINT 10100  *                                            002250
S        SURF=10150,TYPE=POINT                                          002260
       P1=0.,0.,0.                                                      002270
       POSIT=0.,0.,150.                                                 002280
       COM=* POINT 10150  *                                             002290
S        SURF=10200,TYPE=POINT                                          002300
       P1=0.,0.,0.                                                      002310
       POSIT=0.,0.,200.                                                 002320
       COM=*  POINT 10200  *                                            002330
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S       SURF=10300,TYPE=POINT
      P1=0.,0.,0.
      POSIT=0.,0.,300.
      COM=*   POINT 10300   *
```

Table B-II. Spacelab LMOP Geometry Breakdown

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
MODULE	TUNNEL 1 TOP	CYLINDER	1000	4	1000, 1001, 1002, 1003
	TUNNEL 1 BOTTOM	CYLINDER	1005	1	1005
	TUNNEL 2 TOP	CYLINDER	1010	4	1010, 1011, 1012, 1013
	TUNNEL 2 BOTTOM	CYLINDER	1015	1	1015
	FORWARD CONE TOP	CONE	1020	4	1020, 1021, 1022, 1023
	FORWARD CONE BOTTOM	CONE	1025	1	1025
	ECS CONDENSATE VENT	DISK	1200	2	1200, 1201
	CORE SEGMENT TOP	CYLINDER	1030	4	1030, 1031, 1032, 1033
	CORE SEGMENT BOTTOM	CYLINDER	1035	1	1035
	EXPERIMENT SEGMENT TOP	CYLINDER	1040	4	1040, 1041, 1042, 1043
	EXPERIMENT SEGMENT BOTTOM	CYLINDER	1045	1	1045
	AFT CONE TAPER BOTTOM	CONE	1055	1	1055

Table B-II. Spacelab LMOP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
MODULE	AFT AIRLOCK	CYLINDER	1060	2	1060, 1061
	AFT AIRLOCK DISK	DISK	1065	1	1065
	CORE SEGMENT WINDOW	DISK	1110	2	1110, 1111
	EXPERIMENT SEGMENT WINDOW	DISK	1120	2	1120, 1121
	AFT VIEWING WINDOW	DISK	1130	2	1130, 1131
MODULE:	TOTAL SURFACES = 17		TOTAL NODES = 37		
PALLET	PALLET BOTTOM CYLINDER	CYLINDER	1070	1	1070
	-Y PALLET OUTSIDE STRIP	RECTANGLE	1080	1	1080
	+Y PALLET OUTSIDE STRIP	RECTANGLE	1081	1	1081
	-Y PALLET TOP STRIP	RECTANGLE	1082	1	1082
	+Y PALLET TOP STRIP	RECTANGLE	1083	1	1083
	INSIDE TOP PALLET (-Y)	RECTANGLE	1084	1	1084

Table B-II. Spacelab LMOP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
PALLET	INSIDE TOP PALLET (+Y)	RECTANGLE	1085	1	1085
	INSIDE BOTTOM PALLET (-Y)	RECTANGLE	1086	1	1086
	INSIDE BOTTOM PALLET (+Y)	RECTANGLE	1087	1	1087
	PALLET BOTTOM	RECTANGLE	1088	1	1088
PALLET:	TOTAL SURFACES = 10		TOTAL NODES = 10		
BAY	BAY AREA CYLINDER	CYLINDER	1401	8	1401, 1402, 1403, 1404, 1405, 1406, 1407, 1408
	INSIDE LINER STRIP (-Y)	RECTANGLE	1440	4	1440, 1441, 1442, 1443
	INSIDE LINER STRIP (+Y)	RECTANGLE	1445	4	1445, 1446, 1447, 1448
	FRONT BAY AREA DISK	DISK	1413	1	1413
	END BAY AREA DISK	DISK	1411	1	1411
BAY:	TOTAL SURFACES = 5		TOTAL NODES = 18		

SPACELAB LMOP TRASYS INPUT LISTING

```
BCS     LMOP                                                                    000100
D       1. $REVERT M-IN FACTOR                                                  000110
S       SURF=1000,TYPE=CYL,ACTIVE=OUT,BSHADE=BOTH, SHADE=BOTH                   000120
           ICSN=50                                                              000130
        P1=582.,0.,366.                                                         000140
        P2=582.,-31.5,366.                                                      000150
        P3=582.,31.5,366.                                                       000160
        P4=672.4,31.5,400.                                                      000170
        PROP=0.,0.                                                              000180
        NNX=4                                                                   000190
        COM=* TUNNEL 1, X=582 TO 672.4, SPACELAB1 *                             000200
S       SURF=1005,TYPE=CYL,ACTIVE=OUT,BSHADE=BOTH, SHADE=BOTH                   000210
           ICSN=50                                                              000220
        P1=582.,0.,366.                                                         000230
        P2=582.,31.5,366.                                                       000240
        P3=582.,-31.5,366.                                                      000250
        P4=672.4,-31.5,400.                                                     000260
        PROP=0.,0.                                                              000270
        COM=* TUNNEL 1,BOTTOM,X=582 TO 672.4, SPACELAB1 *                       000280
S       SURF=1010,TYPE=CYL,ACTIVE=OUT,BSHADE=BOTH,SHADE=BOTH                    000290
           ICSN=50                                                              000300
        P1=672.4,0.,400.                                                        000310
        P2=672.4,-31.5,400.                                                     000320
        P3=672.4,31.5,400.                                                      000330
        P4=790.4,31.5,400.                                                      000340
        PROP=0.,0.                                                              000350
        NNX=4                                                                   000360
        COM=* TUNNEL 2, X=672.4 TO 790.4, SPACELAB1 ,SEG 1     *                000370
S       SURF=1015,TYPE=CYL,ACTIVE=OUT,BSHADE=BOTH,SHADE=BOTH                    000380
           ICSN=50                                                              000390
        P1=672.4,0.,400.                                                        000400
        P2=672.4,31.5,400.                                                      000410
        P3=672.4,-31.5,400.                                                     000420
        P4=790.4,-31.5,400.                                                     000430
        PROP=0.,0.                                                              000440
        COM=* TUNNEL 2,BOTTOM, X=672.4 TO 790.4, SPACELAB1 ,SEG 1     *         000450
S       SURF=1020,TYPE=CONE,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH               000460
           ICSN=50                                                              000470
        P1=816.1,0.,400.                                                        000480
        P2=816.1,79.9,400.                                                      000490
        P3=816.1,-79.9,400.                                                     000500
        P4=773.68,0.,400.                                                       000510
        P5=790.4,-31.5,400.                                                     000520
        PROP=0.,0.,NNX=4                                                        000530
S       SURF=1025,TYPE=CONE,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH               000540
           ICSN=50                                                              000550
        P1=816.1,0.,400.                                                        000560
        P2=816.1,-79.9,400.                                                     000570
        P3=816.1,79.9,400.                                                      000580
        P4=773.68,0.,400.                                                       000590
        P5=790.4,31.5,400.                                                      000600
        PROP=0.,0.                                                              000610
        COM=*FWD CONE,BOTTOM X=790.4 TO 816.1, SPACELAB 1  *                    000620
S       SURF=1200,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH                  000630
           ICSN=50                                                              000640
        P1=802.1,0.,456.94                                                      000650
        P2=802.10,3.0,456.94                                                    000660
        P3=804.74,0.00,458.34                                                   000670
        P4=804.74,0.,458.34                                                     000680
        PROP=0.,0.                                                              000690
        COM=*ECS CONDENSATE VENT  802.1, SPACELAB 1  *                          000700
S       SURF=1030,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH                000710
           ICSN=50                                                              000720
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      P1=816.1,0.,400.                                                  000730
      P2=816.1,-79.9,400.                                               000740
      P3=816.1,79.9,400.                                                000750
      P4=922.,79.9,400.                                                 000760
      PROP=0.,0.,NNX=4                                                  000770
      COM=*      CORE  SEGMENT   X=816.1 TO 922. , SPACELAB 1*          000780
S     SURF=1035,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH          000790
        ICSN=50                                                         000800
      P1=816.1,0.,400.                                                  000810
      P2=816.1,79.9,400.                                                000820
      P3=816.1,-79.9,400.                                               000830
      P4=922.,-79.9,400.                                                000840
      PROP=0.,0.                                                        000850
      COM=*      CORE  SEGMENT,BOTTOM  X=816.1 TO 922. , SPACELAB 1*    000860
S     SURF=1040,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH          000870
        ICSN=50                                                         000880
      P1=922.,0.,400.                                                   000890
      P2=922.,-79.9,400.                                                000900
      P3=922.,79.9,400.                                                 000910
      P4=1027.9,79.9,400.                                               000920
      PROP=0.,0.,NNX=4                                                  000930
      COM= *     EXPERIMENT SEGMENT  X=922 TO 1027.9, SPACELAB1*        000940
S     SURF=1045,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH          000950
        ICSN=50                                                         000960
      P1=922.,0.,400.                                                   000970
      P2=922.,79.9,400.                                                 000980
      P3=922.,-79.9,400.                                                000990
      P4=1027.9,-79.9,400.                                              001000
      PROP=0.,0.                                                        001010
      COM= * EXPERIMENT SEGMENT BOTTOM, X=922 TO 1027.9, SPACELAB1*     001020
S     SURF=1050,TYPE=CONE,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH         001030
        ICSN=50                                                         001040
      P1=1027.9,0.,400.                                                 001050
      P2=1027.9,-79.9,400.                                              001060
      P3=1027.9,79.9,400.                                               001070
      P4=1078.07,0.,400.                                                001080
      P5=1059.3,25.6,400.                                               001090
      PROP=0.,0.,NNX=4                                                  001100
      COM=*  AFT CONE TAPER, X=1027.9 TO 1059.3 SPACELAB1*              001110
S     SURF=1055,TYPE=CONE,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH         001120
        ICSN=50                                                         001130
      P1=1027.9,0.,400.                                                 001140
      P2=1027.9,79.9,400.                                               001150
      P3=1027.9,-79.9,400.                                              001160
      P4=1078.07,0.,400.                                                001170
      P5=1059.3,-25.6,400.                                              001180
      PROP=0.,0.                                                        001190
      COM=*  AFT CONE TAPER BOTTOM, X=1027.9 TO 1059.3 SPACELAB1*       001200
S     SURF=1060,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH          001210
        ICSN=50                                                         001220
      P1=1059.3,0.,400.                                                 001230
      P2=1059.3,25.6,400.                                               001240
      P3=1059.3,25.6,400.                                               001250
      P4=1088.8,25.6,400.0                                              001260
      PROP=0.,0.,NNX=2                                                  001270
      COM=*  AFT AIRLOCK, X=1059.3 TO 1088.8, SPACELAB1*                001280
S     SURF=1065,TYPE=DISC,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH             001290
        ICSN=50                                                         001300
      P1=1088.8,0.,400.                                                 001310
      P2=1088.8,25.6,400.                                               001320
      P3=1088.8,00.0,425.6                                              001330
      P4=1088.8,00.0,425.6                                              001340
      PROP=0.,0.                                                        001350
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      COM=*  AFT AIRLOCK DISC X= 1088.8, SPACELAB1*                      001360
S     SURF=1070,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH           001370
        ICSN=50                                                          001380
      P1=1101.2,0.,400.                                                  001390
      P2=1101.2,78.8,400.                                                001400
      P3=1101.2,-78.8,400.                                               001410
      P4=1215.2,-78.8,400.                                               001420
      PROP=0.,0.                                                         001430
      COM = * PALLET BOTTOM CYLINDER X= 1101.2 TO 1215.2 *               001440
S     SURF=1080,TYPE=RECT,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH          001450
        ICSN=50                                                          001460
      P1=1101.2,-78.8,400.                                               001470
      P2=1215.2,-78.8,400.                                               001480
      P3=1215.2,-78.8,414.                                               001490
      PROP= 0.,0.                                                        001500
      COM=  * -Y PALLET OUTSIDE STRIP *                                  001510
S     SURF=1081,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH              001520
        ICSN=50                                                          001530
      P1=1215.2,78.8,414.                                                001540
      P2=1215.2,78.8,400.                                                001550
      P3=1101.2,78.8,400.                                                001560
      PROP= 0.,0.                                                        001570
      COM=*  +Y PALLET OUTSIDE STRIP *                                   001580
S     SURF=1082,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH              001590
        ICSN=50                                                          001600
      P1=1101.2,-78.8,414.                                               001610
      P2=1215.2,-78.8,414.                                               001620
      P3=1215.2,-72.8,414.                                               001630
      PROP=0.,0.                                                         001640
      COM=*-Y PALLET TOP STRIP X=1101.2 TO 1215.2 *                      001650
S     SURF=1083,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH              001660
        ICSN=50                                                          001670
      P1=1101.2,72.8,414.                                                001680
      P2=1215.2,72.8, 414.                                               001690
      P3=1215.2,78.8,414.                                                001700
      PROP=0.,0.                                                         001710
      COM= * +Y PALLET TOP STRIP ,X= 1101.2 TO 1215.2 *                  001720
S     SURF=1084,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH              001730
        ICSN=50                                                          001740
      P1=1101.2,-72.8,414.                                               001750
      P2=1215.2,-72.8,414.                                               001760
      P3=1215.2,-58.5,371.                                               001770
      PROP=0.,0.                                                         001780
      COM = * -Y INSIDE TOP PANNEL,X=1101.2 TO 1215.2 *                  001790
S     SURF=1085,TYPE = RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH            001800
        ICSN=50                                                          001810
      P1=1215.2,58.5,371.                                                001820
      P2=1215.2,72.8,414.                                                001830
      P3=1101.2,72.8,414.                                                001840
      PROP=0.,0.                                                         001850
      COM= * +Y INSIDE TOP PANNEL,X=1101.2 TO 1215.2 *                   001860
S     SURF=1086, TYPE= RECT, ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH           001870
        ICSN=50                                                          001880
      P1=1101.2,-58.5,371.                                               001890
      P2=1215.2,-58.5,371.                                               001900
      P3=1215.2,-34.5,344.3                                              001910
      PROP=0.,0.                                                         001920
      COM=* -Y INSIDE BOTTOM PANNEL, X=1101.2 TO 1215.2 *                001930
S     SURF=1087,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH              001940
        ICSN=50                                                          001950
      P1=1101.2,34.5,344.3                                               001960
      P2=1215.2,34.5,344.3                                               001970
      P3=1215.2,58.5,371.                                                001980
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      PROP=0.,0.                                                          001990
      COM=* +Y INSIDE BOTTOM PANNEL,X 1101.2 TO 1215.2 *                  002000
S     SURF=1088 , TYPE= RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH           002010
        ICSN=50                                                           002020
      P1=1101.2,-34.5,344.3                                               002030
      P2=1215.2,-34.5,344.3                                               002040
      P3=1215.2,34.5,344.3                                                002050
      PROP= 0.,0.                                                         002060
      COM = * PALLET BOTTOM,X= 1101.2 TO 1215.2 *                         002070
S     SURF=1110,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH              002080
        ICSN=50                                                           002090
      P1=869.,0.,480.9                                                    002100
      P2=869.,19.7,480.9                                                  002110
      P3=849.3,0.,480.9                                                   002120
      P4=849.3,0.,480.9                                                   002130
      PROP=0.,0.                                                          002140
      COM= * CORE SEGMENT WINDOW, X=869. SPACELAB 1 *                     002150
S     SURF=1120,TYPE=DISC, ACTIVE=BOTH,SHADE= BOTH, BSHADE=BOTH           002160
        ICSN=50                                                           002170
      P1=975.,0.,480.9                                                    002180
      P2=975.,25.6,480.9                                                  002190
      P3=949.4,0.,480.9                                                   002200
      P4=949.4,0.,480.9                                                   002210
      PROP=0.,0.                                                          002220
      COM=*   EXPERIMENT SEGIMENT WINDOW,X=975. SPACELAB 1*               002230
S     SURF=1130,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH              002240
        ICSN=50                                                           002250
      P1=1043.6,0.,454.49                                                 002260
      P2=1039.43,0.,462.23                                                002270
      P3=1043.6,7.85,454.49                                               002280
      P4=1043.6,7.85,454.49                                               002290
      PROP=0.,0.                                                          002300
      COM=* AFT VIEWING WINDOW X=1043.6, SPACELAB1*                       002310
BCS       BAY                                                             002320
D       1.   $REVERT M-IN CONVERSION                                      002330
S       SURFN=1401,SHADE=BOTH,BSHADE=BOTH,ALPHA=0.,EMISS=0.               002340
        TRANS=-0.    ,TRANI=-0.    ,COM=*BAY AREA CYLINDER          *    002350
        TYPE=CYLINDER  ,ACTIVE=INSIDE ,ALPH= 93.5                         002360
        BMIN= 0.          ,BMAX= 7.25000E+02,GMIN= 0.                     002370
        GMAX= 1.80000E+02,NNX=     2,NNY=     4,ICSN=    -0              002380
        POSITION=-5.07000E+02, 0.          , 0.                           002390
        ROTZ    =    -0.    , ROTY    =   90.0000, ROTX    =    0.       002400
S       SURF=1440,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH             002410
        P1=218.,93.5,0.                                                   002420
        P2=218.,93.5,19.                                                  002430
        P3=-507.,93.5,19.                                                 002440
        PROP=0.,0.                                                        002450
        NNX=4                                                             002460
        COM=* INSIDE +Y LINER STRIP*                                      002470
S       SURF=1445,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH          002480
        P1=218.,-93.5,0.                                                  002490
        P2=218.,-93.5,19.                                                 002500
        P3=-507.,-93.5,19.                                                002510
        PROP=0.,0.                                                        002520
        NNX=4                                                             002530
        COM=* INSIDE -Y LINER STRIP*                                      002540
S       SURFN=  1413,SHADE=BOTH,BSHADE=BOTH,ALPHA=-0.    ,EMISS=-0.       002550
        TRANS=-0.    ,TRANI=-0.    ,COM=* FRONT BAY AREA DISK         *    002560
        TYPE=DISC       ,ACTIVE=TOP     ,ALPH= 0.                         002570
        BMIN= 0.          ,BMAX= 1.02000E+02,GMIN= 0.                     002580
        GMAX= 3.60000E+02,NNX=     1,NNY=     1,ICSN=    -0              002590
        POSITION= 2.18000E+02, 0.          , 0.                           002600
        ROTZ    =    -0.    , ROTY    =  -90.0000, ROTX    =    0.       002610
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S       SURFN=  1411,SHADE=BOTH,BSHADE=BOTH,ALPHA=-0.    ,EMISS=-0.        002620
        TRANS=-0.    ,TRANI=-0.    ,COM=*  END  BAY AREA DISK          *  002630
        TYPE=DISC       ,ACTIVE=TOP     ,ALPH= 0.                          002640
        BMIN= 0.          ,BMAX= 1.02000E+02,GMIN= 0.                      002650
        GMAX= 3.60000E+02,NNX=     1,NNY=     1,ICSN=    -0                002660
        POSITION=-507.,0.,0.                                               002670
        ROTZ    =   -0.     , ROTY    =   90.0000, ROTX    =    0.         002680
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Table B-III. Spacelab SMTP Geometry Breakdown

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
MODULE	TUNNEL1 TOP	CYLINDER	2010	4	2010, 2011, 2012, 2013
	TUNNEL1 BOTTOM	CYLINDER	2015	1	2015
	FORWARD CONE TOP	CONE	2020	4	2020, 2021, 2022, 2023
	FORWARD CONE BOTTOM	CONE	2025	1	2025
	ECS CONDENSATE VENT	DISK	2200	2	2200, 2201
	CORE SEGMENT TOP	CYLINDER	2030	4	2030, 2031, 2032, 2033
	CORE SEGMENT BOTTOM	CYLINDER	2035	1	2035
	AFT CONE TAPER TOP	CONE	2050	4	2050, 2051, 2052, 2053
	AFT CONE TAPER BOTTOM	CONE	2055	1	2055
	AFT AIRLOCK	CYLINDER	2060	2	2060, 2061
	AFT AIR LOCK DISK	DISK	2065	1	2065
	CORE SEGMENT WINDOW	DISK	2110	2	2110, 2111

Table B-III. Spacelab SMTP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
AFT VIEWING WINDOW	DISK	DISK	2130	2	2130, 2131
MODULE:	TOTAL SURFACES = 13		TOTAL NODES = 29		
PALLET 1	PALLET 1 BOTTOM CYLINDER	CYLINDER	2070	1	2070
	PALLET 1 OUTSIDE STRIP (-Y)	RECTANGLE	2071	1	2071
	PALLET 1 OUTSIDE STRIP (+Y)	RECTANGLE	2072	1	2072
	PALLET 1 TOP STRIP (-Y)	RECTANGLE	2073	1	2073
	PALLET 1 TOP STRIP (+Y)	RECTANGLE	2074	1	2074
	INSIDE TOP PALLET 1 (-Y)	RECTANGLE	2075	1	2075
	INSIDE TOP PALLET 1 (+Y)	RECTANGLE	2076	1	2076
	INSIDE BOTTOM PALLET 1(-Y)	RECTANGLE	2077	1	2077
	INSIDE BOTTOM PALLET 1 (+Y)	RECTANGLE	2078	1	2078
	BOTTOM PANEL	RECTANGLE	2079	1	2079

Table B-III. Spacelab SMTP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
PALLET 1:	TOTAL SURFACES = 10		TOTAL NODES = 10		
PALLET 2	PALLET 2 BOTTOM CYLINDER	CYLINDER	2080	1	2080
	PALLET 2 OUTSIDE STRIP (-Y)	RECTANGLE	2081	1	2081
	PALLET 2 OUTSIDE STRIP (+Y)	RECTANGLE	2082	1	2082
	PALLET 2 TOP STRIP (-Y)	RECTANGLE	2083	1	2083
	PALLET 2 TOP STRIP (+Y)	RECTANGLE	2084	1	2084
	INSIDE TOP PALLET 2 (-Y)	RECTANGLE	2085	1	2085
	INSIDE TOP PALLET 2 (+Y)	RECTANGLE	2086	1	2086
	INSIDE BOTTOM PALLET 2 (-Y)	RECTANGLE	2087	1	2087
	INSIDE BOTTOM PALLET 2 (+Y)	RECTANGLE	2088	1	2088
	PALLET 2 BOTTOM	RECTANGLE	2089	1	2089
PALLET 2:	TOTAL SURFACES = 10	TOTAL NODES = 10			

Table B-III. Spacelab SMTP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
PALLET 3	BOTTOM CYLINDER	CYLINDER	2090	1	2090
	PALLET 3 OUTSIDE STRIP (-Y)	RECTANGLE	2091	1	2091
	PALLET 3 OUTSIDE STRIP (+Y)	RECTANGLE	2092	1	2092
	PALLET 3 TOP STRIP (-Y)	RECTANGLE	2093	1	2093
	PALLET 3 TOP STRIP (+Y)	RECTANGLE	2094	1	2094
	INSIDE TOP PALLET 3 (-Y)	RECTANGLE	2095	1	2095
	INSIDE TOP PALLET 3 (+Y)	RECTANGLE	2096	1	2096
	INSIDE BOTTOM PALLET 3 (-Y)	RECTANGLE	2097	1	2097
	INSIDE BOTTOM PALLET 3 (+Y)	RECTANGLE	2098	1	2098
	PALLET 3 BOTTOM	RECTANGLE	2099	1	2099

PALLET 3: TOTAL SURFACES = 10 TOTAL NODES = 10

Table B-III. Spacelab SMTP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
BAY	BAY AREA CYLINDER	CYLINDER	2401	8	2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408
	INSIDE LINER STRIP (-Y)	RECTANGLE	2440	4	2440, 2441, 2442, 2443
	INSIDE LINER STRIP (+Y)	RECTANGLE	2445	4	2445, 2446, 2447, 2448
	FRONT BAY AREA DISK	DISK	2413	1	2413
	END BAY AREA DISK	DISK	2411	1	2411
BAY:	TOTAL:SURFACES = 5		TOTAL NODES = 18		

SPACELAB SMTP TRASYS INPUT LISTING

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BCS     SMTP                                                              000100
D         1. $REVERT METER INCH CONVERSION                                000110
S       SURF=2010,TYPE=CYL,ACTIVE=OUT,BSHADE=BOTH, SHADE=BOTH             000120
           ICSN=50                                                        000130
        P1=582.,0.,366.                                                   000140
        P2=582.,-31.5,366.                                                000150
        P3=582.,31.5,366.                                                 000160
        P4=668.3,31.5,400.                                                000170
        PROP=0.,0.                                                        000180
        NNX=4                                                             000190
        COM=* TUNNEL 1, X=582 TO 668.3, SPACELAB2  TOP     *              000200
S       SURF=2015,TYPE=CYL,ACTIVE=OUT,BSHADE=BOTH, SHADE=BOTH             000210
           ICSN=50                                                        000220
        P1=582.,0.,366.                                                   000230
        P2=582.,31.5,366.                                                 000240
        P3=582.,-31.5,366.                                                000250
        P4=668.3,-31.5,400.                                               000260
        PROP=0.,0.                                                        000270
        COM=* TUNNEL 1, X=582 TO 668.3, SPACELAB2  BOTTOM *               000280
S       SURF=2020,TYPE=CONE,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH         000290
           ICSN=50                                                        000300
        P1=694.0,0.,400.                                                  000310
        P2=694.0,79.9,400.                                                000320
        P3=694.0,-79.9,400.                                               000330
        P4=651.58,0.,400.                                                 000340
        P5=668.3,-31.5,400.                                               000350
        PROP=0.,0.                                                        000360
        NNX=4                                                             000370
        COM=*FWD CONE, X=668.3 TO 694.0, SPACELAB 2  TOP    *            000380
S       SURF=2025,TYPE=CONE,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH         000390
           ICSN=50                                                        000400
        P1=694.0,0.,400.                                                  000410
        P2=694.0,-79.9,400.                                               000420
        P3=694.0,79.9,400.                                                000430
        P4=651.58,0.,400.                                                 000440
        P5=668.3,31.5,400.                                                000450
        PROP=0.,0.                                                        000460
        COM=*FWD CONE, X=668.3 TO 694.0, SPACELAB 2  BOTTOM*              000470
S       SURF=2200,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH            000480
           ICSN=50                                                        000490
        P1=681.0,0.,456.94                                                000500
        P2=681.0,3.0,456.94                                               000510
        P3=683.64,00.0,458.34                                             000520
        P4=683.64,0.,458.34                                               000530
        PROP=0.,0.                                                        000540
        COM=*ECS,CONDENSATE VENT,X=681, SPACELAB 2  *                     000550
S       SURF=2030,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH          000560
           ICSN=50                                                        000570
        P1=694.0,0.,400.                                                  000580
        P2=694.0,-79.9,400.                                               000590
        P3=694.0,79.9,400.                                                000600
        P4=799.9,79.9,400.                                                000610
        NNX=4,PROP=0.,0.                                                  000620
        COM=*      CORE  SEGMENT   X=694.0 TO 799.9 , SPACELAB 2 TOP*     000630
S       SURF=2035,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH          000640
           ICSN=50                                                        000650
        P1=694.0,0.,400.                                                  000660
        P2=694.0,79.9,400.                                                000670
        P3=694.0,-79.9,400.                                               000680
        P4=799.9,-79.9,400.                                               000690
        PROP=0.,0.                                                        000700
        COM=*  CORE  SEGMENT   X=694.0 TO 799.9 , SPACELAB 2 BOTTOM*      000710
S       SURF=2050,TYPE=CONE,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH         000720
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      ICSN=50                                                                  000730
     P1=799.90,0.,400.                                                         000740
     P2=799.90,-79.9,400.                                                      000750
     P3=799.90,79.9,400.                                                       000760
     P4=850.070,0.,400.                                                        000770
     P5=831.30,25.6,400.                                                       000780
     PROP=0.,0.,NNX=4                                                          000790
     COM=*  AFT CONE TAPER, X=799.90 TO 831.30 SPACELAB2  TOP*                 000800
S    SURF=2055,TYPE=CONE,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH                 000810
      ICSN=50                                                                  000820
     P1=799.90,0.,400.                                                         000830
     P2=799.90,79.9,400.                                                       000840
     P3=799.90,-79.9,400.                                                      000850
     P4=850.070,0.,400.                                                        000860
     P5=831.30,-25.6,400.                                                      000870
     PROP=0.,0.                                                                000880
     COM=*  AFT CONE TAPER, X=799.90 TO 831.30 SPACELAB2  BOTTOM*              000890
S    SURF=2060,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH                  000900
      ICSN=50                                                                  000910
     P1=831.30,0.,400.                                                         000920
     P2=831.30,25.6,400.                                                       000930
     P3=831.30,25.6,400.                                                       000940
     P4=860.80,25.6,400.                                                       000950
     PROP=0.,0.                                                                000960
     NNX=2                                                                     000970
     COM=*  AFT AIRLOCK, X=831.30 TO 860.80, SPACELAB2*                        000980
S    SURF=2065,TYPE=DISC,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                     000990
      ICSN=50                                                                  001000
     P1=860.80,0.,400.                                                         001010
     P2=860.80,25.6,400.                                                       001020
     P3=860.80,00.0,425.6                                                      001030
     P4=860.80,00.0,425.6                                                      001040
     PROP=0.,0.                                                                001050
     COM=*AFT AIR LOCK DISK SL2*                                               001060
S    SURF=2070,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH                  001070
      ICSN=50                                                                  001080
     P1=873.2,0.,400.                                                          001090
     P2=873.2,78.8,400.                                                        001100
     P3=873.2,-78.8,400.                                                       001110
     P4=987.2,-78.8,400.                                                       001120
     PROP= 0.,0.                                                               001130
     COM=  *  PALLET1 BOTTOM CYLINDER SL2  *                                   001140
S    SURF=2071,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                     001150
      ICSN=50                                                                  001160
     P1=873.2,-78.8,400.                                                       001170
     P2=987.2,-78.8,400.                                                       001180
     P3=987.2,-78.8,414.                                                       001190
     PROP= 0.,0.                                                               001200
     COM=  * -Y PALLET1 OUTSIDE STRIP SL2  *                                   001210
S    SURF=2072,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                     001220
      ICSN=50                                                                  001230
     P1=987.2,78.8,414.                                                        001240
     P2=987.2,78.8,400.                                                        001250
     P3=873.2,78.8,400.                                                        001260
     PROP= 0.,0.                                                               001270
     COM=*  +Y PALLET1 OUTSIDE STRIP SL2  *                                    001280
S    SURF=2073,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                     001290
      ICSN=50                                                                  001300
     P1=873.2,-78.8,414.                                                       001310
     P2=987.2,-78.8,414.                                                       001320
     P3=987.2,-72.8,414.                                                       001330
     PROP=0.,0.                                                                001340
     COM=*-Y PALLET3 TOP STRIP X=873.2 TO 987.2 SL2 *                          001350
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S     SURF=2074,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                  001360
         ICSN=50                                                             001370
      P1=873.2,72.8,414.                                                     001380
      P2=987.2,72.8, 414.                                                    001390
      P3=987.2,78.8,414.                                                     001400
      PROP=0.,0.                                                             001410
      COM= * +Y PALLET3 TOP STRIP ,X= 873.2 TO 987.2 SL2  *                  001420
S     SURF=2075,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                  001430
         ICSN=50                                                             001440
      P1=873.2,-72.8,414.                                                    001450
      P2=987.2,-72.8,414.                                                    001460
      P3=987.2,-58.5,371.                                                    001470
      PROP=0.,0.                                                             001480
      COM = * -Y INSIDE TOP PANNEL3 ,X=873.2 TO 987.2SL2 *                   001490
S     SURF=2076,TYPE = RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                001500
         ICSN=50                                                             001510
      P1=987.2,58.5,371.                                                     001520
      P2=987.2,72.8,414.                                                     001530
      P3=873.2,72.8,414.                                                     001540
      PROP=0.,0.                                                             001550
      COM= * +Y INSIDE TOP PANNEL3,X=873.2 TO 987.2 SL2  *                   001560
S     SURF=2077, TYPE= RECT, ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH               001570
         ICSN=50                                                             001580
      P1=873.2,-58.5,371.                                                    001590
      P2=987.2,-58.5,371.0                                                   001600
      P3=987.2,-34.5,344.3                                                   001610
      PROP=0.,0.                                                             001620
      COM=* -Y INSIDE BOTTOM PANNEL3, X=873.2 TO 987.2SL2  *                 001630
S     SURF=2078,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                  001640
         ICSN=50                                                             001650
      P1=873.2,34.5,344.3                                                    001660
      P2=987.2,34.5,344.3                                                    001670
      P3=987.2,58.5,371.                                                     001680
      PROP=0.,0.                                                             001690
      COM=* +Y INSIDE BOTTOM PANNEL3,X 873.2 TO 987.2 SL2  *                 001700
S     SURF=2079 , TYPE= RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH               001710
         ICSN=50                                                             001720
      P1=873.2,-34.5,344.3                                                   001730
      P2=987.2,-34.5,344.3                                                   001740
      P3=987.2,34.5,344.3                                                    001750
      PROP= 0.,0.                                                            001760
      COM=*...BOTTOM PANNEL3 ,X=873.2 TO 987.2, SL2*                         001770
S     SURF=2080,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH               001780
         ICSN=50                                                             001790
      P1=987.2,0.,400.                                                       001800
      P2=987.2,78.8,400.                                                     001810
      P3=987.2,-78.8,400.                                                    001820
      P4=1101.2,-78.8,400.                                                   001830
      PROP=0.,0.                                                             001840
      COM = * PALLET4 BOTTOM CYLINDER X= 987.2 TO 1101.2 SL2*                001850
S     SURF=2081,TYPE=RECT,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH              001860
         ICSN=50                                                             001870
      P1=987.2,-78.8,400.                                                    001880
      P2=1101.2,-78.8,400.                                                   001890
      P3=1101.2,-78.8,414.                                                   001900
      PROP= 0.,0.                                                            001910
      COM=   * -Y PALLET4 OUTSIDE STRIP SL2  *                               001920
S     SURF=2082,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                  001930
         ICSN=50                                                             001940
      P1=1101.2,78.8,414.                                                    001950
      P2=1101.2,78.8,400.                                                    001960
      P3=987.2,78.8,400.                                                     001970
      PROP= 0.,0.                                                            001980
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      COM=*  +Y PALLET4 OUTSIDE STRIP SL2    *                              001990
S     SURF=2083,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                 002000
        ICSN=50                                                             002010
      P1=987.2,-78.8,414.                                                   002020
      P2=1101.2,-78.8,414.                                                  002030
      P3=1101.2,-72.8,414.                                                  002040
      PROP=0.,0.                                                            002050
      COM=*-Y PALLET4 TOP STRIP X=987.2 TO 1101.2 SL2 *                     002060
S     SURF=2084,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                 002070
        ICSN=50                                                             002080
      P1=987.2,72.8,414.                                                    002090
      P2=1101.2,72.8, 414.                                                  002100
      P3=1101.2,78.8,414.                                                   002110
      PROP=0.,0.                                                            002120
      COM= * +Y PALLET4 TOP STRIP .,X= 987.2 TO 1101.2SL2  *                002130
S     SURF=2085,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                 002140
        ICSN=50                                                             002150
      P1=987.2,-72.8,414.                                                   002160
      P2=1101.2,-72.8,414.                                                  002170
      P3=1101.2,-58.5,371.                                                  002180
      PROP=0.,0.                                                            002190
      COM = * -Y INSIDE TOP PANNEL4,X=987.2 TO 1101.2 *                     002200
S     SURF=2086,TYPE = RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH               002210
        ICSN=50                                                             002220
      P1=1101.2,58.5,371.                                                   002230
      P2=1101.2,72.8,414.                                                   002240
      P3=987.2,72.8,414.                                                    002250
      PROP=0.,0.                                                            002260
      COM= * +Y INSIDE TOP PANNEL4,X=987.2 TO 1101.2 SL2   *                002270
S     SURF=2087, TYPE= RECT, ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH              002280
        ICSN=50                                                             002290
      P1=987.2,-58.5,371.                                                   002300
      P2=1101.2,-58.5,371.0                                                 002310
      P3=1101.2,-34.5,344.3                                                 002320
      PROP=0.,0.                                                            002330
      COM=* -Y INSIDE BOTTOM PANNEL4, X=987.2 TO 1101.2 SL2 *               002340
S     SURF=2088,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                 002350
        ICSN=50                                                             002360
      P1=987.2,34.5,344.3                                                   002370
      P2=1101.2,34.5,344.3                                                  002380
      P3=1101.2,58.5,371.                                                   002390
      PROP=0.,0.                                                            002400
      COM=* +Y INSIDE BOTTOM PANNEL4,X 987.2 TO 1101.2  SL2*                002410
S     SURF=2089 , TYPE= RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH              002420
        ICSN=50                                                             002430
      P1=987.2,-34.5,344.3                                                  002440
      P2=1101.2,-34.5,344.3                                                 002450
      P3=1101.2,34.5,344.3                                                  002460
      PROP= 0.,0.                                                           002470
      COM = * PALLET4 BOTTOM,X= 987.2 TO 1101.2 SL2 *                       002480
S     SURF=2090,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH              002490
        ICSN=50                                                             002500
      P1=1101.2,0.,400.                                                     002510
      P2=1101.2,78.8,400.                                                   002520
      P3=1101.2,-78.8.400.                                                  002530
      P4=1215.2,-78.8,400.                                                  002540
      PROP=0.,0.                                                            002550
      COM = * PALLET5 BOTTOM CYLINDER X= 1101.2 TO 1215.2 *                 002560
S     SURF=2091,TYPE=RECT,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH             002570
        ICSN=50                                                             002580
      P1=1101.2,-78.8,400.                                                  002590
      P2=1215.2,-78.8,400.                                                  002600
      P3=1215.2,-78.8,414.                                                  002610
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      PROP= 0.,0.                                                          002620
      COM=  * -Y PALLET5 OUTSIDE STRIP *                                   002630
S     SURF=2092,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                002640
         ICSN=50                                                           002650
      P1=1215.2,78.8,414.                                                  002660
      P2=1215.2,78.8,400.                                                  002670
      P3=1101.2,78.8,400.                                                  002680
      PROP= 0.,0.                                                          002690
      COM=*  +Y PALLET5 OUTSIDE STRIP *                                    002700
S     SURF=2093,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                002710
         ICSN=50                                                           002720
      P1=1101.2,-78.8,414.                                                 002730
      P2=1215.2,-78.8,414.                                                 002740
      P3=1215.2,-72.8,414.                                                 002750
      PROP=0.,0.                                                           002760
      COM=*-Y PALLET5 TOP STRIP X=1101.2 TO 1215.2 *                       002770
S     SURF=2094,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                002780
         ICSN=50                                                           002790
      P1=1101.2,72.8,414.                                                  002800
      P2=1215.2,72.8, 414.                                                 002810
      P3=1215.2,78.8,414.                                                  002820
      PROP=0.,0.                                                           002830
      COM= * +Y PALLET5 TOP STRIP ,X= 1101.2 TO 1215.2 *                   002840
S     SURF=2095,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                002850
         ICSN=50                                                           002860
      P1=1101.2,-72.8,414.                                                 002870
      P2=1215.2,-72.8,414.                                                 002880
      P3=1215.2,-58.5,371.                                                 002890
      PROP=0.,0.                                                           002900
      COM = * -Y INSIDE TOP PANNEL5,X=1101.2 TO 1215.2 *                   002910
S     SURF=2096,TYPE = RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH              002920
         ICSN=50                                                           002930
      P1=1215.2,58.5,371.                                                  002940
      P2=1215.2,72.8,414.                                                  002950
      P3=1101.2,72.8,414.                                                  002960
      PROP=0.,0.                                                           002970
      COM= * +Y INSIDE TOP PANNEL5,X=1101.2 TO 1215.2 *                    002980
S     SURF=2097, TYPE= RECT, ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH             002990
         ICSN=50                                                           003000
      P1=1101.2,-58.5,371.                                                 003010
      P2=1215.2,-58.5,371.0                                                003020
      P3=1215.2,-34.5,344.3                                                003030
      PROP=0.,0.                                                           003040
      COM=* -Y INSIDE BOTTOM PANNEL5, X=1101.2 TO 1215.2 *                 003050
S     SURF=2098,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH                003060
         ICSN=50                                                           003070
      P1=1101.2,34.5,344.3                                                 003080
      P2=1215.2,34.5,344.3                                                 003090
      P3=1215.2,58.5,371.                                                  003100
      PROP=0.,0.                                                           003110
      COM=* +Y INSIDE BOTTOM PANNEL5,X 1101.2 TO 1215.2 *                  003120
S     SURF=2099 , TYPE= RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH             003130
         ICSN=50                                                           003140
      P1=1101.2,-34.5,344.3                                                003150
      P2=1215.2,-34.5,344.3                                                003160
      P3=1215.2,34.5,344.3                                                 003170
      PROP= 0.,0.                                                          003180
      COM=*PALLET 5 BOTTOM,X=1011.2 TO 1215.2 SL2*                         003190
S     SURF=2110,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH               003200
         ICSN=50                                                           003210
      P1=746.9,0.,480.9                                                    003220
      P2=746.9,19.7,480.9                                                  003230
      P3=727.2,0.,480.9                                                    003240
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      P4=727.2,0.,480.9                                                    003250
      PROP=0.,0.                                                           003260
      COM= * CORE SEGMENT WINDOW, X=746.9 SPACELAB 2 *                     003270
S     SURF=2130,TYPE=DISC,ACTIVE=BOTH,SHADE=BOTH,BSHADE=BOTH               003280
        ICSN=50                                                            003290
      P1=815.6,0.,454.49                                                   003300
      P2=811.43,0.,462.23                                                  003310
      P3=815.6,7.85,454.49                                                 003320
      P4=815.6,7.85,454.49                                                 003330
      PROP=0.,0.                                                           003340
      COM=* AFT VIEWING WINDOW X=815.6, SPACELAB2*                         003350
BCS       BAY                                                              003360
D       1.   SREVERT M-IN CONVERSION                                       003370
S       SURFN=2401,SHADE=BOTH,BSHADE=BOTH,ALPHA=0.,EMISS=0.                003380
        TRANS=-0.    ,TRANI=-0.    ,COM=*BAY AREA CYLINDER            *    003390
        TYPE=CYLINDER  ,ACTIVE=INSIDE ,ALPH= 93.5                          003400
        BMIN= 0.          ,BMAX= 7.25000E+02,GMIN= 0.                      003410
        GMAX= 1.80000E+02,NNX=     2,NNY=     4,ICSN=    -0                003420
        POSITION=-5.07000E+02, 0.          , 0.                            003430
        ROTZ    =    -0.     , ROTY    =   90.0000, ROTX    =    0.        003440
S       SURF=2440,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH              003450
        P1=218.,93.5,0.                                                    003460
        P2=218.,93.5,19.                                                   003470
        P3=-507.,93.5,19.                                                  003480
        PROP=0.,0.                                                         003490
        NNX=4                                                              003500
        COM=* INSIDE +Y LINER STRIP*                                       003510
S       SURF=2445,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH           003520
        P1=218.,-93.5,0.                                                   003530
        P2=218.,-93.5,19.                                                  003540
        P3=-507.,-93.5,19.                                                 003550
        PROP=0.,0.                                                         003560
        NNX=4                                                              003570
        COM=* INSIDE -Y LINER STRIP*                                       003580
S       SURFN=  2413,SHADE=BOTH,BSHADE=BOTH,ALPHA=-0.    ,EMISS=-0.       003590
        TRANS=-0.    ,TRANI=-0.    ,COM=* FRONT BAY AREA DISK         *    003600
        TYPE=DISC       ,ACTIVE=TOP     ,ALPH= 0.                          003610
        BMIN= 0.          ,BMAX= 1.02000E+02,GMIN= 0.                      003620
        GMAX= 3.60000E+02,NNX=     1,NNY=     1,ICSN=    -0                003630
        POSITION= 2.18000E+02, 0.          , 0.                            003640
        ROTZ    =    -0.     , ROTY    =  -90.0000, ROTX    =    0.        003650
S       SURFN=  2411,SHADE=BOTH,BSHADE=BOTH,ALPHA=-0.    ,EMISS=-0.       003660
        TRANS=-0.    ,TRANI=-0.    ,COM=*  END  BAY AREA DISK         *    003670
        TYPE=DISC       ,ACTIVE=TOP     ,ALPH= 0.                          003680
        BMIN= 0.          ,BMAX= 1.02000E+02,GMIN= 0.                      003690
        GMAX= 3.60000E+02,NNX=     1,NNY=     1,ICSN=    -0                003700
        POSITION=-507.,0.,0.                                               003710
        ROTZ    =    -0.     , ROTY    =   90.0000, ROTX    =    0.        003720
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Table B-IV. Spacelab FIVP Geometry Breakdown

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
PALLET 1	PALLET 1 BOTTOM CYLINDER	CYLINDER	3050	1	3050
	PALLET 1 (-Y) OUTSIDE STRIP	RECTANGLE	3051	1	3051
	PALLET 1 OUTSIDE STRIP (+Y)	RECTANGLE	3052	1	3052
	PALLET 1 TOP STRIP (-Y)	RECTANGLE	3053	1	3053
	PALLET 1 TOP STRIP (+Y)	RECTANGLE	3054	1	3054
	INSIDE TOP PALLET 1 (-Y)	RECTANGLE	3055	1	3055
	INSIDE TOP PALLET 1 (+Y)	RECTANGLE	3056	1	3056
	INSIDE BOTTOM PALLET 1 (-Y)	RECTANGLE	3057	1	3057
	INSIDE BOTTOM PALLET 1 (+Y)	RECTANGLE	3058	1	3058
	BOTTOM PANEL 1	RECTANGLE	3059	1	3059
PALLET 1:	TOTAL SURFACES = 10		TOTAL NODES = 10		

Table B-IV. Spacelab FIVP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
PALLET 2	PALLET 2 BOTTOM CYLINDER	CYLINDER	3060	1	3060
	PALLET 2 OUT-SIDE STRIP (-Y)	RECTANGLE	3061	1	3061
	PALLET 2 OUT-SIDE STRIP (+Y)	RECTANGLE	3062	1	3062
	PALLET 2 TOP STRIP (-Y)	RECTANGLE	3063	1	3063
	PALLET 2 TOP STRIP (+Y)	RECTANGLE	3064	1	3064
	INSIDE TOP PALLET 2 (-Y)	RECTANGLE	3065	1	3065
	INSIDE TOP PALLET 2 (+Y)	RECTANGLE	3066	1	3066
	INSIDE BOTTOM PALLET 2 (-Y)	RECTANGLE	3067	1	3067
	INSIDE BOTTOM PALLET 2 (+Y)	RECTANGLE	3068	1	3068
	PALLET 2 BOTTOM	RECTANGLE	3069	1	3069
PALLET 2:	TOTAL SURFACES = 10		TOTAL NODES = 10		

Table B-IV. Spacelab FIVP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
PALLET 3	PALLET 3 BOTTOM CYLINDER	CYLINDER	3070	1	3070
	PALLET 3 OUTSIDE STRIP (-Y)	RECTANGLE	3071	1	3071
	PALLET 3 OUTSIDE STRIP (+Y)	RECTANGLE	3072	1	3072
	PALLET 3 TOP STRIP (-Y)	RECTANGLE	3073	1	3073
	PALLET 3 TOP STRIP (+Y)	RECTANGLE	3074	1	3074
	INSIDE TOP PALLET 3 (-Y)	RECTANGLE		1	3075
	INSIDE TOP PALLET 3 (+Y)	RECTANGLE	3076	1	3076
	INSIDE BOTTOM PALLET 3 (-Y)	RECTANGLE	3077	1	3077
	INSIDE BOTTOM PALLET 3 (+Y)	RECTANGLE	3078	1	3078
	BOTTOM PANEL 3	RECTANGLE	3079	1	3079
PALLET 3:	TOTAL SURFACES = 10		TOTAL NODES = 10		

Table B-IV. Spacelab FIVP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
PALLET 4	PALLET 4 BOTTOM CYLINDER	CYLINDER	3080	1	3080
	PALLET 4 OUTSIDE STRIP (-Y)	RECTANGLE	3081	1	3081
	PALLET 4 OUT-SIDE STRIP (+Y)	RECTANGLE	3082	1	3082
	PALLET 4 TOP STRIP (-Y)	RECTANGLE	3083	1	3083
	PALLET 4 TOP STRIP (+Y)	RECTANGLE	3084	1	3084
	INSIDE TOP PALLET 4 (-Y)	RECTANGLE	3085	1	3085
	INSIDE TOP PALLET 4 (+Y)	RECTANGLE	3086	1	3086
	INSIDE BOTTOM PALLET 4 (-Y)	RECTANGLE	3087	1	3087
	INSIDE BOTTOM PALLET 4 (+Y)	RECTANGLE	3088	1	3088
	PALLET 4 BOTTOM	RECTANGLE	3089	1	3089
PALLET 4:	TOTAL SURFACES = 10		TOTAL NODES = 10		

Table B-IV. Spacelab FIVP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
PALLET 5	PALLET 5 BOTTOM CYLINDER	CYLINDER	3090	1	3090
	PALLET 5 OUTSIDE STRIP (-Y)	RECTANGLE	3091	1	3091
	PALLET 5 (+Y) OUTSIDE STRIP	RECTANGLE	3092	1	3092
	PALLET 5 TOP STRIP (-Y)	RECTANGLE	3093	1	3093
	PALLET 5 TOP STRIP (+Y)	RECTANGLE	3094	1	3094
	INSIDE TOP PALLET 5 (-Y)	RECTANGLE	3095	1	3095
	INSIDE TOP PALLET 5 (+Y)	RECTANGLE	3096	1	3096
	INSIDE BOTTOM PALLET 5 (-Y)	RECTANGLE	3097	1	3097
	INSIDE BOTTOM PALLET 5 (+Y)	RECTANGLE	3098	1	3098
	PALLET 5 BOTTOM	RECTANGLE	3099	1	3099
PALLET 5:	TOTAL SURFACES = 10		TOTAL NODES = 10		

Table B-IV. Spacelab FIVP Geometry Breakdown (cont'd)

GENERAL AREA	NAME	TYPE	SURFACE NUMBER	NUMBER OF NODES	NODE NUMBERS
BAY	BAY AREA CYLINDER	CYLINDER	3401	8	3401, 3402, 3403, 3404, 3405, 3406, 3407, 3408
	INSIDE -Y LINER STRIP	RECTANGLE	3440	4	3440, 3441, 3442, 3443
	INSIDE +Y LINER STRIP	RECTANGLE	3445	4	3445, 3446, 3447, 3448
	FRONT BAY AREA DISK	DISK	3413	1	3413
	END BAY AREA DISK	DISK	3411	1	3411
BAY:	TOTAL SURFACES = 5		TOTAL NODES = 18		

SPACELAB FIVP TRASYS INPUT LISTING

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BCS     F1VP
D         1.  $REVERT METER INCH CONVERSION
S       SURF=3050,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
           ICSN=50
        P1=645.2,0.,400.
        P2=645.2,78.8,400.
        P3=645.2,-78.8,400.
        P4=759.2,-78.8,400.
        PROP=0.,0.
        COM = * PALLET1 BOTTOM CYLINDER X= 645.2 TO 759.2 SL3  *
S       SURF=3051,TYPE=RECT,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
           ICSN=50
        P1=645.2,-78.8,400.
        P2=759.2,-78.8,400.
        P3=759.2,-78.8,414.
        PROP= 0.,0.
        COM=   * -Y PALLET1 OUTSIDE STRIP SL3  *
S       SURF=3052,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
           ICSN=50
        P1=645.2,78.8,414.
        P2=759.2,78.8,414.
        P3=759.2,78.8,400.
        PROP= 0.,0.
        COM=*   +Y PALLET1 OUTSIDE STRIP SL3    *
S       SURF=3053,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
           ICSN=50
        P1=645.2,-78.8,414.
        P2=759.2,-78.8,414.
        P3=759.2,-72.8,414.
        PROP=0.,0.
        COM=*-Y PALLET1 TOP STRIP X=645.2 TO 759.2 SL3 *
S       SURF=3054,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
           ICSN=50
        P1=645.2,72.8,414.
        P2=759.2,72.8, 414.
        P3=759.2,78.8,414.
        PROP=0.,0.
        COM= * +Y PALLET1 TOP STRIP ,X= 645.2 TO 759.2 SL3  *
S       SURF=3055,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
           ICSN=50
        P1=645.2,-72.8,414.
        P2=759.2,-72.8,414.
        P3=759.2,-58.5,371.
        PROP=0.,0.
        COM = * -Y INSIDE TOP PANNEL1 ,X=645.2 TO 759.2SL3 *
S       SURF=3056,TYPE = RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
           ICSN=50
        P1=759.2,58.5,371.
        P2=759.2,72.5,414.
        P3=645.2,72.8,414.
        PROP=0.,0.
        COM= * +Y INSIDE TOP PANNEL1,X=645.2 TO 759.2 SL3  *
S       SURF=3057, TYPE= RECT, ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
           ICSN=50
        P1=645.2,-58.5,371.
        P2=759.2,-58.5,371.0
        P3=759.2,-34.5,344.3
        PROP=0.,0.
        COM=* -Y INSIDE BOTTOM PANNEL1, X=645.2 TO 759.2SL3  *
S       SURF=3058,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
           ICSN=50
        P1=645.2,34.5,344.3
        P2=759.2,34.5,344.3
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      P3=759.2,58.5,371.
      PROP=0.,0.
      COM=* +Y INSIDE BOTTOM PANNEL1,X 645.2 TO 759.2 SL3  *
S     SURF=3059 , TYPE= RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=645.2,-34.5,344.3
      P2=759.2,-34.5,344.3
      P3=759.2,34.5,344.3
      PROP= 0.,0.
      COM=* BOTTOM PANNEL 1 X=645.2 TO759.2,  SL3*
S     SURF=3060,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=759.2,0.,400.
      P2=759.2,78.8,400.
      P3=759.2,-78.8,400.
      P4=873.2,-78.8,400.
      PROP=0.,0.
      COM = * PALLET2 BOTTOM CYLINDER X= 759.2 TO 873.2 SL2*
S     SURF=3061,TYPE=RECT,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=759.2,-78.8,400.
      P2=873.2,-78.8,400.
      P3=873.2,-78.8,414.
      PROP= 0.,0.
      COM=  * -Y PALLET2 OUTSIDE STRIP SL3  *
S     SURF=3062,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=873.2,78.8,414.
      P2=873.2,78.8,400.
      P3=759.2,78.8,400.
      PROP= 0.,0.
      COM=*  +Y PALLET2 OUTSIDE STRIP SL3   *
S     SURF=3063,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=759.2,-78.8,414.
      P2=873.2,-78.8,414.
      P3=873.2,-72.8,414.
      PROP=0.,0.
      COM=*-Y PALLET2 TOP STRIP X=759.2 TO 873.2 SL3   *
S     SURF=3064,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=759.2,72.8,414.
      P2=873.2,72.8, 414.
      P3=873.2,78.8,414.
      PROP=0.,0.
      COM= * +Y PALLET2 TOP STRIP ,X= 759.2 TO 873.2SL3  *
S     SURF=3065,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=759.2,-72.8,414.
      P2=873.2,-72.8,414.
      P3=873.2,-58.5,371.
      PROP=0.,0.
      COM = * -Y INSIDE TOP PANNEL2,X=759.2 TO 873.2 *
S     SURF=3066,TYPE = RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=873.2,58.5,371.
      P2=873.2,72.8,414.
      P3=759.2,72.8,414.
      PROP=0.,0.
      COM= * +Y INSIDE TOP PANNEL2,X=759.2 TO 873.2 SL3   *
S     SURF=3067, TYPE= RECT, ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=759.2,-58.5,371.
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      P2=873.2,-58.5,371.0
      P3=873.2,-34.5,344.3
      PROP=0.,0.
      COM=* -Y INSIDE BOTTOM PANNEL2, X=759.2 TO 873.2 SL3 *
S     SURF=3068,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=759.2,34.5,344.3
      P2=873.2,34.5,344.3
      P3=873.2,58.5,371.
      PROP=0.,0.
      COM=* +Y INSIDE BOTTOM PANNEL2,X 759.2 TO 873.2  SL3*
S     SURF=3069 , TYPE= RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=759.2,-34.5,344.3
      P2=873.2,-34.5,344.3
      P3=873.2,34.5,344.3
      PROP= 0.,0.
      COM = * PALLET2 BOTTOM,X= 759.2 TO 873.2 SL3 *
S     SURF=3070,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=873.2,0.,400.
      P2=873.2,78.8,400.
      P3=873.2,-78.8,400.
      P4=987.2,-78.8,400.
      PROP=0.,0.
      COM = * PALLET3 BOTTOM CYLINDER X= 873.2 TO 987.2 SL3  *
S     SURF=3071,TYPE=RECT,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=873.2,-78.8,400.
      P2=987.2,-78.8,400.
      P3=987.2,-78.8,414.
      PROP= 0.,0.
      COM=  * -Y PALLET1 OUTSIDE STRIP SL2  *
S     SURF=3072,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=987.2,78.8,414.
      P2=987.2,78.8,400.
      P3=873.2,78.8,400.
      PROP= 0.,0.
      COM=*  +Y PALLET1 OUTSIDE STRIP SL2   *
S     SURF=3073,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=873.2,-78.8,414.
      P2=987.2,-78.8,414.
      P3=987.2,-72.8,414.
      PROP=0.,0.
      COM=*-Y PALLET3 TOP STRIP X=873.2 TO 987.2 SL2 *
S     SURF=3074,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=873.2,72.8,414.
      P2=987.2,72.8, 414.
      P3=987.2,78.8,414.
      PROP=0.,0.
      COM= * +Y PALLET3 TOP STRIP ,X= 873.2 TO 987.2 SL3  *
S     SURF=3075,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=873.2,-72.8,414.
      P2=987.2,-72.8,414.
      P3=987.2,-58.5,371.
      PROP=0.,0.
      COM = * -Y INSIDE TOP PANNEL3 ,X=873.2 TO 987.2SL3 *
S     SURF=3076,TYPE = RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
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      P1=987.2,58.5,371.
      P2=987.2,72.8,414.
      P3=873.2,72.8,414.
      PROP=0.,0.
      COM= * +Y INSIDE TOP PANNEL3,X=873.2 TO 987.2 SL3  *
S     SURF=3077, TYPE= RECT, ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=873.2,-58.5,371.
      P2=987.2,-58.5,371.0
      P3=987.2,-34.5,344.3
      PROP=0.,0.
      COM=* -Y INSIDE BOTTOM PANNEL3, X=873.2 TO 987.2SL3  *
S     SURF=3078,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=873.2,34.5,344.3
      P2=987.2,34.5,344.3
      P3=987.2,58.5,371.
      PROP=0.,0.
      COM=* +Y INSIDE BOTTOM PANNEL3,X 873.2 TO 987.2 SL3  *
S     SURF=3079 , TYPE= RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=873.2,-34.5,344.3
      P2=987.2,-34.5,344.3
      P3=987.2,34.5,344.3
      PROP= 0.,0.
      COM=*...BOTTOM PANNEL3 ,X=873.2 TO 987.2, SL3*
S     SURF=3080,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=987.2,0.,400.
      P2=987.2,78.8,400.
      P3=987.2,-78.8,400.
      P4=1101.2,-78.8,400.
      PROP=0.,0.
      COM = * PALLET4 BOTTOM CYLINDER X= 987.2 TO 1101.2 SL3*
S     SURF=3081,TYPE=RECT,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=987.2,-78.8,400.
      P2=1101.2,-78.8,400.
      P3=1101.2,-78.8,414.
      PROP= 0.,0.
      COM=  * -Y PALLET4 OUTSIDE STRIP SL3  *
S     SURF=3082,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=1101.2,78.8,414.
      P2=1101.2,78.8,400.
      P3=987.2,78.8,400.
      PROP= 0.,0.
      COM=*  +Y PALLET4 OUTSIDE STRIP SL3   *
S     SURF=3083,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=987.2,-78.8,414.
      P2=1101.2,-78.8,414.
      P3=1101.2,-72.8,414.
      PROP=0.,0.
      COM=*-Y PALLET4 TOP STRIP X=987.2 TO 1101.2 *
S     SURF=3084,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
         ICSN=50
      P1=987.2,72.8,414.
      P2=1101.2,72.8, 414.
      P3=1101.2,78.8,414.
      PROP=0.,0.
      COM= * +Y PALLET4 TOP STRIP ,X= 987.2 TO 1101.2SL3  *
S     SURF=3085,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
```

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      ICSN=50
     P1=987.2,-72.8,414.
     P2=1101.2,-72.8,414.
     P3=1101.2,-58.5,371.
     PROP=0.,0.
     COM = * -Y INSIDE TOP PANNEL4,X=987.2 TO 1101.2 *
S    SURF=3086,TYPE = RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      ICSN=50
     P1=1101.2,58.5,371.
     P2=1101.2,72.8,414.
     P3=987.2,72.8,414.
     PROP=0.,0.
     COM= * +Y INSIDE TOP PANNEL4,X=987.2 TO 1101.2 SL2   *
S    SURF=3087, TYPE= RECT, ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      ICSN=50
     P1=987.2,-58.5,371.
     P2=1101.2,-58.5,371.0
     P3=1101.2,-34.5,344.3
     PROP=0.,0.
     COM=* -Y INSIDE BOTTOM PANNEL4, X=987.2 TO 1101.2 SL3 *
S    SURF=3088,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      ICSN=50
     P1=987.2,34.5,344.3
     P2=1101.2,34.5,344.3
     P3=1101.2,58.5,371.
     PROP=0.,0.
     COM=* +Y INSIDE BOTTOM PANNEL4,X 987.2 TO 1101.2  SL3*
S    SURF=3089 , TYPE= RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      ICSN=50
     P1=987.2,-34.5,344.3
     P2=1101.2,-34.5,344.3
     P3=1101.2,34.5,344.3
     PROP= 0.,0.
     COM = * PALLET4 BOTTOM,X= 987.2 TO 1101.2 SL3 *
S    SURF=3090,TYPE=CYL,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
      ICSN=50
     P1=1101.2,0.,400.
     P2=1101.2,78.8,400.
     P3=1101.2,-78.8,400.
     P4=1215.2,-78.8,400.
     PROP=0.,0.
     COM = * PALLET5 BOTTOM CYLINDER X= 1101.2 TO 1215.2 *
S    SURF=3091,TYPE=RECT,ACTIVE=OUTSIDE,SHADE=BOTH,BSHADE=BOTH
      ICSN=50
     P1=1101.2,-78.8,400.
     P2=1215.2,-78.8,400.
     P3=1215.2,-78.8,414.
     PROP= 0.,0.
     COM=  * -Y PALLET5 OUTSIDE STRIP *
S    SURF=3092,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      ICSN=50
     P1=1215.2,78.8,414.
     P2=1215.2,78.8,400.
     P3=1101.2,78.8,400.
     PROP= 0.,0.
     COM=*  +Y PALLET5 OUTSIDE STRIP *
S    SURF=3093,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
      ICSN=50
     P1=1101.2,-78.8,414.
     P2=1215.2,-78.8,414.
     P3=1215.2,-72.8,414.
     PROP=0.,0.
     COM=*-Y PALLET5 TOP STRIP X=1101.2 TO 1215.2 *
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S     SURF=3094,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=1101.2,72.8,414.
      P2=1215.2,72.8, 414.
      P3=1215.2,78.8,414.
      PROP=0.,0.
      COM= * +Y PALLET5 TOP STRIP ,X= 1101.2 TO 1215.2 *
S     SURF=3095,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=1101.2,-72.8,414.
      P2=1215.2,-72.8,414.
      P3=1215.2,-58.5,371.
      PROP=0.,0.
      COM = * -Y INSIDE TOP PANNEL5,X=1101.2 TO 1215.2 *
S     SURF=3096,TYPE = RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=1215.2,58.5,371.
      P2=1215.2,72.8,414.
      P3=1101.2,72.8,414.
      PROP=0.,0.
      COM= * +Y INSIDE TOP PANNEL5,X=1101.2 TO 1215.2 *
S     SURF=3097, TYPE= RECT, ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=1101.2,-58.5,371.
      P2=1215.2,-58.5,371.0
      P3=1215.2,-34.5,344.3
      PROP=0.,0.
      COM=* -Y INSIDE BOTTOM PANNEL5, X=1101.2 TO 1215.2 *
S     SURF=3098,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=1101.2,34.5,344.3
      P2=1215.2,34.5,344.3
      P3=1215.2,58.5,371.
      PROP=0.,0.
      COM=* +Y INSIDE BOTTOM PANNEL5,X 1101.2 TO 1215.2 *
S     SURF=3099 , TYPE= RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        ICSN=50
      P1=1101.2,-34.5,344.3
      P2=1215.2,-34.5,344.3
      P3=1215.2,34.5,344.3
      PROP= 0.,0.
      COM=*PALLET 5 BOTTOM,X=1011.2 TO 1215.2 SL2*
BCS         BAY
D       1.    $REVERT M-IN CONVERSION
S       SURFN=3401,SHADE=BOTH,BSHADE=BOTH,ALPHA=0.,EMISS=0.
        TRANS=-0.    ,TRANI=-0.    ,COM=*BAY AREA CYLINDER
        TYPE=CYLINDER  ,ACTIVE=INSIDE ,ALPH= 93.5
        BMIN= 0.          ,BMAX= 7.25000E+02,GMIN= 0.
        GMAX= 1.80000E+02,NNX=     2,NNY=     4,ICSN=    -0
        POSITION=-5.07000E+02, 0.          , 0.
        ROTZ    =    -0.    , ROTY    =    90.0000, ROTX    =     0.
S       SURF=3440,TYPE=RECT,ACTIVE=TOP,SHADE=BOTH,BSHADE=BOTH
        P1=218.,93.5,0.
        P2=218.,93.5,19.
        P3=-507.,93.5,19.
        PROP=0.,0.
        NNX=4
        COM=* INSIDE +Y LINER STRIP*
S       SURF=3445,TYPE=RECT,ACTIVE=BOTTOM,SHADE=BOTH,BSHADE=BOTH
        P1=218.,-93.5,0.
        P2=218.,-93.5,19.
        P3=-507.,-93.5,19.
        PROP=0.,0.
```

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NNX=4
COM=* INSIDE -Y LINER STRIP*
S       SURFN=  3413,SHADE=BOTH,BSHADE=BOTH,ALPHA=-0.    ,EMISS=-0.
        TRANS=-0.    ,TRANI=-0.    ,COM=* FRONT BAY AREA DISK
        TYPE=DISC       ,ACTIVE=TOP     ,ALPH= 0.
        BMIN= 0.          ,BMAX= 1.02000E+02,GMIN= 0.
        GMAX= 3.60000E+02,NNX=     1,NNY=     1,ICSN=    -0
        POSITION= 2.18000E+02, 0.          , 0.
        ROTZ    =   -0.    , ROTY    =  -90.0000, ROTX    =    0.
S       SURFN=  3411,SHADE=BOTH,BSHADE=BOTH,ALPHA=-0.    ,EMISS=-0.
        TRANS=-0.    ,TRANI=-0.    ,COM=*  END  BAY AREA DISK
        TYPE=DISC       ,ACTIVE=TOP     ,ALPH= 0.
        BMIN= 0.          ,BMAX= 1.02000E+02,GMIN= 0.
        GMAX= 3.60000E+02,NNX=     1,NNY=     1,ICSN=    -0
        POSITION=-507.,0.,0.
        ROTZ    =   -0.    , ROTY    =   90.0000, ROTX    =    0.
```

APPENDIX C

SPACE PROGRAM LISTING

APPENDIX C
SPACE PROGRAM LISTING

1. INTRODUCTION

This appendix presents the current CDC "Update" source listing of the SPACE Program. The user will note the following text flags, and be able to determine which code he will find in his SPACE model as a function of computer type: CDC or UNIVAC.

Text Flag	Definition
*IF U1100 Text ↓ *END IF	If a UNIVAC source code generation run is desired, the lines of code inclusive between these flags are inserted. This code is unique to UNIVAC.
*IF -U1100 Text ↓ *END IF	This is the flag for unique CDC code and will only be inserted in a CDC source code generation run. This code is also inclusive between the two cards.

This listing allows the user to see both sets of code that generate the same program for each computer. It also highlights the differences between the CDC and UNIVAC computer systems.

```
*COMDECK SAVEP
      COMMON /SAVEP/ SAVEPT(400),SAVEC(400)
*COMDECK PTSLCT
      COMMON/PTSLCT/ NUMBER(50,8),CNTRIB(50,8),DL(25)
*COMDECK MDF
      COMMON/MDF/ ATCODE, TIMEOO(6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6            DPHI(10),DOMEGA(10),DTHETA(10),
     7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8            XO(10),YO(10),ZO(10),DSRTNF(25),RMAXRF
*DECK MICAP
*IF IDENT,U1100
{FOR,IS MAIN
*ENDIF
*IF -IDENT,U1100
      SUBROUTINE MAIN
*ENDIF
C
C             ****************************************
C             *                                      *
C             *     SHUTTLE                          *
C             *          PAYLOAD                     *
C             *               CONTAMINATION          *
C             *                    EVALUATION        *
C             *                         PROGRAM      *
C             *                                      *
C             ****************************************
C             DEVELOPED BY:                  DESIGNED BY :
C             MARTIN MARIETTA AEROSPACE      M. A. HETRICK,JR.
C             DENVER DIVISION                PROGRAMMED BY:
C             APRIL 1977                     M. A. HETRICK,JR.
C                                            D. A. STRANGE
C  OBJECTIVE:
C    THE FOLLOWING SET OF LOGIC IS THE EXECUTIVE PORTION OF THE N A S A
C    SHUTTLE/PAYLOAD CONTAMINATION EVALUATION (SPACE) PROGRAM DESIGNED
C    AND DEVELOPED BY MARTIN MARIETTA AEROSPACE(DENVER).  THE ANALYSIS
C    IS CONTROLLED AT THIS LEVEL.  THIS PROGRAM HAS BEEN DESIGNED TO BE
C    USED FOR EITHER SHUTTLE ORBITER/SPACELAB SYSTEMS INTEGRATION OR
C    AS A GENERAL ANALYSIS TOOL WHICH MONITORS ON-ORBIT CONTAMINATION
C    INVOLVING FROM 1 TO 300 SURFACES AND 1 TO 50 CONCENTRATED SOURCES
C    SUCH AS ENGINES OR VENTS.
C
C      SEGMENT A:  COLLECT INPUT DATA
C      SEGMENT B:  MASS LOSS AUDIT
C      SEGMENT C:  DEPOSITION - DIRECT TRANSPORT
C      SEGMENT D:  MCD/NCD
C      SEGMENT E:  RETURN FLUX DEPOSITION
C
C
C  COMMON BLOCKS USED IN THE MAIN OVERLAY
      COMMON/CMLOSS/MLR(300,10),MDOTJ(300)
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),     TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/MDF/ ATCODE, TIME(6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
```

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     4             ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5             COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6             DPHI(10),DOMEGA(10),DTHETA(10),
     7             PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8             X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
      COMMON/MISC/LINE,IPAGE,CFLAG
      COMMON/NPLM/NPLUME(5)
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/RATES1/RATE(15,10),TAU(15,10)
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15), SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SEGD1/NLOS,RFSTK
      COMMON/SEGE/ ICSURF
      COMMON/SPEC/ MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      LOGICAL DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1        EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2        MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3        MINTMP,ORBITR,OUT,   REFLCT,REPORT,
     4        RFAS,  RFSS,  SMTP,  GO,SUNL,SUNM,SUNH
      INTEGER ATCODE,RECEVR,RFSURF,SECT,SURFSC,SSURFS
      NAMELIST/CONTRL/DBUGA, DBUGB, DBUGC, DBUGD, DEPSIT,ED,     ENG,
     1                EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2                MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3                MINTMP,ORBITR,OUT,   REFLCT,REPORT,RFAS,
     4                RFSS,  SMTP,  TSTART,TSTOP, ATCODE,GO
      REWIND 8
C     ****************************************************************
C
C     FIRST INITIALIZE ALL CONTROL VARIABLES FOR DEFAULT PURPOSES.
C
C     ASSUME A COMPLETE CONTAMINATION ANALYSIS IS TO BE CONDUCTED.
      DEPSIT = .FALSE.
      MCD    = .TRUE.
C     CONSIDER ONLY SURFACE OUTGASSING AS A SOURCE OF CONTAMINANTS.
      ED     = .FALSE.
      OUT    = .TRUE.
      ENG    = .FALSE.
      EVAP   = .FALSE.
      LEAK   = .FALSE.
C     CONSIDER THE FOLLOWING TYPES OF TRANSPORT MECHANISMS
      REFLCT = .FALSE.
      RFAS   = .FALSE.
      RFSS   = .FALSE.
      MFPATH = .FALSE.
C     ONLY VIEW FACTOR DATA WILL BE READ IN VIA CARDS
      NEWMLC = .FALSE.
      NEWMFS = .FALSE.
      NEWMFP = .FALSE.
      NEWTNL = .FALSE.
      NEWCON = .FALSE.
      NEWTCD = .FALSE.
C     ANALYZE THE LMOP SPACELAB CONFIGURATION ONLY
      ORBITR = .FALSE.
      SMTP   = .FALSE.
      FIVP   = .FALSE.
      LMOP   = .TRUE.
C     USE MAXIMUM TEMPERATURES FOR SURFACES
```

```
      MAXTMP = .TRUE.
      MINTMP = .FALSE.
      ATCODE =  0
C  THE DEBUG OPTION IS NOT DESIRED IN ANY OF THE PROGRAM SEGMENTS
      DBUGA  = .FALSE.
      DBUGB  = .FALSE.
      DBUGC  = .FALSE.
      DBUGD  = .FALSE.
C  THE CALCULATIONS WILL NOT PROCEED BEYOND THE NEXT GATE UNLESS A GO
C  IS GIVEN.
      GO     = .FALSE.
C
C  ASSUME THE USER WANTS ONLY BASIC OUTPUT REPORTS. OTHER REPORTS CAN
C  BE WRITTEN IF REQUESTED THROUGH NAMELIST CONTRL.
      DO 10 I=1,50
      REPORT(I)=.FALSE.
   10 CONTINUE
C
      REPORT(1)  = .TRUE.
      REPORT(3)  = .TRUE.
      REPORT(8)  = .TRUE.
      REPORT(11) = .TRUE.
      REPORT(32) = .TRUE.
      REPORT(33) = .TRUE.
      REPORT(42) = .TRUE.
      REPORT(43) = .TRUE.
      REPORT(47) = .TRUE.
      REPORT(50) = .TRUE.
C  SET THE TIME INTERVAL TO BE EVALUATED TO 1 SEC AT 10 HRS INTO THE
C  MISSION.
      TSTART(1) = 10.
      TSTART(2) =  0.
      TSTART(3) =  0.
      TSTOP(1) =  10.
      TSTOP(2) =   0.
      TSTOP(3) =   1.
C  ********************************************************************
C  FIRST READ IN A DESCRIPTION OF THE PROBLEM
C
      READ(5,1001)TITLE
C
C  NEXT READ IN THE NECESSARY CONTROL PARAMETERS USED TO DEFINE THE
C  CONTAMINATION ANALYSIS PROBLEM.
   20 READ(5,CONTRL)
C
C  NEXT CALL THE ROUTINE COLLECT TO GATHER THE DETAILED DATA INPUT.
C  COLLECT INITIALIZES DATA AND THEN READS IN GEOMETRY AND TEMPERATURE
C  DATA FROM CARDS, BLOCK DATA OR TAPES.
C
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGA0,1,0)
*ENDIF
*IF IDENT,U1100
      CALL COLLCT
      CALL CLOSMS(100)
*ENDIF
C
C  NOW THAT ALL THE DATA HAVE BEEN LOADED IN, CALL UP AN AUDIT OF THE
C  MASS LOSS FROM ALL SURFACES THAT ARE SOURCES OF CONTAMINATION
C
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGB0,2,0)
*ENDIF
```

```
*IF IDENT,U1100
      CALL AUDIT
*ENDIF
C
C  AT THIS POINT THE ANALYSIS WILL TERMINATE AND ALLOW THE USER TO
C  EXAMINE THE CONFIGURATION AND MASS LOSS CHARACTERISTICS BEFORE
C  PROCEEDING UNLESS A GO WAS GIVEN IN NAMELIST MPDB.
      IF (.NOT.GO) CALL EXIT
C
C  CYCLE THRU ALL CRITICAL SURFACES THAT ARE SUSCEPTIBLE TO DIRECT LINE-
C  OF-SIGHT DEPOSITION
C
      IF ( .NOT. DEPSIT ) GO TO 40
      DO 30 ISURF=1,100
      IF(RECEVR(ISURF).EQ.0) GO TO 30
C
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGC0,3,0)
*ENDIF
*IF IDENT,U1100
      CALL DEPST
*ENDIF
  30  CONTINUE
C
C  EVALUATE THE MCD/NCD AND RETURN FLUX
C
  40  IF(.NOT.MCD.AND..NOT.RFAS.AND..NOT.RFSS) GO TO 50
C     CALL MCD/NCD AND RETURN FLUX ROUTINES
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGD0,4,0)
*ENDIF
*IF IDENT,U1100
      CALL MCDRTF
*ENDIF
  50  CONTINUE
C
C  GO ON TO THE NEXT TIME SLICE OR NEXT CASE TO BE ANALYSED
      READ(5,1001)TITLE
      IF(TITLE(1).EQ.4HSTOP) GO TO 100
C
      GO TO 20
 1001 FORMAT(12A6)
  100 CALL EXIT
      END
*DECK COLLCT
*IF IDENT,U1100
{FOR,IS COLLCT
*ENDIF
      SUBROUTINE COLLCT
C           ************************************************
C           *                                              *
C           *                 COLLECT   DATA               *
C           *                                              *
C           ************************************************
C                                    CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    TO COLLECT THE NECESSARY DATA FOR THE PRESCRIBED ANALYSIS.
C    DATA CAN BE OBTAINED FROM CARDS, BLOCK DATA, OR PREVIOUSLY
C    GENERATED TAPES.  IF REQUESTED, THE NEW DATA READ FROM CARDS
C    CAN BE USED TO UPDATE THE PERMANENT TAPES.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,    ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
```

```
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/MDF/ ATCODE, TIMEOO(6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6            DPHI(10),DOMEGA(10),DTHETA(10),
     7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8            XO(10),YO(10),ZO(10),DSRTNF(25),RMAXRF
      COMMON/MISC/LINE,IPAGE,CFLAG
      COMMON/NPLM/NPLUME(5)
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/RATES1/RATE(15,10),TAU(15,10)
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15), SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      COMMON/TRASYS/NODEI,JDATA,NODEJ(300),MFIJ(300),MFJI(300),
     1              AREAJ(300),THETAI(300),THETAJ(300),R(300)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SEGD1/NLOS,RFSTK
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/MS/INDEX(521)
      DIMENSION RECEV(50),RFSUR(10)
      INTEGER RECEV,RECEVR,RFSUR,RFSURF,SECT,SSURFS,SURFSC
      INTEGER CIDENT,CLOC,CTYPE,CXLOC,CYLOC,CZLOC,PNTSC,CHNGEK,CHNGES
      INTEGER CHNGEP
      REAL MFIJ,MFJI
      LOGICAL          DBUGA, DBUGB, DBUGC, DBUGD, DEPSIT,ED,    ENG,
     1                 EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2                 MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3                 MINTMP,ORBITR,OUT,   REFLCT,REPORT,RFAS,
     4                 RFSS,  SMTP,GO,
     5                 SUNL,  SUNM,  SUNH, ALLNEW
      NAMELIST/CONTRL/DBUGA, DBUGB, DBUGC, DBUGD, DEPSIT,ED,    ENG,
     1                 EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2                 MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3                 MINTMP,ORBITR,OUT,   REFLCT,REPORT,RFAS,
     4                 RFSS,  SMTP,  TSTART,TSTOP ,ATCODE,GO
      NAMELIST/INPUTA/SURFSC,SSURFS,PNTSC, ONTIME,RECEVR,RFSURF,GO
      NAMELIST/INPUTB/RATE,TAU,AGEORB,AGESLB,PLUMEC,SPECMF,CHNGES,
     1                CHNGEK,CHNGEP,MOUT1,MOUT2,MED1,MED2,M1,M2
      NAMELIST/MPDB/    BETA,  PITCH, YAW,   ROLL,  ALT,   SUNL,  SUNM,
     ,                  SUNH,  VX,    VY,    VZ,
     ,           NLOS,  XLOS,  YLOS,  ZLOS,  THETAL,PHIL,  DSMCD, RMAXL,
     ,                  RFSURF,COSXX, COSXY, COSXZ, COSYX, COSYY,
     ,                  COSYZ, COSZX, COSZY, COSZZ,
     ,                  THETA1,THETA2,PHI1,  PHI2,  DOMEGA,
     ,         DSRTNF,DTHETA,DPHI,RMAXRF,RFSTK,VFACTR,
     ,                  TIMEOO,JKEEP, XO,    YO,    ZO,    GO
C     ****************************************************************
      DATA(RECEV (I),I=1,50)/50*0/
      DATA(RFSUR (I),I=1,10)/10*0/
C     THE FOLLOWING IS REQUIRED TO PLACATE THE CDC LOADER
      DO 10 I=1,50
   10 RECEVR(I)=RECEV(I)
      DO 20 I=1,10
```

```
   20  RFSURF(I)=RFSUR(I)
       AGESLB=0.
       AGEORB=0.
       JTOTAL=0
       JKEEP =300
       IF(.NOT.(ED.OR.OUT.OR.LEAK.OR.REFLCT )) JKEEP=0
       KSC    =0
       IPAGE =1
C
C  INITIALIZE THE DBUG TAPE IF REQUESTED
       CALL DATE(TODAY)
       CALL TIME(HMS)
       IF(DBUGA.OR.DBUGB.OR.DBUGC.OR.DBUGD) WRITE(8,1010)TODAY,HMS,TITLE
 1010 FORMAT(1H1,/// '  ****** DEBUG OUTPUT ******'//
      ,   2A10,10X,12A6///)
C  ***************************************************************
C             SOURCE SELECTION
C
C  SET UP THE RANGE OF SPECIES TO CONSIDER IN THIS ANALYSIS
       MOUT1 = 1
       MOUT2 = 2
       MED1 = 3
       MED2 = 6
       M1=1
       M2=10
       IF(.NOT. OUT) M1=3
       IF(.NOT. ENG) M2=6
       IF(.NOT.ENG.AND..NOT.ED.AND..NOT.LEAK) M2=3
       IF(.NOT.ENG.AND..NOT.ED.AND..NOT.LEAK.AND..NOT.EVAP ) M2=2
C  ***************************************************************
C
       IF(REPORT(1) ) CALL PRINTA(1)
       IF(REPORT(1) ) WRITE(6,CONTRL)
C
C  IF THE USER DOES NOT WISH TO USE THE ORBITER OR LMOP OR SMTP OR FIVP
C  CONFIGURATION, SKIP THE BLOCKA DATA.
C
       IF(.NOT.ORBITR.AND..NOT.LMOP.AND..NOT.SMTP.AND..NOT.FIVP) GO TO 30
       IF(.NOT.ORBITR.AND.(EVAP.OR.ENG)) CALL ERRORA(3,0)
C
C  THE ROUTINE BLCKA ASSUMES THE USER WANTS A FULL ORBITER CONFIGURATION
C  AND PROCEEDS TO SET UP SUCH AN ANALYSIS.  THE USER WILL LATER HAVE
C  THE OPTION OF OVERIDING ANY OF THESE DATA THAT ARE INSERTED.
C  INSERTED AUTOMATICALLY.
*IF -IDENT,U1100
       IF(    ORBITR  ) CALL OVERLAY(5HSEGA1,1,1)
*ENDIF
*IF IDENT,U1100
       IF(    ORBITR  ) CALL BLCKA
*ENDIF
*IF -IDENT,U1100
       IF( LMOP.OR. SMTP.OR.FIVP ) CALL OVERLAY(5HSEGA2,1,2)
*ENDIF
*IF IDENT,U1100
       IF( LMOP.OR. SMTP.OR.FIVP ) CALL BLCKB
*ENDIF
       IF( REPORT(2) ) CALL PRINTA(2)
C
C  AT THIS POINT THE USER CAN ZERO OUT PORTIONS OF THE PRESET CONFIG-
C  URATION OR ALTER ENGINE/VENT ONTIMES THAT WERE PRESET AUTOMATICALLY
C  THIS CAN BE ACCOMPLISHED IN TWO WAYS:
C     1) ZERO OUT PORTIONS OF THE CONFIGURATION LIST
C        E.G.  SURFSC(11) = 0,
```

```
C      2) INSERT A NEW CONFIGURATION LIST
C         E.G.  SURFSC(1) = 1,2,6,148,1070,
C
       READ(5,INPUTA)
C  CONSOLIDATE THE DATA
       CALL CRUNCH
       IF( REPORT(3) ) CALL PRINTA(3)
C
   30  CONTINUE
C
C  AT THIS POINT THE USER HAS THE OPTION OF MODIFYING THE PRESET STS
C  ORBITER/SPACELAB CONFIGURATION OR READING IN A COMPLETELY NEW CONFIG-
C  URATION IF NEWCON = TRUE.  A BLANK CARD CONCLUDES THE DATA SET.
C
       IF(.NOT. NEWCON) GO TO 50
       IF( REPORT(4) ) CALL PRINTA(4)
   40  READ(5,1003)I,IDENT(I),SECT(I),MATRL(I),AREA(I),DUM1,DUM2
       IF(I.EQ.0) GO TO 50
       IF(IDENT(I).LT.5000) GO TO 45
       IF(I.GT.300) CALL ERRORA(18,0)
       IF(I.GT.JTOTAL ) JTOTAL = I
       WRITE(6,1003)I,IDENT(I),SECT(I),MATRL(I),AREA(I)
  1003 FORMAT(2I10,2A10,F10.0)
       SURFSC(I) = IDENT(I)
       GO TO 40
    45 CONTINUE
       KSC=KSC+1
       IF(KSC.GT.50) CALL ERRORA(19,0)
       CIDENT(KSC) = IDENT(I)
       CLOC(KSC)   = SECT(I)
       CTYPE(KSC)  = MATRL(I)
       CXLOC(KSC)  = AREA(I)
       CYLOC(KSC)  = DUM1
       CZLOC(KSC)  = DUM2
       WRITE(6,1004)I,CIDENT(I),CLOC(I),CTYPE(I),CXLOC(I),CYLOC(I),
      ,             CYLOC(I),CZLOC(I)
  1004 FORMAT(2I10,2A10,3F10.0)
       GO TO 40
    50  CONTINUE
C  THE ROUTINE BLOCKB ASSUMES THE USER WANTS TO USE SURFACE MATERIALS
C  MASS LOSS RATES,AND ENGINE/VENT PLUME FUNCTIONS THAT ARE STORED
C  INTERNALLY IN THE PROGRAM.
C
*IF -IDENT,U1100
       CALL OVERLAY(5HSEGA3,1,3)
*ENDIF
*IF IDENT,U1100
       CALL BLCKC
*ENDIF
       IF( REPORT(5) ) CALL PRINTA(5)
       IF( REPORT(5) ) WRITE(6,INPUTB)
C  IF NEW MASS LOSS CHARACTERISTICS OR ORBITER/SPACELAB AGES ARE TO BE
C  READ IN, SET NEWMLC = .TRUE.
       IF(.NOT.NEWMLC) GO TO 60
       CHNGES = 0
       CHNGEK = 0
       CHNGEP = 0
       READ(5,INPUTB)
       IF(CHNGES.NE.0) READ(5,1007)(MM,SPECIE(MM),MOLWT(MM),DIA(MM),
      1                             I=1,CHNGES)
       IF(CHNGEK.NE.0) READ(5,1008)(KK,KIND(KK),I=1,CHNGEK)
       IF(CHNGEP.NE.0) READ(5,1008)(LL,PLACE(LL),I=1,CHNGEP)
  1007 FORMAT(I3,1X,A6,E10.3,E10.3)
```

```
 1008 FORMAT(8(I3,1X,A6))
      IF( REPORT(6) ) CALL PRINTA(6)
      IF( REPORT(6) ) WRITE(6,INPUTB)
C
 60   CONTINUE
C  CALL TEMPERATURE LOADER,LOADT, TO LOAD IN SURFACE TEMPERATURES.
C  THE USER CAN  READ IN NEW TEMPERATURES FROM CARDS IF NEWTCD = .TRUE.
C  THE ARRAY TEMP EMERGES WITH ALL SURFACE TEMPERATURES WHERE THE INDEX
C  IS THE SURFACE ID NUMBER (SURFACES MUST BE NUMBERED FROM 1 TO 4000).
C  THESE TEMPERATURES ARE LATER REWRITTEN INTO TEMPOS AND TEMPOR FOR
C  COMPACTNESS.
C     ASSUME  TEMPERATURES WILL BE READ FROM TAPE 10
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGA4,1,4)
*ENDIF
*IF IDENT,U1100
      CALL LOADT
*ENDIF
C
C     CALL BLOCKC TO SET UP THE MISSION PROFILE DATA
C  THIS ROUTINE INSERTS DATA FOR LINE-OF-SIGHT AND RETURN FLUX
C  CALCULATIONS.
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGA5,1,5)
*ENDIF
*IF IDENT,U1100
      CALL BLCKD
*ENDIF
C
C  AT THIS POINT THE USER CAN WRITE OUT THE PRESET MISSION DATA AND
C  THEN MODIFY THESE DATA.
      READ(5,MPDB)
      IF( REPORT(8) ) CALL PRINTA(8)
      IF(REPORT(8)) WRITE(6,MPDB)
C
C  GIVEN THE SPACECRAFT ALTITUDE, DETERMINE THE AMBIENT DENSITY FOR SEGD
      AMBND = AMBDEN(ALT)
C
C  READ AND STORE MASS TRANSPORT FACTORS
      IF(.NOT.NEWMFP) GO TO 240
      CALL OPENMS(13,INDEX,521,1)
C
      ALLNEW = .FALSE.
      IF((.NOT.(ORBITR.OR.LMOP.OR.SMTP.OR.FIVP)).AND.NEWCON)
     + ALLNEW=.TRUE.
      TINCD=0.0
      CTINCD=0.0
C
C  CHECK TAPE14(IF ORBITR) AND TAPE 15(IF PAYLOAD) TO SEE IF THE
C  DATA ARE AVAILABLE.
C
  70  CONTINUE
      JDATA = 300
C
C  ZERO OUT STORAGE ARRAY FOR VIEW FACTOR CARDS
  90  ITPTS = ITPTS +1
      DO 100 K=1,JDATA
      NODEJ(K) = 0
      MFIJ(K) = 0
      MFJI(K) = 0
      AREAJ(K) = 0
      THETAI(K)=0.
      THETAJ(K)=0.
```

```
      R(K)=0.
  100 CONTINUE
C
C  READ IN DATA FOR MASS TRANSPORT FRACTIONS.
C
C  A BLANK CARD IS INSERTED BETWEEN DATA FOR DIFFERENT
C  RECEIVING NODES. A NON ZERO CONTRIBUTION PLACED IN COLUMNS 1 TO 6
C  IS USED ON AN OTHERWISE BLANK CARD TO SIGNAL THE END OF THE DATA
C
      J = 0
      NODEI = 0
      JDATA = 0
      IF(.NOT.(ORBITR.OR.ALLNEW)) GO TO 140
      IPASS = 0
  110 J = J + 1
      IF(J .GT. 300) CALL ERRORA(13,0)
      READ(14,1000)IDI14,NODEJ(J),MFIJ(J),MFJI(J),AREAJ(J),THETAI(J),
     *             THETAJ(J),R(J)
C
      IF( EOF(14)) 120,130
  120 IF(LMOP.OR.SMTP.OR.FIVP) GO TO  140
      GO TO 230
C
 1000 FORMAT(2I10,3E10.3,2F10.2,E10.3)
  130 JDATA=J-1
      IF(IDI14.EQ.30010) JJDATA=JDATA
      ILAST = IDI14
      IF(NODEJ(J).EQ.0.) GO TO 140
      IF(IDI14.NE.NODEI.AND.IPASS.GT.0) CALL ERRORA(14,0)
      NODEI = IDI14
      IPASS = 1
      GO TO 110
  140 CONTINUE
C
C  CHECK TAPE 15
      IF(.NOT.(LMOP.OR.SMTP.OR.FIVP)) GO TO 200
      IPASS = 0
      J = JDATA
  150 J=J+1
      IF(J .GT.300) CALL ERRORA(13,0)
C
      READ(15,1000)IDI15,NODEJ(J),MFIJ(J),MFJI(J),AREAJ(J),THETAI(J),
     *             THETAJ(J),R(J)
C
      IF( EOF(15)) 230,160
  160 JDATA=J-1
      ILAST = IDI15
      IF(NODEJ(J).EQ.0.) GO TO 200
      IF(IDI15.NE.NODEI.AND.IPASS.GT.0) CALL ERRORA(14,0)
C
C  IF ORBITER DATA ARE ALSO BEING TRANSFERRED TO TAPE13, CHECK TO ASSURE
C  IDI15 IS THE SAME AS NODEI(IDI14)
C
      IF(.NOT.ORBITR) GO TO 190
      IF(IDI15.EQ.NODEI) GO TO 190
      BACKSPACE 15
C
C  ZERO OUT THIS LAST SET OF DATA
      NODEJ(J) = 0
      MFIJ(J) = 0
      MFJI(J) = 0
      AREAJ(J) = 0
      THETAI(J)=0.
```

```
      THETAJ(J)=0.
      R(J)=0.
C
C  FLUSH THE TRASYS ARRAY PRTIALLY FILED WITH ORBITER DATA
      CALL WRITMS(13,NODEI,2102,NODEI)
      IF(IDI15 .EQ.INDEX(II) ) GO TO 180
C
C  CCHECK TO SEE IF IDI15 WAS STORED ON TAPE13 PREVIOUSLY
      DO 170 II=1,521
      IF(IDI15.EQ.INDEX(II)) GO TO 180
C
 170  CONTINUE
C
C  SOMEHOW PAYLOAD POINT IDI15 IS LESS THAN LAST ORBITER POINT STORED
C  BUT A CORRESPONDING POINT DOES NOT EXIST FOT THE ORBITER
C
      NODEI = IDI15
      JDATA = 0
      GO TO 140
 180  CONTINUE
C  HERE IF ORBITER DATA FOR IDI15 HAS ALREADY BEEN STORED ON TAPE13
C
      CALL READMS(13,NODEI,2102,IDI15)
C
C  SET THE J COUNTER AT JDATA
      J = JDATA
      NODEI = IDI15
      GO TO 150
C
 190  NODEI = IDI15
      IPASS = 1
      GO TO 150
 200  CONTINUE
C
C  ALL MASS TRANSPORT FACTORS TO POINTS ARE STORED ON TAPE 13
      CALL WRITMS(13,NODEI,2102,NODEI)
      IF( REPORT(9) ) CALL PRINTA(9)
      IF( REPORT(9)) WRITE(6,1006)(NODEI,NODEJ(JJ),MFIJ(JJ),MFJI(JJ),
     ,                AREAJ(JJ),THETAI(JJ),THETAJ(JJ),R(JJ),JJ=1,JDATA)
 1006 FORMAT(1X,2I10,2X,6E10.3)
C
      IF(NODEI.NE.30010) GO TO 220
      NODEI=30015
      IDI15=NODEI
      DO 210 N=JJDATA,300
      NODEJ(N) = 0.0
      MFIJ(N) = 0.0
      MFJI(N) = 0.0
      AREAJ(N) = 0.0
      THETAI(N) = 0.0
      THETAJ(N) = 0.0
      R(N) = 0.0
 210  CONTINUE
      GO TO 170
 220  GO TO 70
C  HERE IF EOF WAS HIT ON TAPE14
 230  CALL CLOSMS(13)
C  ALL DATA HAVE BEEN READ OFF TAPE14 AND INFO FOR IPNT WAS NOT FOUND
C  TO DROP IPNT BACK TOWARD Z-AXIS.
C     IPNT = IPNT - 10000
C     IF(IPNT .LT.10000) CALL ERRORD(11,IPNT)
C     IF(IPNT .LT.20000) IPNT = 10000
C  GO BACK AND CHECK INDEX
```

```
C
C  APPARENTLY THE TERMINATOR TO THE VIEW FACTOR CARDS WAS READ
C  NOW THAT THE RANDOM MASS STORAGE FILE HAS BEEN CLOSED TURN NEWMFP OFF
      NEWMFP=.FALSE.
 240  CONTINUE
      IF(.NOT. NEWMFS) RETURN
      REWIND 12
      IF( REPORT(10) )CALL PRINTA(10)
 250  READ(5,1005)  NODEI,NODJ,VFIJ,VFJI,A,THI,THJ,RADIUS
 1005 FORMAT(2I10,6E10.3)
      IF(NODEI.EQ.0) GO TO 260
      WRITE(12,1005)NODEI,NODJ,VFIJ,VFJI,A,THI,THJ,RADIUS
      IF(REPORT(10))WRITE(6,1001)NODEI,NODJ,VFIJ,VFJI,A,THI,THJ,RADIUS
 1001 FORMAT(1X,2I10,2X,6E10.3)
      GO TO 250
 260  END FILE 12
      RETURN
      END
*DECK PRINTA
*IF IDENT,U1100
{FOR,IS PRINTA
*ENDIF
      SUBROUTINE PRINTA(IPRINT)
C
C
C           ********************************************
C           *                                          *
C           *          PRINTER FOR SEGMENT A           *
C           *                                          *
C           ********************************************
C                                    CODED BY: M. METRICK  2/16/77
C  OBJECTIVE:
C     THIS ROUTINE IS CALLED TO SET UP THE VARIOUS OUTPUT REPORTS THAT
C     ARE REQUESTED BY THE USER. IT CAN BE ACCESSED FROM ANY ROUTINE
C
*CALL MDF
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/MISC/ LINE,IPAGE,CFLAG
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      DIMENSION IDT(3)
      LOGICAL ED,ENG,EVAP,LEAK,OUT,REFLCT,DEPSIT
      INTEGER PNTSC,CIDENT,CLOC,CTYPE
      IMAX=10
      IPRINT=IPRINT
      IF(IPRINT.GT.IMAX) GO TO 100
*IF -IDENT,U1100
      CALL DATE(TODAY)
      CALL TIME(HMS)
      IF(IPRINT.GT.IMAX) GO TO 100
      WRITE(6,1000) IPRINT,TITLE,TODAY,HMS,IPAGE
 1000 FORMAT(1H1,///,13H  REPORT NO. ,I2,12A6,10X,2A10,"  PAGE",I5/)
*ENDIF
*IF IDENT,U1100
```

```
      CALL FDATEX(IDT)
      WRITE(6,1000) IPRINT,TITLE,IDT,IPAGE
 1000 FORMAT(1H1,///,13H  REPORT NO. ,I2,12A6,10X,3A6,"  PAGE",I5/)
*ENDIF
      IPAGE = IPAGE + 1
C
      GO TO (1,2,3,4,5,6,7,8,9,10),IPRINT
C
   1  WRITE(6,1010)
 1010 FORMAT(11H  CONTENTS:,
     ,          40H  LISTING OF INPUT CONTROL PARAMETERS    )
C     WRITE(6,CNTRL)
      RETURN
   2  WRITE(6,1020)
 1020 FORMAT(11H  CONTENTS:,
     ,          50H  PRESET LIST OF SURFACES,ENGINES, AND VENTS       )
      IF(.NOT.(ED.OR.OUT.OR.LEAK.OR.REFLCT)) GO TO 21
      WRITE(6,1021)
 1021 FORMAT(//,5X,30H* * *  SURFACES * * *                ,
     ,       //,5X,45HSEQUENCE   IDENT    SECTION   MATERIAL   AREA,/
     ,          5X,49HNO.         NO.                          (SQ IN) )
      WRITE(6,1022)(I,IDENT(I),SECT(I),MATRL(I),AREA(I),I=1,JTOTAL)
 1022 FORMAT(    2I10,  5X,A6,5X, A6,  F10.0)
   21 IF(.NOT.(ENG .OR. EVAP))   RETURN
      WRITE(6,1023)
 1023 FORMAT(//,5X,48H* * *  ENGINE OPERATION  * * *                ,
     ,       //,5X,48HSEQUENCE   IDENT    LOCATION  TYPE'       ON-TIME,/
     ,          5X,48HNO.         NO.                           (SEC) )
      WRITE(6,1024)(I,PNTSC(I),CLOC(I),CTYPE(I),ONTIME(I),I=1,KTOTAL)
 1024 FORMAT(2I10,5X,A6,3X,A6,F10.3)
      RETURN
   3  WRITE(6,1030)
 1030 FORMAT(11H  CONTENTS:,
     ,          48H  LIST OF SOURCES TO BE EVALUATED              )
      IF(.NOT.(ED.OR.OUT.OR.LEAK.OR.REFLCT)) GO TO 31
      WRITE(6,1021)
      WRITE(6,1022)(I,IDENT(I),SECT(I),MATRL(I),AREA(I),I=1,JTOTAL)
   31 IF(.NOT.(ENG .OR. EVAP))   RETURN
      WRITE(6,1023)
      WRITE(6,1024)(I,CIDENT(I),CLOC(I),CTYPE(I),ONTIME(I),I=1,KTOTAL)
      RETURN
   4  WRITE(6,1040)
 1040 FORMAT(11H  CONTENTS:,
     ,          48H LIST OF CHANGES TO PRESET CONTAMINATION SOURCES)
      RETURN
   5  WRITE(6,1050)
 1050 FORMAT(11H  CONTENTS:,
     ,          48H  LIST OF PRESET MASS LOSS RATE COEFFICIENTS    )
      RETURN
   6  WRITE(6,1060)
 1060 FORMAT(11H  CONTENTS:,
     ,          48H  MODIFIED LIST OF MASS LOSS RATE COEFFICIENTS  )
      RETURN
   7  WRITE(6,1070)
 1070 FORMAT(11H  CONTENTS:,
     ,          48H  LIST OF SURFACE TEMPERATURES THAT WILL BE USED)
      WRITE(6,1071)
 1071 FORMAT(//,5X,45HSEQUENCE   IDENT    TEMP      MATERIAL   AREA,/
     ,          5X,49HNO.         NO.      (DEG C)              (SQ IN) )
      WRITE(6,1072)(I,IDENT(I),TEMPOS(I),MATRL(I),AREA(I),I=1,JTOTAL)
 1072 FORMAT(    2I10,  F10.0,4X, A6,  F10.0)
C
      IF(.NOT.DEPSIT) RETURN
```

```
      WRITE(6,1073)
 1073 FORMAT(///,5X,"    ***   SURFACES CRITICAL TO DEPOSITION   ***"/)
      WRITE(6,1074)
      DO 71 I=1,50
      IF(RECEVR(I).EQ.0) GO TO 71
      WRITE(6,1075)I,RECEVR(I),TEMPOR(I)
   71 CONTINUE
 1074 FORMAT(//,5X,45HLIST OF DIRECT LINE OF SIGHT SURFACES          //
     ,          5X,45HSEQUENCE    IDENT     TEMP                    /
     ,          5X,49HNO.         NO.       (DEG C)                   )
 1075 FORMAT(2I10,F10.0)
      WRITE(6,1076)
      DO 72 I=1,10
      IF(RFSURF(I).EQ.0) GO TO 72
      II=I + 50
      WRITE(6,1075)I,RFSURF(I),TEMPOR(II)
   72 CONTINUE
 1076 FORMAT(//,5X,45HLIST OF RETURN FLUX SURFACES                   //
     ,          5X,45HSEQUENCE    IDENT     TEMP                    /
     ,          5X,49HNO.         NO.       (DEG C)                   )
      RETURN
    8 WRITE(6,1080)
 1080 FORMAT(11H  CONTENTS:,
     ,           48H  LIST OF MISSION DATA THAT WILL BE USED          )
C     WRITE(6,MPDB)
      RETURN
    9 WRITE(6,1090)
 1090 FORMAT(11H  CONTENTS:,
     ,   58H  LIST OF MASS TRANSPORT FACTOR DATA - SURFACE TO POINTS  ,/
     ,   58H  (DATA ARE BEING LOADED ONTO TAPE 13)                    ,/
     ,     / 4X,   48H  NODEI      NODEJ    MFIJ      MFJI      AREAJ  ,
     ,       4X,   48HTHETAI    THETAJ    RADIUS                      )
C     WRITE(6,VIEW FACTORS)
      RETURN
   10 WRITE(6,1100)
 1100 FORMAT(11H  CONTENTS:,
     ,   58H  LIST OF MASS TRANSPORT FACTOR DATA - SURFACE TO SURFACE ,/
     ,           48H  (DATA ARE BEING LOADED ONTO TAPE 12)            ,/
     ,     / 4X,   48H  NODEI      NODEJ    MFIJ      MFJI      AREAJ  ,
     ,       4X,   48HTHETAI    THETAJ    RADIUS                      )
  100 RETURN
      END
*DECK RMS
*IF IDENT,U1100
{FOR,IS RMS
C
      SUBROUTINE RMS(NUNIT,NWDS,NR)
      COMMON/MS/ INDEX(521)
      INTEGER FWA
      DIMENSION FWA(1),INDUM(1)
      ENTRY OPENMS(NUNIT,INDUM,NRECS,IDUM)
      I=0
      MAXR=NRECS-1
      IF(IDUM.EQ.1) MAXR=(NRECS-1)/2
      DEFINE FILE NUNIT(MAXR,2102,U,IV)
      REWIND 4
      READ(4,ERR=5) INDEX
    5 RETURN
      ENTRY WRITMS(NUNIT,FWA,NWDS,NR)
      I=I+1
      INDEX(I)= NR
      WRITE(NUNIT"I) (FWA(J),J=1,NWDS)
      RETURN
```

```
      ENTRY READMS(NUNIT,FWA,NWDS,NR)
      DO 1 K=1,MAXR
      KK=K
      IF(INDEX(K).EQ.NR) GO TO 2
    1 CONTINUE
      WRITE(6,3) NR
    3 FORMAT(10X,///,' READMS COULD NOT FIND DATA FOR ',I10,///)
    2 CONTINUE
      IF( NR).EQ.0) RETURN
      READ(NUNIT"KK) (FWA(J),J=1,NWDS)
      RETURN
      ENTRY CLOSMS(NUNIT)
       REWIND 4
       WRITE(4)  INDEX
      RETURN
      END
*ENDIF
*DECK ERRORA
*IF IDENT,U1100
{FOR,IS ERRORA
*ENDIF
      SUBROUTINE ERRORA(IMBAD,IPROB)
C
C           ************************************************
C           *                                              *
C           *        ERROR  MESSAGES  FOR  SEGMENT  A      *
C           *                                              *
C           ************************************************
C                                    CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    THIS ROUTINE IS CALLED WHEN AN ERROR MESSAGE IS DESIRED. IT CAN BE
C    ACCESSED FROM ANY ROUTINE IN SEGMENT A.
C
      IMAX=20
      IF(IMBAD.GT.IMAX)WRITE(6,1000)IMBAD
C
      GO TO (101,102,103,104,105,106,107,108,109,110,
     ,       111,112,113,114,115,116,117,118,119,120),IMBAD
C  ***************************************************************
    1 FORMAT("  TAPE",I3,"ENCOUNTERED AN EOF (FATAL)")
    2 FORMAT("  PARITY ERROR WAS FOUND ON TAPE",I3," (FATAL) " )
    3 FORMAT("  YOU HAVE REQUESTED ENG OR EVAP WITHOUT THE ORBITER ")
    4 FORMAT("  TBD " )
    5 FORMAT("  TBD   ")
    6 FORMAT("  LOADT-  FOUND MAXTMP SET EQUAL TO MINTMP (FATAL)")
    7 FORMAT("  LOADT- ATCODE WAS SET GREATER THAN 5(FATAL)")
    8 FORMAT("  TBD ")
    9 FORMAT("  TBD " )
   10 FORMAT("  TBD " )
   11 FORMAT("  TBD " )
   12 FORMAT("  TBD " )
   13 FORMAT(" COLLECT(145) ATTEMPT TO LOAD MORE THAN 300 VIEW FACTORS")
   14 FORMAT(" COLLECT(150) A BLANK CARD WAS NOT INSERTED BETWEEN SETS")
   15 FORMAT(" BLOCKA(380) ATTEMPT TO LOAD MORE THAN 300 SURFACES ")
   16 FORMAT(" COLLCT - IDENT(I) IS",I10,"MUST BE LESS THAN 9999")
   17 FORMAT(" THE TYPE OF ENGINE NUMBERED",I10,"HAS NOT BEEN DEFINED")
   18 FORMAT(" COLLCT-YOU ARE TRYING TO LOAD IN MORE THAN 300 SURFACES")
   19 FORMAT(" COLLCT-YOU ARE TRYING TO LOAD IN MORE THAN 50 ENGINES")
   20 FORMAT(" TBD")
C  CALLED FROM COLLECT
  101 WRITE(6,1)IPROB
      CALL EXIT
C  CALLED FROM COLLECT
```

```
 102  WRITE(6,2)IPROB
      CALL EXIT
C  CALLED FROM COLLECT
 103  WRITE(6,3)
      CALL EXIT
C  CALLED FROM COLLECT
 104  WRITE(6,4)
      CALL EXIT
C  CALLED FROM LOADT
 105  WRITE(6,5)
      CALL EXIT
C  CALLED FROM LOADT
 106  WRITE(6,6)
      CALL EXIT
C  CALLED FROM LOADT
 107  WRITE(6,7)
      CALL EXIT
C  CALLED FROM RTNFLX
 108  WRITE(6,8)IPROB
      RETURN
C  CALLED FROM MLOSSR
 109  WRITE(6,9)IPROB
      CALL EXIT
C  CALLED FROM
 110  WRITE(6,10)
      CALL EXIT
C  CALLED FROM
 111  WRITE(6,11)IPROB
      CALL EXIT
C  CALLED FROM
 112  WRITE(6,12)IPROB
      CALL EXIT
C  CALLED FROM
 113  WRITE(6,13)
      CALL EXIT
C  CALLED FROM
 114  WRITE(6,14)
      CALL EXIT
C  CALLED FROM
 115  WRITE(6,15)
      CALL EXIT
 116  WRITE(6,16)IPROB
      CALL EXIT
 117  WRITE(6,17)IPROB
      CALL EXIT
C  CALL FROM COLLECT
 118  WRITE(6,18)
      CALL EXIT
C  CALL FROM COLLECT
 119  WRITE(6,19)
      CALL EXIT
 120  WRITE(6,20)
      CALL EXIT
 1000 FORMAT("   ERROR CODE REQUESTED",I10,"DOES NOT EXIST IN SUBOUTINE
     ,ERROR ")
      END
*DECK AMBDEN
*IF IDENT,U1100
{FOR,IS AMBDEN
*ENDIF
      FUNCTION AMBDEN (ALT)
C
C          ************************************************
```

```
C          *                                                    *
C          *              AMBIENT  NUMBER DENSITY               *
C          *                                                    *
C          ******************************************************
C                                        CODED BY: M. HARTLE   2/16/77
C  OBJECTIVE:
C    THIS FUNCTION DEFINES THE AMBIENT NUMBER DENSITY GIVEN AN ALTITUDE
C    AND SUN SPOT ACTIVITY.
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      DIMENSION ALTUD(26),DEN1(26),DEN2(26),DEN3(26)
      LOGICAL SUNL,SUNM,SUNH
      DATA(ALTUD(I),I=1,26)
     ,/105.,110.,120.,130.,140.,150.,160.,180.,200.,220.,240.,260.,
     , 280.,300.,350.,400.,450.,500.,600.,700.,800.,900.,1000.,1500.,
     , 2000.,2500./
      DATA(DEN1(I),I=1,26)
     ,/4.59E+12,2.14E+12,5.51E+11,1.76E+11,6.83E+10,3.21E+10,1.71E+10,
     , 6.25E+09,2.80E+09,1.40E+09,7.47E+08,4.21E+08,2.43E+08,1.44E+08,
     , 4.11E+07,1.28E+07,4.46E+06,1.85E+06,6.34E+05,3.93E+05,2.93E+05,
     , 2.32E+05,1.90E+05,9.20E+04,5.34E+04,3.35E+04/
      DATA(DEN2(I),I=1,26)
     ,/4.59E+12,2.13E+12,5.47E+11,1.51E+11,6.09E+10,3.33E+10,2.18E+10,
     , 1.14E+10,6.85E+09,4.39E+09,2.91E+09,1.99E+09,1.39E+09,9.83E+08,
     , 4.41E+08,2.09E+08,1.04E+08,5.36E+07,1.54E+07,4.82E+06,1.68E+06,
     , 6.79E+05,3.30E+05,5.95E+04,2.40E+04,1.24E+04/
      DATA(DEN3(I),I=1,26)
     ,/4.59E+12,2.12E+12,4.41E+11,1.58E+11,7.90E+10,5.00E+10,3.56E+10,
     , 2.15E+10,1.39E+10,9.50E+09,6.65E+09,4.79E+09,3.50E+09,2.60E+09,
     , 1.31E+09,7.09E+08,4.02E+08,2.35E+08,8.73E+07,3.50E+07,1.49E+07,
     , 6.63E+06,3.10E+06,1.84E+05,5.41E+04,2.60E+04/
C
      DO 1 I=1,26
    1 IF (ALT .LE. ALTUD(I)) GO TO 2
      GO TO 101
    2 IF (ALT .EQ. ALTUD(I)) GO TO 100
      IF (ALT .LT. 105) GO TO 102
      DIF1= ALTUD(I) - ALTUD(I-1)
      DIF2= ALT - ALTUD(I-1)
      IF (SUNL) X1= DEN1(I)
      IF (SUNL) X2= DEN1(I-1)
      IF (SUNM) X1= DEN2(I)
      IF (SUNM) X2= DEN2(I-1)
      IF (SUNH) X1= DEN3(I)
      IF (SUNH) X2= DEN3(I-1)
      DDIF= X1 - X2
      ANSR= (DIF2 * DDIF) / DIF1
      ANS= ANSR + X2
      GO TO 57
  100 IF (SUNL) ANS= DEN1(I)
      IF (SUNM) ANS= DEN2(I)
      IF (SUNH) ANS= DEN3(I)
      GO TO 57
  101 ALT= 2500.
      WRITE (6,11) ALT
      IF (SUNL) ANS= DEN1(26)
      IF (SUNM) ANS= DEN2(26)
      IF (SUNH) ANS= DEN3(26)
      GO TO 57
```

```
 102   ALT= 105.
       WRITE (6,11) ALT
       IF (SUNL) ANS= DEN1(1)
       IF (SUNM) ANS= DEN2(1)
       IF (SUNH) ANS= DEN3(1)
  57   AMBDEN= ANS
  11   FORMAT (1X,"ERROR - AADDF ALTITUDE LIMITS EXCEEDED.",1X,F6.1,1X,
       "KM DENSITY USED IN THIS ANALYSIS.")
       RETURN
       END
*DECK BLCKA
*IF IDENT,U1100
(FOR,IS BLCKA
*ENDIF
      SUBROUTINE  BLCKA
C
C           ********************************************************
C           *                                                      *
C           *                    BLOCK  DATA  A                    *
C           *                                                      *
C           ********************************************************
C                                      CODED BY: M. HETRICK  2/16/77
C                                                D. STRANGE  1/21/77
C  OBJECTIVE:
C    THIS ROUTINE SETS UP THE STS ORBITER CONFIGURATION BY DEFINING
C    GEOMETRIC SURFACES,THEIR IDENTIFICATION NUMBERS, LOCATION, MATERIAL
C    AND AREA.
C      IDENT     = SURFACE IDENTIFICATION NUMBER
C      SECT      = ORBITER/SPACELAB GEOMETRIC SUBSECTION
C         RADOOR= RADIATOR DOOR
C         BAY    = PAYLOAD BAY LINER, SIDE STRIPS, BULKHEADS
C         TAIL   = TAILFIN
C         CREW   = NOSE,CREW SECTION
C         WING   = WINGS
C         FUSLAG= FUSELAGE
C         OMS    = OMS PODS
C      MATRL     = SURFACE MATERIAL
C         LINER = PAYLOAD BAY LINER
C         BLKHED= FORE AND AFT BAY BULKHEADS
C         TEFLON= TEFLON
C         LRSI   = LOW TEMP RSI
C         HRSI   = HIGH TEMP RSI
C         NOMEX = PAINTED FELT
C         RCC    = CARBON
C         CRACKS= LEAKING SURFACE
C         WINDOW= CABIN WINDOWS
C      AREA      = SURFACE AREA IN SQUARE INCHES
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),     TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      LOGICAL   DBUGA,ED,ENG,EVAP,FIVP,LEAK,LMOP,ORBITR,OUT,SMTP,REFLCT
      DIMENSION IORBTR(1000),IPTS(300)
      INTEGER CIDENT,CLOC,CTYPE,CXLOC,CYLOC,CZLOC,PNTSC,SECT,SSURFS,
     1        SURFSC
```

```
C
C  CURRENTLY THERE ARE 174 SURFACES USED ON THE ORBITER SYNTHESIS
      DATA NSURFO /174/
C  ************************************
C     * * MASTER ARRAY FOR ORBITER * *
C
      DATA(IORBTR(I),I=1,40)
     1  /20,6HRADOOR,6HTEFLON,-12200,
     2   22,6HRADOOR,6HTEFLON, 12200,
     3   24,6HRADOOR,6HTEFLON, 12200,
     4   26,6HRADOOR,6HTEFLON, 12200,
     5   30,6HRADOOR,6HTEFLON, 12200,
     6   32,6HRADOOR,6HTEFLON, 12200,
     7   34,6HRADOOR,6HTEFLON, 12200,
     8   36,6HRADOOR,6HTEFLON, 12200,
     9   40,6HRADOOR,6HTEFLON, 25580,
     *   42,6HRADOOR,6HTEFLON, 25580/
C    10
      DATA(IORBTR(I),I=41,80)
     1  /44,6HRADOOR,6HTEFLON, 25580,
     2   46,6HRADOOR,6HTEFLON, 25580,
     3   50,6HRADOOR,6HTEFLON, 25580,
     4   52,6HRADOOR,6HTEFLON, 25580,
     5   54,6HRADOOR,6HTEFLON, 25580,
     6   56,6HRADOOR,6HTEFLON, 24990,
     7   21,6HFUSLAG,6H  LRSI, 12200,
     8   23,6HFUSLAG,6H  LRSI, 12200,
     9   25,6HFUSLAG,6H  LRSI, 12200,
     *   27,6HFUSLAG,6H  LRSI, 12200/
C    20
      DATA(IORBTR(I),I=81,120)
     1  /31,6HFUSLAG,6H  LRSI, 12200,
     2   33,6HFUSLAG,6H  LRSI, 12200,
     3   35,6HFUSLAG,6H  LRSI, 12200,
     4   37,6HFUSLAG,6H  LRSI, 12200,
     5   41,6HFUSLAG,6H  LRSI, 25580,
     6   43,6HFUSLAG,6H  LRSI, 25580,
     7   45,6HFUSLAG,6H  LRSI, 25580,
     8   47,6HFUSLAG,6H  LRSI, 25580,
     9   51,6HFUSLAG,6H  LRSI, 24990,
     *   53,6HFUSLAG,6H  LRSI, 24990/
C    30
      DATA(IORBTR(I),I=121,160)
     1  /55,6HFUSLAG,6H  LRSI, 24990,
     2   57,6HFUSLAG,6H  LRSI, 24990,
     3  202,6HFUSLAG,6H  LRSI, 32520,
     4  203,6HFUSLAG,6H  LRSI, 32520,
     5  230,6HFUSLAG,6H  LRSI, 25730,
     6  240,6HFUSLAG,6H  LRSI, 16340,
     7  241,6HFUSLAG,6H  LRSI, 16340,
     8  250,6HFUSLAG,6H  LRSI, 19580,
     9  260,6HFUSLAG,6H  LRSI, 20240,
     *  301,6HFUSLAG,6H  LRSI, 26600/
C    40
      DATA(IORBTR(I),I=161,200)
     1 /305,6HFUSLAG,6H  LRSI, 30930,
     2  306,6HFUSLAG,6H NOMEX, 30930,
     3  307,6HFUSLAG,6H NOMEX, 24770,
     4  311,6HFUSLAG,6H  LRSI, 26600,
     5  315,6HFUSLAG,6H  LRSI, 30930,
     6  316,6HFUSLAG,6H NOMEX, 30930,
     7  317,6HFUSLAG,6H NOMEX, 24770,
     8  420,6HFUSLAG,6H  LRSI,  1312,
```

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     9  425,6HFUSLAG,6H   LRSI,   1312,
     *   60,6H    OMS,6H   LRSI,   1145/
C    50
      DATA(IORBTR(I),I=201,240)
     1  /62,6H    OMS,6H   LRSI,   7850,
     2   64,6H    OMS,6H   LRSI,  37920,
     3   66,6H    OMS,6H   LRSI,   1991,
     4   67,6H    OMS,6H   LRSI,   2028,
     5   68,6H    OMS,6H   LRSI,    415,
     6   70,6H    OMS,6H   LRSI,    895,
     7   72,6H    OMS,6H   LRSI,   1406,
     8   74,6H    OMS,6H   LRSI,   1312,
     9   76,6H    OMS,6H   LRSI,    715,
     *   77,6H    OMS,6H   LRSI,    600/
C    60
      DATA(IORBTR(I),I=241,280)
     1  /80,6H    OMS,6H   LRSI,   1145,
     2   82,6H    OMS,6H   LRSI,   7813,
     3   84,6H    OMS,6H   LRSI,  37740,
     4   86,6H    OMS,6H   LRSI,   1991,
     5   87,6H    OMS,6H   LRSI,   2028,
     6   88,6H    OMS,6H   LRSI,    415,
     7   90,6H    OMS,6H   LRSI,    895,
     8   92,6H    OMS,6H   LRSI,   1406,
     9   94,6H    OMS,6H   LRSI,   1312,
     *   96,6H    OMS,6H   LRSI,    715/
C    70
      DATA(IORBTR(I),I=281,320)
     1  /97,6H    OMS,6H   LRSI,    601,
     2  100,6H   WING,6H NOMEX,   6356,
     3  102,6H   WING,6H NOMEX,  29590,
     4  104,6H   WING,6H NOMEX,   9125,
     5  110,6H   WING,6H NOMEX,  23340,
     6  112,6H   WING,6H NOMEX,  19380,
     7  115,6H   WING,6H  LRSI,  19280,
     8  117,6H   WING,6H  HRSI,   5650,
     9  118,6H   WING,6H  HRSI,   2508,
     *  119,6H   WING,6H  LRSI,   3302/
C    80
      DATA(IORBTR(I),I=321,360)
     1 /121,6H   WING,6H   RCC,   2251,
     2  122,6H   WING,6H   RCC,   3123,
     3  130,6H   WING,6H NOMEX,   6356,
     4  132,6H   WING,6H NOMEX,  29590,
     5  134,6H   WING,6H NOMEX,   9125,
     6  140,6H   WING,6H NOMEX,  23340,
     7  142,6H   WING,6H NOMEX,  19380,
     8  145,6H   WING,6H  LRSI,  19280,
     9  147,6H   WING,6H  HRSI,   5650,
     *  148,6H   WING,6H  HRSI,   2508/
C    90
      DATA(IORBTR(I),I=361,400)
     1 /149,6H   WING,6H  LRSI,   3302,
     2  151,6H   WING,6H   RCC,   2251,
     3  152,6H   WING,6H   RCC,   3123,
     4  106,6HELEVON,6H NOMEX,   6499,
     5  107,6HELEVON,6H NOMEX,  17210,
     6  136,6HELEVON,6H NOMEX,   6499,
     7  137,6HELEVON,6H NOMEX,   9125,
     8  450,6HELEVON,6H NOMEX,    138,
     9  451,6HELEVON,6H NOMEX,    415,
     *  452,6HELEVON,6H NOMEX,    692/
C   100
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      DATA(IORBTR(I),I=401,440)
     1 /453,6HELEVON,6H NOMEX,   960,
     2  454,6HELEVON,6H NOMEX,  1246,
     3  455,6HELEVON,6H NOMEX,  1523,
     4  456,6HELEVON,6H NOMEX,  1800,
     5  457,6HELEVON,6H NOMEX,  2076,
     6  458,6HELEVON,6H NOMEX,  2353,
     7  459,6HELEVON,6H NOMEX,  2630,
     8  460,6HELEVON,6H NOMEX,   138,
     9  461,6HELEVON,6H NOMEX,   415,
     *  462,6HELEVON,6H NOMEX,   692/
C  110
      DATA(IORBTR(I),I=441,480)
     1 /463,6HELEVON,6H NOMEX,   969,
     2  464,6HELEVON,6H NOMEX,  1246,
     3  465,6HELEVON,6H NOMEX,  1523,
     4  466,6HELEVON,6H NOMEX,  1800,
     5  467,6HELEVON,6H NOMEX,  2076,
     6  468,6HELEVON,6H NOMEX,  2353,
     7  469,6HELEVON,6H NOMEX,  2630,
     8  160,6H  CREW,6H   RCC,  7191,
     9  161,6H  CREW,6H  LRSI,  9348,
     *  162,6H  CREW,6H  LRSI,  9348/
C  120
      DATA(IORBTR(I),I=481,520)
     1 /163,6H  CREW,6H  LRSI,  3380,
     2  164,6H  CREW,6H  LRSI,  3380,
     3  165,6H  CREW,6H  LRSI,  4253,
     4  166,6H  CREW,6H  LRSI,  4253,
     5  167,6H  CREW,6H  HRSI, 12590,
     6  168,6H  CREW,6H  HRSI, 12590,
     7  169,6H  CREW,6H  HRSI,  9600,
     8  170,6H  CREW,6H  HRSI,  9600,
     9  171,6H  CREW,6H  HRSI,  3705,
     *  172,6H  CREW,6H  HRSI,  3705/
C  130
      DATA(IORBTR(I),I=521,560)
     1 /174,6H  CREW,6H  LRSI, 20720,
     2  175,6H  CREW,6H  LRSI, 10150,
     3  177,6H  CREW,6H  LRSI, 10150,
     4  180,6H  CREW,6HWINDOW,  1424,
     5  181,6H  CREW,6HWINDOW,  1424,
     6  182,6H  CREW,6HWINDOW,  1424,
     7  183,6H  CREW,6HWINDOW,  1424,
     8  184,6H  CREW,6HWINDOW,  1424,
     9  185,6H  CREW,6HWINDOW,  1424,
     *  190,6H  CREW,6H  LRSI, 10250/
C  140
      DATA(IORBTR(I),I=561,600)
     1 /380,6H  TAIL,6H  LRSI, 16920,
     2  381,6H  TAIL,6H  LRSI, 16920,
     3  382,6H  TAIL,6H  LRSI,  8833,
     4  383,6H  TAIL,6H  LRSI,  8833,
     5  384,6H  TAIL,6H  LRSI, 13940,
     6  385,6H  TAIL,6H  LRSI, 13940,
     7  386,6H  TAIL,6H  LRSI,  6116,
     8  387,6H  TAIL,6H  LRSI,  6116,
     9  388,6H  TAIL,6H  LRSI,  2744,
     *  389,6H  TAIL,6H  LRSI,  2744/
C  150
      DATA(IORBTR(I),I=601,640)
     1 /390,6H  TAIL,6H  LRSI,  1160,
     2  391,6H  TAIL,6H  LRSI,  1160,
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     3  392,6H  TAIL,6H  LRSI,  3081,
     4  393,6H  TAIL,6H  LRSI,  3081,
     5  399,6H  TAIL,6H  HRSI,  3823,
     6    1,6H   BAY,6H LINER, 26620,
     7    2,6H   BAY,6H LINER, 26620,
     8    3,6H   BAY,6H LINER, 26620,
     9    4,6H   BAY,6H LINER, 26620,
     *    5,6H   BAY,6H LINER, 26620/
C  160
      DATA(IORBTR(I),I=641,680)
     1   /6,6H   BAY,6H LINER, 26620,
     2    7,6H   BAY,6H LINER, 26620,
     3    8,6H   BAY,6H LINER, 26620,
     4   11,6H   BAY,6HBLKHED, 32690,
     5   13,6H   BAY,6HBLKHED, 32690,
     6  440,6H   BAY,6H LINER,  3444,
     7  441,6H   BAY,6H LINER,  3444,
     8  442,6H   BAY,6H LINER,  3444,
     9  443,6H   BAY,6H LINER,  3444,
     *  445,6H   BAY,6H LINER,  3444/
C  170
      DATA(IORBTR(I),I=681,696)
     1 /446,6H   BAY,6H LINER,  3444,
     2  447,6H   BAY,6H LINER,  3444,
     3  448,6H   BAY,6H LINER,  3444,
     4   13,6H  BAYL,6HCRACKS, 32690/
C  ************************************
C     * * MASTER ARRAY FOR ENGINES * *
C
C
C  FORWARD RCS ENGINES
      DATA(IPTS(I),I=1,84)
     1 /7112,6HFLF -X,6H   RCS,  332,   -14,   389,
     2  7122,6HFCF -X,6H   RCS,  332,     0,   391,
     3  7132,6HFRF -X,6H   RCS,  332,    14,   389,
     4  7123,6HFLS +Y,6H   RCS,  360,   -47,   368,
     5  7113,6HFLS +Y,6H   RCS,  360,   -47,   354,
     6  7115,6HFLU +Z,6H   RCS,  350,   -13,   395,
     7  7125,6HFCU +Z,6H   RCS,  350,     0,   395,
     8  7135,6HFRU +Z,6H   RCS,  350,    13,   395,
     9  7116,6HFLD -Z,6H   RCS,  333,   -41,   381,
     *  7126,6HFLD -Z,6H   RCS,  347,   -45,   386,
     1  7144,6HFRS -Y,6H   RCS,  362,    47,   368,
     2  7134,6HFRS -Y,6H   RCS,  362,    47,   354,
     3  7136,6HFRD -Z,6H   RCS,  333,    41,   381,
     4  7146,6HFRD -Z,6H   RCS,  347,    45,   386/
C  AFT RCS ENGINES LEFT SIDE OF ORBITER
      DATA(IPTS(I),I=85,156)
     5 /7211,6HALA +X,6H   RCS, 1557,  -119,   473,
     6  7231,6HALA +X,6H   RCS, 1557,  -132,   473,
     7  7243,6HALS +Y,6H   RCS, 1516,  -123,   459,
     8  7223,6HALS +Y,6H   RCS, 1529,  -123,   459,
     9  7233,6HALS +Y,6H   RCS, 1542,  -122,   459,
     *  7213,6HALS +Y,6H   RCS, 1555,  -122,   459,
     1  7245,6HALU +Z,6H   RCS, 1516,  -132,   481,
     2  7225,6HALU +Z,6H   RCS, 1529,  -132,   481,
     3  7215,6HALU +Z,6H   RCS, 1542,  -132,   481,
     4  7246,6HALD -Z,6H   RCS, 1516,  -112,   437,
     5  7226,6HALD -Z,6H   RCS, 1529,  -111,   440,
     6  7236,6HALD -Z,6H   RCS, 1542,  -110,   443/
C  AFT RCS ENGINES RIGHT SIDE OF ORBITER
      DATA(IPTS(I),I=157,228)
     7 /7311,6HARA +X,6H   RCS, 1557,   119,   473,
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     8  7331,6HARA +X,6H   RCS, 1557,   132,   473,
     9  7344,6HARS -Y,6H   RCS, 1516,   123,   459,
     *  7324,6HARS -Y,6H   RCS, 1529,   123,   459,
     1  7334,6HARS -Y,6H   RCS, 1542,   123,   459,
     2  7314,6HARS -Y,6H   RCS, 1555,   123,   459,
     3  7345,6HARU +Z,6H   RCS, 1516,   132,   481,
     4  7325,6HARU +Z,6H   RCS, 1529,   132,   481,
     5  7315,6HARU +Z,6H   RCS, 1542,   132,   481,
     6  7346,6HARD -Z,6H   RCS, 1516,   112,   437,
     7  7326,6HARD -Z,6H   RCS, 1529,   111,   440,
     8  7336,6HARD -Z,6H   RCS, 1542,   110,   443/
C  RCS VERNIER ENGINES
      DATA(IPTS(I),I=229,264)
     9 /8116,6HFLD -Z,6H   VCS,  324,   -46,   374,
     *  8136,6HFRD -Z,6H   VCS,  324,    46,   374,
     1  8257,6HALD -Z,6H   VCS, 1565,  -144,   459,
     2  8258,6HALS +Y,6H   VCS, 1565,  -118,   457,
     3  8357,6HARD -Z,6H   VCS, 1565,   144,   459,
     4  8358,6HARS +Y,6H   VCS, 1565,  -118,   457/
C  FLASH EVAPORATER
      DATA(IPTS(I),I=265,276)
     5 /6877,6HARS +Y,6H EVAP1, 1506,   127,   305,
     6  6879,6HALS -Y,6H EVAP1, 1506,  -127,   305/
C  OMS ENGINES
      DATA(IPTS(I),I=277,288)
     7 /9000,6HARA +X,6H   OMS, 1557,   127,   473,
     8  9002,6HALA +X,6H   OMS, 1557,  -127,   347/
C
C++++++++++++++++++++++++++++++++++++++++++++++++++
      IF(.NOT.(ENG .OR.EVAP)) GO TO 21
      KK=0
      DO 20 K=1,300,6
      KK=KK+1
      CIDENT(KK)= IPTS(K)
      CLOC(KK)  = IPTS(K+1)
      CTYPE(KK) = IPTS(K+2)
      CXLOC(KK) = IPTS(K+3)
      CYLOC(KK) = IPTS(K+4)
      CZLOC(KK) = IPTS(K+5)
      PNTSC(KK) = IPTS(K)
   20 CONTINUE
      KTOTAL = 48
   21 CONTINUE
C
      NDATAO=4*NSURFO
      II=0
      DO 40 I=1,NDATAO,4
      II=II+1
      IDENT(II)=IORBTR(I)
      SECT(II) =IORBTR(I+1)
      MATRL(II)=IORBTR(I+2)
      AREA(II) =IORBTR(I+3)
      IF(MATRL(II).NE.6HCRACKS ) GO TO 29
      IF(LEAK) GO TO 29
      II=II-1
      GO TO 35
   29 IF( SECT(II).NE.6H   BAY .AND.SECT(II).NE.6H  BAYL) GO TO 30
      IF(LMOP.OR.SMTP.OR.FIVP ) II=II-1
      GO TO 35
   30 IF(.NOT.(ED.OR.OUT.OR.REFLCT)) II=II-1
   35 CONTINUE
   40 CONTINUE
C
```

```
      IF(II.GT.300) CALL ERRORA(15.0)
      JTOTAL = II
      IF (DBUGA) WRITE(8,6000) JTOTAL
 6000 FORMAT("   WRITE(8,6000) JTOTAL  *,I10)
C
C  JTOTAL IS USED TO INDICATE THE MAXIMUM NUMBER OF PRESET SURFACES THAT
C  WILL BE EXAMINED DURING THE ANALYSIS.  THE USER CAN TURN OFF ANY
C  NUMBER THRU NAMELIST MPDB.
C
C  INSERT IDENT INTO SURFSC AND SSURF AS PART OF THE INITIALIZATION
C
      IF(.NOT.(ED.OR.OUT.OR.LEAK.OR.REFLCT)) RETURN
      DO 110 I=1,JTOTAL
      SSURFS(I) = IDENT(I)
      SURFSC(I)=IDENT(I)
  110 CONTINUE
      RETURN
      END
*DECK BLCKB
*IF IDENT,U1100
{FOR,IS BLCKB
*ENDIF
      SUBROUTINE  BLCKB
C
C           ***********************************************************
C           *                                                         *
C           *                    BLOCK  DATA  B                       *
C           *                                                         *
C           ***********************************************************
C                                      CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    THIS ROUTINE SETS UP THE SPACELAB LONG MODULE/ONE PALLET
C    CONFIGURATION (LMOP) BY DEFINING GEOMETRIC SURFACES,THEIR
C    IDENTIFICATION NUMBERS,LOCATION DESCRIPTION,MATERIAL, AND AREA
C      IDENT     = SURFACE IDENTIFICATION NUMBER
C      SECT      = SPACELAB GEOMETRIC SUBSECTION
C         MODULE= MODULE
C         PLT1  = PALLET NO. 1
C         PLT2  = PALLET NO. 2
C         PLT3  = PALLET NO. 3
C         PLT4  = PALLET NO. 4
C         PLT5  = PALLET NO. 5
C         WINDOW= WINDOW
C      MATRL     = SURFACE MATERIAL
C         CRACKS= LEAKING SURFACE
C         MTCS  = SPACELAB SURFACE 1
C         PTCS  = SPACELAB SURFACE 2
C         WINDOW= WINDOW
C      AREA      = SURFACE AREA IN SQUARE INCHES
C
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      LOGICAL DBUGA,FIVP,LEAK,LMOP,ORBITR,SMTP
      DIMENSION ISL1(420),ISL2(420),ISL3(420)
      INTEGER SECT,SSURFS,SURFSC
C
```

```
C  CURRENTLY THERE ARE 50 SURFACES USED ON THE LMOP SYNTHESIS
      DATA NSURFL,NSURFS,NSURFF/95,102,68/
C  ************************************
C     * * MASTER ARRAY FOR LMOP * *
C
      DATA(ISL1(I),I=1,40)
     1/1000,6HMODULE,6H  MTCS,  2389,
     2 1001,6HMODULE,6H  MTCS,  2389,
     3 1002,6HMODULE,6H  MTCS,  2389,
     4 1003,6HMODULE,6H  MTCS,  2389,
     5 1005,6HMODULE,6H  MTCS,  9558,
     6 1010,6HMODULE,6H  MTCS,  2919,
     7 1011,6HMODULE,6H  MTCS,  2919,
     8 1012,6HMODULE,6H  MTCS,  2919,
     9 1013,6HMODULE,6H  MTCS,  2919,
     * 1015,6HMODULE,6H  MTCS, 11680/
C   10
      DATA(ISL1(I),I=41,80)
     1/1020,6HMODULE,6H  MTCS,  2397,
     2 1021,6HMODULE,6H  MTCS,  2397,
     3 1022,6HMODULE,6H  MTCS,  2397,
     4 1023,6HMODULE,6H  MTCS,  2397,
     5 1025,6HMODULE,6H  MTCS,  9589,
     6 1030,6HMODULE,6H  MTCS,  6646,
     7 1031,6HMODULE,6H  MTCS,  6646,
     8 1032,6HMODULE,6H  MTCS,  6646,
     9 1033,6HMODULE,6H  MTCS,  6646,
     * 1035,6HMODULE,6H  MTCS,  2658/
C   20
      DATA(ISL1(I),I=81,120)
     1/1040,6HMODULE,6H  MTCS,  6646,
     2 1041,6HMODULE,6H  MTCS,  6646,
     3 1042,6HMODULE,6H  MTCS,  6646,
     4 1043,6HMODULE,6H  MTCS,  6646,
     5 1045,6HMODULE,6H  MTCS, 26580,
     6 1050,6HMODULE,6H  MTCS,  2628,
     7 1051,6HMODULE,6H  MTCS,  2628,
     8 1052,6HMODULE,6H  MTCS,  2628,
     9 1053,6HMODULE,6H  MTCS,  2628,
     * 1055,6HMODULE,6H  MTCS, 10510/
C   30
      DATA(ISL1(I),I=121,160)
     1/1060,6HMODULE,6H  MTCS,  2373,
     2 1061,6HMODULE,6H  MTCS,  2373,
     3 1065,6HMODULE,6H  MTCS,  2059,
     4 1070,6H  PLT1,6H  PTCS, 28220,
     5 1080,6H  PLT1,6H  PTCS,  1596,
     6 1081,6H  PLT1,6H  PTCS,  1596,
     7 1082,6H  PLT1,6H  PTCS,   684,
     8 1083,6H  PLT1,6H  PTCS,   684,
     9 1084,6H  PLT1,6H  PTCS,  5166,
     * 1085,6H  PLT1,6H  PTCS,  5166/
C   40
      DATA(ISL1(I),I=161,200)
     1/1086,6H  PLT1,6H  PTCS,  4093,
     2 1087,6H  PLT1,6H  PTCS,  4093,
     3 1088,6H  PLT1,6H  PTCS,  7866,
     4 1111,6H WINDL,6H LEAKL,  1219,
     5 1111,6HWINDOW,6H  MTCS,  1219,
     6 1121,6H WINDL,6H LEAKL,  2059,
     7 1121,6HWINDOW,6H  MTCS,  2059,
     8 1130,6HWINDOW,6H  MTCS,   194,
     9 1130,6H WINDL,6H LEAKL,   194,
```

```
     * 1413,6H  BAYL,6HCRACKS, 32690/
C    50
      DATA(ISL1(I),I=201,240)
     1/1401,6H   BAY,6H LINER, 26620,
     2 1402,6H   BAY,6H LINER, 26620,
     3 1403,6H   BAY,6H LINER, 26620,
     4 1404,6H   BAY,6H LINER, 26620,
     5 1405,6H   BAY,6H LINER, 26620,
     6 1406,6H   BAY,6H LINER, 26620,
     7 1407,6H   BAY,6H LINER, 26620,
     8 1408,6H   BAY,6H LINER, 26620,
     9 1411,6H   BAY,6HBLKHED, 32690,
     * 1413,6H   BAY,6HBLKHED, 32690/
C    60
      DATA(ISL1(I),I=241,280)
     1/1440,6H   BAY,6H LINER,  3444,
     2 1441,6H   BAY,6H LINER,  3444,
     3 1442,6H   BAY,6H LINER,  3444,
     4 1443,6H   BAY,6H LINER,  3444,
     5 1445,6H   BAY,6H LINER,  3444,
     6 1446,6H   BAY,6H LINER,  3444,
     7 1447,6H   BAY,6H LINER,  3444,
     8 1448,6H   BAY,6H LINER,  3444,
     9 1061,6H  MODL,6H LEAKL,  2373,
     * 1065,6H  MODL,6H LEAKL,  2059/
C    70
      DATA(ISL1(I),I=281,320)
     1/1000,6H  MODL,6H LEAKL,  2389,
     2 1001,6H  MODL,6H LEAKL,  2389,
     3 1002,6H  MODL,6H LEAKL,  2389,
     4 1003,6H  MODL,6H LEAKL,  2389,
     5 1010,6H  MODL,6H LEAKL,  2919,
     6 1011,6H  MODL,6H LEAKL,  2919,
     7 1012,6H  MODL,6H LEAKL,  2919,
     8 1013,6H  MODL,6H LEAKL,  2919,
     9 1020,6H  MODL,6H LEAKL,  2397,
     * 1021,6H  MODL,6H LEAKL,  2397/
C    80
      DATA(ISL1(I),I=321,360)
     1/1022,6H  MODL,6H LEAKL,  2397,
     2 1023,6H  MODL,6H LEAKL,  2397,
     3 1030,6H  MODL,6H LEAKL,  6646,
     4 1031,6H  MODL,6H LEAKL,  6646,
     5 1032,6H  MODL,6H LEAKL,  6646,
     6 1033,6H  MODL,6H LEAKL,  6646,
     7 1040,6H  MODL,6H LEAKL,  6646,
     8 1041,6H  MODL,6H LEAKL,  6646,
     9 1042,6H  MODL,6H LEAKL,  6646,
     * 1043,6H  MODL,6H LEAKL,  6646/
C    90
      DATA(ISL1(I),I=361,380)
     1/1050,6H  MODL,6H LEAKL,  2628,
     2 1051,6H  MODL,6H LEAKL,  2628,
     3 1052,6H  MODL,6H LEAKL,  2628,
     4 1053,6H  MODL,6H LEAKL,  2628,
     5 1060,6H  MODL,6H LEAKL,  2373/
C    ************************************
C
C      * * MASTER ARRAY FOR SMTP * *
C
C
C
      DATA(ISL2(I),I=1,40)
```

```
     1/2010,6HMODULE,6H  MTCS,  2295,
     2 2011,6HMODULE,6H  MTCS,  2295,
     3 2012,6HMODULE,6H  MTCS,  2295,
     4 2013,6HMODULE,6H  MTCS,  2295,
     5 2015,6HMODULE,6H  MTCS,  9179,
     6 2020,6HMODULE,6H  MTCS,  2397,
     7 2021,6HMODULE,6H  MTCS,  2397,
     8 2022,6HMODULE,6H  MTCS,  2397,
     9 2023,6HMODULE,6H  MTCS,  2397,
     * 2025,6HMODULE,6H  MTCS,  9589/
C   10
      DATA(ISL2(I),I=41,80)
     1/2030,6HMODULE,6H  MTCS,  6646,
     2 2031,6HMODULE,6H  MTCS,  6646,
     3 2032,6HMODULE,6H  MTCS,  6646,
     4 2033,6HMODULE,6H  MTCS,  6646,
     5 2035,6HMODULE,6H  MTCS,  2658,
     6 2050,6HMODULE,6H  MTCS,  2628,
     7 2051,6HMODULE,6H  MTCS,  2628,
     8 2052,6HMODULE,6H  MTCS,  2628,
     9 2053,6HMODULE,6H  MTCS,  2628,
     * 2055,6HMODULE,6H  MTCS, 10510/
C   20
      DATA(ISL2(I),I=  81,120)
     1/2060,6HMODULE,6H  MTCS,  2373,
     2 2061,6HMODULE,6H  MTCS,  2373,
     3 2065,6HMODULE,6H  MTCS,  2059,
     4 2070,6H  PLT1,6H  PTCS, 28220,
     5 2071,6H  PLT1,6H  PTCS,  1596,
     6 2072,6H  PLT1,6H  PTCS,  1596,
     7 2073,6H  PLT1,6H  PTCS,   684,
     8 2074,6H  PLT1,6H  PTCS,   684,
     9 2075,6H  PLT1,6H  PTCS,  5166,
     * 2076,6H  PLT1,6H  PTCS,  5166/
C   30
      DATA(ISL2(I),I= 121,160)
     1/2077,6H  PLT1,6H  PTCS,  4093,
     2 2078,6H  PLT1,6H  PTCS,  4093,
     3 2079,6H  PLT1,6H  PTCS,  7866,
     4 2080,6H  PLT2,6H  PTCS, 28220,
     5 2081,6H  PLT2,6H  PTCS,  1596,
     6 2082,6H  PLT2,6H  PTCS,  1596,
     7 2083,6H  PLT2,6H  PTCS,   684,
     8 2084,6H  PLT2,6H  PTCS,   684,
     9 2085,6H  PLT2,6H  PTCS,  5166,
     * 2086,6H  PLT2,6H  PTCS,  5166/
C   40
      DATA(ISL2(I),I=161,200)
     1/2087,6H  PLT2,6H  PTCS,  4093,
     2 2088,6H  PLT2,6H  PTCS,  4093,
     3 2089,6H  PLT2,6H  PTCS,  7866,
     4 2090,6H  PLT3,6H  PTCS, 28220,
     5 2091,6H  PLT3,6H  PTCS,  1596,
     6 2092,6H  PLT3,6H  PTCS,  1596,
     7 2093,6H  PLT3,6H  PTCS,   684,
     8 2094,6H  PLT3,6H  PTCS,   684,
     9 2095,6H  PLT3,6H  PTCS,  5166,
     * 2096,6H  PLT3,6H  PTCS,  5166/
C   50
      DATA(ISL2(I),I=201,240)
     1/2097,6H  PLT3,6H  PTCS,  4093,
     2 2098,6H  PLT3,6H  PTCS,  4093,
     3 2099,6H  PLT3,6H  PTCS,  7866,
```

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     4 2110,6HWINDOW,6H  MTCS,  1219,
     5 2111,6HWINDOW,6H  MTCS,  1219,
     6 2130,6HWINDOW,6H  MTCS,   194,
     7 2131,6HWINDOW,6H  MTCS,   194,
     8 2200,6HWINDOW,6H  MTCS,    28,
     9 2201,6HWINDOW,6H  MTCS,    28,
     * 2401,6H   BAY,6H LINER, 26620/
C    60
C      ++++++   BAY CHARACTERISTICS FOR SMTP ++++++++++
      DATA(ISL2(I),I=241,280)
     1/2402,6H   BAY,6H LINER, 26620,
     2 2403,6H   BAY,6H LINER, 26620,
     3 2404,6H   BAY,6H LINER, 26620,
     4 2405,6H   BAY,6H LINER, 26620,
     5 2406,6H   BAY,6H LINER, 26620,
     6 2407,6H   BAY,6H LINER, 26620,
     7 2408,6H   BAY,6H LINER, 26620,
     8 2440,6H   BAY,6H LINER,  3444,
     9 2441,6H   BAY,6H LINER,  3444,
     * 2442,6H   BAY,6H LINER,  3444/
C    70
      DATA(ISL2(I),I=281,320)
     1/2443,6H   BAY,6H LINER,  3444,
     2 2445,6H   BAY,6H LINER,  3444,
     3 2446,6H   BAY,6H LINER,  3444,
     4 2447,6H   BAY,6H LINER,  3444,
     5 2413,6H   BAY,6HBLKHED, 32690,
     6 2411,6H   BAY,6HBLKHED, 32690,
     7 2413,6H  BAYL,6HCRACKS, 32690,
     8 2010,6H  MODL,6H LEAKS,  2295,
     9 2011,6H  MODL,6H LEAKS,  2295,
     * 2012,6H  MODL,6H LEAKS,  2295/
C    80
      DATA(ISL2(I),I=321,360)
     1/2200,6H WINDL,6H LEAKS,    28,
     2 2201,6H WINDL,6H LEAKS,    28,
     3 2013,6H  MODL,6H LEAKS,  2295,
     4 2020,6H  MODL,6H LEAKS,  2397,
     5 2021,6H  MODL,6H LEAKS,  2397,
     6 2022,6H  MODL,6H LEAKS,  2397,
     7 2023,6H  MODL,6H LEAKS,  2397,
     8 2030,6H  MODL,6H LEAKS,  6646,
     9 2031,6H  MODL,6H LEAKS,  6646,
     * 2032,6H  MODL,6H LEAKS,  6646/
C    90
      DATA(ISL2(I),I=361,400)
     1/2033,6H  MODL,6H LEAKS,  6646,
     2 2050,6H  MODL,6H LEAKS,  2628,
     3 2051,6H  MODL,6H LEAKS,  2628,
     4 2052,6H  MODL,6H LEAKS,  2628,
     5 2053,6H  MODL,6H LEAKS,  2628,
     6 2060,6H  MODL,6H LEAKS,  2373,
     7 2061,6H  MODL,6H LEAKS,  2373,
     8 2065,6H  MODL,6H LEAKS,  2059,
     9 2110,6H WINDL,6H LEAKS,  1219,
     * 2111,6H WINDL,6H LEAKS,  1219/
C   100
      DATA(ISL2(I),I=401,408)
     1/2130,6H WINDL,6H LEAKS,   194,
     2 2131,6H WINDL,6H LEAKS,   194/
C
C     +++++++++     FIVP MASTER ARRAY  ++++++++
C
```

```
C
C
      DATA(ISL3(I),I=1,40)
     1/3050,6H   PLT1,6H   PTCS,  28220,
     2 3051,6H   PLT1,6H   PTCS,   1596,
     3 3052,6H   PLT1,6H   PTCS,   1596,
     4 3053,6H   PLT1,6H   PTCS,    684,
     5 3054,6H   PLT1,6H   PTCS,    684,
     6 3055,6H   PLT1,6H   PTCS,   5166,
     7 3056,6H   PLT1,6H   PTCS,   5166,
     8 3057,6H   PLT1,6H   PTCS,   4093,
     9 3058,6H   PLT1,6H   PTCS,   4093,
     * 3059,6H   PLT1,6H   PTCS,   7866/
C    10
      DATA(ISL3(I),I=41,80)
     1/3060,6H   PLT2,6H   PTCS,  28220,
     2 3061,6H   PLT2,6H   PTCS,   1596,
     3 3062,6H   PLT2,6H   PTCS,   1596,
     4 3063,6H   PLT2,6H   PTCS,    684,
     5 3064,6H   PLT2,6H   PTCS,    684,
     6 3065,6H   PLT2,6H   PTCS,   5166,
     7 3066,6H   PLT2,6H   PTCS,   5166,
     8 3067,6H   PLT2,6H   PTCS,   4093,
     9 3068,6H   PLT2,6H   PTCS,   4093,
     * 3069,6H   PLT1,6H   PTCS,   7866/
C    20
      DATA(ISL3(I),I=81,120)
     1/3070,6H   PLT3,6H   PTCS,  28220,
     2 3071,6H   PLT3,6H   PTCS,   1596,
     3 3072,6H   PLT3,6H   PTCS,   1596,
     4 3073,6H   PLT3,6H   PTCS,    684,
     5 3074,6H   PLT3,6H   PTCS,    684,
     6 3075,6H   PLT3,6H   PTCS,   5166,
     7 3076,6H   PLT3,6H   PTCS,   5166,
     8 3077,6H   PLT3,6H   PTCS,   4093,
     9 3078,6H   PLT3,6H   PTCS,   4093,
     * 3079,6H   PLT3,6H   PTCS,   7866/
C    30
      DATA(ISL3(I),I=121,160)
     1/3080,6H   PLT4,6H   PTCS,  28220,
     2 3081,6H   PLT4,6H   PTCS,   1596,
     3 3082,6H   PLT4,6H   PTCS,   1596,
     4 3083,6H   PLT4,6H   PTCS,    684,
     5 3084,6H   PLT4,6H   PTCS,    684,
     6 3085,6H   PLT4,6H   PTCS,   5166,
     7 3086,6H   PLT4,6H   PTCS,   5166,
     8 3087,6H   PLT4,6H   PTCS,   4093,
     9 3088,6H   PLT4,6H   PTCS,   4093,
     * 3089,6H   PLT4,6H   PTCS,   7866/
C    40
      DATA(ISL3(I),I=161,200)
     1/3090,6H   PLT5,6H   PTCS,  28220,
     2 3091,6H   PLT5,6H   PTCS,   1596,
     3 3092,6H   PLT5,6H   PTCS,   1596,
     4 3093,6H   PLT5,6H   PTCS,    684,
     5 3094,6H   PLT5,6H   PTCS,    684,
     6 3095,6H   PLT5,6H   PTCS,   5166,
     7 3096,6H   PLT5,6H   PTCS,   5166,
     8 3097,6H   PLT5,6H   PTCS,   4093,
     9 3098,6H   PLT5,6H   PTCS,   4093,
     * 3099,6H   PLT5,6H   PTCS,   7866/
C    50
C
```

```
C     FIVP BAY
C
      DATA(ISL3(I),I=201,240)
     1/3401,6H    BAY,6H LINER, 26620,
     2 3402,6H    BAY,6H LINER, 26620,
     3 3403,6H    BAY,6H LINER, 26620,
     4 3404,6H    BAY,6H LINER, 26620,
     5 3405,6H    BAY,6H LINER, 26620,
     6 3406,6H    BAY,6H LINER, 26620,
     7 3407,6H    BAY,6H LINER, 26620,
     8 3408,6H    BAY,6H LINER, 26620,
     9 3440,6H    BAY,6H LINER,  3444,
     * 3441,6H    BAY,6H LINER,  3444/
C   60
      DATA(ISL3(I),I=241,272)
     1/3442,6H    BAY,6H LINER,  3444,
     2 3443,6H    BAY,6H LINER,  3444,
     3 3445,6H    BAY,6H LINER,  3444,
     4 3446,6H    BAY,6H LINER,  3444,
     5 3447,6H    BAY,6H LINER,  3444,
     6 3413,6H    BAY,6HBLKHED, 32690,
     7 3410,6H    BAY,6HBLKHED, 32690,
     8 3413,6H   BAYL,6HCRACKS, 32690/
C     +++++++++ END  SPACE LAB HERE    ++++++++++
C
C
C
      II=JTOTAL
      NDATAL=4*NSURFL
      IF(.NOT. LMOP) GO TO 60
      DO 50 I=1,NDATAL,4
      II=II+1
      IDENT(II)=ISL1(I)
      SECT(II) =ISL1(I+1)
      MATRL(II)=ISL1(I+2)
      AREA(II) =ISL1(I+3)
      IF(MATRL(II).NE. 6HCRACKS .AND.MATRL(II).NE.6H LEAKL ) GO TO 49
      IF(.NOT.LEAK) II=II-1
      GO TO 50
   49 IF( SECT(II).NE.6H   BAY .AND.SECT(II).NE. 6H  BAYL ) GO TO 50
      IF(.NOT.ORBITR) II=II-1
   50 CONTINUE
   60 CONTINUE
C
      NDATAS=4*NSURFS
      IF(.NOT. SMTP) GO TO 80
      DO 70 I=1,NDATAS,4
      II=II+1
      IDENT(II)=ISL2(I)
      SECT(II) =ISL2(I+1)
      MATRL(II)=ISL2(I+2)
      AREA(II) =ISL2(I+3)
      IF(MATRL(II).NE. 6HCRACKS .AND.MATRL(II).NE.6H LEAKS ) GO TO 69
      IF(.NOT.LEAK) II=II-1
      GO TO 70
   69 IF( SECT(II).NE.6H   BAY .AND.SECT(II).NE. 6H  BAYL ) GO TO 70
      IF(.NOT.ORBITR) II=II-1
   70 CONTINUE
   80 CONTINUE
C
      NDATAF=4*NSURFF
      IF(.NOT. FIVP ) GO TO 100
      DO 90 I=1,NDATAF.4
```

```
      II=II+1
      IDENT(II)=ISL3(I)
      SECT(II) =ISL3(I+1)
      MATRL(II)=ISL3(I+2)
      AREA(II) =ISL3(I+3)
      IF(MATRL(II).NE. 6HCRACKS .AND.MATRL(II).NE.6H LEAKL ) GO TO 89
      IF(.NOT.LEAK) II=II-1
      GO TO 90
   89 IF( SECT(II).NE.6H   BAY .AND.SECT(II).NE. 6H  BAYL ) GO TO 90
      IF(.NOT.ORBITR) II=II-1
   90 CONTINUE
  100 CONTINUE
C
      IF(II.GT.300) CALL ERRORA(15,0)
      JTOTAL = II
C
      DO 110 I=1,JTOTAL
      SURFSC(I)=IDENT(I)
  110 SSURFS(I)=IDENT(I)
      RETURN
      END
*DECK BLCKC
*IF IDENT,U1100
{FOR,IS BLCKC
*ENDIF
      SUBROUTINE  BLCKC
C     ******************************************************
C     *                                                    *
C     *                  BLOCK  DATA  C                    *
C     *                                                    *
C     ******************************************************
C                                 CODED BY: M. HETRICK  2/16/77
C
C  OBJECTIVE:
C    THIS ROUTINE SETS UP THE MATERIALS MASS LOSS RATES FOR THE CURRENT
C    MATERIALS BEING USED ON THE STS ORBITER AND SPACELAB VEHICLES.  THE
C    USER CAN MODIFY THESE DATA THRU NAMELIST INPUTB OR MPDB.  UP TO
C    10 SPECIES ARE MONITORED. THE FOLLOWING TABLE LISTS MASS FRACTIONS
C    OF THOSE SPECIES LOST DURING CERTAIN ON-ORBIT EVENTS. MOLE FRACTION
C    ARE GIVEN IN PARENTHESES.
C
C    SPECIE,M        EARLY      OUTGAS      ENG          EVAP          LEAKAGE
C                    DESORP     PERIOD      FIRINGS      OPERATION
C                    PERIOD
C                                 1.0
C                                  X
C     1- OUTGAS1
C     2- OUTGAS2
C     3- H2O         .420(.570)               .290(.328)  1.0          .010(.016)
C     4- N2          .262(.229)               .420(.306)               .750(.760)
C     5- CO2         .212(.118)               .078(.036)               .010(.007)
C     6- O2          .100(.076)               .001(.001)               .230(.219)
C     7- CO                                   .184(.134)
C     8- H2                                   .017(.170)
C     9- ENG1(H)                              .001(.015)
C     10- ENG2(NO)                            .002(.001)
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1            EVAP,   FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2            MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3            MINTMP,ORBITR,OUT,    REFLCT,REPORT(50),
     4            RFAS,  RFSS,  SMTP,   TITLE(12),     TSTART(3),
     5            TSTOP(3),     GO,     SUNL,  SUNM,   SUNH
      COMMON/NPLM/NPLUME(5)
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
```

```
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/RATES1/RATE(15,10),TAU(15,10)
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15), SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      DIMENSION  RTE(15,10),TAW(15,10),NPLME(5),
     1           KKIND(15),SDATA(30),PLCE(20),SPDATA(50),PFDATA(50)
      INTEGER PLACE,PLCE
      REAL MOLWT
C
C     ***  PAYLOAD BAY LINER  ***
      DATA(RTE(1,M),M=1,10)
     1                    /8.00E-11,
     2                     0.0,
     3                     3.30E-10,
     4                     2.07E-10,
     5                     1.68E-10,
     6                     8.00E-11,
     7                        4*0.0/
      DATA(TAW(1,M),M=1,10)/2*4100.,8*18./
C
C     ***  TEFLON  ***
      DATA(RTE(2,M),M=1,10)
     1                    /5.00E-10,
     2                     0.0,
     3                     2.10E-09,
     4                     1.31E-09,
     5                     1.06E-09,
     6                     5.00E-10,
     7                        4*0.0/
      DATA(TAW(2,M),M=1,10)/2*4100.,8*18./
C
C     ***  NOMEX  ***
      DATA(RTE(3,M),M=1,10)
     1                    /1.24E-09,
     2                     0.0,
     3                     5.21E-09,
     4                     3.25E-09,
     5                     2.62E-09,
     6                     1.24E-09,
     7                       4*0.0/
      DATA(TAW(3,M),M=1,10)/2*4100.,8*18./
C
C     ***  LRSI  ***
      DATA(RTE(4,M),M=1,10)
     1                    /5.10E-10,
     2                     0.0,
     3                     2.14E-09,
     4                     1.34E-09,
     5                     1.08E-09,
     6                     5.10E-10,
     7                        4*0.0/
      DATA(TAW(4,M),M=1,10)/2*4100.,8*18./
C
C     ***  HRSI  ***
      DATA(RTE(5,M),M=1,10)
     1                    /5.20E-10,
     2                     0.0,
     3                     2.18E-09,
     4                     1.36E-09,
     5                     1.10E-09,
     6                     5.20E-10,
```

```
     7                          4*0.0/
      DATA(TAW(5,M),M=1,10)/2*4100.,8*18./
C
C     *** RCC ***
      DATA(RTE(6,M),M=1,10)
     1                        /1.00E-12,
     2                         0.0,
     3                         4.20E-12,
     4                         2.62E-12,
     5                         2.12E-12,
     6                         1.00E-12,
     7                           4*0.0/
      DATA(TAW(6,M),M=1,10)/2*4100.,8*18./
C
C     *** BULKHEAD ***
      DATA(RTE(7,M),M=1,10)
     1                        /1.00E-09,
     2                         0.0,
     3                         4.20E-09,
     4                         2.62E-09,
     5                         2.12E-09,
     6                         1.00E-09,
     7                           4*0.0/
      DATA(TAW(7,M),M=1,10)/2*4100.,8*18./
C
C     *** WINDOW ***
      DATA(RTE(8,M),M=1,10)
     1                        /0.0,
     2                         0.0,
     3                         0.0,
     4                         0.0,
     5                         0.0,
     6                         0.0,
     7                       4*0.0/
      DATA(TAW(8,M),M=1,10)/10*4100./
C
C     *** MTCS ***
      DATA(RTE(9,M),M=1,10)
     1                        /6.00E-09,
     2                         0.0,
     3                         1.64E-07,
     4                         1.02E-07,
     5                         8.27E-08,
     6                         3.90E-08,
     7                           4*0.0/
      DATA(TAW(9,M),M=1,10)/2*4100.,8*18./
C
C     *** PTCS ***
      DATA(RTE(10,M),M=1,10)
     1                        /6.01E-09,
     2                         0.0,
     3                         1.64E-07,
     4                         1.02E-07,
     5                         8.27E-08,
     6                         3.90E-08,
     7                           4*0.0/
      DATA(TAW(10,M),M=1,10)/2*4100.,8*18./
C
C     *** CABIN ATMOSPHERE LEAKS ***
      DATA(RTE(11.,M),M=1,10)
     1                        /0.0,
     2                         0.0,
     3                         1.745E-12,
```

```
     4                    1.308E-10,
     5                    1.745E-10,
     6                    4.014E-11,
     7                       4*0.0/
      DATA(TAW(11,M),M=1,10)/10*0.0/
C
C     ***  LMOP LEAKAGE (LEAKL)***
C     AREA = 1.012E5 SQ INCHES
      DATA(RTE(12,M),M=1,10)
     1                    /0.0,
     2                     0.0,
     3                     2.39E-13,
     4                     1.79E-11,
     5                     2.39E-13,
     6                     5.50E-12,
     7                        4*0.0/
      DATA(TAW(12,M),M=1,10)/10*0.0/
C     ***  SMTP LEAKAGE (LEAKS)***
C     AREA = 6.267E4 SQ INCHES
      DATA(RTE(13,M),M=1,10)
     1                    /0.0,
     2                     0.0,
     3                     3.86E-13,
     4                     2.90E-11,
     5                     3.86E-13,
     6                     8.89E-12,
     7                        4*0.0/
      DATA(TAW(13,M),M=1,10)/10*0.0/
C  THE FOLLOWING IS USED TO PLACATE THE CDC LOADER
C
      DO 10 M=1,10
      DO 5 K=1,15
      RATE(K,M) = RTE(K,M)
    5 TAU(K,M)  = TAW(K,M)
   10 CONTINUE
C
C  ****************************
C    * * MATERIALS  LIST * *
      KINDS=15
      DATA(KKIND(K),K=1,15)
     1    /6H LINER,
     2     6HTEFLON,
     3     6H NOMEX,
     4     6H  LRSI,
     5     6H  HRSI,
     6     6H   RCC,
     7     6HBLKHED,
     8     6HWINDOW,
     9     6H  MTCS,
     *     6H  PTCS,
     1     6HCRACKS,
     2     6H LEAKL,
     3     6H LEAKS,
     4     6H  NONE,
     5     6H  NONE/
C
      DO 20 K=1,15
   20 KIND(K)=KKIND(K)
C
C  ***************************************************************************
C  * * LIST OF SPECIES,MOLECULAR WEIGHTS AND DIAMETERS(CENTIMETERS) * *
C  * * THAT WILL BE USED TO COMPUTE COLLISION CROSS SECTIONS        * *
C  * * REFERENCE HIRSCHFELDER,CURTISS AND BIRD
```

```
C  * *
      DATA(SDATA(K),K=1,30)
     1    /6H OUTG1,    100.,   9.967E-8,
     2     6H OUTG2,     85.,   6.633E-8,
     3     6H   H2O,     18.,   3.245E-8,
     4     6H    N2,     28.,   4.132E-8,
     5     6H   CO2,     44.,   4.485E-8,
     6     6H    O2,     32.,   3.853E-8,
     7     6H    CO,     28.,   4.029E-8,
     8     6H    H2,      2.,   3.331E-8,
     9     6H     H,      1.,   2.640E-8,
     *     6HMMHNO3,     46.,   4.500E-8/
C
      KK=0
      DO 30 K=1,28,3
      KK=KK+1
      SPECIE(KK) = SDATA(K)
      MOLWT(KK)  = SDATA(K+1)
   30 DIA(KK)    = SDATA(K+2)
C  ******************************
C    * * LIST OF SURFACE LOCATIONS * *
      DATA(PLCE(K),K=1,10)
     1    /6H   BAY,
     2     6H  CREW,
     3     6HFUSLAG,
     4     6H   OMS,
     5     6HRADOOR,
     6     6H  TAIL,
     7     6H  WING,
     8     6HMODULE,
     9     6H  PLT1,
     *     6H  PLT2/
      DATA(PLCE(K),K=11,20)
     1    /6H  PLT3,
     2     6H  PLT4,
     3     6H  PLT5,
     4     6HWINDOW,
     5     6HELEVON,
     6     6H  BAYL,
     7     6H  MODL,
     8     6H WINDL,
     9     6H  NONE,
     *     6H  NONE/
C
      DO 40 I=1,20
   40 PLACE(I)=PLCE(I)
C
C*****************************************************************
C   LOAD IN THE SPECIES MASS FRACTIONS TO BE USED FOR THE
C   SHUTTLE ENGINES AND EVAPORATOR
C
      DATA(SPDATA(K),K=1,50)
C  TYPE OUT1   OUT2   H2O    N2     CO2    O2     CO     H2     H     MMH HNO3
     1 /0.0,   0.0,  .290,  .420,  .078,  .001,  .184,  .017,  .001,  .002,
     2  0.0,   0.0,  .290,  .420,  .078,  .001,  .184,  .017,  .001,  .002,
     3  0.0,   0.0,  .290,  .420,  .078,  .001,  .184,  .017,  .001,  .002,
     4  0.0,   0.0, 1.000,  0.0,   0.0,   0.0,   0.0,   0.0,   0.0,   0.0,
     5  0.0,   0.0, 1.000,  0.0,   0.0,   0.0,   0.0,   0.0,   0.0,   0.0/
      DO 60 K=1,5
      DO 50 L=1,10
   50 SPECMF(L,K)=SPDATA( (K-1)*10+L )
   60 CONTINUE
C
```

```
C   LOAD IN THE PLUME FUNCTION COEFICIENTS
C
      DATA(PFDATA(K),K=1,50)
C       C1     C2      C3    THETA1 C5    C6    THETA2 MFLUX VELOC  TYPE
     1 /1351.,10.00,.0126,64.0, 35.0,-.0350,180.,  0.,3.5E+5,6H   RCS,
     2   23.2, 8.65,.0137,40.0,5.810,-.0467,140.,.054,3.5E+5,6H   VCS,
     3  9332.,10.65,.0126,64.0,235.5,-.0350,180.,  0.,3.5E+5,6H   OMS,
     4   4.47, 6.00,.0176,36.8, 1.14,-.0773,148.,.002,1.0E+5,6H EVAP2,
     5  1.963, 6.00,.0106,148.,   0.,    0.,148.,  0.,1.0E+5,6H EVAP1/
C
      DATA(NPLME(K),K=1,5)
C      TYPES OF ENGINES/VENTS
     1 /  6H   RCS,
     2    6H   VCS,
     3    6H   OMS,
     4    6H EVAP2,
     5    6H EVAP1/
C
C
      DO 80 K=1,5
      DO 70 L=1,10
  70  PLUMEC(L,K) = PFDATA( (K-1) * 10 + L )
  80  CONTINUE
      DO 90 K=1,5
  90  NPLUME(K) = NPLME(K)
      RETURN
      END
*DECK LOADT
*IF IDENT,U1100
{FOR,IS LOADT
*ENDIF
      SUBROUTINE  LOADT
C
C           ************************************************
C           *                                              *
C           *              TEMPERATURE LOADER              *
C           *                                              *
C           ************************************************
C                                      CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C
C  THIS ROUTINE IS USED TO LOAD IN ALL SURFACE TEMPERATURES FROM EITHER
C  CARDS OR TAPE10(THE TEMPERATURE PROFILE TAPE)
C  CURRENTLY THERE IS NO TIME VARIATION IN SURFACE TEMPERATURE, ONLY
C  AVERAGE STEADY STATE TEMPERATURES ARE AVAILABLE.
C
C  GO INTO THIS ROUTINE WITH THE VEHICLE ATTITUDE CODE (ATCODE) AND
C  SELECT THE PROPER SURFACE TEMPERATURES
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/MDF/ ATCODE, TIME(6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6            DPHI(10),DOMEGA(10),DTHETA(10),
     7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8            X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
```

```
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      DIMENSION TEMP(2000)
      LOGICAL DBUGA,MAXTMP,MINTMP,NEWTCD,NEWTNL,REPORT,SMTP,
     1        FIVP,LMOP,ORBITR
      INTEGER ATCODE,RECEVR,RFSURF,SSURFS,SURFSC
      NAMELIST/TEMPS/ TEMPOS,TEMPOR
      NAMELIST/INPUTC/TEMP
C  ********************************************************************
C  INITIALIZE ALL TEMPERATURES TO 100C
      DO 5 I=1,2000
    5 TEMP(I) = 100.
      NUNIT=11
C  CHECK FOR CONSISTENCY IN THE INPUT CONTROL DATA
      IF(MAXTMP.AND.MINTMP) CALL ERRORA(6,0)
      IF(ATCODE.GT.5) CALL ERRORA(7,0)
      IF(.NOT.NEWTCD) NUNIT = 10
      IF(.NOT.NEWTCD) GO TO 111
C  ************************************************************
C  READ NEW TEMPERATURES FROM CARDS AND STORE ON SCRATCH TAPE 11
C  THE DATA DECK MUST TERMINATE WITH A BLANK CARD.
      REWIND 10
      REWIND 11
 1000 FORMAT(I5,7F10.2)
   10 READ(5,1000) ISURFN,TMAXN,TMINN,T1N,T2N,T3N,T4N,T5N
      IF(ISURFN.EQ.0)GO TO 20
C
C  COPY THE NEW DATA ONTO THE NEW "PERMANENT" TEMPERATURE PROFILE TAPE
C          IF(DBUGA)WRITE(8,6011)ISURFN,TMAXN,TMINN,T1N,T2N,T3N,T4N,T5N
*IF IDENT,U1100
   12 READ(10,1000,END=14)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
*ENDIF
*IF -IDENT,U1100
   12 READ(10,1000)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
               IF(EOF(10) )14,13
*ENDIF
C
C
C
   13 CONTINUE
C          IF(DBUGA)WRITE(8,6012)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
      IF(ISURF.NE.ISURFN) GO TO 15
C  ONLY NEW NON ZERO TEMPERATURES WILL BE TRANSFERED TO TAPE11 FOR
C  TEMPERATURES OTHER THAN THOSE CURRENTLY BEING PROCESSED
      IF(TMAXN.NE.0.) TMAX=TMAXN
      IF(TMINN.NE.0.) TMIN=TMINN
      IF(MAXTMP) TMAX=TMAXN
      IF(MINTMP) TMIN=TMINN
      IF(T1N.NE.0..OR.ATCODE.EQ.1) T1=T1N
      IF(T2N.NE.0..OR.ATCODE.EQ.2) T2=T2N
      IF(T3N.NE.0..OR.ATCODE.EQ.3) T3=T3N
      IF(T4N.NE.0..OR.ATCODE.EQ.4) T4=T4N
      IF(T5N.NE.0..OR.ATCODE.EQ.5) T5=T5N
C
      WRITE(11,1000)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
C          IF(DBUGA)WRITE(8,6013)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
      GO TO 10
C  NEW SURFACE NUMBER
   14 BACKSPACE 10
      WRITE(11,1000)ISURFN,TMAXN,TMINN,T1N,T2N,T3N,T4N,T5N
C          IF(DBUGA)WRITE(8,6014)ISURFN,TMAXN,TMINN,T1N,T2N,T3N,T4N,T5N
C
```

```
      GO TO 10
   15 WRITE(11,1000)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
      GO TO 12
C  REWIND THE TEMPERATURE FILE AND LOAD IN THE PROPER VALUES INTO TEMP
   20 CONTINUE
*IF -IDENT,U1100
   21 READ(10,1000)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
            IF(EOF(10) )111,41
*ENDIF
*IF IDENT,U1100
   21 READ(10,1000,END=111)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
*ENDIF
   41 WRITE(11,1000)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
      GO TO 21
  111 REWIND NUNIT
*IF IDENT,U1100
   30 READ(NUNIT,1000,END=110)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
*ENDIF
*IF -IDENT,U1100
   30 READ(NUNIT,1000)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
            IF(EOF(NUNIT) )110,40
*ENDIF
C          IF(DBUGA)WRITE(8,6012)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5
C
C
C
   40 CONTINUE
      IF(ISURF.EQ.0) GO TO 110
C  SINCE THERE IS CORE FOR SUBSCRIPTS UP TO 2000 ONLY, SMTP AND FIVP
C  SURFACE NUMBERS MUST BE ADJUSTED TEMPORARILY.  THIS HAS NO EXTERNAL
C  EFFECT ON SMTP OR FIVP SURFACE IDENTIFICATION NUMBERS.
C
C  CHECK THE RANGE OF THE VALUE ISURF
      IF(ISURF.LT.1000) GO TO 42
      IF(ISURF.LT.2000) GO TO 44
      IF(ISURF.LT.3000) GO TO 46
      IF(ISURF.LT.4000) GO TO 48
      CALL ERRORA(8,ISURF)
   42 IF(.NOT.ORBITR) GO TO 30
      GO TO 50
   44 IF(.NOT.LMOP) GO TO 30
      GO TO 50
   46 IF(.NOT.SMTP) GO TO 30
      ISURF=ISURF-1000
      GO TO 50
   48 IF(.NOT.FIVP) GO TO 30
      ISURF=ISURF-2000
   50 CONTINUE
      TEMP(ISURF) = TMAX
      IF(MAXTMP) GO TO 30
      IF(MINTMP) TEMP(ISURF) = TMIN
      IF(ATCODE.EQ.1) TEMP(ISURF) = T1
      IF(ATCODE.EQ.2) TEMP(ISURF) = T2
      IF(ATCODE.EQ.3) TEMP(ISURF) = T3
      IF(ATCODE.EQ.4) TEMP(ISURF) = T4
      IF(ATCODE.EQ.5) TEMP(ISURF) = T5
      GO TO 30
  110 CONTINUE
C
      IF(.NOT.NEWTNL) GO TO 130
      READ(5,INPUTC)
  130 CONTINUE
C
```

```
C  FOR EASE IN HANDLING THESE SURFACE TEMPERATURES LATER, SAVE ONLY THE
C  PERTINENT DATA
      DO 150 J=1,JTOTAL
      NJ=SURFSC(J)
      IF(NJ.EQ.0) GO TO 150
      IF(NJ.LE.2000) GO TO 140
      IF(SMTP) NJ=NJ-1000
      IF(FIVP ) NJ=NJ-2000
 140  TEMPOS(J)=TEMP(NJ)
 150  CONTINUE
      DO 170 I=1,50
      NI=RECEVR(I)
      IF(NI.EQ.0) GO TO 170
      IF(NI.LE.2000) GO TO 160
      IF(SMTP) NI=NI-1000
      IF(FIVP ) NI=NI-2000
 160  TEMPOR(I)=TEMP(NI)
 170  CONTINUE
      DO 190 I=1,10
      J = I + 50
      NI=RFSURF(I)
      IF(NI.EQ.0) GO TO 190
      IF(NI.LE.2000) GO TO 180
      IF(SMTP) NI=NI-1000
      IF(FIVP ) NI=NI-2000
 180  TEMPOR(J)=TEMP(NI)
 190  CONTINUE
      REWIND 10
      REWIND 9
      IF( REPORT(7) ) CALL PRINTA(7)
C
 6011      FORMAT(' READ(INPUT)ISURFN,TMAXN,TMINN,T1N,T2N,T3N,T4N,T5N',
     ,           /I15,7F10.2)
 6012      FORMAT(' READ(NUNIT)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5 ',
     ,           /I15,7F10.2)
 6013      FORMAT(' WRITE(11)ISURF,TMAX,TMIN,T1,T2,T3,T4,T5 ',
     ,           /I15,7F10.2)
 6014      FORMAT(' WRITE(11)ISURFN,TMAXN,TMINN,T1N,T2N,T3N,T4N,T5N ',
     ,           /I15,7F10.2)
      RETURN
      END
*DECK BLCKD
*IF IDENT,U1100
{FOR,IS BLCKD
*ENDIF
      SUBROUTINE  BLCKD
C
C           ************************************************
C           *                                              *
C           *                BLOCK  DATA  D                *
C           *                                              *
C           ************************************************
C                                      CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    THIS ROUTINE SETS UP THE MISSION PROFILE DATA REQUIRED FOR THE
C    PREDICTION OF MASS COLUMN DENSITY AND RETURN FLUX.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
```

```
      COMMON/MDF/ ATCODE, TIME(6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6            DPHI(10),DOMEGA(10),DTHETA(10),
     7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8            X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SEGD1/NLOS,RFSTK
      DIMENSION DS1(25),THETL1(25),PHIL1(25),XLOS1(25),
     ,    YLOS1(25),ZLOS1(25),X00(10),Y00(10),Z00(10),T1(10),T2(10),
     ,    P1(10),P2(10)
      LOGICAL SUNL,SUNM,SUNH
C
      DATA(DS1(I),I=1,25)/2.5,9*5.,15.,25.,37.5,50.,124.,10*0./
      DATA(XLOS1(I),I=1,25)/25*1107./
      DATA(YLOS1(I),I=1,25)/25*0./
      DATA(ZLOS1(I),I=1,25)/25*507./
      DATA(THETL1(I),I=1,25)/0.,30.,60.,30.,60.,30.,60.,30.,60.,30.,60.,
     ,     30.,60.,30.,60.,30.,60.,8*82.5/
      DATA(PHIL1(I),I=1,25)/0.,0.,0.,45.,45.,90.,90.,135.,135.,180.,
     ,     180.,225.,225.,270.,270.,315.,315.,0.,45.,90.,135.,180.,225.,
     ,     270.,315./
      DATA(X00(I),I=1,10)/10*1107./
      DATA(Y00(I),I=1,10)/10*0./
      DATA(Z00(I),I=1,10)/10*507./
      DATA(T1(I),I=1,10)/10*0./
      DATA(T2(I),I=1,10)/10*10.24/
      DATA(P1(I),I=1,10)/10*0./
      DATA(P2(I),I=1,10)/10*360./
      RMAXL= 300
      RMAXRF = 300
      ALT    = 400.
      VX = 0.0
      VY = 0.0
      VZ = -7650.
      SUNL = .FALSE.
      SUNM = .TRUE.
      SUNH = .FALSE.
      VFACTR = 3.
      RFSTK = 1.0
      NLOS = 1
C
C  THE FOLLOWING IS USED TO PLACATE THE CDC LOADER
      DO 10 I=1,25
      THETAL(I)=THETL1(I)
      PHIL(I)=PHIL1(I)
      XLOS(I)=XLOS1(I)
      YLOS(I)=YLOS1(I)
      ZLOS(I)=ZLOS1(I)
      DSMCD(I)=DS1(I)
   10 DSRTNF(I)=DS1(I)
      DO 20 I=1,10
      COSXX(I) = 1.
      COSXY(I) = 0.
      COSXZ(I) = 0.
      COSYX(I) = 0.
      COSYY(I) = 1.
      COSYZ(I) = 0.
      COSZX(I) = 0.
      COSZY(I) = 0.
      COSZZ(I) = 1.
```

```
      THETA1(I)=T1(I)
      THETA2(I)=T2(I)
      PHI1(I)=P1(I)
      PHI2(I)=P2(I)
      DTHETA(I)=10.24
      DPHI(I)=10.24
      DOMEGA(I)= .10
      X0(I)=X00(I)
      Y0(I)=Y00(I)
 20   Z0(I)=Z00(I)
      RETURN
      END
*DECK AUDIT
*IF IDENT,U1100
(FOR,IS AUDIT
*ENDIF
      SUBROUTINE  AUDIT
C
C           ***************************************************
C           *                                                 *
C           *                MASS LOSS AUDIT                  *
C           *                                                 *
C           ***************************************************
C                                    CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    THE OBJECTIVE OF THIS ROUTINE IS TO TAKE THE EXISTING INFORMATION
C    CONCERNING SURFACE TEMPERATURES AND MASS LOSS CHARACTERISTICS AND
C    COMPUTE THE ACTUAL MASS THAT WILL BE LOST FROM THE SURFACES. THIS
C    PROVIDES THE ANALYST WITH AN IDEA OF THE MAGNITUDE OF THE SOURCES.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      COMMON/RATES1/RATE(15,10),TAU(15,10)
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15), SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/MFDATA/NODEI,NODEJ(300),MFIJ(300),THETAI(300),THETAJ(300),
     1              R(300)
      COMMON/CMLOSS/MLR(300,10),MDOTJ(300)
      REAL MDOTJ,MLR,MLOSS,IRMF
      INTEGER SECT,SSURFS,SURFSC
      DIMENSION IRMF(10),TMLR(10)
      LOGICAL REPORT,REFLCT,DBUGB,ED,OUT,LEAK
C ***************************************************************
C
      TMDOT = 0.
C  ZERO OUT THE MLR ARRAY
      DO 10 I=1,JTOTAL
      DO 10 J=1,10
  10  MLR(I,J)=0.
C  ZERO OUT THE TMLR AND IRMF ARRAYS
      DO 11 J=1,10
      IRMF(J)=0.
  11  TMLR(J)=0.
C ***************************************************************
```

```
      IF(.NOT.ED.AND..NOT.OUT.AND..NOT.LEAK) GO TO 80
      IF(REPORT(11))CALL PRINTB(11)
C  EXAMINE EACH SURFACE AND COMPUTE ITS MASS LOSS RATE
      DO 30 J=1,JTOTAL
      CALL MLOSSR(J)
C  NEXT COMPUTE THE MASS LOST PER SECOND FROM THE TOTAL SURFACE AREA
      MDOTJ(J)=0.
      DO 20 M=M1,M2
      MLOSS = MLR(J,M) * AREA(J) * 2.54**2.
   20 MDOTJ(J) = MDOTJ(J) + MLOSS
   30 CONTINUE
C
C  NEXT ORDER THE SURFACES IN TERMS OF DECREASING CONTRIBUTIONS TO MASS
C  LOSS.
      CALL ORDER
C
      IF(.NOT.REPORT(11)) GO TO 80
      TMDOT = 0.
      TAREA = 0.
      TOGR = 0.
      TEDR = 0.
      IF(JTOTAL.LT.JKEEP) JKEEP = JTOTAL
      DO 70 J=1,JKEEP
      IF(SURFSC(J).EQ.0) GO TO 70
      TMDOT = TMDOT + MDOTJ(J)
      TAREA = TAREA + AREA(J)
      DO 40 M=1,10
   40 TMLR(M) = TMLR(M) + MLR(J,M)*AREA(J)*2.54**2.
C  DETERMINE THE PORTION THATS CONSIDERED OFFGASSING OR EARLY DESORPTION
      OFFR=0.
      DO 50 M=MED1,MED2
   50 OFFR=OFFR+MLR(J,M)
      TEDR = TEDR + OFFR * AREA(J)*2.54**2.
C  DETERMINE THE LONG TERM OUTGASSING MASS LOSS RATE
      OUTR=0.
      DO 60 M=MOUT1,MOUT2
   60 OUTR=OUTR+MLR(J,M)
      TOGR = TOGR + OUTR * AREA(J)*2.54**2.
      AREACM = 6.4516*AREA(J)
      WRITE(6,1020) SURFSC(J),AREA(J),SECT(J),MDOTJ(J),(MLR(J,M),M=1,5)
                   ,AREACM,MATRL(J),TEMPOS(J),(MLR(J,M),M=6,10),OFFR,OUTR
   70 CONTINUE
      TAREAC=TAREA*6.4516
C
      DO 65 M=1,10
   65 TMLR(M)=TMLR(M)/TAREAC
      TEDR=TEDR/TAREAC
      TOGR=TOGR/TAREAC
      WRITE(6,1030)TAREA,TMDOT,TAREAC,(TMLR(M),M=1,5),TEDR,TOGR,
                                                    (TMLR(M),M=6,10)
 1020 FORMAT(I10,2X,E8.2,2X,A6,2X,E10.3,3X,5E9.2/
     ,       10X,2X,E8.2,2X,A6,2X,F10.0,3X,5E9.2,9X,E10.3,3X,E10.3/)
 1030 FORMAT("     ------------------------------------------------------
     ,------------------------------          --------------------"/
     ,"     TOTALS",2X,E8.2,10X,E10.3/
     ,"           ",2X,E8.2/
     ,"     AVERAGE",32X,5E9.2,9X,E10.3,3X,E10.3,/43X,5E9.2)
C
C  NEXT IF THE REFLECT OPTION IS DESIRED, THE PROCEDURE IS TO RECYCLE
C  AND DETERMINE HOW MUCH MASS IS INCIDENT ON EACH SURFACE FROM OTHER
C  SURFACES ,ENGINES OR VENTS WHICH IN TURN COULD BE REEMITTED AND ADDED
C  TO ITS ORIGINAL CONTRIBUTION.
C
```

```
   80  IF(.NOT.REFLCT) RETURN
C
       DO 85 J=1,10
   85  TMLR(J) = 0.
C
       IF(REPORT(12))CALL PRINTB(12)
       DO 140 J=1,JTOTAL
       IF(SURFSC(J).EQ.0)GO TO 140
C  CHECK TO SEE IF SURFSC(J) IS AN ALLOWABLE SOURCE OF SECOND SURFACE MA
       DO 90 JCHEK=1,300
       IF(SURFSC(J).EQ.SSURFS(JCHEK) ) GO TO 110
   90  CONTINUE
C  APPARENTLY SURFSC(J) WAS NOT AN ALLOWABLE SECOND SURFACE SOURCE
       GO TO 140
  110  CONTINUE
       CALL LOADB(SURFSC(J),NUMBER)
       IF(NUMBER.EQ.0) GO TO 125
       CALL RFLCT(NUMBER,J,IRMF)
            IF(DBUGB) WRITE(8,6060)SURFSC(J),(IRMF(M),M=1,10)
  6060      FORMAT(' IN AUDIT(110) SURFSC / REEMITTED M FLUX',I10/10E9.2)
C
C  COMBINE THE INCIDENT REEMITTED MASS FLUX COMING FROM OTHER SOURCES
C  WITH THE ORIGINAL MASS LOSS RATE
       DO 120 M=M1,M2
       MLR(J,M) = MLR(J,M)+IRMF(M)
  120  CONTINUE
  125  CONTINUE
       MDOTJ(J) = 0.
       DO 130 M=M1,M2
       MLOSS = MLR(J,M)*AREA(J)*2.54**2.
  130  MDOTJ(J)=MDOTJ(J)+MLOSS
  140  CONTINUE
C
C  NEXT ORDER THE SURFACES IN TERMS OF DECREASING CONTRIBUTIONS TO MASS
C  LOSS.
       CALL ORDER
C
       IF(.NOT.REPORT(12)) RETURN
       TMDOT = 0.
       TAREA = 0.
       TOGR = 0.
       TEDR = 0.
       DO 200 J=1,JKEEP
       IF(SURFSC(J).EQ.0) GO TO 200
       DO 150 M=1,10
  150  TMLR(M)=TMLR(M) + MLR(J,M) * AREA(J)*2.54**2.
       OFFR=0.
       DO 180 M=MED1,MED2
  180  OFFR=OFFR+MLR(J,M)
       TEDR = TEDR + OFFR * AREA(J) * 2.54**2.
       OUTR=0.
       DO 190 M=MOUT1,MOUT2
  190  OUTR=OUTR+MLR(J,M)
       TOGR = TOGR + OUTR * AREA(J) * 2.54**2.
       AREACM = 6.4516*AREA(J)
       WRITE(6,1020) SURFSC(J),AREA(J),SECT(J),MDOTJ(J),(MLR(J,M),M=1,5)
      ,              ,AREACM,MATRL(J),TEMPOS(J),(MLR(J,M),M=6,10),OFFR,OUTR
       TMDOT = TMDOT + MDOTJ(J)
       TAREA = TAREA + AREA(J)
  200  CONTINUE
       TAREAC=TAREA*6.4516
C
       DO 210 M=1,10
```

```
 210  TMLR(M)=TMLR(M)/TAREAC
      TEDR=TEDR/TAREAC
      TOGR=TOGR/TAREAC
      WRITE(6,1030)TAREA,TMDOT,TAREAC,(TMLR(M),M=1,5),TEDR,TOGR,
     *                                          (TMLR(M),M=6,10)
      RETURN
      END
*DECK PRINTB
*IF IDENT,U1100
{FOR,IS PRINTB
*ENDIF
      SUBROUTINE PRINTB(IPRINT)
C
C           ********************************************
C           *                                          *
C           *          PRINTER FOR SEGMENT B           *
C           *                                          *
C           ********************************************
C                                     CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    THIS ROUTINE IS CALLED TO SET UP THE VARIOUS OUTPUT REPORTS THAT
C    ARE REQUESTED BY THE USER. IT CAN BE ACCESSED FROM ANY ROUTINE
C    IN SEGMENT B.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),   TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/MISC/LINE,IPAGE,CFLAG
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15), SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      DIMENSION IDT(3)
      LOGICAL ENG,EVAP,REPORT
C
      IMAX=10
      IPRNT = IPRINT - 10
C
*IF -IDENT,U1100
      CALL DATE(TODAY)
      CALL TIME(HMS)
*ENDIF
*IF IDENT,U1100
      CALL FDATEX(IDT)
*ENDIF
      IF(IPRNT.GT.IMAX) GO TO 100
C
*IF IDENT,U1100
      WRITE(6,1000) IPRINT,TITLE,IDT,IPAGE
 1000 FORMAT(1H1,///," REPORT NO. ",I2,12A6,10X,3A6,"  PAGE",I5/)
*ENDIF
*IF -IDENT,U1100
      WRITE(6,1000) IPRINT,TITLE,TODAY,HMS,IPAGE
 1000 FORMAT(1H1,///," REPORT NO. ",I2,12A6,10X,2A10,"  PAGE",I5/)
*ENDIF
      IPAGE = IPAGE + 1
C
      GO TO (1,2,3,4,5,6,7,8,9,10) IPRNT
```

```
C
   1  WRITE(6,1110)(TSTART(I),I=1,3)
 1110 FORMAT(
     ,' CONTENTS:  PHYSICAL CHARACTERISTICS OF SURFACE SOURCES AT TIME',
     ,        2X,F6.0,'HRS',F4.0,'MINS',F4.0,'SECS'//)
      WRITE(6,1111)(SPECIE(M),M=1,10)
 1111 FORMAT('     SURFACE  AREA      SECTION    MASS LOSS ',3X,
     ,                                        'SPECIES MASS LOSS RATES'/
     ,        '     NUMBER   (IN',2H**,'2)              (GM/SEC)   ',
     ,                                 2X, '(GM/CM',2H**,'2/SEC)'/
     ,        '              (CM',2H**,'2)  MATERIAL   TEMP       ',
     ,                   2X,5(A6,3X),
     ,    8X,'EARLY         OUT'/,
     ,        '                                    (DEG C) ',5X,
     ,                   5(A6,3X),
     ,    8X,'DESORPTION    GASSING',
     ,     / '    ------------------------------------------------------
     ,-----------------------------          ------------------')
      RETURN
   2  WRITE(6,1120)(TSTART(I),I=1,3)
 1120 FORMAT('  CONTENTS:',
     ,   '  SURFACE CHARACTERISTICS INCLUDING SECOND SOURCES AT TIME ',
     ,         2X,F6.0,'HRS',F4.0,'MINS',F4.0,'SECS'//)
      WRITE(6,1111)(SPECIE(M),M=1,10)
      RETURN
   3  WRITE(6,1030)
 1030 FORMAT(' REPORT NO. 13    ')
C
      RETURN
   4  WRITE(6,1040)
 1040 FORMAT(' REPORT NO. 14    ')
C
      RETURN
   5  WRITE(6,1050)
 1050 FORMAT(' REPORT NO. 15    ')
C
      RETURN
   6  WRITE(6,1060)
 1060 FORMAT(' REPORT NO. 16    ')
C
      RETURN
   7  WRITE(6,1070)
 1070 FORMAT(' REPORT NO. 17    ')
C
      RETURN
   8  WRITE(6,1080)
 1080 FORMAT(' REPORT NO. 18    ')
C
      RETURN
   9  WRITE(6,1090)TITLE,IDT
 1090 FORMAT(' REPORT NO. 19    ')
C
      RETURN
  10  WRITE(6,1100)TITLE,IDT
 1100 FORMAT(' REPORT NO. 20    ')
C
      RETURN
 100  RETURN
      END
*DECK ERRORB
*IF IDENT,U1100
{FOR,IS ERRORB
*ENDIF
```

```
      SUBROUTINE ERRORB(IMBAD,IPROB)
C
C           ************************************************
C           *                                              *
C           *        ERROR  MESSAGES  FOR  SEGMENT  B      *
C           *                                              *
C           ************************************************
C                                      CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    THIS ROUTINE IS CALLED WHEN AN ERROR MESSAGE IS DESIRED. IT CAN BE
C    ACCESSED FROM ANY ROUTINE IN SEGMENT B.
C
       IMAX=10
       IF(IMBAD.GT.IMAX)WRITE(6,1000)IMBAD
C
       GO TO (101,102,103,104,105,106,107,108,109,110),IMBAD
C  ********************************************************************
    1  FORMAT("  TIME ON-ORBIT IS IN ERROR IN MLOSSR(FATAL)")
    2  FORMAT(///"  DID NOT FIND MATRL",1X,A7,"IN LIST IN MLOSSR "////)
    3  FORMAT(" LOADB(70) MORE THAN 300 SURFACES CAN SEE ISURF",I10)
    4  FORMAT("  IN LOADB CALLED FOR",I9," NO VIEW FACTORS ON TAPE12")
    5  FORMAT(" RFLCT(60)  DID NOT FIND ",I9,"IN CTYPE LIST  ")
    6  FORMAT("           TBD          ")
    7  FORMAT("           TBD          ")
    8  FORMAT("           TBD          ")
    9  FORMAT("           TBD          ")
   10  FORMAT(" TBD ")
C  CALLED FROM MLOSSR
  101  WRITE(6,1)
       CALL EXIT
C  CALLED FROM MLOSSR
  102  WRITE(6,2)IPROB
       CALL EXIT
C  CALLED FROM LOADB
  103  WRITE(6,3)IPROB
       CALL EXIT
C  CALLED FROM LOADB
  104  WRITE(8,4)IPROB
       RETURN
C  CALLED FROM RFLCT
  105  WRITE(6,5)IPROB
       CALL EXIT
C  CALLED FROM
  106  WRITE(6,6)
       CALL EXIT
C  CALLED FROM
  107  WRITE(6,7)
       CALL EXIT
C  CALLED FROM
  108  WRITE(6,8)
       RETURN
C  CALLED FROM
  109  WRITE(6,9)
       CALL EXIT
C  CALLED FROM
  110  WRITE(6,10)
       CALL EXIT
       CALL EXIT
 1000  FORMAT("   ERROR CODE REQUESTED",I10,"DOES NOT EXIST IN SUBOUTINE
      ,ERROR ")
       END
*DECK ORDER
*IF IDENT,U1100
```

```
{FOR,IS ORDER
*ENDIF
      SUBROUTINE ORDER
C
C            ************************************************
C            *                                              *
C            *            ORDER SURFACE SOURCES             *
C            *                                              *
C            ************************************************
C                                        CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    THE OBJECTIVE OF THIS ROUTINE IS TO ARRANGE THE SURFACES IN A
C    DECREASING ORDER BASED ON THE TOTAL MASS LOSS RATE (MDOTJ) FROM
C    THE SURFACE. USE THE BUBBLE METHOD - FIRST LOOK AT MDOTJ(I). IF
C    MDOTJ(J) IS GREATER THAN MDOTJ(I), SWITCH POSITIONS.
C
      COMMON/CMLOSS/MLR(300,10),MDOTJ(300)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      INTEGER SURFSC,SECT
      REAL MDOTJ,MLR
      DIMENSION STORE(10)
C
      DO  50 I=1,JTOTAL
      II=I+1
      DO  40 J=II,JTOTAL
      IF(MDOTJ(J).LE.MDOTJ(I) ) GO TO 40
C  APPARENTLY J IS GREATER THAN I - STUFF I OFF INTO STORAGE
      SAVE1 = MDOTJ(I)
      ISAVE2= IDENT(I)
      ISAVE3= SECT(I)
      ISAVE4= MATRL(I)
      SAVE5 = AREA(I)
      ISAVE6= SURFSC(I)
      SAVE7= TEMPOS(I)
C  SWITCH J TO I
      DO 10 JJ=M1,M2
 10   STORE(JJ) = MLR(I,JJ)
      MDOTJ(I) = MDOTJ(J)
      IDENT(I) = IDENT(J)
      SECT(I)  = SECT(J)
      MATRL(I) = MATRL(J)
      AREA(I)  = AREA(J)
      SURFSC(I)= SURFSC(J)
      TEMPOS(I)= TEMPOS(J)
      DO 20 JJ=M1,M2
 20   MLR(I,JJ) = MLR(J,JJ)
      MDOTJ(J) = SAVE1
      IDENT(J) = ISAVE2
      SECT(J)  = ISAVE3
      MATRL(J) = ISAVE4
      AREA(J)  = SAVE5
      SURFSC(J)= ISAVE6
      TEMPOS(J)= SAVE7
      DO 30 JJ=M1,M2
 30   MLR(J,JJ) = STORE(JJ)
 40   CONTINUE
 50   CONTINUE
      RETURN
      END
```

```
*DECK MLOSSR
*IF IDENT,U1100
{FOR,IS MLOSSR
*ENDIF
      SUBROUTINE MLOSSR(J)
C
C           ************************************************
C           *                                              *
C           *          SPECIES  MASS  LOSS  RATE           *
C           *                                              *
C           ************************************************
C                                      CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    THE OBJECTIVE OF THIS FUNCTION IS TO ASSIGN THE RATE AT WHICH
C    SPECIES M IS LEAVING THE SURFACES. THERE ARE 10 SPECIES CURRENTLY
C    BEING MONITORED ALTHOUGH ONLY SIX (M=1,6) ARE LOST AS ORIGINAL
C    MATERIAL FROM SURFACES. THE FOLLOWING TABLE LISTS MASS FRACTIONS
C    OF THE VARIOUS SPECIES DURING CERTAIN ON-ORBIT EVENTS. MOLE
C    FRACTION ARE GIVEN IN PARENTHESES.
C
C    SPECIE,M       EARLY      OUTGAS      ENG          EVAP        LEAKAGE
C                   DESORP     PERIOD      FIRINGS      OPERATION
C                   PERIOD
C     1- OUTGAS1                1.0
C     2- OUTGAS2                 X
C     3- H2O       .420(.570)               .290(.328)  1.0         .010(.016)
C     4- N2        .262(.229)               .420(.306)              .750(.760)
C     5- CO2       .212(.118)               .078(.036)              .010(.007)
C     6- O2        .100(.076)               .001(.001)              .230(.219)
C     7- CO                                 .184(.134)
C     8- H2                                 .017(.017)
C     9- ENG1(H)                            .001(.015)
C    10- ENG2(MMHNO3)                       .002(.001)
C
C  TESTING HAS SHOWN THAT THE H2O,CO2,N2,AND O2 ARE DESORBED FROM A
C  SURFACE WITHIN 10 TO 20 HOURS AFTER INSERTION INTO VACUMN(ORBIT)
C  THESE GASES ARE REABSORBED UPON RE-ENTRY SO THEIR MASS LOSS RATES
C  ARE NOT A FUNCTION OF THE AGE OF THE SURFACE. HOWEVER SPECIES THAT
C  ARE UNIQUE TO THE MANUFACTURING PROCESS SUCH AS LARGE MOLECULAR
C  WEIGHT OILS DO HAVE MASS LOSS RATES THAT ARE A FUNCTION OF LONG TERM
C  SURFACE HISTORY. GENERALLY THESE OILS HAVE A LOW CONCENTRATION ON
C  THE GROUND AND THERE IS NO SIGNIFICANT REABSORPTION.
C
      COMMON/CMLOSS/MLR(300,10),MDOT(300)
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,    ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/MDF/ ATCODE, TIME(6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6            DPHI(10),DOMEGA(10),DTHETA(10),
     7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8            X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      COMMON/RATES1/RATE(15,10),TAU(15,10)
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15), SPECIE(10),MOLWT(10),
```

```
     1               PLACE(20),DIA(10)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      DIMENSION T(10),TCOEF(10)
      REAL MLR
      INTEGER SSURFS,SURFSC
      LOGICAL DBUGA,ED,OUT
C
C
C
C  THE AGE OF THE ORBITER AND SPACELAB SURFACES IS SPECIFIED AS AGEORB
C  AND AGESLB.
C
      AGE = AGEORB
      IF(SURFSC(J).GT.1000)AGE=AGESLB
C
C  IN GENERAL THE TIME USED FOR LOSS OF THE LOW MOLECULAR WEIGHT GASES
C  IS THE TIME FROM LAUNCH MINUS 3 MINUTES(TIME TO REACH C.10-3 TORR)
C  WHEREAS THE TIME USED FOR THE LARGE MOLECULAR WEIGHT SPECIES(M=1&2)
C  IS FIGURED USING THE AGE OF THE SURFACE PLUS TIME ON ORBIT
C
      TIMEOO=TSTART(1)*60.+ TSTART(2) + TSTART(3)/60. - 3.
C
      IF(TIMEOO.LT.0.) CALL ERRORB(1,0)
      T(1)=TIMEOO + AGE
      T(2)=TIMEOO + AGE
      T(3)=TIMEOO
      T(4)=TIMEOO
      T(5)=TIMEOO
      T(6)=TIMEOO
      T(7)=TIMEOO
      T(8)=TIMEOO
      T(9)=TIMEOO
      T(10)=TIMEOO
C
C  THE CURRENT TEMPERATURE OF SURFACE SURFSC(J) IS TEMPOS(J)
C
      TJ = TEMPOS(J)
CL,1100,1300
C  DEFINE THE MATERIAL AND COMPUTE THE MASS LOSS RATE OF EACH SPECIES
C
C  THE SECTION OF THE CONFIGURATION IN WHICH NJ CAN BE FOUND IS SECT(J)
C  THE KIND OF SURFACE IS MATRL(J)
      DO 30 K=1,KINDS
      IF(MATRL(J).EQ. KIND(K)) GO TO 40
   30 CONTINUE
      CALL ERRORB(2,MATRL(J))
   40 CONTINUE
      IKIND=K
C
           IF(DBUGA) WRITE(8,6100)IKIND,SURFSC(J),J
      GO TO (100,200,300,400,500,600,700,800,900,1000,1100,1200,1300,
     ,       1400,1500),IKIND
C
C  ***  MATERIAL IS PAYLOAD LINER  ***
  100 CONTINUE
      DO 101 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(1,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(1,M)*60.))
  101 CONTINUE
      RETURN
C
C  ***  MATERIAL IS TEFLON  ***
```

```
  200 CONTINUE
      DO 201 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(2,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(2,M)*60.))
  201 CONTINUE
      RETURN
C
C  ***  MATERIAL IS NOMEX  ***
  300 CONTINUE
      DO 301 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(3,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(3,M)*60.))
  301 CONTINUE
      RETURN
C
C  ***  MATERIAL IS LRSI  ***
  400 CONTINUE
      DO 401 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(4,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(4,M)*60.))
  401 CONTINUE
      RETURN
C
C  ***  MATERIAL IS HRSI  ***
  500 CONTINUE
      DO 501 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(5,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(5,M)*60.))
  501 CONTINUE
      RETURN
C
C  ***  MATERIAL IS RCC  ***
  600 CONTINUE
      DO 601 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(6,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(6,M)*60.))
  601 CONTINUE
      RETURN
C
C  ***  MATERIAL IS THE BULKHEAD  ***
  700 CONTINUE
      DO 701 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(7,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(7,M)*60.))
  701 CONTINUE
      RETURN
C
C  ***  MATERIAL IS A SURFACE THAT LEAKS CABIN ATMOSPHERE  ***
 1100 CONTINUE
      DO 1101 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(11,M)
 1101 CONTINUE
      RETURN
C
C  ***  MATERIAL IS MTSC  ***
  900 CONTINUE
      DO 901 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(9,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(9,M)*60.))
  901 CONTINUE
      RETURN
C
```

```
C
C  ***  MATERIAL IS PTSC  ***
 1000 CONTINUE
      DO 1001 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(10,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(10,M)*60.))
 1001 CONTINUE
      RETURN
C
C  ***  MATERIAL IS WINDOW  ***
  800 CONTINUE
      DO 801 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(8,M) * EXP(TCOEF(M)) * EXP(T(M)/(-TAU(8,M)*60.))
  801 CONTINUE
      RETURN
C
C  ***  MATERIAL IS LMOP CABIN LEAKS  ***
 1200 CONTINUE
      DO 1201 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(12,M)
 1201 CONTINUE
      RETURN
C
C  ***  MATERIAL IS SMTP CABIN LEAKS  ***
 1300 CONTINUE
      DO 1301 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(13,M)
 1301 CONTINUE
      RETURN
C
C  ***  MATERIAL IS         ***
 1400 CONTINUE
      DO 1401 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(14,M)
 1401 CONTINUE
      RETURN
C
C  ***  MATERIAL IS         ***
 1500 CONTINUE
      DO 1501 M=M1,M2
      TCOEF(M)=(TJ - 100.) / 29.
      MLR(J,M)= RATE(15,M)
 1501 CONTINUE
      RETURN
C
 6100      FORMAT(*   MLOSSR(100) IKIND,SURFSC(J),J*,3I10)
      END
*DECK LOADB
*IF IDENT,U1100
{FOR,IS LOADB
*ENDIF
      SUBROUTINE LOADB(ISURF,NUMBER)
C
C           ************************************************
C           *                                              *
C           *       LOADER  FOR  MASS  FRACTION  DATA      *
C           *                                              *
C           ************************************************
C                                  CODED BY: M. HETRICK  2/16/77
```

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C  OBJECTIVE:
C    THIS ROUTINE READS TAPE 12 AND PULLS OFF THE BLOCK OF DATA NEEDED
C    TO DEFINE THE MASS COMING DIRECTLY TO SURFACE ISURF FROM OTHER
C    SOURCES. ONLY THE MASS TRANSPORT DATA FOR ALLOWABLE SOURCES WILL
C    BE LOADED INTO BLOCK MFDATA.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/MFDATA/NODEI,NODEJ(300),MFIJ(300),THETAI(300),THETAJ(300),
     1              R(300)
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      INTEGER PNTSC,SSURFS,SURFSC
      REAL MFIJ
      LOGICAL DBUGA,EVAP,ENG
      JJ = 0
      NUMBER = 0
      REWIND 12
*IF IDENT,U1100
  10  READ(12,1000,END=200)NJ,NK,FIJ,FJI,AREA,TI,TJ,RADIUS
*ENDIF
*IF -IDENT,U1100
  10  READ(12,1000)NJ,NK,FIJ,FJI,AREA,TI,TJ,RADIUS
             IF(EOF(12))200,20
*ENDIF
 1000 FORMAT(2I10,6E10.3)
C
C
  20  CONTINUE
          IF(DBUGA)WRITE(8,6010)NJ,NK,FIJ,FJI,AREA,TI,TJ,RADIUS
      IF(NJ.EQ.ISURF) GO TO 30
      IF(NK.EQ.ISURF) GO TO 100
      GO TO 10
  30  CONTINUE
C
C  APPARENTLY NJ IS ISURF SO THE DATA ON THIS RECORD MAY BE USED, BUT
C  FIRST CHECK NK TO BE SURE IT IS AN ALLOWABLE SOURCE.
      IF(NK.GE.7000) GO TO 50
      IF(NK.GE.6000) GO TO 60
C
C  CHECK THE SURFACE SOURCES.
      DO 40 KCHEK=1,JTOTAL
  40  IF(NK.EQ.SURFSC(KCHEK))GO TO 90
      GO TO 10
C  CHECK TO SEE IF ENGINES ARE TO BE EVALUATED
  50  IF(.NOT.ENG) GO TO 10
      GO TO 70
C  CHECK TO SEE IF VENTS ARE TO BE EVALUATED
  60  IF(.NOT.EVAP) GO TO 10
  70  DO 80 KCHEK=1,KTOTAL
  80  IF(NK.EQ.PNTSC(KCHEK).AND.ONTIME(KCHEK).GT.0.) GO TO 90
      GO TO 10
  90  JJ = JJ + 1
      IF(JJ.GT.300) CALL ERRORB(3,ISURF)
      NODEI = NJ
      NODEJ(JJ) = NK
      MFIJ(JJ) = FIJ
      THETAI(JJ) = TI
      THETAJ(JJ) = TJ
```

```
      R(JJ) = RADIUS
            IF(DBUGA)WRITE(8,6021)(NODEI,NODEJ(J),MFIJ(J),THETAI(J),
     ,      THETAJ(J),R(J),J=JJ,JJ)
      GO TO 10
  100 CONTINUE
C
C  APPARENTLY NK IS ISURF SO THE DATA ON THIS RECORD MUST BE REARRANGED
C  TO BE USED. FIRST CHECK TO SEE IF NJ IS AN ALLOWABLE SOURCE.
      IF(NJ.GE.7000) GO TO 120
      IF(NJ.GE.6000) GO TO 130
C
C  CHECK THE SURFACE SOURCES.
      DO 110 KCHEK=1,JTOTAL
  110 IF(NJ.EQ.SURFSC(KCHEK) )GO TO 160
      GO TO 10
C  CHECK TO SEE IF ENGINES ARE TO BE EVALUATED
  120 IF(.NOT.ENG) GO TO 10
      GO TO 140
C  CHECK TO SEE IF VENTS ARE TO BE EVALUATED
  130 IF(.NOT.EVAP) GO TO 10
  140 DO 150 KCHEK=1,KTOTAL
  150 IF(NJ.EQ.PNTSC(KCHEK).AND.ONTIME(KCHEK).GT.0.) GO TO 160
      GO TO 10
  160 JJ = JJ + 1
      IF(JJ.GT.300) CALL ERRORB(3,ISURF)
      NODEI = NK
      NODEJ(JJ) = NJ
      MFIJ(JJ) = FJI
      THETAI(JJ) = TJ
      THETAJ(JJ) = TI
      R(JJ) = RADIUS
            IF(DBUGA)WRITE(8,6022)(NODEI,NODEJ(J),MFIJ(J),THETAI(J),
     ,      THETAJ(J),R(J),J=JJ,JJ)
      GO TO 10
  200 NUMBER = JJ
C
      IF(NUMBER.EQ.0)CALL ERRORB(4,ISURF)
C
            IF(DBUGA)WRITE(8,6020)(NODEI,NODEJ(J),MFIJ(J),THETAI(J),
     ,      THETAJ(J),R(J),J=1,JJ)
 6020       FORMAT(' LOADB(6020) NI,NJ,MFIJ,TI,TJ,R',2I10,4E12.3)
 6022       FORMAT(' LOADB(6022) NI,NJ,MFIJ,TI,TJ,R',2I10,4E12.3)
 6021       FORMAT(' LOADB(6021) NI,NJ,MFIJ,TI,TJ,R',2I10,4E12.3)
      RETURN
C
 6010 FORMAT('  LOADB(6010) NI,NJ,MFIJ,MFJI,AREA,TI,TJ,R',2I10,6E10.3)
      END
*DECK RFLCT
*IF IDENT,U1100
(FOR,IS RFLCT
*ENDIF
      SUBROUTINE RFLCT(NUMBER,IRECV,IRMF)
C
C           ***************************************************
C           *                                                 *
C           *          SURFACE REFLECTION/REEMISSION          *
C           *                                                 *
C           ***************************************************
C                                      CODED BY: M. METRICK  2/16/77
C  OBJECTIVE:
C    THIS ROUTINE COMPUTES THE MASS INCIDENT ON SURFACE J AS A RESULT OF
C    DIRECT LINE OF SIGHT TRANSPORT FROM K (OTHER SURFACES,ENGINES,ETC)
C    A CONDENSATION OR STICKING COEFFICIENT IS DEFINED AND THE RESULTING
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C     REEMITTED MASS LOSS RATE IS DEFINED.
C     PRIOR TO CALLING RFLCT, THE ROUTINE LOADB(ISURF,NUMBER) MUST BE
C     CALLED TO FILL THE FOLLOWING ARRAYS:
C       NODEI
C       NODEJ(300)
C       MFIJ(300)
C       THETAI(300)
C       THETAJ(300)
C       R(300)
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/CMLOSS/MLR(300,10),MDOTJ(300)
      COMMON/MFDATA/NODEI,NODEJ(300),MFIJ(300),THETAI(300),THETAJ(300),
     1              R(300)
      COMMON/NPLM/NPLUME(5)
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15),SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      LOGICAL EVAP,ENG,REPORT,DBUGA
      DIMENSION IRMF(10),IMFJ(10),FLUX(10),RHO(10)
      REAL IRMF,IMFJ,MLR,MFIJ
      INTEGER CIDENT,CLOC,CTYPE,PNTSC,SURFSC,TYPE
C
      DATA RDPDG/.0174533/
C  ZERO OUT THE INCIDENT REEMITTED MASS FLUX ARRAY(IRMF)
      DO 10 M=1,10
   10 IRMF(M) = 0.
C
      DO 90 J=1,NUMBER
      NJ=NODEJ(J)
      IF(NJ.EQ.0)RETURN
C  SEPARATE OUT SOURCES THAT ARE CONCENTRATED SOURCES
      IF(NJ.GT.6000) GO TO 50
C
C  FIND NJ IN THE SOURCE ARRAY
      DO 20 K=1,JTOTAL
      ISURF=SURFSC(K)
      IF(ISURF.EQ.NJ) GO TO 30
   20 CONTINUE
C
C  NJ WAS NOT FOUND AMONG THE ALLOWABLE SURFACE SOURCES
      GO TO 90
   30 CONTINUE
      KNJ = K
C  ZERO OUT THE INCIDENT MASS FLUX FROM J (IMFJ) ARRAY
      DO 35 M=1,10
   35 IMFJ(M)= 0.
C
      STICK=0.0
      DO 40 M=1,10
      IMFJ(M)=MLR(KNJ,M)*MFIJ(J)
C
      IF(IMFJ(M).EQ.0.0) GO TO 40
```

```
C  OBJECTIVE:
C    THIS ROUTINE COMPUTES THE EVAPORATION OR SUBLIMATION RATE OF
C    SPECIES M FROM SURFACE IRECV AT TEMPERATURE TEMPOS(IRECV)
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15),SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/TMP/TEMPOS(360)
C
C
      TC = TEMPOS(IRECV)
      TK = TC + 273.
C
C  CALCULATE THE VAPOR PRESSURE OF WATER
      PV = (2.9E+10)*EXP(-12200./(1.987*TK))
C
C  THIS PRESSURE IS A MOMENTUM FLUX WHICH CAN BE CONVERTED TO A MASS,
C  FLUX USING THE LANGMUIR - KNUDSEN RELATIONSHIP (I.E. DIVIDE THE VAPOR
C  PRESSURE (RHO*V**2) BY VELOCITY)
C
      SUBLIM = .0583 * PV * SQRT( 18./TK)
      RETURN
      END
*DECK CRUNCH
*IF IDENT,U1100
(FOR,IS CRUNCH
*ENDIF
      SUBROUTINE CRUNCH
C
C           ****************************************************
C           *                                                  *
C           *            CRUNCH INPUT MATRICES DOWN            *
C           *                                                  *
C           ****************************************************
C                                    CODED BY: M. METRICK  3/28/77
C  OBJECTIVE:
C    THIS ROUTINE WILL CONDENSE THE ARRAYS SURFSC,IDENT,SECT,MATRL,AND
C    AREA TO A TOTAL OF JTOTAL SURFACES. AS A RESULT SURFSC AND IDENT
C    WILL BE EQUIVALENT.
C
C    THIS ROUTINE ALSO CONDENSES THE ARRAYS PNTSC,CIDENT,CLOC,CTYPE,
C    CXLOC,CYLOC,AND CZLOC TO KTOTAL CONCENTRATED SOURCES. AS A RESULT
C    PNTSC AND CIDENT WILL BE EQUIVALENT.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
C
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
```

```
C  OBJECTIVE:
C    THIS ROUTINE COMPUTES THE EVAPORATION OR SUBLIMATION RATE OF
C    SPECIES M FROM SURFACE IRECV AT TEMPERATURE TEMPOS(IRECV)
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LNOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/RATES2/AGEDRP,   AGESLB,   KIND(15),SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/TMP/TEMPOS(360)
C
C
      TC = TEMPOS(IRECV)
      TK = TC + 273.
C
C  CALCULATE THE VAPOR PRESSURE OF WATER
      PV = (2.9E+10)*EXP(-12200./(1.987*TK))
C
C  THIS PRESSURE IS A MOMENTUM FLUX WHICH CAN BE CONVERTED TO A MASS
C  FLUX USING THE LANGMUIR - KNUDSEN RELATIONSHIP (I.E. DIVIDE THE VAPOR
C  PRESSURE (RHO*V**2) BY VELOCITY)
C
      SUBLIM = .0583 * PV * SQRT( 18./TK)
      RETURN
      END
*DECK CRUNCH
*IF IDENT,U1100
(FOR,IS CRUNCH
*ENDIF
      SUBROUTINE CRUNCH
C
C           ************************************************
C           *                                              *
C           *            CRUNCH INPUT MATRICES DOWN        *
C           *                                              *
C           ************************************************
C                                      CODED BY: M. METRICK  3/28/77
C  OBJECTIVE:
C    THIS ROUTINE WILL CONDENSE THE ARRAYS SURFSC,IDENT,SECT,MATRL,AND
C    AREA TO A TOTAL OF JTOTAL SURFACES. AS A RESULT SURFSC AND IDENT
C    WILL BE EQUIVALENT.
C
C    THIS ROUTINE ALSO CONDENSES THE ARRAYS PNTSC,CIDENT,CLOC,CTYPE,
C    CXLOC,CYLOC,AND CZLOC TO KTOTAL CONCENTRATED SOURCES. AS A RESULT
C    PNTSC AND CIDENT WILL BE EQUIVALENT.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LNOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
C
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
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```
      DIMENSION SAVE(50)
      INTEGER SECT,SURFSC,CIDENT,CLOC,CTYPE,CXLOC,CYLOC,CZLOC,PNTSC
      LOGICAL DBUGA,ED,ENG,EVAP,LEAK,OUT,REFLCT
      DATA IBLANK/6H      /
C
      IF(.NOT.(ED.OR.OUT.OR.LEAK.OR.REFLCT)) GO TO 52
C
C FIRST LOOK AT IDENT(1) AND DETERMINE IF IT IS AN ALLOWABLE SOURCE AS
C DEFINED BY SURFSC
      DO 40 I=1,JTOTAL
   10 CONTINUE
      DO 20 J=1,300
      IF(IDENT(I).EQ.SURFSC(J) ) GO TO 40
   20 CONTINUE
C
C  EXIT OUT BOTTOM OF LOOP IMPLIES IDENT(I) WAS NOT AN ALLOWABLE SOURCE
C  SO OVER WRITE ITS INFORMATION AND BURP UP THIS BUBBLE IN THE ARRAY.
C
      DO 30 K=I,299
      IDENT(K)=IDENT(K+1)
      MATRL(K)=MATRL(K+1)
      SECT(K)=SECT(K+1)
   30 AREA(K)=AREA(K+1)
      JTOTAL =JTOTAL - 1
      IDENT(300)=0
      MATRL(300)= IBLANK
      SECT(300)= IBLANK
      AREA(300)= 0.
      IF(JTOTAL.EQ.I) GO TO 41
      GO TO 10
   40 CONTINUE
   41 CONTINUE
      DO 50 L=1,300
   50 SURFSC(L)=IDENT(L)
C
      WRITE(8,6003)(SURFSC(I),I=1,JTOTAL)
 6003 FORMAT( "CRUNCH(6003) SURFSC ",10I10)
C
   52 IF(.NOT.(ENG.OR.EVAP))  RETURN
C NEXT LOOK AT CIDENT(1) AND DETERMINE IF IT IS AN ALLOWABLE SOURCE AS
C DEFINED BY PNTSC(I)
C
      DO 55 K=1,KTOTAL
   55 SAVE(K) = ONTIME(K)
C
      KT1 = KTOTAL
      DO 90 I=1,KTOTAL
   60 CONTINUE
            IF(DBUGA) WRITE(8,6001) I,J,KTOTAL
      DO 70 J=1,KT1
      IF(CIDENT(I).EQ.PNTSC(J).AND.ONTIME(J).NE.0.) GO TO 89
   70 CONTINUE
            IF(DBUGA) WRITE(8,6002) I,J,KTOTAL,CIDENT(I),ONTIME(J)
C
C  EXIT OUT BOTTOM OF LOOP IMPLIES CIDENT(I) WAS NOT AN ALLOWABLE SOURCE
C  SO OVER WRITE ITS INFORMATION AND BURP UP THIS BUBBLE IN THE ARRAY.
C
      KTM1 = KTOTAL - 1
      DO 80 K=I,KTM1
      CIDENT(K)=CIDENT(K+1)
      CTYPE(K)=CTYPE(K+1)
      CLOC(K)=CLOC(K+1)
      CXLOC(K)=CXLOC(K+1)
```

```
      CYLOC(K)=CYLOC(K+1)
      CZLOC(K)=CZLOC(K+1)
   80 SAVE(K)=SAVE(K+1)
      CIDENT(KTOTAL)=0
      CTYPE(KTOTAL)= IBLANK
      CLOC(KTOTAL)= IBLANK
      CXLOC(KTOTAL)= 0.
      CYLOC(KTOTAL)= 0.
      CZLOC(KTOTAL)= 0.
      SAVE(KTOTAL)= 0.
      KTOTAL = KTOTAL - 1
      IF(KTOTAL.EQ.I) GO TO 91
      GO TO 60
   89 SAVE(I) = ONTIME(J)
   90 CONTINUE
   91 CONTINUE
      KTOTAL = KTOTAL - 1
      DO 100 L=1,KTOTAL
      ONTIME(L) = SAVE(L)
  100 PNTSC(L)=CIDENT(L)
      WRITE(8,6004)(PNTSC(I),I=1,KTOTAL)
 6004 FORMAT( "CRUNCH(6004) PNTSC  ",10I10)
      RETURN
 6001 FORMAT(" IN CRUNCH WRITE(6,6001)I,J,KTOTAL ",3I10)
 6002 FORMAT(50H IN CRUNCH WRITE(6,6002) I,J,KTOTAL,CIDENT,ONTIME ,4I10,
     ,E10.3)
      END
*DECK PLUMES
*IF IDENT,U1100
{FOR,IS PLUMES
*ENDIF
      SUBROUTINE PLUMES(L,RADIUS,THETA,MFLUX,DENSTY)
C
C           ************************************************
C           *                                              *
C           *          EXHAUST  PLUME  FLOWFIELDS          *
C           *                                              *
C           ************************************************
C                                        CODED BY: M. HETRICK  3/16/77
C  OBJECTIVE:
C    THIS ROUTINE IS A GENERALIZED VERSION OF SIMONS SOURCE FLOW PLUME
C    MODEL DEFINED IN AIAA JOURNAL, VOL 10, NO.11, 1972. THE FLOWFIELD
C    IS DIVIDED INTO THREE ZONES. COEFFICIENTS ARE DEFINED BY THE USER
C         ZONE 1    THETA = CENTERLINE TO THETA1(C4)
C                   MFLUX = (C1*(COSINE(C3*THETA))**C2)/RADIUS**2
C         ZONE 2    THETA = THETA1 TO THETA2(C7)
C                   MFLUX = (C5* EXP(C6*(THETA-C4)) )/RADIUS**2
C         ZONE 3    THETA = THETA2 TO 180 DEGREES
C                   MFLUX =  C8/RADIUS**2
C    THE REMAINING CONSTANT THAT MUST BE DEFINED IS A LIMITING VELOCITY
C    OF THE FLOW, C9 = VELOCITY(CM/SEC)
C
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      DIMENSION MFLUX(10),DENSTY(10)
      REAL MFLUX
C  FIRST DETERMINE WHICH ZONE THETA IS IN
      IF(THETA.GT.PLUMEC(7,L) ) GO TO 30
      IF(THETA.GT.PLUMEC(4,L) ) GO TO 20
C
C   * * * *  ZONE 1 * * * *
      DO 10 M=1,10
      MFLUX(M) = SPECMF(M,L)*(PLUMEC(1,L)*(COS(PLUMEC(3,L)*THETA))
```

```
     ,           ** PLUMEC(2,L))/ RADIUS**2.
  10 DENSTY(M) = MFLUX(M)/ PLUMEC(9,L)
     RETURN
C    * * * *  ZONE 2 * * * *
  20 CONTINUE
     DO 21 M=1,10
     MFLUX(M) = SPECMF(M,L)*(PLUMEC(5,L)* EXP(PLUMEC(6,L)*
     ,           (THETA-PLUMEC(4,L))))/ RADIUS**2.
  21 DENSTY(M) = MFLUX(M)/ PLUMEC(9,L)
     RETURN
C    * * * *  ZONE 3 * * * *
  30 CONTINUE
     DO 31 M=1,10
     MFLUX(M) =(SPECMF(M,L)*PLUMEC(8,L))/ RADIUS**2.
  31 DENSTY(M) = MFLUX(M)/ PLUMEC(9,L)
     RETURN
     END
*DECK DEPST
*IF IDENT,U1100
{FOR,IS DEPST
*ENDIF
     SUBROUTINE  DEPST
     COMMON/SEGB/ISURF
     COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
    1             EVAP,   FIVP,   LEAK,   LMOP,   MAXTMP,MCD,
    2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
    3             MINTMP,ORBITR,OUT,    REFLCT,REPORT(50),
    4             RFAS,   RFSS,   SMTP,   TITLE(12),     TSTART(3),
    5             TSTOP(3),     GO,     SUNL,   SUNM,   SUNH
     LOGICAL ED,OUT
C
     IF(ED.OR.OUT)CALL MASLOS
     RETURN
     END
*DECK MASLOS
*IF IDENT,U1100
{FOR,IS MASLOS
*ENDIF
     SUBROUTINE MASLOS
C    WRITE(6,1000)
 1000 FORMAT("  IN MASLOS OVERLAY(3,0) WHICH HAS NOT YET BEEN WRITTEN")
     RETURN
     END
*DECK MCDRTF
*IF IDENT,U1100
{FOR,IS MCDRTF
*ENDIF
     SUBROUTINE  MCDRTF
C
C            ****************************************
C            *                                      *
C            *    MASS/NUMBER COLUMN DENSITY        *
C            *                                      *
C            ****************************************
C                                   CODED BY: M. HETRICK  3/28/77
C  OBJECTIVE:
C    THE FOLLOWING SET OF LOGIC IS DESIGNED TO PROVIDE THE USER WITH A
C    DEFINITION OF THE MASS AND NUMBER COLUMN DENSITY ALONG A LINE OF
C    SIGHT PASSING THRU THE CONTAMINANT CLOUD THAT SURROUNDS THE SPACE
C    CRAFT.
C
C  BACKGROUND:
C    FOR STS ORBITER/SPACELAB ANALYSES, A GENERAL MATRIX OF POINTS THAT
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C     ENCOMPASSES THE HEMISPHERICAL SPACE ABOVE THE SPACECRAFT HAS BEEN
C     CONSTRUCTED. VIEW FACTORS OF EACH ORBITER/SPACELAB SURFACE TO EACH
C     POINT HAS BEEN PRECALCULATED AND STORED ON TAPE 13.
C
      COMMON/CMLOSS/MLR(300,10),MDOTJ(300)
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/MDF/ ATCODE, TIME(6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6            DPHII(10),DOMEG(10),DTHET(10),
     7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VVX,VVY,VVZ,
     8            X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
      COMMON/NPLM/NPLUME(5)
*CALL PTSLCT
      COMMON /PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1               CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SEGD1/NLOS,SC
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      COMMON /GOMTRY/ THETAI,THETAF,DTHETA,PHII,PHIF,DPHI,X00C,Y00C,Z00C
     1,SMAX,VX,VY,VZ,ULX,ULY,ULZ,VLX,VLY,VLZ,WLX,WLY,WLZ,DS(25),DOMEGA
     2  ,RMAX,ICSURF
      LOGICAL DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1        EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2        MNCD,  MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3        MINTMP,ONELOS,ORBITR,OUT,   REFLCT,REPORT,
     4        RFAS,  RFSS,  SMTP,  GO,    SUNL,  SUNM,  SUNH
      INTEGER RECEVR,RFSURF,SECT
      DATA RDPDG/.0174533/
C     ******************************************************************
      IF(.NOT.MCD) GO TO 40
      DO  10  I=1,25
   10 DS(I)=DSMCD(I)
C
C   ZERO OUT THE ARRAYS THAT SAVE POINTS
      DO 15 I=1,400
      NUMBER(I) = 0
      CNTRIB(I) = 0.
   15 CONTINUE
      RMAX = RMAXL
      SMAX=0.
      DO 20 I=1,25
   20 SMAX = SMAX + DS(I)
      ULX = 1.
      ULY = 0.
      ULZ = 0.
      VLX = 0.
      VLY = 1.
      VLZ = 0.
      WLX = 0.
      WLY = 0.
      WLZ = 1.
      VX=VVX
      VY=VVY
```

```
      VZ=VVZ
      DA = 3.0E-8
C
      DO 30 LOS=1,NLOS
      IF(THETAL(LOS).EQ.0..AND.PHIL(LOS).EQ.0..AND.LOS.NE.1) GO TO 30
C
      DTHETA = 32.7705
      THETAI= THETAL(LOS)
      THETAF= THETAL(LOS)
      DPHI = 0.0
      PHII= PHIL(LOS)
      DOMEGA = 0.0
      PHIF=PHIL(LOS)
C  SPECIFY LOCATION OF THE ORIGIN OF THE LINE-OF-SIGHT IN  ORBITER
C  COORDINATES (INCHES)
      XOOC=XLOS(LOS)
      YOOC=YLOS(LOS)
      ZOOC=ZLOS(LOS)
      MNCD = .TRUE.
C
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGD1,4,1)
*ENDIF
*IF IDENT,U1100
      CALL PTSLCT
*ENDIF
C
C  NOW THAT ALL THE MATRIX POINTS FOR THE LOS HAVE BEEN DEFINED, CALL UP
C  THE ROUTINE THAT COMPUTES DENSITY.
C
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGD2,4,2)
*ENDIF
*IF IDENT,U1100
      CALL MCDNCD
*ENDIF
C
  30  CONTINUE
  40  CONTINUE
C
      IF(.NOT. RFAS.AND..NOT.RFSS) RETURN
C
C  SET UP THE INPUT INFORMATION REQUIRED FOR RETURN FLUX CALCULATIONS
C  NOTE THAT IF THE USER HAS REPORTS(33-37) TURNED ON, NCD INFORMATION
C  WILL BE PRINTED OUT AS WELL AS RETURN FLUX INFORMATION BASED ON A
C  SINGLE LINE-OF-SIGHT THRU THE FIELD OF VIEW.
C  FOR MORE ACCURATE RETURN FLUX COMPUTATIONS TURN OFF NCD PRINTOUT.
C
      MNCD=.FALSE.
      DO 50 K=33,39
  50  IF(REPORT(K) ) MNCD=.TRUE.
      DO 60 I=1,25
  60  DS(I) = DSRTNF(I)
      RMAX = RMAXRF
      SMAX=0.
      DO 70 I=1,25
  70  SMAX= SMAX+DS(I)
      DA = 3.0E-8
      VX = VVX
      VY = VVY
      VZ = VVZ
      DO 80 ISURF=1,10
      IF( RFSURF(ISURF).EQ.0 ) GO TO 80
```

```
      DTHETA = DTHET(ISURF)
      ICSURF = RFSURF(ISURF)
      IF(DTHETA.EQ.0.) DTHETA = 10.24
      THETAI= THETA1(ISURF)
      THETAF= THETA2(ISURF)
      DPHI = DPHII(ISURF)
      PHII= PHI1(ISURF)
      PHIF= PHI2(ISURF)
      DOMEGA = DOMEG(ISURF)
      X0OC=X0(ISURF)
      Y0OC=Y0(ISURF)
      Z0OC=Z0(ISURF)
      ULX = COSXX(ISURF)
      ULY = COSXY(ISURF)
      ULZ = COSXZ(ISURF)
      VLX = COSYX(ISURF)
      VLY = COSYY(ISURF)
      VLZ = COSYZ(ISURF)
      WLX = COSZX(ISURF)
      WLY = COSZY(ISURF)
      WLZ = COSZZ(ISURF)
      LOS=RFSURF(ISURF)
C
      IF(.NOT. MNCD) GO TO 75
      DTHETA = 2.*THETA2(ISURF)
      PHI1(ISURF)=0.
      PHI2(ISURF)=360.
 75   CONTINUE
C
C     CALL PTSELCT
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGD1,4,1)
*ENDIF
*IF IDENT,U1100
      CALL PTSLC
*ENDIF
C
C  NOW THAT ALL THE MATRIX POINTS FOR THE FOV HAVE BEEN DEFINED, CALL UP
C  THE ROUTINE THAT COMPUTES DENSITY AND RETURN FLUX.
C
*IF -IDENT,U1100
      CALL OVERLAY(5HSEGD3,4,3)
*ENDIF
*IF IDENT,U1100
      CALL RTNFLX
*ENDIF
C
 80   CONTINUE
      RETURN
      END
*DECK PRINTD
*IF IDENT,U1100
{FOR,IS PRINTD
*ENDIF
      SUBROUTINE PRINTD(IPRINT)
C
C           ********************************************
C           *                                          *
C           *        PRINTER FOR SEGMENT D             *
C           *                                          *
C           ********************************************
C                                    CODED BY: D. STRANGE  2/16/77
C  OBJECTIVE:
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C     THIS ROUTINE IS CALLED TO SET UP THE VARIOUS OUTPUT REPORTS THAT
C     ARE REQUESTED BY THE USER. IT CAN BE ACCESSED FROM ANY ROUTINE
C     IN SEGMENT D.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),     TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/MDF/ ATCODE, TIM (6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6            DPHI(10),DOMEGA(10),DTHETA(10),
     7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8            X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
      COMMON/MISC/LINE,IPAGE,CFLAG
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/TEMPOS(360)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SEGD/AMBDN,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/RATES2/AGEORB,AGESLB,KIND(15),SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      DIMENSION IDT(3)
      LOGICAL REPORT
C
      IMAX=20
      IPRNT = IPRINT - 30
C
*IF -IDENT,U1100
      CALL DATE(TODAY)
      CALL TIME(HMS)
*ENDIF
*IF IDENT,U1100
      CALL FDATEX(IDT)
*ENDIF
      IF(IPRNT.GT.IMAX) GO TO 100
C
*IF IDENT,U1100
      WRITE(6,1000) IPRINT,TITLE,IDT,IPAGE
 1000 FORMAT(1H1,///," REPORT NO. ",I2,12A6,10X,3A6,"  PAGE",I5/)
*ENDIF
*IF -IDENT,U1100
      WRITE(6,1000) IPRINT,TITLE,TODAY,HMS,IPAGE
 1000 FORMAT(1H1,///," REPORT NO. ",I2,12A6,10X,2A10,"  PAGE",I5/)
*ENDIF
      IPAGE = IPAGE + 1
C
      GO TO (1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20) IPRNT
C
C
C
   1  WRITE(6,1010)
 1010 FORMAT(" CONTENTS:  OUTPUT FROM LINE-OF-SIGHT POINT SELECTOR"//)
      RETURN
C
   2  WRITE(6,1020)
 1020 FORMAT(" CONTENTS:  SUMMARY OUTPUT FROM LINE-OF-SIGHT POINT SELECT
     1OR ",//)
```

```
      RETURN
C
   3  WRITE(6,1030) LOS,THETA,PHI,CFLAG
 1030 FORMAT(" CONTENTS:  NUMBER COLUMN DENSITIES -  ENUMERATED BY SOURC
     1E ",38X,"LINE-OF-SIGHT NO.     =",I10,/
     2       99X,"THETA (DEG)          =",F10.1,/
     3       99X,"PHI   (DEG)          =",F10.1,/
     4        5X,"  ***  HIGHEST TO LOWEST CONTRIBUTOR  ***  ",A6/)
      RETURN
C
   4  WRITE(6,1040)LOS,THETA,PHI,CFLAG
 1040 FORMAT(" CONTENTS:  MASS/NUMBER COLUMN DENSITIES",58X,
     1          "LINE-OF-SIGHT NO.     =",I10,/
     2       99X,"THETA (DEG)          =",F10.1,/
     3       99X,"PHI   (DEG)          =",F10.1,/
     4        5X,"  ***  SORTED BY MATERIALS  ***  ",A6)
C
      WRITE(6,1041)
 1041 FORMAT(/"    SURFACE    SECTION    MASS LOSS   SPECIES NUMBER COLU
     ,MN DENSITY",32X,"EARLY      OUT           TOTAL",/
     2        "    NUMBER    ","             (GM/SEC)   ",
     ,  1X, "(MOLECULES/CM**2)",44X,"DESORPTION GASSING       MCD/NCD")
C
      WRITE(6,1042)(SPECIE(M),M=1,10)
 1042 FORMAT("               ","  MATERIAL   TEMP       ",
     ,              2X,5(A6,4X),10X,"(GM/CM**2)",/
     ,26X,"(DEG C)",6X,5(A6,4X),10X,"(MOLECULES/CM**2)",/
     ,        "    ------------------------------------------------------
     ,------------------------------        ---------------------",
     ,"   --------")
      RETURN
C
C
   5  WRITE(6,1050)LOS,THETA,PHI,CFLAG
 1050 FORMAT(" CONTENTS:  SUMMARY  ***  MASS/NUMBER COLUMN DENSITIES  **
     1*  ",37X,"LINE-OF-SIGHT NO.     =",I10,/
     2       99X,"THETA (DEG)          =",F10.1,/
     3       99X,"PHI   (DEG)          =",F10.1,/
     4        5X," ***   LISTED BY MATERIALS   ***   ",A6)
      WRITE(6,1051)
      WRITE(6,1052)(SPECIE(M),M=1,10)
 1051 FORMAT(/"         SECTION                      ",2X,"SPECIES NUMBER
     ,COLUMN DENSITY",30X,"EARLY      OUT        TOTAL    % OF",/
     2        "         SUMMARY                      ",
     ,2X,"(MOLECULES/CM**2)",42X,"DESORPTION GASSING            TOTAL")
C
 1052 FORMAT(       40X,5(A6,4X),7X,"(GM/CM**2)",/
     ,          40X,5(A6,4X),7X,"(MOLECULES/CM**2)",/
     ,        "    ------------------------------------------------------
     ,------------------------------        ---------------------",
     , "----------")
      RETURN
C
C
   6  WRITE(6,1060)LOS,THETA,PHI,CFLAG
 1060 FORMAT(" CONTENTS:  MASS/NUMBER COLUMN DENSITIES",
     1       58X,"LINE-OF-SIGHT NO.     =",I10,/
     2       99X,"THETA (DEG)          =",F10.1,/
     3       99X,"PHI   (DEG)          =",F10.1,/
     4        5X," ***   SORTED BY LOCATION ON VEHICLE   *** ",A6)
C
      WRITE(6,1041)
      WRITE(6,1042)(SPECIE(M),M=1,10)
```

```
      RETURN
C
C
   7  WRITE(6,1070)LOS,THETA,PHI,CFLAG
 1070 FORMAT(" CONTENTS:  SUMMARY  ***  MASS/NUMBER COLUMN DENSITIES  **
     1*       ",33X,"LINE-OF-SIGHT NO.    =",I10,/
     2       99X,"THETA (DEG)          =",F10.1,/
     3       99X,"PHI   (DEG)          =",F10.1,/
     4        5X," ***   LISTED BY LOCATION   *** ",A6)
      WRITE(6,1051)
      WRITE(6,1052)(SPECIE(M),M=1,10)
      RETURN
C
C
   8  CONTINUE
      RETURN
   9  CONTINUE
      RETURN
  10  CONTINUE
      RETURN
C
C
  11  WRITE(6,1100) ALT,RFSURF(ISURF),DOMEGA(ISURF),CFLAG
 1100 FORMAT(" CONTENTS:  RETURN FLUX AT ",F6.1," KM ALTITUDE - ENUMERAT
     ,ED BY SOURCE",30X,"CRITICAL SURFACE NO. =",I10,/98X,"FIELD-OF-VIEW
     , (SR)  =",F10.3,
     ,          //16X,"***   HIGHEST TO LOWEST CONTRIBUTOR  ***",A6//)
C
      RETURN
C
C
  12  WRITE(6,1200) ALT,RFSURF(ISURF),DOMEGA(ISURF),CFLAG
 1200 FORMAT(" CONTENTS:  RETURN FLUX AT ",F6.1," KM ALTITUDE - ENUMERAT
     ,ED BY SOURCE",30X,"CRITICAL SURFACE NO. =",I10,/98X,"FIELD-OF-VIEW
     , (SR)  =",F10.3,
     ,          //15X," ***   SORTED BY TYPE OF MATERIAL   ***",A6//)
      WRITE(6,1201)
 1201 FORMAT(/"    SURFACE    SECTION    MASS LOSS   SPECIES RETURN FLUX
     , CONTRIBUTIONS",28X,"EARLY      OUT           TOTAL",/
     2       "    NUMBER    "," (GM/SEC)   ",
     ,  1X, "(MOLECULES/CM**2)",44X,"DESORPTION GASSING       RTNFLX ")
C
      WRITE(6,1042)(SPECIE(M),M=1,10)
      RETURN
C
C
  13  WRITE(6,1300) ALT,RFSURF(ISURF),DOMEGA(ISURF),CFLAG
 1300 FORMAT(" CONTENTS:  SUMMARY    RETURN FLUX AT ",F6.1," KM ALTITUDE
     ,          ",30X,"CRITICAL SURFACE NO. =",I6,/98X,"FIELD-OF-VIEW
     ,(SR)  =",F10.3,//15X," ***   LISTED BY MATERIAL TYPE    ***",A6//)
      WRITE(6,1302)
      WRITE(6,1052)(SPECIE(M),M=1,10)
 1302 FORMAT(/"         SECTION                    ",2X,"SPECIES RETURN
     , FLUX         ",30X,"EARLY      OUT       TOTAL    % OF",/
     2       "         SUMMARY                    ",
     ,2X,"(MOLECULES/CM**2)",42X,"DESORPTION GASSING            TOTAL")
C
      RETURN
C
C
  14  WRITE(6,1400) ALT,RFSURF(ISURF),DOMEGA(ISURF),CFLAG
 1400 FORMAT(" CONTENTS:  RETURN FLUX AT ",F6.1," KM ALTITUDE - ENUMERAT
     ,ED BY SOURCE",30X,"CRITICAL SURFACE NO. =",I6,/98X,"FIELD-OF-VIEW
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```
     ,(SR)  =",F10.3,//15X," ***   SORTED BY LOCATION    ***",A6)
      WRITE(6,1201)
      WRITE(6,1042)(SPECIE(M),M=1,10)
      RETURN
C
C
  15  WRITE(6,1500) ALT,RFSURF(ISURF),DOMEGA(ISURF),CFLAG
 1500 FORMAT(" CONTENTS:  SUMMARY    RETURN FLUX AT ",F6.1," KM ALTITUDE
     ,            ",30X,"CRITICAL SURFACE NO. =",I6,/98X,"FIELD-OF-VIEW
     ,(SR)  =",F10.3,//15X," ***   LISTED BY LOCATION    ***",A6)
      WRITE(6,1302)
      WRITE(6,1052)(SPECIE(M),M=1,10)
      RETURN
C
C
  16  CONTINUE
      WRITE(6,1600) ALT,RFSURF(ISURF),DOMEGA(ISURF),CFLAG
 1600 FORMAT(" CONTENTS:  RETURN FLUX DUE TO SELF SCATTERING",F7.1," KM
     , ALTITUDE   ",30X,"CRITICAL SURFACE NO. =",I6,/100X,"FIELD-OF-VIEW
     , (SR)  =",F9.3,//15X," ***   LISTED BY LOS SEGMENT   ***",A6,//
     , 13X,"SPECIES",
     , 2X,"COLLISION   TOTAL       FLUX        FLUX        ACCUMULATED"/
     ,22X,"FREQUENCY   DENSITY     FROM        TO          RETURN      "/
     ,22X,"                        SEGMENT     SEGMENT     FLUX        "/
     ,22X,"(NO./SEC)   (GM/CM**3)  (MOLECULES/ (GM/CM**2/  (MOLECULES/"/
     ,22X,"                        CM**2/SEC)       /SEC)  CM**2/SEC) "/
     ,22X,"*************************************************************")
      RETURN
C
   17 CONTINUE
      IREC = 300 + 50 + ISURF
      WRITE(6,1700) ALT,RFSURF(ISURF),DOMEGA(ISURF),TEMPOS(IREC)
 1700 FORMAT(" CONTENTS:  SUMMARY    RETURN FLUX AT ",F6.1," KM ALTITUDE
     ,            ",30X,"CRITICAL SURFACE NO. =",I6,/98X,"FIELD-OF-VIEW
     ,(SR)  =",F10.3,/,98X,"SURFACE TEMP(ISURF) =",F6.1,/
     , /15X," ***   INCIDENT FLUX -  AMBIENT/SELF SCATTERING    ***")
      WRITE(6,1701)(SPECIE(M),M=1,10)
 1701 FORMAT(25X,"SPECIES CONTRIBUTIONS"/
     ,       25X,"(MOLECULES/CM**2/SEC)"/
     ,       25X,10(A6,4X),/
     ,       25X,"*************************************************
     ,*********************************************")
      RETURN
C
  18  CONTINUE
      RETURN
  19  CONTINUE
      RETURN
  20  CONTINUE
      RETURN
  100  CONTINUE
      RETURN
      END
*DECK PTSLC
*IF IDENT,U1100
{FOR,IS PTSLC
*ENDIF
      SUBROUTINE  PTSLC
C           ***********************************************
C           *                                             *
C           *               POINT    SELECTOR             *
C           *                                             *
C           ***********************************************
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C                                          CODED BY: M. HETRICK  3/21/77
C  OBJECTIVE:
C    TO SELECT POINTS FROM THE GENERAL MATRIX THAT ARE REQUIRED TO
C    DEFINE MASS COLUMN DENSITY AND RETURN FLUX ALONG A GENERALIZED
C    LINE OF SIGHT.
C
C  BACKGROUND:
C    CURRENTLY THE DENSITY CREATED BY THE OUTGASSING SOURCES ON THE STS
C    ORBITER AND SPACELAB PAYLOAD CAN BE DEFINED AT DISCRETE POINTS IN
C    THE HEMISPHERICAL SPACE ABOVE THE ORBITER.  THIS MATRIX OF POINTS
C    CAN BE DESCRIBED AS FOLLOWS:
C       1) THERE ARE 15 RADIAL LOCATIONS ABOVE THE ORBITER INCLUDING THE
C          ORIGIN WHICH IS AT ORBITER STATION ( 1107,0,507 )
C              I INDEX      RADIAL POSITION(METERS)
C                 1               0
C                 2               5
C                 3              10  ETC
C
C       2) EACH SET OF RADIAL LOCATIONS HAS 8 ANGULAR SUBDIVISIONS
C          ABOUT THE Z-AXIS (SIMILAR TO EARTH LONGITUDINAL SEGMENTS)
C              J INDEX      ETA POSITION(DEGREES)
C                 1               0
C                 2              45
C                 .               .
C                 .               .
C                 8             315
C
C
C       3) WITHIN EACH LONGITUDINAL SEGMENT THERE ARE 4 LATITUDES
C          DEFINED BY AN ANGLE OFF THE Z-AXIS CALLED ZETA
C          WHERE ZETA(L) IS DEFINED BELOW:
C              L INDEX      ZETA(DEGREES)
C                 1               0
C                 2              30
C                 3              60
C                 4              82.5
C     THUS BY SPECIFYING THREE INDICES (I,J,L) A POINT IN THE CLOUD
C     CAN BE DEFINED.
C
C  USER INPUT:
C    THE USER DEFINES THE DIRECTON OF THE LINE OF SIGHT OR FIELD OF VIEW
C    ITS ORIGIN,ITS LENGTH,AND THE SPACING BETWEEN SEGMENTS.
C
C  OUTPUT:
C    THE ROUTINE LISTS THE IDENTIFICATION NUMBERS OF THE POINTS THAT
C    SHOULD BE USED TO INTEGRATE ALONG A LINE OF SIGHT. THE CONTRIBUTION
C    TO THIS SEGMENT OF THE LINE OF SIGHT FROM ITS 8 SURROUNDING MATRIX
C    POINTS IS ALSO GIVEN.
C
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON /GOMTRY/ THETAI,THETAF,DTHETA,PHII,PHIF,DPHI,XOOC,YOOC,ZOOC
     1,SMAX,VX,VY,VZ,ULX,ULY,ULZ,VLX,VLY,VLZ,WLX,WLY,WLZ,DS(25),DOMEGA
     2  ,RMAX,ICSURF
      COMMON/GRID/ RL(16),ZETA(4)
*CALL PTSLCT
      COMMON /SAVEM/ NUMB(100),CNTRB(100)
*CALL SAVEP
```

```
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      DIMENSION ETA(9),RL1(16),ZETA1(4)
      DIMENSION RPT(25),RBACK(25),DVOL(25)
      INTEGER SAVEPT
      LOGICAL DBUGD,EXTRAP,MNCD,REPORT
C  *********************************************************************
      DATA PIE,PIEINV,RDPDG,CMTIN/3.1415927,.31830989,.0174533,39.370/
      DATA LPTMAX/25/
      DATA (ZETA1(K),K=1,4)/0.,30.,60.,82.5/
      DATA(RL1(I),I=1,16)/0.,5.,10.,15.,20.,25.,30.,35.,40.,45.,50.,75.,
     ,100.,150.,200.,300./
C             ***************
C THE FOLLOWING IS USED TO PLACATE THE CDC LOADER
      DO 10 I=1,4
   10 ZETA(I)=ZETA1(I)
      DO 20 I=1,16
   20 RL(I)=RL1(I)
C             ***************
      PHIIS=PHII
      PHIFS=PHIF
C
C  SET IN TOLERANCES FOR INTERPOLATION
      RSLOP=.05
      ZSLOP=.05
      ESLOP=.05
      LPT=1
C  THE PROGRAM IS CURRENTLY HARD WIRED TO INSERT A SPERICAL COODINATE
C  SYSTEM AT ORBITER STATION(1107,0,507)
      XORGIN = 1107.
      YORGIN = 0.
      ZORGIN = 507.
      VOLUME = 0.
      ISTORD=0
      FOV = 0.0
C  *********************************************************************
C
C  ADJUST DPHI TO MAKE SURE THERE ARE EQUAL SUBDIVISIONS BETWEEN
C  PHII AND PHIF.
      IF(DPHI.EQ.0.) GO TO 40
   30 IDPHI=(PHIF-PHII)/DPHI
      IF(IDPHI.LE.0) CALL ERROR0(12,ICSURF)
      IF(IDPHI.LE.0) IDPHI=1
      DPHI=(PHIF-PHII)/IDPHI
      DPHIS=DPHI
C  SAVE THE RADIAL DISTANCE THAT THE POINT WILL BE MULTIPLIED BY
C  WHEN INTEGRATING ALONG A LINE-OF-SIGHT.  EACH POINT WILL BE IN THE
C  CENTER OF ITS SEGMENT OR VOLUME ELEMENT.
C
   40 DL(1) = DS(1) + .5 * DS(2)
      RPT(1) = DS(1)
      RBACK(1)= DL(1)
C  FOR THE SECOND AND SUBSEQUENT ELEMENTS,
      DO 100 I=2,25
      RPT(I)=RPT(I-1) + DS(I)
      DL(I) = 2.*(DS(I)-(RBACK(I-1)-RPT(I-1)))
  100 RBACK(I) = RPT(I) + .5 * DL(I)
C    I IS THE INDEX ON THE RADIUS AS INDICATED IN DATA STATEMENT FOR RL
C  VIEW FACTORS ARE COMPUTED FROM TRASYS FOR DISTANCES UP TO RMAX.
C  BEYOND RMAX (SAY 200 METERS) THE VIEW FACTORS TO A POINT IN THE CLOUD
C  CAN BE DEFINED ACCURATELY BY EXTRAPOLATION AS 1/R **2 FROM RMAX
C
C  FIND THE INDEX,NR FOR THE LAST CLOUD MATRIX POINT THAT SHOULD BE
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```
C  USED.
       DO 105 I=1,16
       IF(RL(I).GT.RMAX) GO TO 106
   105 CONTINUE
   106 NR = I - 1
C      IF(NR.LT.1) CALL ERROR(4,0)
C
C     THERE ARE 8 ETA PLANES 45 DEG APART WHICH ARE CURRENTLY BEING USED
       NET=9
C     J IS THE INDEX ON THE ETA PLANE,  ETA(J)= (J-1)*45.
C     THERE ARE CURRENTLY 4 VALUES OF THE ANGLE ZETA (SEE DATA STATEMENT)
       NZETA=4
       DO 110 J=1,NET
   110 ETA(J)= (J-1)*45.
C  POSITION ONESELF ON THE CRITICAL SURFACE AND SET UP THE LINES OF
C  SIGHT NEEDED TO ENCOMPASS THE USER DEFINED FIELD OF VIEW.
C
C  THETA AND PHI ARE MEASURED IN THE COORDINATE SYSTEM OF THE CRITICAL
C  SURFACE(U,V,W). THE W-AXIS IS THE SURFACE NORMAL VECTOR.
       THETA=THETAI
       SINDT= SIN(DTHETA*RDPDG/2.)
       TVOL = 2./3. * RBACK(25)**3. * PIE
   120 SINT=SIN(THETA*RDPDG)
       COST=COS(THETA*RDPDG)
C  IF THETA IS EQUAL TO ZERO SKIP THE AUTO CHECK ON DPHI
       IF (THETA.EQ.0.) GO TO 135
C
C  THE USER HAS THE OPTION OF DEFINING EITHER THE INCREMENT IN PHI(DEG)
C  OR THE INCREMENT IN THE SOLID ANGLE,DOMEGA(STERADIANS)
       IF (DOMEGA.EQ.0.) GO TO  135
       DPHI=DOMEGA/(SINT*DTHETA*RDPDG)/RDPDG
       IF(DPHI.GT.360.) DPHI=360.
       FI=(PHIFS-PHIIS)/DPHI+1.
       I=FI
       FI=I
       DPHI=(PHIFS-PHIIS)/FI
C  COMPARE THE INTERNALLY GENERATED DPHI USING THE SOLID ANGLE
C  SPECIFICATION WITH THE USER DEFINED DPHI. THE LARGEST IS USED.
       IF (DPHI.LT.DPHIS) DPHI=DPHIS
   135 CONTINUE
       PHI=PHII
C
C  AT THIS POINT DECISIONS HAVE BEEN MADE CONCERNING THE INCREMENTS IN
C  RADIUS,THETA,AND PHI.  DEFINE THE VOLUME OF EACH SEGMENT ALONG THIS
C  SERIES OF LINES-OF-SIGHT USING A SPHERICAL SECTOR FORMULA
       IF(THETA.EQ.0.)  DVOL(1)=PIE/3.*RBACK(1)*
     ,                  (RBACK(1) * SINDT)**2.
       DO 136 IPT=2,25
       H1 = RBACK(IPT) * (COS((THETA-DTHETA/2.)*RDPDG)
     ,                   -COS((THETA+DTHETA/2.)*RDPDG))
       H2 = RBACK(IPT-1) * (COS((THETA-DTHETA/2.)*RDPDG)
     ,                   -COS((THETA+DTHETA/2.)*RDPDG))
       IF(DPHI.EQ.0.0) GO TO 137
       DVOL(IPT)= 2./3. * PIE * (RBACK(IPT)**2.*H1 - RBACK(IPT-1)**2.*H2)
     ,                    / (360./DPHI)
   137 CONTINUE
       IF(THETA.EQ.0.)  DVOL(IPT)=PIE/3. * (RBACK(IPT) - RBACK(IPT-1)) *
     ,                  (RBACK(IPT-1)**2.  +
     ,                   RBACK(IPT-1)*RBACK(IPT) +
     ,                   RBACK(IPT)**2.) * SINDT**2.
C  DEFINE THE SOLID ANGLE ENCOMPASSED BY THIS LINE-OF-SIGHT
       SANGLE = SINT * DTHETA *RDPDG * DPHI * RDPDG
       IF(THETA.EQ.0.) SANGLE=2.*PIE*(1.-COS(DTHETA/2.*RDPDG))
```

```
  136 CONTINUE
      IF(DPHI.EQ.0.0) GO TO 140
      TVOLOS=0.
      DO 138 I=1,25
  138 TVOLOS = TVOLOS + DVOL(I)
      FRACTN =TVOLOS/TVOL
  140 CONTINUE
C
C  ZERO OUT LOS STORAGE ARRAYS
      DO 145 I=1,25
      DO 144 N=1,8
      NUMBER(I,N) = 0
  144 CNTRIB(I,N) = 0.
  145 CONTINUE
      SINP=SIN(PHI*RDPDG)
      COSP=COS(PHI*RDPDG)
C  FOR A GIVEN SEGMENT ALONG THE LINE OF SIGHT, DEFINE ITS U,V,AND W
C  COMPONENTS DU,DV, AND DW.
C
C  DU/DS
      DUODS=SINT*COSP
C  DV/DS
      DVODS=SINT*SINP
C  DW/DS
      DWODS=COST
C  NEXT DEFINE THESE COMPONENTS IN THE BASE COORDINATE SYSTEM
C  AS DX,DY, AND DZ.
C
C  DX/DS = DU*(COMPONENT OF U IN THE X DIRECTION) + DV*(COMPONENT OF V I
C          THE X DIRECTION) + DZ*(COMPONENT OF W IN THE X DIRECTION)
      DXDS=ULX*DUODS+VLX*DVODS+WLX*DWODS
      DYDS=ULY*DUODS+VLY*DVODS+WLY*DWODS
      DZDS=ULZ*DUODS+VLZ*DVODS+WLZ*DWODS
           IF (DBUGD) WRITE (8,6125) THETA,DOMEGA,PHI,DUODS,SMAX,DPHI
           IF (DBUGD) WRITE (8,6127) DXDS,DYDS,DZDS,ULX,ULY,ULZ,WLX,WLY,
     ,                               WLZ,VLX,VLY,VLZ
C
          IF(REPORT(31)) CALL PRINTD(31)
C
      VA = SQRT( VX**2. + VY**2. + VZ**2. )
C
      IF(VA.EQ.0.) CALL ERRORD(8,0)
      VXOVA = VX/VA
      VYOVA = VY/VA
      VZOVA = VZ/VA
C
C  CHECK THE ORIENTATION OF THIS LOS RELATIVE TO THE INCOMING AMBIENT
C  VELOCITY VECTOR
       ALPH =ACOS( (VX*DXDS+VY*DYDS+VZ*DZDS)/ VA   )
       ALPHA = 180.- (ALPH  / RDPDG)
C
C  WHEN PERFORMING THE VOLUME INTEGRATION FOR COMPUTING RETURN FLUX, THE
C  NUMBER DENSITY AT THE MIDPOINT OF EACH SEGMENT OF THIS LOS SHOULD BE
C  MULTIPLIED BY THE FOLLOWING WEIGHTING FACTOR TIMES THE LENGTH OF THE
C  SEGMENT.
      WFAS = SINT * COST * DTHETA * DPHI * RDPDG**2.* COS(ALPHA*RDPDG)
      COSDT = COS(DTHETA/2.*RDPDG)
      IF(THETA.EQ.0.) WFAS = 2.*PIE *(1.-COSDT) * COS(ALPHA*RDPDG)
C ***************************************************************
C     PRINT THIS SET-UP INFORMATION IF REPORT(31) = .TRUE.
          IF(.NOT.REPORT(31) ) GO TO 150
          WRITE(6,5130)
 5130     FORMAT(  /,76H     * * * * * *      LINE  OF  SIGHT  POINT  SELEC
```

```
     ,TOR     * * * * * *         ,)
          WRITE(6,5131)LOS,XOOC,YOOC,ZOOC,THETA,PHI,DXDS,DYDS,DZDS
 5131     FORMAT(//29H     ORIGIN OF LINE OF SIGHT ,I4,10X,1H(,F6.1,
     ,    1H,,F6.1,1H,,F6.1,1H),/
     ,          ,/20H      LOS ORIENTATION,
     ,           /22H          THETA(DEG)  =,F6.1,/
     ,            22H          PHI  (DEG)  =,F6.1,/
     ,            26H          DIRECTION COSINES,/
     ,            22H            S DOT XO  =,F6.3,/
     ,            22H            S DOT YO  =,F6.3,/
     ,            22H            S DOT ZO  =,F6.3)
          WRITE(6,5134)VA,VXOVA,VYOVA,VZOVA,AMBND,ALPHA
 5134     FORMAT(/"      INCOMING AMBIENT CHARACTERISTICS"/
     ,            24H          SPEED(M/SEC)  =,E9.3/
     ,            26H          DIRECTION COSINES,/
     ,            22H           VA DOT XO  =,F6.3,/
     ,            22H           VA DOT YO  =,F6.3,/
     ,            22H           VA DOT ZO  =,F6.3,/
     ,            24H          DENSITY(#/CC) =,E9.3/
     ,            30H      ANGLE BETWEEN VA AND LOS /
     ,            20H           ALPHA     =,F6.1)
C ************************************************************
  150 IF(ALPHA.GT.90.) WRITE(6,5138)
      IF(ALPHA.GT.90.) GO TO 400
 5138 FORMAT( "    THE ANGLE BETWEEN THE LOS AND INCOMING FLUX IS GREATER
     ,THAN 90 DEGREES")
C
      DX=DS(LPT)*DXDS
      DY=DS(LPT)*DYDS
      DZ=DS(LPT)*DZDS
           IF (DBUGD) WRITE (8,6150) DS(LPT),DX,DY,DZ
      IF (DZ.GT.0.0) GO TO 235
      WRITE(6,5150)
 5150 FORMAT(17H  DZ IS NEGATIVE )
      GO TO 380
  235 S=DS(LPT)
      IF (S .GT.SMAX) GO TO 380
      X= (XOOC-XORGIN)/CMTIN  + DX
      Y= (YOOC-YORGIN)/CMTIN  + DY
      Z= (ZOOC-ZORGIN)/CMTIN  + DZ
      IF(Z.LT.0.) CALL ERROR(3,LPT)
      GO TO  245
C     INCREMENT X,Y,Z
  240 X=X+DS(LPT)*DXDS
      Y=Y+DS(LPT)*DYDS
      Z=Z+DS(LPT)*DZDS
  245 R = SQRT( X*X + Y*Y + Z*Z )
           IF(DBUGD)WRITE(8,6246)X,Y,Z,R,DS(LPT)
      EXTRAP = .FALSE.
      EXTRA = 1.
C     LOCATE MIDPOINT ON LINE OF SIGHT BETWEEN HEMISPHERES
      DO  250 I=2,NR
      IF (R.LT.RL(I)) GO TO 255
  250 CONTINUE
      IF(REPORT(31)) WRITE(6,5250) RL(NR),R
 5250 FORMAT(22H POINT IS BEYOND RMAX(,F9.0,25HMETERS ) - EXTRAPOLATE TO
     ,                                                    ,E10.3)
      EXTRAP = .TRUE.
      I = NR
      EXTRA = ( RL(NR)/R ) ** 2.
  255 CONTINUE
C  THE POINT HAS NOW BEEN BRACKETED BETWEEN TWO HEMISPHERES
C  FIND THE LONGITUDE AND LATITUDE OF THIS MIDPOINT
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      IF( X. EQ. 0. .AND. Y .EQ. 0.) GO TO 260
      BETA=ATAN2(Y,X)
      ETAP=BETA
      IF(BETA.LT.0.) ETAP=BETA+2.*PIE
      XY=SQRT(X*X+Y*Y)
      ZETAP=ATAN2( XY,Z )
      GO TO 265
  260                          BETA = 0.
                               ETAP = 0.
                               ZETAP= 0.
  265 ETAPD=ETAP/RDPDG
      ZETAPD=ZETAP/RDPDG
      ZETAPD=ABS( ZETAPD )
C     SET UP PARAMETERS AND LIMITS FOR INTERPOLATION
      I1=I-1
      I2=I
      RRATIO=(R-RL(I1))/(RL(I2)-RL(I1))
      IF(EXTRAP) RRATIO = 1.
C
           IF(DBUGD) WRITE(8,6200)
           IF(DBUGD) WRITE(8,6201)I1,I2,RL(I1),RL(I2),R,RRATIO
C
C  BETWEEN THE TWO PLANES JUST FOUND, BRACKET THE POINT BETWEEN TWO ETAS
      DO  280 J=2,NET
      IF (ETAPD.LE.ETA(J)) GO TO  285
  280 CONTINUE
C     WARNING - ETAPD EXCEEDS MAX ETA
      IF(ETAPD.GT.360.) WRITE(6,5282)
 5282 FORMAT(50H  WARNING THE ANGLE OF THE POINT ETAPD EXCEEDS 360)
  285 CONTINUE
C   THE POINT HAS BEEN BRACKETED BY TWO ETA PLANES.
C
      J1=J-1
      J2=J
      ERATIO=(ETAPD-ETA(J1))/(ETA(J2)-ETA(J1))
           IF(DBUGD) WRITE(8,6230) J1,J2,ETA(J1),ETA(J2),ERATIO,ETAPD
C
      DO  290 L=2,NZETA
      IF(ZETAPD.LT.ZETA(L) ) GO TO 295
  290 CONTINUE
      WRITE(6,5290)
 5290 FORMAT(22H  ZETAP WAS NOT FOUND )
  295 CONTINUE
      L1=L-1
      L2=L
C   TO GET HERE A SEARCH WAS MADE ON R AND RJ HAS JUST BEEN BRACKETED BY
C   RADIAL POINTS AT L1 AND L2.
C
      ZRATIO=(ZETAPD-ZETA(L1))/(ZETA(L2)-ZETA(L1))
           IF(DBUGD)WRITE(8,6240)I,L1,L2,ZETA(L1),ZETA(L2),ZRATIO,ZETAPD
C
C
C  TOLERANCES CAN BE SET BY THE USER TO CONTROL THE ACCURACY OF THE
C  INTERPOLATION SCHEME. IF THE DESIRED POINT IS RELATIVELY CLOSE TO A
C  CLOUD GENERAL MATRIX POINT, ONE CAN IGNORE THE INTERPOLATION AND USE
C  THE CLOSEST POINTS. THIS CUTS DOWN ON THE COMPUTATIONAL TIME.
C
      IF(RRATIO .LT. RSLOP) RRATIO =  0.
      IF(ZRATIO .LT. ZSLOP) ZRATIO =  0.
      IF(ERATIO .LT. ESLOP) ERATIO =  0.
      IF(RRATIO .GT. (1-RSLOP) ) RRATIO =  1.
      IF(ZRATIO .GT. (1-ZSLOP) ) ZRATIO =  1.
      IF(ERATIO .GT. (1-ESLOP) ) ERATIO =  1.
```

```
C
      NUMBER(LPT,1)=IDCODE(I1,J1,L1)
      NUMBER(LPT,2)=IDCODE(I1,J1,L2)
      NUMBER(LPT,3)=IDCODE(I1,J2,L1)
      NUMBER(LPT,4)=IDCODE(I1,J2,L2)
      NUMBER(LPT,5)=IDCODE(I2,J1,L1)
      NUMBER(LPT,6)=IDCODE(I2,J1,L2)
      NUMBER(LPT,7)=IDCODE(I2,J2,L1)
      NUMBER(LPT,8)=IDCODE(I2,J2,L2)
      CNTRIB(LPT,1)= ( 1- ZRATIO)*( 1-ERATIO)*( 1-RRATIO)
      CNTRIB(LPT,2)= (    ZRATIO)*( 1-ERATIO)*( 1-RRATIO)
      CNTRIB(LPT,3)= ( 1- ZRATIO)*(   ERATIO)*( 1-RRATIO)
      CNTRIB(LPT,4)= (    ZRATIO)*(   ERATIO)*( 1-RRATIO)
      CNTRIB(LPT,5)= ( 1- ZRATIO)*( 1-ERATIO)*(   RRATIO)*EXTRA
      CNTRIB(LPT,6)= (    ZRATIO)*( 1-ERATIO)*(   RRATIO)*EXTRA
      CNTRIB(LPT,7)= ( 1- ZRATIO)*(   ERATIO)*(   RRATIO)*EXTRA
      CNTRIB(LPT,8)= (    ZRATIO)*(   ERATIO)*(   RRATIO)*EXTRA
C  ***************************************************************
C  PRINT THESE INTERMEDIATE RESULTS
C
      IF(.NOT. REPORT(31) ) GO TO 370
      XOC = XORGIN + X * CMTIN
      YOC = YORGIN + Y * CMTIN
      ZOC = ZORGIN + Z * CMTIN
      WRITE(6,5270)LPT,LOS,XOC,YOC,ZOC,S,DL(LPT),DVOL(LPT)
 5270 FORMAT(/12H      SEGMENT,I5,    30X, 7HLOS = (,I4,1H)/
     ,       40H      MIDPOINT:    ORBITER COORDINATES(,F6.0,1H,,F6.0,
     ,        1H,,F6.0,1H)/
     ,       38H      DISTANCE FROM LOS ORIGIN (M)  =,F7.1/
     ,       38H      LENGTH OF SEGMENT (M)         =,F7.1/
     ,       38H      VOLUME OF SEGMENT (M**3)      =,E10.2/
     ,       38H      NEAREST MATRIX POINTS          ,/
     ,         *              ID            RELATIVE      SEG LENGTH",/
     ,         *              NUMBER        CONTRIBUTION  (CM) ")
     ,       41H              NUMBER        CONTRIBUTION)
      DLCM= DL(LPT)*100
      WRITE(6,5286)(NUMBER(LPT,I),CNTRIB(LPT,I),DLCM,I=1,8)
C  ***************************************************************
 5286 FORMAT( 10X,I10,5X,F9.3,5X,1H*,F9.1)
  370 IF (LPT.GE.LPTMAX) GO TO  380
      LPT=LPT+1
      S=S+DS(LPT)
      IF (DS(LPT).NE.0.) GO TO 240
C   THE LOS HAS JUST BEEN CUT-OFF BECAUSE DS WAS FOUND TO BE ZERO.
C
  380 CONTINUE
      CALL CNDNSE(ISAVED,WFAS)
      IF(.NOT.REPORT(32)) GO TO 390
C  WRITE OUT A SUMMARY FOR THIS LINE-OF-SIGHT
      CALL PRINTD(32)
      WRITE(6,5130)
      WRITE(6,5129)LOS
 5129    FORMAT(44H     * * * * * *          SUMMARY  FOR  LOS(,I4,
     ,           31H)           * * * * * *         ,)
      WRITE(6,5131)LOS,XOOC,YOOC,ZOOC,THETA,PHI,DXDS,DYDS,DZDS
      WRITE(6,5134)VA,VXOVA,VYOVA,VZOVA,AMBND,ALPHA
      WRITE(6,5136)TVOL,TVOLOS,FRACTN
      WRITE(6,5140)
      WRITE(6,5141)(NUMB(IPT),CNTRB(IPT),IPT=1,ISAVED)
 5140 FORMAT("     CLOUD CONTIBUTORS TO COLUMN DENSITY ")
 5141 FORMAT("          RHO(",I5,4H)   *,E10.2)
C
  390 IF(MNCD)RETURN
```

```
C  ******************************************************************
C
C  ENTER THIS SET OF LOGIC ONLY WHEN COMPUTING RETURN FLUX
C
      IF(.NOT.REPORT(32)) GO TO 396
      WRITE(6,5136)TVOL,TVOLOS,FRACTN
      WRITE(6,5137) WFAS
 5137    FORMAT(/"      WEIGHTING FACTORS FOR RETURN FLUX */
     ,           36H          NCD * AMBND * SIGMA * VA * ,F9.3)
 5136    FORMAT(/"      VOLUME CONSIDERATIONS      */
     ,           37H          HEMISPERICAL CLOUD (M**3)   =,E9.3/
     ,           37H          VOL. ENCOMPASSED BY LOS     =,E9.3/
     ,           37H          FRACTION OF TOTAL           =,F6.3//)
  396 CONTINUE
C
C  BEFORE MOVING ON TO THE NEXT LINE-OF-SIGHT, STORE THESE CONTRIBUTORS
C  THAT WERE FOUND TO BE REQUIRED FOR EVALUATING THIS LOS.
C
      CALL STORE(ISAVED,NUMB,CNTRB,ISTORD)
C
C  STORE THE VOLUME CONTRIBUTION FROM THE LOS JUST PROCESSED
      FOV = FOV + SANGLE
      VOLUME = VOLUME + TVOLOS
      LOS=LOS+1
  400 LPT=1
      IF(SINT.LE.1.E-5) GO TO 410
      PHI=PHI+DPHI
      IF ( PHI .LT. (PHIF-DPHI/2.) )  GO TO 140
C  AT THIS POINT THE ANGLE THETA IS TO BE INCREMENTED TO THETA + DTHETA.
C  HOWEVER A CHECK IS NOW MADE TO ASSURE THAT THIS DOES NOT EXCEED THE
C  LIMITING VALUE,THETAF. THETA IS THE ANGLE OF THE CENTER OF THE VOLUME
C  ELEMENT.  THE ELEMENT ACTUALLY EXTENDS .5*DTHETA TO EITHER SIDE OF
C  THETA.
C
  410 THETA0 = THETA
      IF(THETA0.EQ.0..AND.THETAF.EQ.DTHETA) GO TO 415
      IF(THETA0+1.5*DTHETA.LE.THETAF) THETA=THETA0+DTHETA
      IF(THETA0+1.5*DTHETA.GT.THETAF) THETA=.5*(THETA0+.5*DTHETA+THETAF)
      IF(THETA0+1.5*DTHETA.GT.THETAF) DTHETA = 2.* (THETAF-THETA)
      IF(DTHETA.LT.1.) GO TO 415
      IF ( THETA .LT. THETAF ) GO TO 120
  415 CONTINUE
C  STUFF ALL POINTS SAVED AND THEIR CONTRIBUTIONS INTO NUMBER AND CONTRB
      DO 420 I=1,400
      NUMBER(I) = SAVEPT(I)
      CNTRIB(I) = SAVEC(I)
  420 CONTINUE
C
C  AT THIS POINT WRITE A SUMMARY FOR THIS CRITICAL SURFACE
C
      IF(.NOT. REPORT(32)) RETURN
      ALPHA0 = 180. - ACOS( (VX*WLX + VY*WLY + VZ*WLZ) / VA) / RDPDG
      WRITE(6,5445)ICSURF,WLX,WLY,WLZ,ALPHA0,FOV,TVOL,VOLUME
 5445 FORMAT(1H1,5X,50H* * *  SUMMARY  FOR  FIELD  OF  VIEW  OF  SURFACE
     ,(, I5,  9H)  * * * .///
     ,       *     SURFACE NORMAL ORIENTATION */
     ,       *         DIRECTION COSINES      */
     ,       *           N DOT X0 =",F6.3,     /
     ,       *           N DOT Y0 =",F6.3,     /
     ,       *           N DOT Z0 =",F6.3      /
     ,       *         ANGLE WRT AMBIENT      */
     ,       *           ALPHA    =",F6.3      /
     ,       *     FIELD OF VIEW (STERADIANS) */
```

```
     ,       "          FOV      =",F6.3       /
     ,       "      VOLUME OF CLOUD CONSIDERED "/
     ,       "       TOTAL VOLUME =",E10.3      /
     ,       "       VOLUME OF FOV=",E10.3      )
      WRITE(6,5450)
 5450 FORMAT("     CLOUD CONTRIBUTORS          ")
      WRITE(6,5451)(SAVEPT(I),SAVEC(I),I=1,ISTORD)
 5451 FORMAT(10X,I10,5X,E10.2)
      RETURN
C
 6125      FORMAT("  PTSELCT(6125) THETA      DOMEGA     PHI        DUODS
     ,   SMAX       DPHI   ",/,12X,6F10.4)
 6127      FORMAT("  PTSELCT(6127) DXDS     DYDS     DZDS     UX       UY
     ,    UZ       WX       WY       WZ       VX       VY      VZ",/13X,12F8.4)
 6150      FORMAT("  PTSELCT(6150) DS(1)       DX         DY         DZ   ",
     ,       /,12X,4F10.4)
 6246 FORMAT("  PTSELCT  X          Y          Z          R          DS",
     ,                          /,10X,5E10.3)
 6200      FORMAT("  MIDPOINT OF A LOS SEGMENT HAS BEEN FOUND BETWEEN TW
     ,O Z-PLANES ")
 6201      FORMAT("  PTSELCT(6201) I1         I2         RL(I1)     RL(I2)
     ,    R          RRATIO",/,8X,2I10,7X,4E10.4)
 6230 FORMAT("  PTSELCT(6230)  J1    J2        ETA(J1)    ETA(J2)    ERATIO
     ,    ETAPD ",/,13X,2I5,6X,4E10.3)
 6240 FORMAT("  PTSELCT(6240) I    L1    L2   Z(L1)      Z(L2)      ZRATIO
     , ZETAPD  ",        /,12X,3I5,4F10.4)
      END
*DECK ERRORD
*IF IDENT,U1100
{FOR,IS ERRORD
*ENDIF
      SUBROUTINE ERRORD(IMBAD,IPROB)
C
C           ************************************************
C           *                                              *
C           *        ERROR  MESSAGES  FOR  SEGMENT  D      *
C           *                                              *
C           ************************************************
C                                     CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C    THIS ROUTINE IS CALLED WHEN AN ERROR MESSAGE IS DESIRED. IT CAN BE
C    ACCESSED FROM ANY ROUTINE IN SEGMENT D.
C
      IMAX=10
      IF(IMBAD.GT.IMAX)WRITE(6,1000)IMBAD
C
      GO TO (101,102,103,104,105,106,107,108,109,110),IMBAD
C  ********************************************************************
    1  FORMAT("  TAPE",I3,"ENCOUNTERED AN EOF (FATAL)")
    2  FORMAT("  PARITY ERROR WAS FOUND ON TAPE",I3," (FATAL) " )
    3  FORMAT("  IN PTSLCT. LOS SEGMENT",I4," IS IN SOUTHERN HEMISPHERE")
    4  FORMAT("  IN CNDNSE. TRYED TO STORE MORE THAN 100 POINTS ")
    5  FORMAT("  IN MCDNCD. NO VIEW FACTORS EXIST FOR THE POINT",I10)
    6  FORMAT("  PNTDEN(56). DID NOT FIND ",I7,"  IN NPLUME(LTYPE)",
     1       /"  ASSUME TYPE NO.1 FOR THIS CONCENTRATED SOURCE")
    7  FORMAT("  IN RTNFLX. NO VIEW FACTORS EXIST FOR THE POINT",I10)
    8  FORMAT("  IN PTSLCT. THERE IS ZERO INCOMING AMBIENT VELOCITY")
    9  FORMAT("  TBD ")
   10  FORMAT("  TBD ")
C  CALLED FROM
  101  WRITE(6,1) IPROB
       CALL EXIT
C  CALLED FROM
```

```
 102  WRITE(6,2) IPROB
      CALL EXIT
C  CALLED FROM PTSLCT
 103  WRITE(6,3)IPROB
      CALL EXIT
C  CALLED FROM CNDNSE
 104  WRITE(6,4)
      CALL EXIT
C  CALLED FROM MCDNCD
 105  WRITE(6,5)IPROB
      RETURN
C  CALLED FROM PNTDEN
 106  WRITE(6,6) IPROB
      IPROB=1
      RETURN
C  CALLED FROM RTNFLX
 107  WRITE(6,7) IPROB
      CALL EXIT
C  CALLED FROM PTSLCT
 108  WRITE(6,8)
      RETURN
C  CALLED FROM
 109  WRITE(6,9)
      CALL EXIT
C  CALLED FROM
 110  WRITE(6,10)
      CALL EXIT
 1000 FORMAT("   ERROR CODE REQUESTED",I10,"DOES NOT EXIST IN SUBOUTINE
     ,ERROR D    ")
      END
*DECK IDCODE
*IF IDENT,U1100
{FOR,IS IDCODE
*ENDIF
      FUNCTION IDCODE(IZ,JETA,LR)
C
C           ***********************************************
C           *                                             *
C           *                POINT    DECODER             *
C           *                                             *
C           ***********************************************
C                                    CODED BY: M. HETRICK  2/16/77
C
C  THIS ROUTINE TRANSLATES THE THREE INDICES OF A POINT INTO A NODE
C  NUMBER.
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,    ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/GRID/RL(16),ZETA(4)
      LOGICAL DBUGD
      IDCODE=LR*10000 + (JETA-1)*1000 + RL(IZ)
      IF(JETA.EQ.9) IDCODE=IDCODE-8000
      IF( RL(IZ) .EQ. 0.) IDCODE = 10000
      IF( LR .EQ.1)IDCODE=LR*10000 + RL(IZ)
C     IF(DBUGD) WRITE(8,1000) IZ,JETA,LR,IDCODE,RL(IZ)
 1000 FORMAT(" IDCODE   I    J    L    IDCODE   Z",/,8X,3I5,I10,F10.4)
      RETURN
      END
*DECK CNDNSE
*IF IDENT,U1100
```

```
{FOR,IS CNDNSE
*ENDIF
      SUBROUTINE CNDNSE(ISAVED,WFAS)
C
C           ***********************************************
C           *                                             *
C           *             CONDENSE  POINTS                *
C           *                                             *
C           ***********************************************
C                                       CODED BY: M. HETRICK  2/16/77
C  OBJECTIVE:
C  THE OBJECTIVE OF THIS ROUTINE IS TO TAKE THE POINTS SELECTED BY POINT
C  SELECT ALONG A LINE-OF-SIGHT AND CONDENSE THEM BY ELIMINATING NON-
C  CONTRIBUTORS. THE ROUTINE ALSO ARRANGES THE POINTS IN NUMERICALLY
C  INCREASING ORDER.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,    ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
*CALL PTSLCT
      COMMON /SAVEM/ NUMB(100),CNTRB(100)
      LOGICAL DBUGD
C
C  ZERO OUT THE STORAGE ARRAYS
      DO 10 I=1,100
      NUMB(I) = 0
   10 CNTRB(I)  = 0.
      ISAVE=1
      DO 41 LPT=1,25
      DO 40 I=1,8
C  CHECK TO SEE IF NUMBER(LPT,I) HAS A CONTRIBUTION TO MAKE TO THIS LOS
      IF(CNTRIB(LPT,I) .EQ. 0.) GO TO 40
C  YES  IT DOES
C  IS THIS A NEW POINT?
           IF(DBUGD) WRITE(8,6020) LPT,I,NUMBER(LPT,I),CNTRIB(LPT,I)
 6020      FORMAT(' CNDNSE(6020)    LPT        I     NUMBER   CNTRIB */
     ,             15X,I5,5X,I5,5X,I5,E10.3)
      DO 20 ICK = 1, ISAVE
      IF(NUMBER(LPT,I).EQ.NUMB(ICK) ) GO TO 30
   20 CONTINUE
C  APPARENTLY IT HAS NOT BEEN SAVED BEFORE SO SAVE IT
      NUMB(ISAVE) = NUMBER(LPT,I)
      CNTRB(ISAVE)= CNTRIB(LPT,I) * DL(LPT) * 100. * WFAS
           IF(DBUGD) WRITE(8,6035) ISAVE,ICK,NUMB(ISAVE),CNTRB(ISAVE)
      ISAVE = ISAVE + 1
 6035      FORMAT(' CNDNSE(6035)     ISAVE       ICK    NUMB    CNTRB */
     ,             15X,I5,5X,I5,5X,I5,E10.3)
      IF(ISAVE.GT.100) CALL ERROR0(4,IPROB)
C  CHECK ON THE NEXT NUMBER
      GO TO 40
   30 CONTINUE
C  APPARENTLY NUMBER(I) HAS BEEN SAVED BEFORE, ADD THIS CONTRIBUTION TO
C  THE OLD.
      CNTRB(ICK) = CNTRB(ICK) + CNTRIB(LPT,I) * DL(LPT) * 100. * WFAS
   40 CONTINUE
   41 CONTINUE
      ISAVED = ISAVE - 1
C  FOR SPEEDIER MANIPULATION OF VIEW FACTOR DATA, SORT THE POINTS INTO
C  A NUMERICALLY INCREASING ORDER.(USING THE BUBBLE METHOD)
C
```

```
      ISM1 = ISAVED - 1
      DO 60 I=1,ISM1
      II=I+1
      DO 50 J=II,ISAVED
      IF(NUMB(J).GE.NUMB(I) ) GO TO 50
      ISAVE1=NUMB(I)
      SAVE2 =CNTRB(I)
      NUMB(I)=NUMB(J)
      CNTRB(I)=CNTRB(J)
      NUMB(J)=ISAVE1
      CNTRB(J)=SAVE2
   50 CONTINUE
   60 CONTINUE
      RETURN
      END
*DECK STORE
*IF IDENT,U1100
(FOR,IS STORE
*ENDIF
      SUBROUTINE STORE(ISAVED,NUMB,CNTRB,ISTORD)
C
C           ***********************************************
C           *                                             *
C           *                STORE   POINTS               *
C           *                                             *
C           ***********************************************
C                                      CODED BY: M. HETRICK  2/16/77
C
C  OBJECTIVE:
C  THE OBJECTIVE OF THIS ROUTINE IS TO TAKE THE POINTS AND CONTRIBUTIONS
C  REQUIRED FOR THIS LINE-OF-SIGHT AND STORE THEM IN NUMERICALLY
C  INCREASING ORDER.
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
*CALL SAVEP
      DIMENSION NUMB(1),CNTRB(1)
      INTEGER SAVEPT
      LOGICAL DBUGD
      ISTORE = ISTORD + 1
      DO 40 I=1,ISAVED
C  IS THIS A NEW POINT?
           IF(DBUGD) WRITE(8,6020) I,NUMB(I),CNTRB(I)
 6020      FORMAT(" CNDNSE(6020)    I     NUMB    CNTRB        "/
     ,          15X,I5,5X,I5,2E10.3)
      DO 20 ICK = 1, ISTORE
      IF(NUMB(I).EQ.SAVEPT(ICK) ) GO TO 30
   20 CONTINUE
C  APPARENTLY IT HAS NOT BEEN SAVED BEFORE SO SAVE IT
      SAVEPT(ISTORE) = NUMB(I)
      SAVEC(ISTORE)  = CNTRB(I)
      ISTORE = ISTORE + 1
           IF(DBUGD) WRITE(8,6035) ISTORE,I,NUMB(I),CNTRB(I)
 6035      FORMAT(" CNDNSE(6035)  ISTORE  I   NUMB    CNTRB       "/
     ,          15X,I5,5X,I5,5X,I5,2E10.3)
C  CHECK ON THE NEXT NUMBER
      GO TO 40
   30 CONTINUE
C  APPARENTLY NUMBER(I) HAS BEEN SAVED BEFORE, ADD THIS CONTRIBUTION TO
C  THE OLD.
      SAVEC(ICK) = SAVEC(ICK) + CNTRB(I)
```

```
   40  CONTINUE
       ISTORD = ISTORE - 1
C   FOR SPEEDIER MANIPULATION OF VIEW FACTOR DATA, SORT THE POINTS INTO
C   A NUMERICALLY INCREASING ORDER.(USING THE BUBBLE METHOD)
C
       ISM1 = ISTORD - 1
       DO 60 I=1,ISM1
       II=I+1
       DO 50 J=II,ISTORD
       IF(SAVEPT(J).GE.SAVEPT(I) ) GO TO 50
       ISAVE1   = SAVEPT(I)
       SAVE2    = SAVEC(I)
       SAVEPT(I)= SAVEPT(J)
       SAVEC(I) = SAVEC(J)
       SAVEPT(J)= ISAVE1
       SAVEC(J) = SAVE2
   50  CONTINUE
   60  CONTINUE
       RETURN
       END
*DECK MCDNCD
*IF IDENT,U1100
(FOR,IS MCDNCD
*ENDIF
       SUBROUTINE  MCDNCD
C
C              ****************************************
C              *                                      *
C              *     MASS/NUMBER  COLUMN  DENSITY     *
C              *                                      *
C              ****************************************
C                                      CODED BY: D. STRANGE  2/16/77
C                                                M. METRICK  4/10/77
C  OBJECTIVE:
C    THE FOLLOWING SET OF LOGIC CALCULATES THE DENSITY AT POINTS ALONG
C    A LINE-OF-SIGHT AND COMPUTES THE RESULTING MASS/NUMBER COLUMN
C    DENSITY AND RETURN FLUX.
C
       COMMON/MDF/ ATCODE, TIME(6),RFSURF(10),RECEVR(50),
      2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
      3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
      4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
      5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
      6            DPHI(10),DOMEGA(10),DTHETA(10),
      7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
      8            X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
       COMMON/CMLOSS/MLR(300,10),MDOTJ(300)
       COMMON/CNCDS/CDEN(25,10),CPNCD(50,10),CSTNCD(50),CTINCD,
      1             CFLUXT(25,10)
       COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
      1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
      2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
      3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
      4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
      5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
       COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
       COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
       COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
       COMMON/TMP/ TEMPOS(300),TEMPOR(60)
       COMMON/TRASYS/NODEI,JDATA,NODEJ(300),MFIJ(300),MFJI(300),
      1              AREAJ(300),THETI(300),THETAJ(300),R(300)
*CALL PTSLCT
       COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
```

```
     1               CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/NCDS/ DEN(25,10),PNCD(300,10),STNCD(300),TINCD,
     1             FLUXJT(25,10)
      COMMON/MISC/LINE,IPAGE,CFLAG
      COMMON/NPLM/NPLUME(5)
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/RATES2/AGEORB,AGESLB,KIND(15),SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/MS/INDEX(521)
C  THE FOLLOWING ARRAY IS USED FOR THE RANDOM MASS STORAGE WORD INDEX
C  IT SHOULD BE DIMENSIONED TO 2*RECORDS + 1
C
C
C
      LOGICAL DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,    ENG,
     1        EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2        MNCD,  MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3        MINTMP,ORBITR,OUT,   REFLCT,REPORT,
     4        RFAS,  RFSS,  SMTP,  GO,    SUNL,  SUNM,   SUNH
      INTEGER PLACE,SECT
      REAL MFIJ,MFJI,MOLWT
C ***************************************************************
C
C  OPEN THE MASS STORAGE FILE
      CALL OPENMS(13,INDEX,521,1)
C
      TINCD=0.0
      CTINCD=0.0
C
      DO 10 I=1,300
      DO 9 J=1,10
    9 PNCD(I,J)=0.0
   10 STNCD(I)=0.0
C
      DO 20 I=1,250
      DEN(I)=0.0
      CDEN(I)=0.0
   20 CONTINUE
C
      DO 25 I=1,50
      DO 24 J=1,10
   24 CPNCD(I,J)=0.0
   25 CSTNCD(I)=0.0
C
      IPNTO=0
   30 CONTINUE
      DO 60 IPOINT = 1,25
C
      DO 50 KK=1,8
      K=KK
      IPNT=NUMBER(IPOINT,K)
           IF (DBUGD)WRITE(8,6051)IPOINT,K,IPNT,CNTRIB(IPOINT,K)
C     TEST FOR THE END OF THE LOS.
      IF(IPNT.GT.39999) IPNT=IPNT-10000
C  THE ABOVE STATEMENT IS INSERTED ONLY BECAUSE MASS TRANSPORT DATA
C  ARE NOT AVAILABLE BEYOND 60 DEG. OFF THE Z-AXIS.
      IF(IPNT.EQ.0) GO TO 60
C       POINT 30015 IS DIS-ALLOWED IN AN ORBITER CONFIGURATION
C       INTERFERENCE WITH THE TAILFIN.
      IF(.NOT.ORBITR) GO TO 35
      IF(IPNT.EQ.30015) IPNT=30010
   35 IF(CNTRIB(IPOINT,K).EQ.0.) GO TO 50
C
```

```
C  TEST TO SEE IF DATA FOR THIS POINT IS ALREADY LOADED IN CORE.
      IF(IPNTO.EQ.IPNT) GO TO 40
C
C  APPARENTLY NOT
      IPNTO=IPNT
            IF (DBUGD)WRITE(8,6050)IPOINT,K,IPNT,CNTRIB(IPOINT,K)
C
C  FILL THE TRASYS BLOCK WITH DATA
      CALL READMS(13,NODEI,2102,IPNT)
      IF(NODEI.EQ.0) CALL ERROR(5,IPNT)
   40 CONTINUE
C
C
C  COMPUTE THE CLOUD DENSITY AT THE POINT INDEXED BY IPOINT
C  AND FILL THE ARRAY PNCD FOR SURFACES AND CPNCD FOR CONCENTRATED
C  SOURCES.
      CALL PNTDEN(IPOINT,K)
C
   50 CONTINUE
   60 CONTINUE
C
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C  AT THIS POINT THE ARRAYS PNCD AND CPNCD CAN BE ARRANGED IN DESCENDING
C  ORDER BASED ON STNCD AND CSTNCD
C
      IF(.NOT.REPORT(33) ) GO TO 90
      CALL RATIOS(33)
C
   90 CONTINUE
C
      IF(.NOT.(ED.OR.OUT.OR.LEAK)) GO TO 110
C  CHECK TO SEE IF THE USER WANTS SURFACE SOURCES SORTED BY MATERIALS
      IF(.NOT.REPORT(34).AND..NOT.REPORT(35)) GO TO 100
      CFLAG = 6H
      WRITE(6,2000)
      LINE = 12
 2000 FORMAT(1H1)
      CALL SORTER(MATRL,KIND,15,34)
  100 CONTINUE
C  CHECK TO SEE IF THE USER WANTS SURFACE SOURCES SORTED BY LOCATIONS
      IF(.NOT.REPORT(36).AND..NOT.REPORT(37)) GO TO 110
      CFLAG = 6H
      WRITE(6,2000)
      LINE = 12
      CALL SORTER(SECT,PLACE,20,36)
  110 CONTINUE
C+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C+++++++                    PLOTS              +++++++++++++++
C
      IF(REPORT(39) .OR. REPORT(40) ) CALL DENPLT
C
      CALL CLOSMS(13)
C
      WRITE(6,2001)
      RETURN
 2001 FORMAT(1H1,/////,20X,"*************************************",
     ,              /,20X,"*                                   *",
     ,              /,20X,"*          END  OF  MCDNCD          *",
     ,              /,20X,"*                                   *",
     ,              /,20X,"*************************************")
 6050       FORMAT("  IN MCDNCD(6050) IPOINT,K,IPNT,CNTRIB(IPOINT,K) */
     ,             3I10,E12.3)
```

```
 6051       FORMAT(*  IN MCDNCD(6051) IPOINT,K,IPNT,CNTRIB(IPOINT,K) */
     ,              3I10,E12.3)
      END
*DECK PNTDEN
*IF IDENT,U1100
{FOR,IS PNTDEN
*ENDIF
      SUBROUTINE PNTDEN(IPOINT,K)
C
C           ******************************************
C           *                                        *
C           *            POINT  DENSITY              *
C           *                                        *
C           ******************************************
C                                     CODLD BY: D. STRANGE  2/16/77
C                                               M. HETRICK  3/21/77
C  OBJECTIVE:
C     THIS SUBROUTINE CALCULATES THE DENSITY AT A POINT GIVEN THE
C     MASS LOSS RATE OF EACH SURFACE OR ENGINE/VENT PLUME FUNCTION.
C     IT ALSO COMPUTES A RUNNING INTEGRATED VALUE OF THE NUMBER COLUMN
C     DENSITY(PNCD) ATTRIBUTED TO EACH SOURCE(JEMIT).
C
      COMMON/CMLOSS/MLR(300,10),MDOTJ(300)
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/MISC/LINE,IPAGE,CFLAG
      COMMON/NCDS/ DEN(25,10),PNCD(300,10),STNCD(300),TINCD,
     1             FLUXJT(25,10)
      COMMON/NPLM/NPLUME(5)
      COMMON/CNCDS/CDEN(25,10),CPNCD(50,10),CSTNCD(50),CTINCD,
     1             CFLUXT(25,10)
*CALL PTSLCT
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/RATES2/AGEORB,AGESLB,KIND(15),SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      COMMON/TRASYS/NODEI,JDATA,NODEJ(300),MFIJ(300),MFJI(300),
     1              AREAJ(300),THETI(300),THETAJ(300),R(300)
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      DIMENSION FLUX(10),RHO(10)
      INTEGER CIDENT,CLOC,CTYPE,PNTSC,TYPE
C
      LOGICAL DBUGD,ENG,EVAP,MFPATH,MNCD
      REAL LAMBDA,MFIJ,MFJI,MLR,MOLWT,NA
C
      NA = 6.023E+23
      DO 120 I=1,JDATA
      JEMIT=NODEJ(I)
C
C  SIFT OUT THE SOURCES THAT ARE ENGINES AND VENTS
      IF(JEMIT.GE.6000.AND.JEMIT.LT.9999) GO TO 50
C
      IF(JKEEP .EQ.0) GO TO 120
      DO 10 J=1,JKEEP
```

```
      JJ=J
C  CHECK TO SEE IF JEMIT IS AN ALLOWABLE SOURCE
 10   IF(IDENT(J).EQ.JEMIT) GO TO 20
      GO TO 120
 20   CONTINUE
      TEMP=TEMPOS(JJ)
      X = R(I)*2.54
C
C     TRACK ALL SPECIES FOR EACH SURFACE
C
      DO 40 M=M1,M2
C  COMPUTE THE MOST PROBABLE VELOCITY FOR SPECIES LEAVING SURFACE JEMIT
      VJ=VELOC(TEMP,MOLWT(M),2.0)
C
C  AT THIS POINT ATTENUATION DUE TO SCATTERING OUT OF THE LINE-OF-SIGHT
C  CAN BE CONSIDERED IF THE CONTROL FLAG MFPATH IS SET TRUE.
C  NOTE:  IF THIS OPTION IS USED, MASS FLUX IS NO LONGER CONSERVED AND
C  CONSIDERATION IS NOT GIVEN TO MOLECULES SCATTERED INTO THE LINE-OF-
C  SIGHT FROM ADJACENT SCATTERING SIGHTS.
C
      ATTEN = 1.0
      IF(.NOT.MFPATH) GO TO 30
      SIGMA = 3.1416 * (VFACTR*(DIA(M) + DA))**2./4.
      LAMBDA = VJ/ (SIGMA * AMBND * VA)
      ATTEN = EXP( - X/LAMBDA   )
 30   FLUXJ=MLR(JJ,M) * MFIJ(I) * 4.0 * ATTEN * CNTRIB(IPOINT,K)
      IF(.NOT.MNCD) GO TO 35
      FLUXJT(IPOINT,M) = FLUXJT(IPOINT,M) +FLUXJ
      DENJ=FLUXJ/VJ
      DEN(IPOINT,M) = DEN(IPOINT,M) +  DENJ
      PNCD(JJ,M) = PNCD(JJ,M) + DENJ * DL(IPOINT) * 100.* NA / MOLWT(M)
      GO TO 40
 35   PNCD(JJ,M)=PNCD(JJ,M)+MLR(JJ,M)*MFIJ(I)*4.*NA/MOLWT(M)
     ,             / VJ * ATTEN * CNTRIB(IPOINT,K)
 40   CONTINUE
C
          IF(DBUGD) WRITE(8,6010)NODEI,JEMIT,IPOINT,K,JJ,M1,M2,I
          IF(DBUGD) WRITE(8,6020)CNTRIB(IPOINT,K),MFIJ(I),
     ,             (PNCD(JJ,M),M=1,10)
      GO TO 120
C
 50   CONTINUE
C  APPARENTLY JEMIT WAS AN ENGINE OR VENT
      IF(.NOT.ENG .AND. .NOT. EVAP ) GO TO 120
C  IS JEMIT TURNED ON?
      DO 60 KE=1,KTOTAL
      KK=KE
 60   IF(CIDENT(KK) .EQ. JEMIT ) GO TO 70
C  A MATCH UP WAS NOT FOUND SO IGNORE JEMIT
      GO TO 120
 70   CONTINUE
      TYPE = CTYPE(KK)
C  LOCATE THIS TYPE OF CONCENTRATED SOURCE IN THE MASTER ARRAY
C
      DO 80 LTYPE = 1,5
 80   IF(TYPE.EQ.NPLUME(LTYPE)) GO TO 90
      IPROB=JEMIT
      CALL ERRORD(6,IPROB)
      LTYPE=IPROB
 90   CONTINUE
      RC=R(I)*2.54
      THETAP = THETAJ(I)
C
```

```
      CALL PLUMES(LTYPE,RC,THETAP,FLUX,RHO)
C
      DO 110 M=M1,M2
C  DEFINE THE LIMITING VELOCITY OF EXHAUST SPECIES
      VJ = PLUMEC(9,LTYPE)
      ATTEN = 1.0
      IF(.NOT.MFPATH) GO TO 100
      SIGMA = 3.1416 * (VFACTR*(DIA(M) + DA))**2./4.
      LAMBDA = VJ/ (SIGMA * AMBND * VA)
      ATTEN = EXP( - X/LAMBDA  )
 100  FLUXJ= FLUX(M) * ATTEN * CNTRIB(IPOINT,K)
      IF(.NOT.MNCD) GO TO 105
      CFLUXT(IPOINT,M) = CFLUXT(IPOINT,M) +FLUXJ
      DENJ=FLUXJ/VJ
      CDEN(IPOINT,M) = CDEN(IPOINT,M) +  DENJ
      CPNCD(KK,M) =CPNCD(KK,M) + DENJ * DL(IPOINT) * 100.* NA / MOLWT(M)
      GO TO 110
 105  CPNCD(JJ,M)=CPNCD(JJ,M)+FLUX(M) * 100.* NA / MOLWT(M)
     ,           / VJ * ATTEN * CNTRIB(IPOINT,K)
 110  CONTINUE
           IF(DBUGD) WRITE(8,6011)NODEI,JEMIT,IPOINT,K,KK,M1,M2,I
           IF(DBUGD) WRITE(8,6021)CNTRIB(IPOINT,K),RC,THETAP,
     ,                                    (CPNCD(KK,M),M=1,10)
 120  CONTINUE
C
      DO 140 J=1,JKEEP
      STNCD(J) = 0.0
      DO 130 M=M1,M2
 130  STNCD(J) = STNCD(J) + PNCD(J,M)
 140  CONTINUE
C
      DO 160 K=1,KTOTAL
      CSTNCD(K) = 0.0
      DO 150 M=M1,M2
 150  CSTNCD(K) = CSTNCD(K) + CPNCD(K,M)
 160  CONTINUE
C
      TINCD = 0.0
      DO 170 J=1,JKEEP
 170  TINCD = TINCD + STNCD(J)
C
      CTINCD = 0.0
      DO 180 K=1,KTOTAL
 180  CTINCD = CTINCD + CSTNCD(K)
C
C
 6010       FORMAT(' IN PNTDEN. NODEI,JEMIT,IPOINT,K,JJ,M1,M2,I ',8I10)
 6020       FORMAT('  IN PNTDEN. CNTRIB(IPOINT,K),MFIJ(I)',
     ,      '                PNCD(JJ,M),M=M1,M2)',/,5X,2E9.3/10(E9.3))
 6021       FORMAT('  IN PNTDEN. CNTRIB(IPOINT,K),RC,THETA',
     ,      '                 CPNCD(JJ,M),M=M1,M2)',/,5X,3E9.3/10(E9.3))
 6011       FORMAT(' IN PNTDEN. NODEI,JEMIT,IPOINT,K,KK,M1,M2,I ',8I10)
C
      RETURN
      END
*DECK VELOC
*IF IDENT,U1100
{FOR,IS VELOC
*ENDIF
      FUNCTION VELOC(TEMP,MW,GAMMA)
C
C           ****************************************
C           *                                      *
```

```
C            *            MOLECULAR  VELOCITY            *
C            *                                           *
C            *********************************************
C                                        CODED BY: M. HETRICK  2/16/77
C
C  THIS FUNCTION CALCULATES THE VELOCITY (CM/SEC) OF A PARTICLE OF
C  MOLECULAR WEIGHT MW LEAVING SURFACE NUMBERED NODEJ
C
C  IF GAMMA IS SET EQUAL TO 2.0, THE FUNCTION CALCULATES THE MOST PROB-
C  ABLE VELOCITY.  IF GAMMA IS SET EQUAL TO THE RATIO OF SPECIFIC HEATS,
C  THE FUNCTION CALCULATES THE SPEED OF SOUND.
C
      REAL MW
C
      R =  8.314E+7
      RG = R/MW
      TC=TEMP
      TK=TC+273.
      VELOC=SQRT( GAMMA * RG * TK )
C
C1
      RETURN
      END
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*DECK RATIOS
*IF IDENT,U1100
{FOR,IS RATIOS
*ENDIF
      SUBROUTINE RATIOS(IPRINT)
C
C            *********************************************
C            *                                           *
C            *                  RATIOS                   *
C            *                                           *
C            *********************************************
C                                        CODED BY: M. HETRICK  4/1/77
C  OBJECTIVE:
C    THE OBJECTIVE OF THIS ROUTINE IS TO ARRANGE THE SOURCES IN A
C    DECREASING ORDER BASED ON THE TOTAL CONTRIBUTION TO NCD(STNCD) FROM
C    THE SURFACE. USE THE BUBBLE METHOD - FIRST LOOK AT STNCD(I). IF
C    STNCD(J) IS GREATER THAN STNCD(I), SWITCH POSITIONS.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/CMLOSS/MLR(300,10),MDOTJ(300)
      COMMON/CNCDS/CDEN(25,10),CPNCD(50,10),CSTNCD(50),CTINCD,
     1             CFLUXT(25,10)
      COMMON/MISC/LINE,IPAGE,CFLAG
      COMMON/NCDS/ DEN(25,10),PNCD(300,10),STNCD(300),TINCD,
     1             FLUXJT(25,10)
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15), SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/SOURCE/SURFSC(300),PNTSC(50),ONTIME(50),SSURFS(300)
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
```

```
      COMMON/TRASYS/NODEI,JDATA,NODEJ(300),MFIJ(300),MFJI(300),
     1               AREAJ(300),THETI(300),THETAJ(300),R(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      INTEGER CIDENT,CLOC,CTYPE,OTHER2,PNTSC,SURFSC,SECT
      LOGICAL ED,ENG,EVAP,LEAK,OUT,REPORT,REFLCT
      REAL MDOTJ,MLR,NA,MOLWT
      DIMENSION STORE(10),STORE1(10)
      DIMENSION SKEY(16),GTKEY(16)
C
      NA = 6.023E+23
C
      IF(.NOT.(ED.OR.OUT.OR.LEAK.OR.REFLCT )) GO TO 175
      JKM1 = JKEEP - 1
      DO  80 I=1,JKM1
      II=I+1
      DO  70 J=II,JKEEP
      IF(STNCD(J).LE.STNCD(I) ) GO TO 70
C  APPARENTLY J IS GREATER THAN I - STUFF I OFF INTO STORAGE
      SAVE1 = MDOTJ(I)
      ISAVE2= IDENT(I)
      ISAVE3= SECT(I)
      ISAVE4= MATRL(I)
      SAVE5 = AREA(I)
      ISAVE6= SURFSC(I)
      SAVE7= TEMPOS(I)
      SAVE8 = STNCD(I)
      DO 10 JJ=M1,M2
 10   STORE(JJ) = MLR(I,JJ)
      DO 20 JJ=M1,M2
 20   STORE1(JJ) = PNCD(I,JJ)
      MDOTJ(I) = MDOTJ(J)
      IDENT(I) = IDENT(J)
      SECT(I)  = SECT(J)
      MATRL(I) = MATRL(J)
      AREA(I)  = AREA(J)
      SURFSC(I)= SURFSC(J)
      TEMPOS(I)= TEMPOS(J)
      STNCD(I) = STNCD(J)
      DO 30 JJ=M1,M2
 30   MLR(I,JJ) = MLR(J,JJ)
      DO 40 JJ=M1,M2
 40   PNCD(I,JJ) = PNCD(J,JJ)
      MDOTJ(J) = SAVE1
      IDENT(J) = ISAVE2
      SECT(J)  = ISAVE3
      MATRL(J) = ISAVE4
      AREA(J)  = SAVE5
      SURFSC(J)= ISAVE6
      TEMPOS(J)= SAVE7
      STNCD(J) = SAVE8
      DO 50 JJ=M1,M2
 50   MLR(J,JJ) = STORE(JJ)
      DO 60 JJ=M1,M2
 60   PNCD(J,JJ) = STORE1(JJ)
 70   CONTINUE
 80   CONTINUE
 90   CONTINUE
C
 95   TMDOT=0.0
      EDNCD=0.0
      OUTNCD=0.0
C
      DO 100 I=1,16
```

```
      GTKEY(I)=0.0
  100 SKEY(I)=0.0
C
      LINE = 1
      CFLAG = 6H
      CALL PRINTD(IPRINT)
      IF(IPRINT.EQ.33)WRITE(6,1001)(SPECIE(M),M=1,10)
      IF(IPRINT.EQ.41)WRITE(6,2001)(SPECIE(M),M=1,10)
      LINE = LINE + 12
C
      DO 150 J=1,JKEEP
      JJ=J
C
      IF(STNCD(JJ).EQ.0.0) GO TO 150
C
C   START ACCUMULATING THE CONTRIBUTIONS FROM SOURCE TYPE KEY(I) AND
C   STUFF RUNNING SUM OF EACH SPECIES IN SKEY(1-10).  SKEY(11) WILL
C   CONTAIN ED CONTRIBUTIONS. SKEY(12) WILL CONTAIN OUTGASSING. SKEY(13)
C   CONTAINS TOTALS OF ALL SPECIES.
C
      DO 110 M=M1,M2
  110 SKEY(M)= SKEY(M)+PNCD(JJ,M)
C
      EDNCD = 0.
      EDMCD = 0.
      DO 120 M=MED1,MED2
      EDNCD = EDNCD + PNCD(JJ,M)
      EDMCD = EDMCD + PNCD(JJ,M)*MOLWT(M)/NA
  120 CONTINUE
      OUTNCD = 0.
      OUTMCD = 0.
      DO 130 M=MOUT1,MOUT2
      OUTNCD = OUTNCD + PNCD(JJ,M)
      OUTMCD = OUTMCD + PNCD(JJ,M)*MOLWT(M)/NA
  130 CONTINUE
      OTHER = 0.
      OTHER2 = MED2 + 1
      DO 140 M=OTHER2,M2
      OTHER = OTHER + PNCD(JJ,M)*MOLWT(M)/NA
  140 CONTINUE
      TMCD = EDMCD + OUTMCD + OTHER
      SKEY(11)=SKEY(11)+EDNCD
      SKEY(12)=SKEY(12)+OUTNCD
      SKEY(13)=SKEY(13)+STNCD(JJ)
      SKEY(14)=SKEY(14)+EDMCD
      SKEY(15)=SKEY(15)+OUTMCD
      SKEY(16)=SKEY(16)+TMCD
      TMDOT=TMDOT+MDOTJ(JJ)
C
C   WRITE OUT THIS CONTRIBUTION FROM SOURCE TYPE KEY(I)
C
      PERCNT=STNCD(JJ)/TINCD * 100.
      IF(REPORT(IPRINT))
     +WRITE(6,1000) IDENT(JJ),SECT(JJ),MDOTJ(JJ),(PNCD(JJ,K),K=1,5),
     +   EDMCD,OUTMCD,TMCD,MATRL(JJ),TEMPOS(JJ),(PNCD(JJ,K),K=6,10),
     +  EDNCD,OUTNCD,STNCD(JJ),PERCNT,JJ
      LINE=LINE+3
      IF(LINE.LT.54) GO TO 150
C
      CFLAG = 6H(CONT)
      LINE=1
      CALL PRINTD(IPRINT)
      IF(IPRINT.EQ.33)WRITE(6,1001)(SPECIE(M),M=1,10)
```

```
      IF(IPRINT.EQ.41)WRITE(6,2001)(SPECIE(M),M=1,10)
      LINE=LINE+12
  150 CONTINUE
C
      IF(SKEY(13).EQ.0.0) GO TO 160
      WRITE(6,1010)        TMDOT,(SKEY(L),L=1,5),(SKEY(N),N=14,16)
     ,                           ,(SKEY(LL),LL=6,13)
C
      LINE=LINE+4
  160 CONTINUE
C
C
 1000 FORMAT(I10,4X,A6,3X,E10.3,3X,5(E9.2,1X),1X,2(E9.2,1X),E9.2,/
     +  10X,4X,A6,3X,F10.3,3X,5(E9.2,1X),1X,2(E9.2,1X),E9.2,1X,F8.4,I5/)
 1010 FORMAT("     ------------------------------------------------",
     +"------------------------------    ----------------",
     +"------------------------",/,
     +4X,"TOTAL",5X,6X,3X,E10.3,3X,5(E9.2,1X),1X,2(E9.2,1X),E9.2,/,
     +              36X,5(E9.2,1X),1X,2(E9.2,1X),E9.2," 100.0000",//)
C
      DO 170 KI=1,16
      GTKEY(KI)=GTKEY(KI)+SKEY(KI)
  170 CONTINUE
  175 IF(.NOT.(ENG.OR.EVAP)) RETURN
      KTM1 = KTOTAL - 1
      DO  220 I=1,KTM1
      II=I+1
      DO  210 J=II,KTOTAL
      IF(CSTNCD(J).LE.CSTNCD(I) ) GO TO 210
C  APPARENTLY J IS GREATER THAN I - STUFF I OFF INTO STORAGE
      ISAVE1= CIDENT(I)
      ISAVE2= CLOC(I)
      ISAVE3= CTYPE(I)
      ISAVE4= CXLOC(I)
      ISAVE5 =CYLOC(I)
      ISAVE6= CZLOC(I)
      ISAVE7= PNTSC(I)
      SAVE8 = ONTIME(I)
      SAVE9 = CSTNCD(I)
      DO 180 JJ=M1,M2
  180 STORE1(JJ) = CPNCD(I,JJ)
      CIDENT(I) = CIDENT(J)
      CLOC(I)   = CLOC(J)
      CTYPE(I) = CTYPE(J)
      CXLOC(I)  = CXLOC(J)
      CYLOC(I)  = CYLOC(J)
      CZLOC(I)  = CZLOC(J)
      PNTSC(I)= PNTSC(J)
      ONTIME(I)= ONTIME(J)
      CSTNCD(I) = CSTNCD(J)
      DO 190 JJ=M1,M2
  190 CPNCD(I,JJ) = CPNCD(J,JJ)
      CIDENT(J) = ISAVE1
      CLOC(J)   = ISAVE2
      CTYPE(J)  = ISAVE3
      CXLOC(J)  = ISAVE4
      CYLOC(J)  = ISAVE5
      CZLOC(J)  = ISAVE6
      PNTSC(J)  = ISAVE7
      ONTIME(J) = SAVE8
      CSTNCD(J) = SAVE9
      DO 200 JJ=M1,M2
  200 CPNCD(I,JJ) = STORE1(JJ)
```

```
 210  CONTINUE
 220  CONTINUE
C
 225  TMDOT=0.0
      EDNCD=0.0
      OUTNCD=0.0
C
      DO 230 I=1,16
 230  SKEY(I)=0.0
C
      LINE = 1
      CFLAG = 6H
      CALL PRINTD(IPRINT)
      IF(IPRINT.EQ.33)WRITE(6,1002)(SPECIE(M),M=1,10)
      IF(IPRINT.EQ.41)WRITE(6,2002)(SPECIE(M),M=1,10)
C
      LINE = LINE + 12
      DO 280 J=1,KTOTAL
      JJ=J
C
      IF(CSTNCD(JJ).EQ.0.0) GO TO 280
C
C   START ACCUMULATING THE CONTRIBUTIONS FROM EACH ENGINE AND VENT AND
C   STUFF THE RUNNING SUM OF EACH SPECIES IN SKEY(1-10).
C   SKEY(13) CONTAINS TOTALS OF ALL SPECIES.
C
      DO 240 M=M1,M2
 240  SKEY(M)= SKEY(M)+CPNCD(JJ,M)
C
      TMCD = 0.
      DO 260 M=M1,M2
      TMCD = TMCD + CPNCD(JJ,M)*MOLWT(M)/NA
 260  CONTINUE
      SKEY(13)=SKEY(13)+CSTNCD(JJ)
      SKEY(16)=SKEY(16)+TMCD
C
C   WRITE OUT THESE CONTRIBUTIONS
C
      PERCNT=CSTNCD(JJ)/CTINCD * 100.
      IF(REPORT(IPRINT))
     +WRITE(6,2000) CIDENT(JJ),CTYPE(JJ),CLOC(JJ),(CPNCD(JJ,K),K=1,5),
     +    TMCD,(CPNCD(JJ,K),K=6,10),CSTNCD(JJ),PERCNT,JJ
 2000 FORMAT(I10,4X,A6,7X,A6,3X,5(E9.2,1X),2X,E9.2,/
     +  10X,4X,6X,3X,10X,3X,5(E9.2,1X),2X,E9.2,15X,F8.4,I5/)
 2010 FORMAT("    ------------------------------------------------",
     +"--------------------------------    ----------",
     +"------------------------",/,
     +4X,"TOTAL",27X,5(E9.2,1X),2X,E9.2,/,
     +             36X,5(E9.2,1X),2X,E9.2,14X," 100.00",//)
      LINE=LINE+3
      IF(LINE.LT.54) GO TO 280
C
      CFLAG = 6H(CONT)
      LINE=1
      CALL PRINTD(IPRINT)
      IF(IPRINT.EQ.33)WRITE(6,1002)(SPECIE(M),M=1,10)
      IF(IPRINT.EQ.41)WRITE(6,2002)(SPECIE(M),M=1,10)
      LINE=LINE+12
 280  CONTINUE
C
C   WRITE THE TOTALS
C
      IF(SKEY(13).EQ.0.0) GO TO 290
```

```
      WRITE(6,2010)(SKEY(L),L=1,5),SKEY(16),(SKEY(LL),LL=6,10),SKEY(13)
C
      LINE=LINE+4
  290 CONTINUE
C*********************************************************************
C
C     WRITE OUT 2ND LEVEL OUTPUT NOW (IF DESIRED)
C
C     DO 300 KI=1,16
C     GTKEY(KI)=GTKEY(KI)+SKEY(KI)
C300  CONTINUE
C     CFLAG = 6H
C     IF(REPORT(IPRINT)) CALL PRINTD(IPRINT)
C     WRITE(6,1040)
C     WRITE(6,1030) (GTKEY(KI),KI=1,5),(GTKEY(LI),LI=14,16),
C    1              (GTKEY(KI),KI=6,13)
 1040 FORMAT("    ------------------------------------------------",
     +"---------------------------------  ------------------",
     +"---------------")
 1030 FORMAT(5X,"TOTAL",27X,5(E9.2,1X),8X,3(E9.2,1X),
     1           ,/37X,5(E9.2,1X),8X,3(E9.2,1X),2X,"100.0",//)
 1001 FORMAT(/"    SURFACE    SECTION    MASS LOSS   SPECIES NUMBER COLU
     1MN DENSITY",22X,"EARLY      OUT       TOTAL      %     PLACE",/
     2       "    NUMBER    ","          (GM/SEC)    ",
     3  1X, "(MOLECULES/CM**2)",34X,"DESORPTION GASSING  MCD/NCD   OF"/
     4       "              ","  MATERIAL   TEMP        ",
     5            2X,5(A6,4X),"(GM/CM**2)",20X,"TOTAL"/
     6  26X,"(DEG C)",6X,5(A6,4X),"(MOLECULES/CM**2)",/
     7 4X,"------------------------------------------------------------
     8--------------------  ---------------------------------------")
 2001 FORMAT(/"    SURFACE    SECTION    MASS LOSS   SPECIES RETURN FLUX
     1 CONTRIBUTION",19X,"EARLY      OUT       TOTAL      %     PLACE",/
     2       "    NUMBER    ","          (GM/SEC)    ",
     3  1X, "(MOLECULES/CM**2)",34X,"DESORPTION GASSING  RTN FLX   OF"/
     4       "              ","  MATERIAL   TEMP        ",
     5            2X,5(A6,4X),"(GM/CM**2)",20X,"TOTAL"/
     6  26X,"(DEG C)",6X,5(A6,4X),"(MOLECULES/CM**2)",/
     7 4X,"------------------------------------------------------------
     8--------------------  ---------------------------------------")
 1002 FORMAT(/"    ENG/VENT   TYPE       LOCATION     SPECIES NUMBER COLU
     1MN DENSITY   ",14X,"      TOTAL                    % OF   PLACE",/
     2       "    NUMBER    ","                          ",
     3  1X, "(MOLECULES/CM**2)",33X," MCD/NCD                    TOTAL"/
     4       "              ","                          ",
     5            2X,5(A6,4X),"(GM/CM**2)",10X,/
     6  26X,"        ",6X,5(A6,4X),"(MOLECULES/CM**2)",/
     7 4X,"------------------------------------------------------------
     8--------------------  ---------------------------------------")
 2002 FORMAT(/"    ENG/VENT   TYPE       LOCATION     SPECIES RETURN FLUX
     1 CONTRIBUTION",14X,"      TOTAL                    % OF   PLACE",/
     2       "    NUMBER    ","                          ",
     3  1X, "(MOLECULES/CM**2)",33X," RTN FLX                    TOTAL"/
     4       "              ","                          ",
     5            2X,5(A6,4X),"(GM/CM**2/SEC)"/
     6 26X,"        ",6X,5(A6,4X),"(MOLECULES/CM**2/SEC)",/
     7 4X,"------------------------------------------------------------
     8--------------------  ---------------------------------------")
      RETURN
      END
*DECK SORTER
*IF IDENT,U1100
{FOR,IS SORTER
*ENDIF
```

```
      SUBROUTINE SORTER(MATCH,KEY,NKEY,IPRINT)
C
C           ******************************************
C           *                                        *
C           *                SORTER                  *
C           *                                        *
C           ******************************************
C                                        CODED BY: D. STRANGE  2/16/77
C                                                  M. HETRICK  3/16/77
C
C  OBJECTIVE:
C     THIS SUBROUTINE SORTS SURFACES BASED ON THE ARRAY KEY WHICH
C     CONTAINS NKEY ENTRIES.
C
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/CMLOSS/MLR(300,10),MDOTJ(300)
      COMMON/MISC/LINE,IPAGE,CFLAG
      COMMON/NCDS/ DEN(25,10),PNCD(300,10),STNCD(300),TINCD,
     1          FLUXJT(25,10)
      COMMON/RATES2/AGEORB,   AGESLB,   KIND(15), SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      COMMON/TRASYS/NODEI,JDATA,NODEJ(300),MFIJ(300),MFJI(300),
     1              AREAJ(300),THETI(300),THETAJ(300),R(300)
C
C
      DIMENSION GTKEY(16),SKEY(20,16),KEY(1),MATCH(1)
      INTEGER SECT
      REAL MDOTJ,NA,MOLWT
      LOGICAL REPORT,ED,OUT
      NA = 6.023E+23
C
      TMDOT=0.0
      EDNCD=0.0
      OUTNCD=0.0
C
      DO 10 I=1,240
   10 SKEY(I)=0.0
      DO 20 I=1,16
   20 GTKEY(I)=0.0
C
      IF(REPORT(IPRINT)) CALL PRINTD(IPRINT)
C
      DO 70 I=1,NKEY
      IF(KEY(I).EQ.6H  NONE)  GO TO 70
C     FIND EACH SURFACE THAT MATCHES WITH KEY(I)
C
      DO 50 J=1,JKEEP
      JJ=J
      IF(KEY(I).EQ.MATCH(JJ)) GO TO 30
      GO TO 50
C
   30 CONTINUE
C     FOUND MATCH UP IN ARRAY KEY
      IF(STNCD(JJ).EQ.0.0) GO TO 50
```

```
C
C   START ACCUMULATING THE CONTRIBUTIONS FROM SOURCE TYPE KEY(I) AND
C   STUFF RUNNING SUM OF EACH SPECIES IN SKEY(1-10).  SKEY(11) WILL
C   CONTAIN ED CONTRIBUTIONS. SKEY(12) WILL CONTAIN OUTGASSING. SKEY(13)
C   CONTAINS TOTALS OF ALL SPECIES.
C
      DO 40 M=M1,M2
   40 SKEY(I,M)= SKEY(I,M)+PNCD(JJ,M)
C
      EDNCD = 0.
      EDMCD = 0.
      IF(.NOT.ED) GO TO 44
      DO 41 M=MED1,MED2
      EDNCD = EDNCD + PNCD(JJ,M)
      EDMCD = EDMCD + PNCD(JJ,M)*MOLWT(M)/NA
   41 CONTINUE
   44 OUTNCD = 0.
      OUTMCD = 0.
      IF(.NOT.OUT) GO TO 45
      DO 42 M=MOUT1,MOUT2
      OUTNCD = OUTNCD + PNCD(JJ,M)
      OUTMCD = OUTMCD + PNCD(JJ,M)*MOLWT(M)/NA
   42 CONTINUE
   45 TMCD = 0.
      DO 43 M=M1,M2
      TMCD = TMCD + PNCD(JJ,M)*MOLWT(M)/NA
   43 CONTINUE
      SKEY(I,11)=SKEY(I,11)+EDNCD
      SKEY(I,12)=SKEY(I,12)+OUTNCD
      SKEY(I,13)=SKEY(I,13)+STNCD(JJ)
      SKEY(I,14)=SKEY(I,14)+EDMCD
      SKEY(I,15)=SKEY(I,15)+OUTMCD
      SKEY(I,16)=SKEY(I,16)+TMCD
      TMDOT=TMDOT+MDOTJ(JJ)
C
C   WRITE OUT THIS CONTRIBUTION FROM SOURCE TYPE KEY(I)
C
      IF(REPORT(IPRINT))
     +WRITE(6,1000) IDENT(JJ),SECT(JJ),MDOTJ(JJ),(PNCD(JJ,K),K=1,5),
     +   EDMCD,OUTMCD,TMCD,MATRL(JJ),TEMPOS(JJ),(PNCD(JJ,K),K=6,10),
     +                                          EDNCD,OUTNCD,STNCD(JJ)
      LINE=LINE+3
      IF(LINE.LT.54) GO TO 50
C
      CFLAG = 6H(CONT)
      LINE=1
      CALL PRINTD(IPRINT)
      LINE=LINE+12
   50 CONTINUE
C
C   END OF SORT ON KEY(I). WRITE TOTALS
C
      IF(SKEY(I,13).EQ.0.0) GO TO 60
      WRITE(6,1010) KEY(I),TMDOT,(SKEY(I,L),L=1,5),(SKEY(I,N),N=14,16)
                                ,(SKEY(I,LL),LL=6,13)
C
      LINE=LINE+4
   60 CONTINUE
C
      EDNCD=0.0
      OUTNCD=0.0
      TMDOT=0.0
C
```

```
   70  CONTINUE
C
C
 1000 FORMAT(I10,4X,A6,3X,E10.3,3X,5(E9.2,1X),11X,2(E9.2,1X),4X,E9.2,/
     +       10X,4X,A6,3X,F10.3,3X,5(E9.2,1X),11X,2(E9.2,1X),4X,E9.2,/)
 1010 FORMAT("     ------------------------------------------------",
     +"-----------------------------------  ----------------",
     +"------","   -------- ",/,
     +4X,"TOTAL",5X,A6,3X,E10.3,4X,5(E9.2,1X),10X,2(E9.2,1X),4X,E9.2,/,
     +                          37X,5(E9.2,1X),10X,2(E9.2,1X),4X,E9.2,//)
C
C*********************************************************************
C
C     WRITE OUT 2ND LEVEL OUTPUT NOW (IF DESIRED)
C
C     TOTAL CONFIGURATION NCD = TINCD
C
      IPRINT = IPRINT + 1
      TINCD=0.0
      DO 80 II=1,JKEEP
   80 TINCD=TINCD+STNCD(II)
C
      IF(TINCD.EQ.0.0) GO TO 120
      IF(REPORT(IPRINT)) CALL PRINTD(IPRINT)
C
      DO 90 I=1,15
      IF(KEY(I).EQ.6H  NONE) GO TO 90
      IF(SKEY(I,13).EQ.0.0)  GO TO 90
      PRCNT=(SKEY(I,13)/TINCD)*100.
      WRITE(6,1020) KEY(I),(SKEY(I,L),L=1,5),(SKEY(I,N),N=14,16)
                                 ,(SKEY(I,LL),LL=6,13),PRCNT
   90 CONTINUE
      DO 110 KI=1,16
      DO 100 I=1,15
  100 GTKEY(KI)=GTKEY(KI)+SKEY(I,KI)
  110 CONTINUE
  120 CONTINUE
      WRITE(6,1040)
      WRITE(6,1030) (GTKEY(KI),KI=1,5),(GTKEY(LI),LI=14,16),
     1              (GTKEY(KI),KI=6,13)
 1040 FORMAT("     ------------------------------------------------",
     +"-----------------------------------  ----------------",
     +"---------------")
 1020 FORMAT(8X,A6,23X,5(E9.2,1X),8X,3(E9.2,1X),
     1                ,/37X,5(E9.2,1X),8X,3(E9.2,1X),2X,F5.1)
 1030 FORMAT(5X,"TOTAL",27X,5(E9.2,1X),8X,3(E9.2,1X),
     1                ,/37X,5(E9.2,1X),8X,3(E9.2,1X),2X,"100.0",//)
      RETURN
      END
*DECK DENPLT
*IF -IDENT,U1100
      SUBROUTINE DENPLT
      COMMON/NCDS/ DEN(25,10),PNCD(300,10),STNCD(300),TINCD,
     1             FLUXJT(25,10)
      COMMON/CNCDS/CDEN(25,10),CPNCD(50,10),CSTNCD(50),CTINCD,
     1             CFLUXT(25,10)
      COMMON/PTSLCT/ DUM1(50,8),DUM2(50,8),DL(25)
      COMMON/RATES2/ AGEORB,AGESLB,KIND(15),SPECIE(10),MOLWT(10),
     1               PLACE(15),DIA(10)
      COMMON/CNTRL/DEPSIT,DBUGA,DBUGB,DBUGC,DBUGD,ED,ENG,
     1             EVAP,FIVP,LEAK,LMOP,MAXTMP,MCD,MFPATH,
     2             NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,REFLCT,REPORT(50),
```

```
     4              RFAS,RFSS,SMTP,TITLE(12),TSTART(3),
     5              TSTOP(3), GO, SUNL,SUNM,SUNH
C
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      DIMENSION DENP(25),X(25),DENIP(25,10),ISKIP(10)
      LOGICAL REPORT,DBUGD
C
C     ISKIP SAVES SPECIES SUBSCRIPTS THAT ARE NOT CALCULATED
C     I.E. ZERO  ,CAUSES AVOIDANCE OF LOG-LOG ERRORS
C
      CALL INIT280
C
C
      AYMIN= 1.0E+30
      YMIN = 1.0E+30
      AYMAX=-1.0E+30
      YMAX =-1.0E+30
C
      IF(DBUGD) WRITE(8,101)
     1 ((DEN(I,K),K=1,10),I=1,25)
      IF(DBUGD) WRITE(8,102)
     2 ((CDEN(I,K),K=1,10),I=1,25)
  101   FORMAT(//,10X," INPUT TO PLOTS ",/
     1 10X,"DEN(I,K) =",/,
     2(10X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3))
  102   FORMAT(//,
     3 10X,"CDEN(I,K) =",/,
     4(10X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3))
C
C      MIN MAX SPECIES DENSITY ACROSS 25 POINTS (AYMIN/AYMAX)
C      MIN MAX TOTAL POINT DENSITY ACROSS 25 POINTS (YMIN/YMAX)
C      DENSITY IS PLOTTED ON Y
C
      DO 1 I=1,25
      II=I
      DENP(I)=0.0
      DO 2 K=1,10
      KK=K
      DENIP(I,K)=DEN(I,K)+CDEN(I,K)
      IF(DENIP(I,K).EQ.0.0) GO TO 12
      IF(DENIP(I,K).LT.AYMIN) AYMIN=DENIP(I,K)
      IF(DENIP(I,K).GT.AYMAX) AYMAX=DENIP(I,K)
      GO TO 13
   12 ISKIP(KK)=KK
   13 DENP(I)=DENP(I)+DENIP(I,K)
    2 CONTINUE
      IF(DENP(I).EQ.0.0) GO TO 3
      IF(DENP(I).LT.YMIN) YMIN=DENP(I)
      IF(DENP(I).GT.YMAX) YMAX=DENP(I)
C
    1 CONTINUE
      GO TO 4
    3 CONTINUE
      II=II-1
    4 CONTINUE
C
C
      IF(DBUGD) WRITE(8,751) YMIN,YMAX
  751 FORMAT(2X,* YMIN,YMAX =*,2E10.2)
C     MUCH HAGGLING MUST BE DONE HERE TO FIND CORRECT X VALUE
C     CORRESPONDING TO DENSITY VOLUME MID-POINTS
C
      X(1)=(DL(1)/2.)
```

```
      XINTER=0.0
      DO 10 I=2,II
      XINTER=XINTER+DL(I-1)
      X(I)=(DL(I)/2.)+XINTER
   10 CONTINUE
C
      AXMIN=X(1)
      XMIN=AXMIN
      AXMAX=X(II)
      XMAX=AXMAX
      AMX= ALOG10(XMIN)
      AMY= ALOG10(YMIN)
      IYY1= IFIX(AMY)-1
      IXX1= IFIX(AMX)
      XMIN=10**IXX1
      YMIN=10.**(IYY1)
      AMAXX= ALOG10(XMAX)
      AMAXY= ALOG10(YMAX)
      IXX2= IFIX(AMAXX) +1
      IYY2= IFIX(AMAXY)
      XMAX= 10**IXX2
      YMAX= 10.**(IYY2)
C
      IF(DBUGD) WRITE(8,750)AXMIN,AMX,IXX1,XMIN,
     +                              AMY,IYY1,YMIN,
     +                      AXMAX,AMAXX,IXX2,XMAX,
     +                              AMAXY,IYY2,YMAX
C
  750 FORMAT(2X,*AXMIN,AMX,IXX1,XMIN=*,2E10.2,I5,E10.2,/,
     +          *      AMY,IYY1,YMIN=*,E10.2,I5,E10.2,/,
     +          *AXMAX,AMAXX,IXX2,XMAX=*,2E10.2,I5,E10.2,/,
     +          *      AMAXY,IYY2,YMAX=*,E10.2,I5,E10.2)
C
      IF(.NOT.REPORT(39))  GO TO 6
C       PLOT MAJOR DENSITY CURVE
C
      IF(DBUGD)  WRITE(8,100) AXMIN,AXMAX,AYMIN,AYMAX,II,
     1           ((DENIP(MM,NN),NN=1,10),MM=1,II)
      IF(DBUGD)  WRITE(8,103)
     2             XMIN,XMAX,YMIN,YMAX,
     3            (DENP(MM),MM=1,II)
      IF(DBUGD)  WRITE(8,104)
     4            (X(MM),MM=1,II)
C
  100 FORMAT(///,10X," PLOT DEBUG ",/,
     1 10X,"AXMM-AYMM,II = ",4(E10.4,1X),I5,/,
     2 10X,"DENIP= ",/,
     3(10X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3))
  103 FORMAT(//,
     4 10X,"XMM,YMM= ",4(E10.4),/,
     5 10X,"DENP=",/,
     6(10X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3))
  104 FORMAT(//,
     7 10X," X  =",/,
     8(10X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3,1X,E9.3))
C
C
      CALL FRAME
      CALL MAPGLL(XMIN,XMAX,YMIN,YMAX,.2,.9,.2,.9)
C
C
      CALL CHAROPT(D,D,1,0,D)
C
```

```
      X1=.10
      Y1=.93
      DO 9 IW=1,12
      CALL ABSBEAM(X1,Y1)
      CALL NUMBER(TITLE(IW),2HA6)
      X1=X1+.07
    9 CONTINUE
      CALL ABSBEAM(.40,.13)
      CALL SYMBOL(29HDISTANCE ALONG LOS (METERS)$.)
      CALL ABSBEAM(.10,.95)
      CALL SYMBOL(29HREPORT 39                    $.)
      CALL ABSBEAM(.37,.07)
      CALL SYMBOL(29HDENSITY ALONG LINE OF SIGHT$.)
      CALL ABSBEAM(.70,.07)
      CALL NUMBER(LOS,2HI2)
C
      CALL CHAROPT(D,D,1,1,D)
      CALL ABSBEAM(.10,.40)
      CALL SYMBOL(17HDENSITY (G/CM3)$.)
C
      CALL SETBEAM(X(1),DENP(1))
      CALL CHARKTR(10,1)
      CALL SETBEAM(X(1),DENP(1))
C
      DO 5 I=2,II
C
      CALL VECTOR(X(I),DENP(I))
      CALL CHARKTR(10,1)
C
    5 CONTINUE
    6 CONTINUE
      IF(.NOT.REPORT(40))  GO TO 14
C
C       PLOT SPECIES/PER POINT DENSITY CURVE
C
      CALL FRAME
      CALL MAPGLL(AXMIN,AXMAX,AYMIN,AYMAX,.2,.85,.2,.9)
C
C
      CALL CHAROPT(D,D,1,0,D)
      X1=.10
      Y1=.93
      DO 11 IW=1,12
      CALL ABSBEAM(X1,Y1)
      CALL NUMBER(TITLE(IW),2HA6)
      X1=X1+.07
   11 CONTINUE
      CALL ABSBEAM(.35,.13)
      CALL SYMBOL(29HDISTANCE ALONG LOS (METERS)$.)
      CALL ABSBEAM(.10,.96)
      CALL SYMBOL(29HREPORT 40                    $.)
      CALL ABSBEAM(.27,.07)
      CALL SYMBOL(43HDENSITY VS DISTANCE (PER SPECIE) FOR LOS $.)
      CALL ABSBEAM(.75,.07)
      CALL NUMBER(LOS,2HI2)
C
      CALL CHAROPT(D,D,1,1,D)
      CALL ABSBEAM(.10,.40)
      CALL SYMBOL(17HDENSITY (G/CM3)$.)
C
C       LOOP OVER EACH SPECIES
C
      CALL CHAROPT(D,D,1,0,D)
```

```
      XX=.87
      YY=.90
      KK=1
      DO 7 I=1,10
      IF(DENIP(1,I).EQ.0) GO TO 7
      CALL SETBEAM(X(1),DENIP(1,I))
      CALL CHARKTR(I,1)
      CALL SETBEAM(X(1),DENIP(1,I))
      DO 8    K=2,II
      CALL VECTOR(X(K),DENIP(K,I))
      CALL CHARKTR(I,1)
    8 CONTINUE
      CALL ABSBEAM(XX,YY)
      CALL CHARKTR(I,1)
      ZZ=XX+.02
      CALL ABSBEAM(ZZ,YY)
      CALL NUMBER(SPECIE(I),2HA6)
      YY=YY-.03
    7 CONTINUE
   14 CONTINUE
      CALL FRAME
      CALL FRAMECT(N,1)
      RETURN
      END
*ENDIF
*IF IDENT,U1100
      SUBROUTINE DENPLT
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/NCDS/ DEN(25,10),PNCD(300,10),STNCD(300),TINCD
      COMMON/PTSLCT/ NUMBR(25,8),CNTRIB(25,8),DL(25)
      COMMON/RATES2/ AGEORB,AGESLB,KIND(15),SPECIE(10),MOLWT(10),
     1               PLACE(15),DIA(10)
      COMMON/CNTRL/DEPSIT,DBUGA,DBUGB,DBUGC,DBUGD,ED,ENG,
     1             EVAP,FIVP,LEAK,LMOP,MAXTR,MAXTS,MCD,MFPATH,
     2             NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTR,MINTS,ORBITR,OUT,REFLCT,REPORT(50),
     4             RFAS,RFSS,SMTP,TITLE(12),TSTART(3),
     5             TSTOP(3), GO, SUNL,SUNM,SUNH
C
      DIMENSION DENP(25),X(25),FLDX(12),FLDY(12)
      LOGICAL REPORT
C
C        MSFC PLOT ++++++++++++++++++++++++++++++++++++++++++++
C        USING SC4020 QUICK LOOK ROUTINES
C        LOG-LOG SCALES
C
      CALL IDENT(0,HARDCOPY,MICROFILM)
      CALL FRAMEV(0)
C
C       DATA IN X TITLE IN FLDX
C
      FLDX(1)=6HDISTAN
      FLDX(2)=6HCE ALO
      FLDX(3)=6HNG LOS
      FLDX(4)=6H (METE
      FLDX(5)=6HRS)
      FLDX(6)=6HLOS =
C
C     ENCODE LINE-OF-SIGHT INTO FIELD DATA
      ENCODE(6,100,FLDX(7),)LOS
      DO 5 IF=8,12
    5 FLDX(IF)=6H
```

```
C      DATA IN Y TITLE IN FLDY
       FLDY(1)=6HDENSIT
       FLDY(2)=6HY (G/C
       FLDY(3)=6HM2
       DO 6 IF=4,12
 6     FLDY(IF)=6H
C
C
  100 FORMAT(A6)
C
C
       YMIN = 1.0E+30
       YMAX =-1.0E+30
C
C
C      MIN MAX TOTAL POINT DENSITY ACROSS 25 POINTS (YMIN/YMAX)
C
C
       DO 1 I=1,25
       II=I
       DENP(I)=0.0
       DO 2 K=1,10
       DENP(I)=DENP(I)+DEN(I,K)
       IF(DENP(I).EQ.0.0) GO TO 3
       IF(DENP(I).LT.YMIN) YMIN=DENP(I)
       IF(DENP(I).GT.YMAX) YMAX=DENP(I)
     2 CONTINUE
     1 CONTINUE
       GO TO 4
     3 CONTINUE
       II=II-1
     4 CONTINUE
C
C      MUCH HAGGLING MUST BE DONE HERE TO FIND CORRECT X VALUE
C      CORRESPONDING TO DENSITY VOLUME MID-POINTS
C
       X(1)=(DL(1)/2.) + .1
       XINTER=.1
       DO 10 I=2,II
       XINTER=XINTER+DL(I-1)
       X(I)=(DL(I)/2.)+XINTER
  10   CONTINUE
C
       XMIN=X(1)
       XMAX=X(II)
C
C      ++++++++++++    PLOT    ++++++++++++++++++++
C
       NP=-II
       CALL SMXYV(0,1)
       CALL QUKLOG(-1,XMIN,XMAX,YMIN,YMAX,1H*,FLDX,FLDY,NP,X,DENP)
C
C
C      THIS ROUTINE SHOULD BE REVIEWED BY MSFC COMPUTER PERSONEL
C      PREVIOUS TO EXECUTION
C
C
       ENDJOB
       RETURN
       END
*ENDIF
*DECK RTNFLX
*IF IDENT,U1100
```

```
{FOR,IS RTNFLX
*ENDIF
      SUBROUTINE  RTNFLX
C
C             ****************************************
C             *                                      *
C             *      RETURN FLUX (RFAS/RFSS)         *
C             *                                      *
C             ****************************************
C                                        CODED BY: M. HETRICK  3/16/77
C  OBJECTIVE:
C    THE FOLLOWING SET OF LOGIC CALCULATES THE DENSITY AT POINTS ALONG
C    A LINE-OF-SIGHT AND COMPUTES THE RESULTING MASS/NUMBER COLUMN
C    DENSITY AND RETURN FLUX.
C
      COMMON/MDF/ ATCODE, TIME(6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6            DPHI(10),DOMEGA(10),DTHETA(10),
     7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8            X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
      COMMON/CNCDS/CDEN(25,10),CPNCD(50,10),CSTNCD(50),CTINCD,
     1CFLUXT(25,10)
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,    ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SEGD1/NLOS,RFSTK
      COMMON/SPEC/ MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/ TEMPOS(360)
      COMMON/TRF/ TRFSSC(10),TRFASS(10),TRFASE(10)
      COMMON/TRASYS/NODEI,JDATA,NODEJ(300),MFIJ(300),MFJI(300),
     1              AREAJ(300),THETI(300),THETAJ(300),R(300)
*CALL PTSLCT
      COMMON/PTSRCE/CIDENT(50),CLOC(50),CTYPE(50),CXLOC(50),CYLOC(50),
     1              CZLOC(50),PLUMEC(10,5),SPECMF(10,5)
      COMMON/NCDS/ DEN(25,10),PNCD(300,10),STNCD(300),TINCD,
     1             FLUXJT(25,10)
      COMMON/MISC/LINE,IPAGE,CFLAG
      COMMON/NPLM/NPLUME(5)
      COMMON/RATES2/AGEORB,AGESLB,KIND(15),SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
C  THE FOLLOWING ARRAY IS USED FOR THE RANDOM MASS STORAGE WORD INDEX
C  IT SHOULD BE DIMENSIONED TO 2*RECORDS + 1
      COMMON/MS/INDEX(521)
      DIMENSION STRFLX(300),CSTRF(50),DRFASS(10),DRFASE(10),DRFSSC(10)
C
      EQUIVALENCE (STNCD(1),STRFLX(1)),(TINCD,TIRFLX)
      EQUIVALENCE (CSTNCD(1),CSTRF(1)),(CTINCD,CTRFLX)
C
      LOGICAL DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,    ENG,
     1        EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2        MNCD,  MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3        MINTMP,ORBITR,OUT,   REFLCT,REPORT,
     4        RFAS,  RFSS,  SMTP,  GO,    SUNL,  SUNM,  SUNH
      INTEGER PLACE,SECT
```

```
      REAL MFIJ,MFJI,MOLWT,NA
      NA = 6.023E+23
C ***************************************************************
C
C  OPEN THE MASS STORAGE FILE
      CALL OPENMS(13,INDEX,521,1)
C
      TINCD=0.0
      CTINCD=0.0
C
      DO 10 I=1,300
      DO 9 J=1,10
    9 PNCD(I,J)=0.0
   10 STNCD(I) = 0.0
C
      DO 20 I=1,250
      DEN(I)=0.0
   20 CDEN(I)=0.0
C
      DO 25 I=1,50
      DO 24 J=1,10
   24 CPNCD(I,J)=0.0
   25 CSTNCD(I)=0.0
C
      IPNTO=0
   30 CONTINUE
      DO 60 IPOINT = 1,50
C
      DO 50 KK=1,8
      K=KK
      IPNT=NUMBER(IPOINT,K)
      IF(IPNT.GT.39999) IPNT=IPNT-10000
           IF(DBUGD) WRITE(8,6060) IPNT,IPOINT,K
 6060      FORMAT(' IN RTNFLX(6060)  IPNT,IPOINT,K',3I10)
C     TEST FOR THE END OF THE LOS.
      IF(IPNT.EQ.0) GO TO 60
      IF(.NOT.ORBITR) GO TO 35
      IF(IPNT.EQ.30015) IPNT=30010
   35 IF(CNTRIB(IPOINT,K).EQ.0.) GO TO 50
C
C  TEST TO SEE IF DATA FOR THIS POINT IS ALREADY LOADED IN CORE
      IF(IPNTO.EQ.IPNT) GO TO 40
C
C  APPARENTLY NOT
      IPNTO=IPNT
            IF (DBUGD)WRITE(8,6050)IPOINT,K,IPNT,CNTRIB(IPOINT,K)
C
C  FILL THE TRASYS BLOCK WITH DATA
      CALL READMS(13,NODEI,2102,IPNT)
      IF(NODEI.EQ.0) CALL ERRORD(7,IPNT)
   40 CONTINUE
C
C
C  COMPUTE THE CLOUD DENSITY AT THE POINT INDEXED BY IPOINT
C  AND FILL THE ARRAY PNCD FOR SURFACES AND CPNCD FOR CONCENTRATED
C  SOURCES.
      CALL PNTDEN(IPOINT,K)
C
   50 CONTINUE
   60 CONTINUE
C
C * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
```

```
C  AT THIS POINT THE ARRAYS PNCD AND CPNCD CAN BE ARRANGED IN DESCENDING
C  ORDER BASED ON STNCD AND CSTNCD
C
      IF(.NOT.REPORT(33) ) GO TO 90
      CALL RATIOS(33)
C
   90 CONTINUE
      IF(.NOT.(ED.OR.OUT.OR.LEAK)) GO TO 110
C
C  CHECK TO SEE IF THE USER WANTS SOURCES SORTED BY MATERIALS
      IF(.NOT.REPORT(34).AND..NOT.REPORT(35)) GO TO 100
      CFLAG = 6H
      WRITE(6,2000)
 2000 FORMAT(1H1)
      LINE = 12
      CALL SORTER(MATRL,KIND,15,34)
  100 CONTINUE
C  CHECK TO SEE IF THE USER WANTS SOURCES SORTED BY LOCATIONS
      IF(.NOT.REPORT(36).AND..NOT.REPORT(37)) GO TO 110
      CFLAG = 6H
      WRITE(6,2000)
      LINE = 12
      CALL SORTER(SECT,PLACE,15,36)
  110 CONTINUE
C  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C                  CALL PLOTS IF DESIRED
C
      IF(REPORT(39).OR. REPORT(40)) CALL DENPLT
C
C  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
      CALL CLOSMS(13)
C
C  AT THIS POINT THE PNCD ARRAY CAN BE REPLACED WITH RETURN FLUX
C  ARRIVING AT SURFACE RFSURF(ICSURF)
C
      IF(.NOT.RFAS) GO TO 160
      CALL RFLXAS
C  AGAIN THE USER MAY WANT TO SORT THE DATA IN DESCENDING ORDER OR BY
C  SURFACE MATERIALS OR BY LOCATION
      IF (.NOT.REPORT(41)) GO TO 140
      CALL RATIOS(41)
C
  140 CONTINUE
C
C  CHECK TO SEE IF THE USER WANTS SOURCES SORTED BY MATERIALS
      IF(.NOT.OUT.AND..NOT.ED.AND..NOT.LEAK) GO TO 160
      IF(.NOT.REPORT(42).AND..NOT.REPORT(43)) GO TO 150
      CFLAG = 6H
      WRITE(6,2000)
      LINE = 12
      CALL SORTER(MATRL,KIND,15,42)
  150 CONTINUE
C  CHECK TO SEE IF THE USER WANTS SOURCES SORTED BY LOCATIONS
      IF(.NOT.REPORT(44).AND..NOT.REPORT(45)) GO TO 160
      CFLAG = 6H
      WRITE(6,2000)
      LINE=12
      CALL SORTER(SECT,PLACE,20,44)
  160 CONTINUE
C
C  COMPUTE THE RETURN FLUX DUE TO SELF SCATTERING WITHIN THE CLOUD OF
C  CONTAMINANTS.
      IF(RFSS) CALL RFLXSS
```

```
C
C  NEXT DETERMINE THE AMOUNT OF DEPOSITION THAT SHOULD RESULT FROM THE
C  ABOVE COMPUTED RETURN FLUX.
C
      IF(.NOT.DEPSIT) GO TO 240
      IREC = 300 + 50 + ISURF
C
      IF(.NOT.RFAS) GO TO 180
C  CHECK THE CONTAMINANTS ORIGINATING FROM SURFACES
      IF(.NOT.(ED.OR.OUT.OR.LEAK)) GO TO 180
      DO 170 M=1,10
      IF(TRFASS(M) .EQ.0.)  GO TO 170
      STICK = ( TRFASS(M) - SUBLIM(IREC,M)* NA/MOLWT(M))/ TRFASS(M)
      IF(M .GE. MOUT1 .AND. M .LE. MOUT2) STICK = RFSTK
      IF(SPECIE(M) .EQ. 6HMMHNO3 ) STICK = 1.0
      IF(STICK .LT. 0. ) STICK = 0.
C
C  NEXT MULTIPLY THE CONDENSATION COEFFICIENT FOR SPECIES M TIMES THE
C  INCOMING FLUX (MOLECULES/CM**2/SEC)
      DRFASS(M) = TRFASS(M) * STICK
 170  CONTINUE
 180  CONTINUE
C
C  CHECK THE CONTAMINANTS ORIGINATING FROM ENGINE AND VENTS
      IF(.NOT.(ENG.OR.EVAP)) GO TO 200
      DO 190 M=1,10
      IF(TRFASE(M) .EQ.0.)  GO TO 190
      STICK = ( TRFASE(M) - SUBLIM(IREC,M)* NA/MOLWT(M))/ TRFASE(M)
      IF(M .GE. MOUT1 .AND. M .LE. MOUT2) STICK = RFSTK
      IF(SPECIE(M) .EQ. 6HMMHNO3 ) STICK = 1.0
      IF(STICK .LT. 0. ) STICK = 0.
C
C  NEXT MULTIPLY THE CONDENSATION COEFFICIENT FOR SPECIES M TIMES THE
C  INCOMING FLUX (MOLECULES/CM**2/SEC)
      DRFASE(M) = TRFASE(M) * STICK
 190  CONTINUE
 200  CONTINUE
C
C  CHECK THE CONTAMINANTS THAT ARE THE SELF SCATTERED COMPONENTS
      IF(.NOT.RFSS) GO TO 220
      DO 210 M=1,10
      IF(TRFSSC(M) .EQ.0.)  GO TO 210
      STICK = ( TRFSSC(M) - SUBLIM(IREC,M)* NA/MOLWT(M))/ TRFSSC(M)
      IF(M .GE. MOUT1 .AND. M .LE. MOUT2) STICK = RFSTK
      IF(SPECIE(M) .EQ. 6HMMHNO3 ) STICK = 1.0
      IF(STICK .LT. 0. ) STICK = 0.
C
C  NEXT MULTIPLY THE CONDENSATION COEFFICIENT FOR SPECIES M TIMES THE
C  INCOMING FLUX (MOLECULES/CM**2/SEC)
      DRFSSC(M) = TRFSSC(M) * STICK
 210  CONTINUE
 220  CONTINUE
C
C  WRITE OUT THESE RESULTS
C
      IF(REPORT(47)) CALL PRINTD(47)
C
      WRITE(6,4000)(TRFASS(M),M=1,10)
      WRITE(6,4001)(TRFASE(M),M=1,10)
      WRITE(6,4002)(TRFSSC(M),M=1,10)
      WRITE(6,4003)
      WRITE(6,4004)(DRFASS(M),M=1,10)
      WRITE(6,4005)(DRFASE(M),M=1,10)
```

```
      WRITE(6,4006)(DRFSSC(M),M=1,10)
C
C  NEXT MULTIPLY THE DEPOSITION RATE TIMES THE TIME INTERVAL FOR THIS
C  TIME SLICE.
      DELTAT =(TSTOP(1) - TSTART(1))* 3600. +
     ,        (TSTOP(2) - TSTART(2))* 60. +
     ,        (TSTOP(3) - TSTART(3))
      DO 230 M=1,10
      DRFASS(M) = DRFASS(M) * DELTAT
      DRFASE(M) = DRFASE(M) * DELTAT
  230 DRFSSC(M) = DRFSSC(M) * DELTAT
      WRITE(6,4007)
      WRITE(6,4008)(DRFASS(M),M=1,10)
      WRITE(6,4009)(DRFASE(M),M=1,10)
      WRITE(6,4010)(DRFSSC(M),M=1,10)
 4007 FORMAT(//15X," ***   DEPOSITION LEVELS   ***"///)
 4008 FORMAT(5X,"SURFACE  CONTRIB.  ",10(E10.3))
 4009 FORMAT(5X,"ENG/VENT CONTRIB   ",10(E10.3))
 4010 FORMAT(5X,"SELF SCATTERING    ",10(E10.3))
 4000 FORMAT(5X,"SURFACE  CONTRIB   ",10(E10.3))
 4001 FORMAT(5X,"ENG/VENT CONTRIB   ",10(E10.3))
 4002 FORMAT(5X,"SELF SCATTERING    ",10(E10.3))
 4003 FORMAT(//15X," ***   DEPOSITION RATES   ***"///)
 4004 FORMAT(5X,"SURFACE  CONTRIB   ",10(E10.3))
 4005 FORMAT(5X,"ENG/VENT CONTRIB   ",10(E10.3))
 4006 FORMAT(5X,"SELF SCATTERING    ",10(E10.3))
 240  CALL CLOSMS(13)
      RETURN
 6050       FORMAT("  IN RTNFLX(6050) IPOINT,K,IPNT,CNTRIB(IPOINT,K) */
     ,             3I10,E12.3)
      END
*DECK RFLXAS
*IF IDENT,U1100
(FOR,IS RFLXAS
*ENDIF
      SUBROUTINE RFLXAS
C
C           ******************************************
C           *                                        *
C           *   RETURN FLUX AMBIENT/SELF SCATTERING  *
C           *                                        *
C           ******************************************
C                                  CODED BY: D. STRANGE  2/16/77
C                                            M. HETRICK  3/18/77
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SEGD/AMBND,DA,LOS,MNCD,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SPEC/MOUT1,MOUT2,MED1,MED2,M1,M2
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      COMMON/NCDS/ DEN(25,10),PNCD(300,10),STNCD(300),TINCD,
     1             FLUXJT(25,10)
      COMMON/CNCDS/CDEN(25,10),CPNCD(50,10),CSTNCD(50),CTINCD,
     1             CFLUXT(25,10)
      COMMON/RATES2/AGEORB,AGESLB,KIND(15),SPECIE(10),MOLWT(10),
     1              PLACE(20),DIA(10)
      COMMON/MDF/ ATCODE, TIME(6),RFSURF(10),RECEVR(50),
     2            BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3            DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4            ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5            COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6            DPHI(10),DOMEGA(10),DTHETA(10),
     7            PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8            X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
```

```
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/TRF/TRFSSC(10),TRFASS(10),TRFASE(10)
      DIMENSION CFREQ(10),RFSSC(10),TDEN(25,10),TFLUX(25,10),VEL(10)
      LOGICAL DBUGD
      LOGICAL ED,ENG,EVAP,LEAK,OUT,REPORT,RFAS,RFSS,REFLCT
      REAL NA,MOLWT
      DATA RDPDG/.0174533/
C
C     THIS SUBROUTINE CALCULATES RETURN FLUX
C
C    ALL NDCS NECESSARY FOR RETURN FLUX ARE STORED IN
C    ARRAYS PNCD AND CPNCD. THESE ARRAYS WILL NOW BE USED TO CALCULATE
C    RETURN FLUX FOR SOURCES OF INTEREST. EACH ELEMENT WILL BE REPLACED
C    WITH THE RETURN FLUX VALUE.
C    100 (METER CM CONVERSION FACTOR)
C
      NA = 6.023E+23
      DO 30 M=M1,M2
      SIGMA = 3.1416 * (VFACTR*(DIA(M)+DA)) **2./4.
      RF = AMBND * 100. * VA * SIGMA/3.1416
      DO 10 I=1,JKEEP
      PNCD(I,M)=PNCD(I,M)*RF
   10 CONTINUE
      DO 20 K=1,KTOTAL
   20 CPNCD(K,M)=CPNCD(K,M)*RF
   30 CONTINUE
C
      DO 32 J=1,JKEEP
      STNCD(J) = 0.0
      DO 31 M=M1,M2
   31 STNCD(J) = STNCD(J) + PNCD(J,M)
   32 CONTINUE
C
      DO 34 K=1,KTOTAL
      CSTNCD(K) = 0.0
      DO 33 M=M1,M2
   33 CSTNCD(K) = CSTNCD(K) + CPNCD(K,M)
   34 CONTINUE
C
      TINCD = 0.0
      DO 35 J=1,JKEEP
   35 TINCD = TINCD + STNCD(J)
C
      CTINCD = 0.0
      DO 36 K=1,KTOTAL
   36 CTINCD = CTINCD + CSTNCD(K)
C
      DO 45 M=M1,M2
      TRFASS(M)=0.
      IF(.NOT.(ED.OR.OUT.OR.LEAK.OR.REFLCT)) GO TO 41
C
      DO 40 J=1,JKEEP
   40 TRFASS(M) = TRFASS(M) + PNCD(J,M)
   41 IF(.NOT.(ENG.OR.EVAP)) GO TO 45
      DO 42 K=1,KTOTAL
   42 TRFASE(M)= TRFASE(M) + CPNCD(K,M)
   45 CONTINUE
C
```

```
   50  RETURN
       ENTRY RFLXSS
C
       DO 55 M=M1,M2
   55  TRFSSC(M)=0.
C
       LINE = 1
       CFLAG = 6H
       IF(REPORT(46)) CALL PRINTD(46)
       LINE = LINE + 14
       DO 100 IPNT = 1,25
       DENCK = 0.0
       DO 60 M=M1,M2
       RFSSC(M)=0.
       CFREQ(M)=0.
       TFLUX(IPNT,M) = FLUXJT(IPNT,M) + CFLUXT(IPNT,M)
       TDEN(IPNT,M) = DEN(IPNT,M) + CDEN(IPNT,M)
       DENCK = DENCK + TDEN(IPNT,M)
   60  VEL(M) = TFLUX(IPNT,M)/TDEN(IPNT,M)
C
       IF( DENCK .EQ.0.) GO TO 100
C  LOOK AT THE FIRST SEGMENT ALONG THIS LINE-OF-SIGHT AND COMPUTE
C  THE COLLISION FREQUENCY OF SPECIES,M WITH ITS COLLEAGUES.
       IF(DBUGD) WRITE(8,200)
  200  FORMAT(* M1 M2   VEL(M)      VEL(N)  DIA(M) DIA(N) VFACTR  MOLWT(M)
      1 MOLWT(N) TDEN(IPNT,M) TDEN(IPNT,M)  M  N  CFREQ*)
  201  FORMAT(2I5,4E10.2,F7.1,4E10.2,2I3,E10.2)
       DO 80 M=M1,M2
       IF(TDEN(IPNT,M).EQ.0.) GO TO 80
       DO 70 N=M1,M2
       IF(TDEN(IPNT,N).EQ.0.) GO TO 70
*IF IDENT,-U1100
       CFREQ(M) = CFREQ(M)+(NA/MOLWT(M))*(NA/MOLWT(N))
      ,                                 *(TDEN(IPNT,N)*TDEN(IPNT,M))
      ,  /4.*(VEL(M) + VEL(N) )  *
      ,   3.1416/4.*(  VFACTR*( DIA(M)+DIA(N) )  )**2.
*ENDIF
*IF IDENT,U1100
       CFREQ(M)=CFREQ(M)+((NA/MOLWT(M)*(TDEN(IPNT,N)))/16.*
      *         TDEN(IPNT,M)*(NA/MOLWT(N))*
      *        (VEL(M)+VEL(N))*3.1316*
      *(VFACTR*(DIA(M)+DIA(N)))**2
*ENDIF
       IF(DBUGD) WRITE(8,201)M1,M2,VEL(M),VEL(N),DIA(M),DIA(N),
      1VFACTR,MOLWT(M),MOLWT(N),TDEN(IPNT,M),TDEN(IPNT,N),M,N,CFREQ
   70  CONTINUE
       GFACTR =  SIN(THETA1(ISURF)*RDPDG) * DTHETA(ISURF)* DPHI(ISURF)
      ,  * COS(THETA1(ISURF)*RDPDG) * RDPDG**2.
       IF(THETA1(ISURF).EQ.0.)GFACTR= 3.1416*(DTHETA(ISURF)*RDPDG)**2./4.
       RFSSC(M) =  CFREQ(M)/4./3.1416*DSRTNF(IPNT) * GFACTR *100.
   80  CONTINUE
C
       IF(.NOT.REPORT(46)) GO TO 100
C
       DO 90 M=M1,M2
   90  TRFSSC(M) = TRFSSC(M) + RFSSC(M)
       WRITE(6,1000)IPNT,(SPECIE(M),CFREQ(M),TDEN(IPNT,M),RFSSC(M),
      ,      TFLUX(IPNT,M),TRFSSC(M),M=M1,M2)
       LINE = LINE + 8
       IF(LINE.LT.48) GO TO 100
       CFLAG = 6H(CONT)
       LINE = 1
       CALL PRINTD(46)
```

```
      LINE = LINE + 14
  100 CONTINUE
 1000 FORMAT( " SEGMENT =",I5/10(14X,A6,5E12.3,/))
      RETURN
      END
*DECK OVER
      OVERLAY(SEG00,0,0)
      PROGRAM SEG00(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE8,TAPE9,
     +TAPE10,TAPE11,TAPE12,TAPE13,TAPE14,TAPE15,FILMPL)
      CALL MAIN
      RETURN
      END
      OVERLAY(SEGA0,1,0)
      PROGRAM SEGA0
      CALL COLLCT
      RETURN
      END
      OVERLAY(SEGA1,1,1)
      PROGRAM SEGA1
      CALL BLCKA
      RETURN
      END
      OVERLAY(SEGA2,1,2)
      PROGRAM SEGA2
      CALL BLCKB
      RETURN
      END
      OVERLAY(SEGA3,1,3)
      PROGRAM SEGA3
      CALL BLCKC
      RETURN
      END
      OVERLAY(SEGA4,1,4)
      PROGRAM SEGA4
      CALL LOADT
      RETURN
      END
      OVERLAY(SEGA5,1,5)
      PROGRAM SEGA5
      CALL BLCKD
      RETURN
      END
      OVERLAY(SEGB0,2,0)
      PROGRAM SEGB0
      CALL AUDIT
      RETURN
      END
      OVERLAY(SEGC0,3,0)
      PROGRAM SEGC0
      CALL DEPST
      RETURN
      END
      OVERLAY(SEGD0,4,0)
      PROGRAM SEGD0
      CALL MCDRTF
      RETURN
      END
      OVERLAY(SEGD1,4,1)
      PROGRAM SEGD1
      CALL PTSLC
      RETURN
      END
      OVERLAY(SEGD2,4,2)
```

```
      PROGRAM SEGD2
      CALL MCDNCD
      RETURN
      END
      OVERLAY(SEGD3,4,3)
      PROGRAM SEGD3
      CALL RTNFLX
      RETURN
      END
*DECK RTFLUX
*IF IDENT,U1100
{FOR,IS RTFLUX
*ENDIF
      SUBROUTINE RTFLUX
C
C                                          CODED BY: D. STRANGE  2/16/77
C                                                    M. HETRICK  3/18/77
C
      COMMON/SEGA/JTOTAL,JKEEP,KINDS,KTOTAL
      COMMON/SEGD/AMBND,DA,LOS,MNCD,M1,M2,VA,VFACTR,WFAS,ISURF,THETA,PHI
      COMMON/SURF/IDENT(300),SECT(300),MATRL(300),AREA(300)
      COMMON/TMP/ TEMPOS(300),TEMPOR(60)
      COMMON/NCDS/ DEN(25,10),PNCD(300,10),STNCD(300),TINCD,
     1             FLUXJT(25,10)
      COMMON/CNCDS/CDEN(25,10),CPNCD(50,10),CSTNCD(50),CTINCD,
     1             CFLUXT(25,10)
      COMMON/RATES2/AGEORB,AGESLB,KIND(15),SPECIE(10),MOLWT(10),
     1              PLACE(15),DIA(10)
      COMMON/MDF/ ATCODE, TIME(6),RFSURF(10),RECEVR(50),
     2           BETA,PITCH,YAW,ROLL,ALT,RMAXL,
     3           DSMCD(25),PHIL(25),THETAL(25),XLOS(25),YLOS(25),
     4           ZLOS(25),COSXX(10),COSXY(10),COSXZ(10),COSYX(10),
     5           COSYY(10),COSYZ(10),COSZX(10),COSZY(10),COSZZ(10),
     6           DPHI(10),DOMEGA(10),DTHETA(10),
     7           PHI1(10),PHI2(10),THETA1(10),THETA2(10),VX,VY,VZ,
     8           X0(10),Y0(10),Z0(10),DSRTNF(25),RMAXRF
      COMMON/CNTRL/DEPSIT,DBUGA, DBUGB, DBUGC, DBUGD, ED,     ENG,
     1             EVAP,  FIVP,  LEAK,  LMOP,  MAXTMP,MCD,
     2             MFPATH,NEWCON,NEWTNL,NEWMFP,NEWMFS,NEWMLC,NEWTCD,
     3             MINTMP,ORBITR,OUT,   REFLCT,REPORT(50),
     4             RFAS,  RFSS,  SMTP,  TITLE(12),    TSTART(3),
     5             TSTOP(3),     GO,    SUNL,  SUNM,  SUNH
      COMMON/TRF/TRFSSC(10)
      DIMENSION CFREQ(10),RFSSC(10),TDEN(25,10)
      LOGICAL REPORT,RFAS,RFSS
      DATA RDPDG/.0174533/
C
C     THIS SUBROUTINE CALCULATES RETURN FLUX
C
C    ALL NDCS NECESSARY FOR RETURN FLUX ARE STORED IN
C    ARRAYS PNCD AND CPNCD. THESE ARRAYS WILL NOW BE USED TO CALCULATE
C    RETURN FLUX FOR SOURCES OF INTEREST. EACH ELEMENT WILL BE REPLACED
C    WITH THE RETURN FLUX VALUE.
C    100 (METER CM CONVERSION FACTOR)
C
      NA = 6.023E+23
      IF(.NOT.RFAS) GO TO 30
      DO 20 M=M1,M2
      SIGMA = 3.1416 * (VFACTR*(DIA(M)+DA)) **2./4.
      RF = AMBND * 100. * VA * SIGMA * WFAS / 3.1416
      DO 10 I=1,JKEEP
      PNCD(I,M)=PNCD(I,M)*RF
   10 CONTINUE
      DO 15 K=1,KTOTAL
```

```
   15  CPNCD(K,M)=CPNCD(K,M)*RF
   20  CONTINUE
       DO 21 M=1,10
   21  TRFSSC(M)=0.
C
   30  CONTINUE
       IF(.NOT.RFSS) RETURN
       DO 60 IPNT = 1,25
       DO 31 M=1,10
       RFSSC(M)=0.
       CFREQ(M)=0.
   31  TDEN(IPNT,M) = DEN(IPNT,M) + CDEN(IPNT,M)
C  LOOK AT THE FIRST SEGMENT ALONG THIS LINE-OF-SIGHT AND COMPUTE
C  THE COLLISION FREQUENCY OF SPECIES,M WITH ITS COLLEAGUES.
       DO 50 M=1,10
       IF(TDEN(IPNT,M).EQ.0.) GO TO 50
       DO 40 N=1,10
       IF(TDEN(IPNT,N).EQ.0.) GO TO 40
       CFREQ(M) = CFREQ(M)+(NA/MOLWT(M))**2.*(TDEN(IPNT,N)*TDEN(IPNT,M))
      ,  /4.*(FLUXJT(IPNT,N)/TDEN(IPNT,N)+FLUXJT(IPNT,M)/TDEN(IPNT,M))
      ,  *3.1416/4.*(VFACTR*(DIA(M)+DA))**2.
   40  CONTINUE
       RFSSC(M) = RFSSC(M) + CFREQ(M)/4./3.1416*DSRTNF(IPNT)*
      ,    SIN(THETA1(ISURF)*RDPDG) * DTHETA(ISURF)* DPHI(ISURF)
      ,  * COS(THETA1(ISURF)*RDPDG) * RDPDG**2.
   50  CONTINUE
C
       WRITE(6,1000)IPNT,(CFREQ(M),TDEN(IPNT,M),RFSSC(M),FLUXJT(IPNT,M)
      ,                  ,M=1,10)
       DO 55 M=1,10
   55  TRFSSC(M) = TRFSSC(M) + RFSSC(M)
       WRITE(6,1001)(TRFSSC(M),M=1,10)
 1001  FORMAT( 'TOTAL RETURN,FLUX DUE TO SELF SCATTERING'/ 10(E10.2))
   60  CONTINUE
 1000  FORMAT(I10,10(4E10.3,/))
       RETURN
       END
```