N73-31842

CR-134031

NASA-JSC
CONTRACT NAS9-7644

THE ENVIRONMENTAL HEAT FLUX ROUTINE, VERSION 4 (EHFR-4) AND MULTIPLE REFLECTIONS ROUTINE (MRR) FINAL REPORT

REPORT NO. T155-01

VOLUME I

24 August 1973

Submitted By

VOUGHT SYSTEMS DIVISION
LTV AEROSPACE CORPORATION
P.O. Box 5907 Dallas, Texas 75222

To

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JOHNSON SPACE CENTER
HOUSTON, TEXAS

NASA-JSC
CONTRACT NAS9-7644

THE ENVIRONMENTAL HEAT FLUX ROUTINE, VERSION 4 (EHFR-4) AND MULTIPLE REFLECTIONS ROUTINE (MRR) FINAL REPORT

REPORT NO. T155-01

VOLUME I

24 August 1973

Submitted By

VOUGHT SYSTEMS DIVISION
LTV AEROSPACE CORPORATION
P.O. Box 5907 Dallas, Texas 75222

To

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JOHNSON SPACE CENTER
HOUSTON, TEXAS

PREPARED BY:

J. B. Dietz
J. B. Dietz

REVIEWED BY:

C. W. Hixon
C. W. Hixon

APPROVED BY:

R. J. French
R. J. French, Supervisor
Environmental Control/
Life Support Group

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

PROGRAMMERS REFERENCE MANUAL VOLUME 2

LIST OF FIGURES

LIST OF TABLES

THIS FORM MUST BE COMPLETED BY TYPEWRITER

DATE RECEIVED

COMPUTER PROGRAM ABSTRACT

014	017 PROGRAM NO.	01 14 CATEGORY	01 16 SUB CATEGORY
	F 250	F	

01 20 TITLE OF PROGRAM (62 CHARACTERS MAXIMUM)	01 72 SYMBOLIC NAME (8 CHARACTERS MAXIMUM)	PARENT PROGRAM 02 14 CATEGORY	02 16 SITE	02 19 PROGRAM NO.
Environmental Heat Flux Routine, Version 4	EHFR - 4			

02 27 LANGUAGE NO. 1	02 32 LANGUAGE NO. 2	02 37 KEY WORDS (8 MAXIMUM, SEPARATED BY COMMAS)
FOR 5		Radiant Heat Flux, Thermal Environment, Space and Lunar Environment

WHOM TO CONTACT ABOUT THE PROGRAM

05 14 CONTACT	05 28 SITE	05 31 ORGN. CODE	05 39 PROJECT NO.	05 45 NASA CENTER
Morris	MSC	EC02	3703	MSC

05 48 STATUS

- ☐ A. UNDER DEVELOPMENT
- ☐ B. OPERATIONAL
- ☒ C. COMPLETED

05 49

- ☐ A. THIS PROGRAM IS NOT FOR SHARING
- ☐ B. LIMITED SHARING (SEE ABSTRACT)

DATES

05 50 INITIATED	05 54 COMPLETED
8-68	5-71

05 58 REVISION CODE

- ☐ A. REVISION
- ☐ B. CANCELLATION

TIME AND COST FOR DEVELOPMENT

05 59 MAN-MONTHS	05 64 MACHINE HOURS	05 69 COMPUTER TYPE	05 74 TOTAL COST (DOLLARS)
10.8	9.2	Univac 1108	

CARD NUMBER | COLUMN 14 | ABSTRACT | ELITE MARGIN | PICA MARGIN

The environmental heat flux routine version 4, (EHFR-4) is a generalized computer program which calculates the steady state and/or transient thermal environments experienced by a space system during lunar surface, deep space, or thermal vacuum chamber operation. The specific environments possible for EHFR analysis include: (1) lunar plain, (2) lunar crater, (3) combined lunar plain and crater, (4) lunar plain in the region of spacecraft surfaces, (5) intravehicular, (6) deep space in the region of spacecraft surfaces, and (7) thermal vacuum chamber operation.

A reference coordinate system is used by the EHFR to represent the space system for which the thermal environments are to be calculated. The reference coordinate system consists of a geometric nodal model which may be arranged in several different nodal configurations (modes). The EHFR has a capability of storing the data for a 420 node model, with nodes arranged in 3 modes, and up to 20 coatings available for each node. Reference coordinate system data stored within the routine may be updated during initiation of program execution. The Apollo Extravehicular Mobility Unit (EMU), EMU-LRV, and EMU-SIM Bay reference coordinate systems are currently stored in the EHFR.

Output from the EHFR is on paper and magnetic tape. Magnetic tape is in a format compatable with thermal digital simulators which analyze the EMU, EMU-LRV, and EMU-SIM Bay.

The EHFR has been used for EMU environment analysis of the Apollo 11-17 missions, EMU manned and unmanned thermal vacuum qualification testing, and EMU-LRV interface environmental analyses.

RELATED DOCUMENTATION (66 CHARACTERS MAXIMUM, SEPARATE EACH REF. BY COMMAS)

MSC Form 800 (Rev Aug 69) PREVIOUS EDITIONS ARE OBSOLETE NASA — MSC

1.0 SUMMARY

The Environmental Heat Flux Routine-Version 4 (EHFR-4) is a generalized computer program which calculates the steady-state and/or transient thermal environments experienced by a space system during lunar surface, deep space, or thermal vacuum chamber operation. The specific environments possible for EHFR analysis include: (1) lunar plain, (2) lunar crater, (3) combined lunar plain and crater, (4) lunar plain in the region of spacecraft surfaces, (5) intravehicular, (6) deep space in the region of spacecraft surfaces, and (7) thermal vacuum chamber operation.

The EHFR analytical approach/techniques, geometric thermal models, and users instructions are documented in this report. The program was developed by the Vought Systems Division (VSD) of the LTV Aerospace Corporation under contract (NAS9-7644) to the NASA-Johnson Space Center.

A reference coordinate system is used by the EHFR to represent the space system for which the thermal environments are to be calculated. The reference coordinate system consists of a geometric nodal model which may be arranged in several different nodal configurations (modes). The reference coordinate system data employed by and stored within the EHFR consists of: geometric model nodal coordinate data, nodal self-blockage data, node-coatings composition data, and curves of coating absorptivity as a function of source emission temperature. The EHFR has the capability of storing the data for a 420 node model, with nodes arranged in 3 modes, and up to 20 coatings available for each node. Reference coordinate system data stored within the routine may be updated during initiation of program execution. The Apollo Extravehicular Mobility Unit (EMU), Scientific Instruments Module Bay (SIM Bay), and Lunar Roving Vehicle (LRV) reference coordinate systems are currently stored in the EHFR (Figure 1-1).

Lunar surface radiosities in the solar and infrared energy regions which are incident on the reference coordinate system are determined in the EHFR. These radiosities are calculated by performing a heat balance on an adiabatic lunar surface. Lunar craters are represented by spherical segments which closely approximate the geometry of newly formed craters. Lunar crater shadowing at low sun angles is considered in the analysis. Spacecraft surfaces and shadow areas located on the lunar plain which affect the reference coordinate system environment are simulated by a series of flat plates which are arranged according to EHFR user specification. Single reflections between these spacecraft surfaces and the lunar plain are considered in the radiosity analysis. Reference coordinate system solar shadowing and infrared blockage by the spacecraft surfaces are considered. Perturbations of the lunar environment caused by the reference coordinate system are considered small and are neglected.

The intravehicular environment is simulated by a rectangular enclosure which emits energy in the infrared spectrum. Enclosure size and temperatures are specified by the user.

The energy sources in the deep space environment option includes solar emissions and spacecraft surface radiosities. As with the lunar plain option, the spacecraft surfaces are simulated by a series of flat plates,

are arranged by the user, include a single diffuse reflection of the solar energy, and consider solar shadowing of the reference coordinate system.

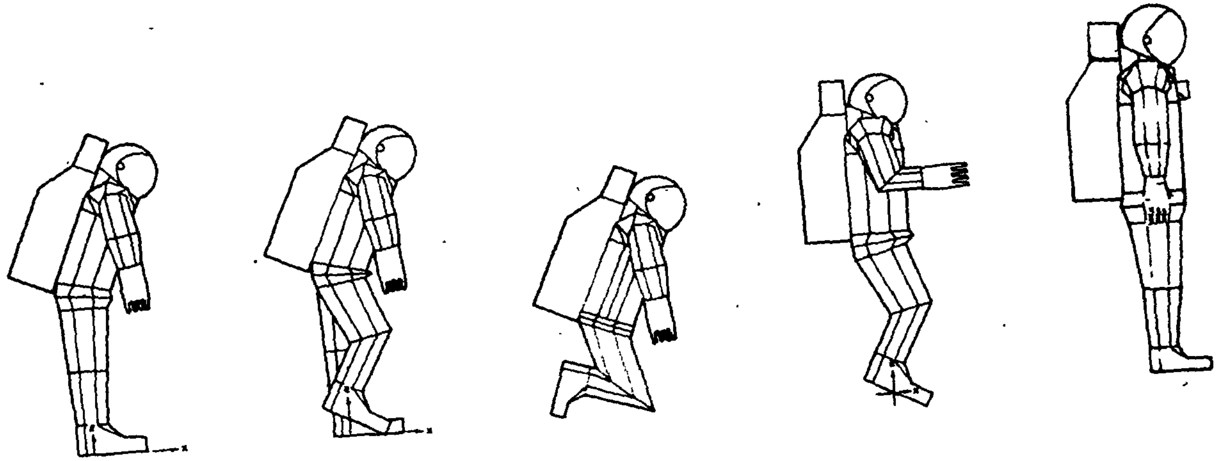
The energies considered for thermal vacuum chamber environment analyses include simulated direct solar radiation, Lunar Surface Thermal Simulator (LSTS) flux infrared heater element emission, solar albedo background, infrared background, and crater floor emitted energy. Direct solar radiation is modeled as collimated flux passing through an imaginary grid perpendicular to the solar rays. Values of the solar flux on each grid element are input from calibration data to permit analysis of non-uniform simulated solar environments on the test article (reference coordinate system) nodes. The floor is subdivided into a large array of finite nodes to allow non-uniform temperature distributions to be evaluated. Solar and infrared backgrounds are taken into account through input tabulations with the data interpolated within the routine. LSTS heater element inclination angles and operation temperatures are input. View factors from test article nodes to the floor and LSTS heater elements are calculated within the routine with the orientations being completely general. An option of the EHFR permits the user to calculate the LSTS zone power settings and infrared heater element temperatures by requiring a least-squares match of the absorbed energy from a real environment (crater, plain, etc.) on the sum of the reference coordinate system nodal surfaces.

The EHFR has been successfully utilized for EMU environment analysis of the Apollo 11-17 missions, EMU manned and unmanned thermal vacuum chamber qualification testing, and EMU-Lunar rover vehicle interface and environment analyses. The generalized nature of the EHFR makes it applicable for environmental calculations for many other space systems such as Lunar Module, ALSEP, etc.

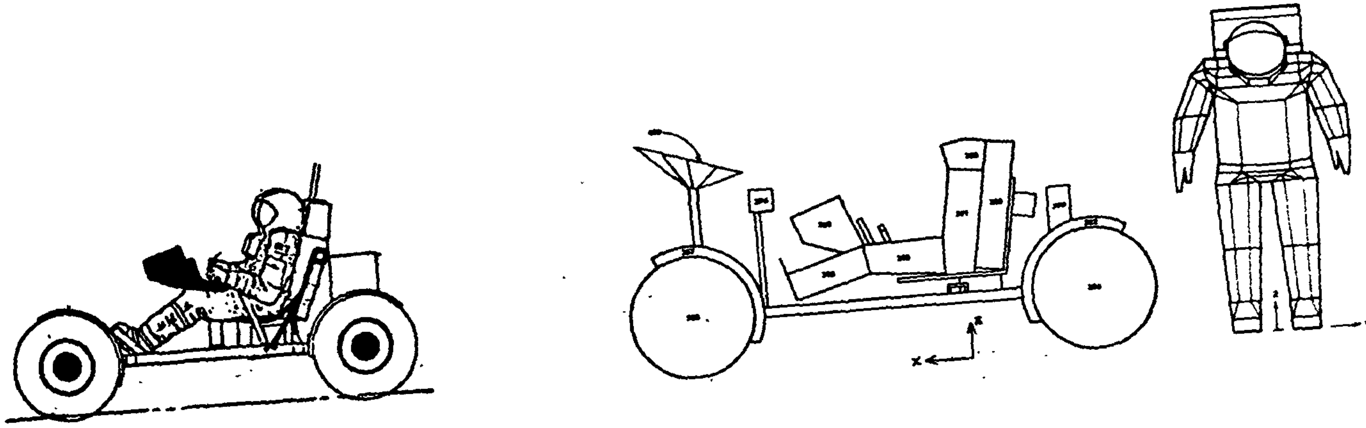
The Multiple Reflections Routine (MRR) is a companion routine to the EHFR which reads the magnetic tape output from the EHFR and an independently generated set of model surface interchange factors and then calculates the reflected energy between the model surfaces. This routine was developed to increase the accuracy of the heat flux predictions on the model.

FIGURE 1-1 EHFR SPACE SYSTEM MODELS DEVELOPED

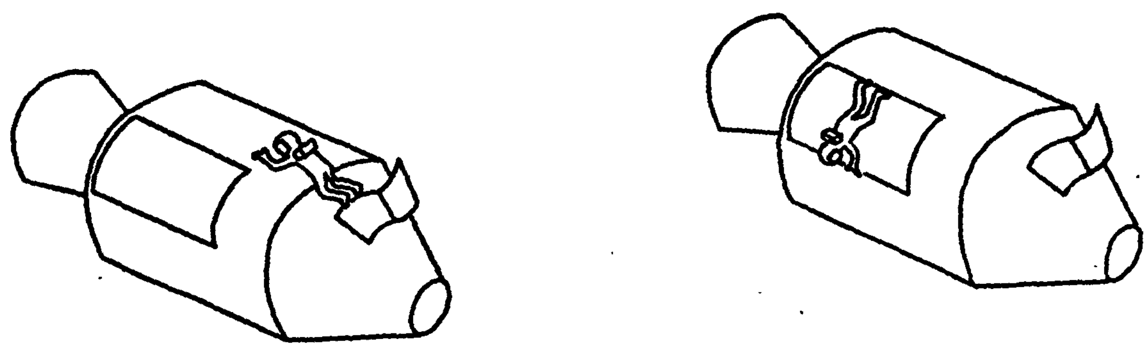
o EMU



o EMU/LRV



o EMU/SIM BAY APOLLO J MISSION CONFIGURATION



2.0 INTRODUCTION

Thermal digital simulation routines for analysis of space operational systems require an environmental radiant heat flux time line to be data input during program execution. Previously funded studies by NASA-JSC have produced several computer programs which calculated thermal environments during orbital operation[1*], and during activity on a lunar plain or in a crater[2]. As a complementary routine to the thermal digital simulators, the environmental heat flux routine (EHFR) was written incorporating existing environment programs and developing additional subroutines as necessary to calculate other expected space system operational environments.

The resulting routine was programmed in a modular fashion using computer overlay techniques for data and subprogram handling. This has resulted in a flexible program into which additional space system modules and environmental programs may be incorporated. To simplify the input, the reference coordinate system data which represents a space system is stored in the EHFR.

The multiple reflections routine was developed as a companion program to the EHFR to account for the solar and infrared spectra energy reflection and absorption between the various portions of the reference coordinate system. The use of the EHFR, MRR, and the thermal simulators is shown in Figure 2-1. As shown in the figure, the magnetic tape output of the EHFR is input to the MRR or may be used directly by the thermal simulators. If the EHFR tape is used by the thermal simulation routines directly, only self blockage is accounted for. The MRR processes the EHFR data tape to account for multiple reflections. The MRR output tape is of the same format as the EHFR and is then used for thermal simulator input.

Figure 2-2 demonstrates the role the EHFR might play in relation to other analysis systems. With model modifications and/or additions the EHFR may be used to provide heat flux to a radiator design program.

---
* Superscript numbers in text indicate references in Section 8.0

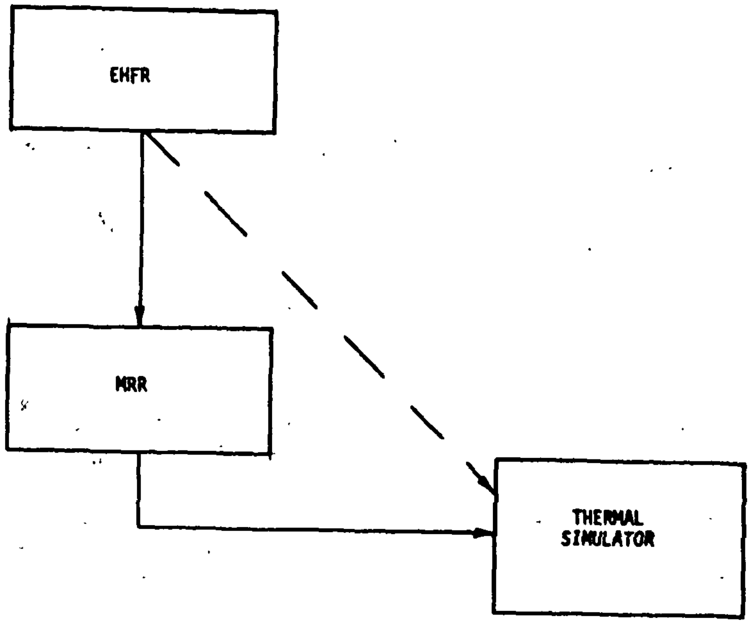


FIGURE 2.1 EHFR-MRR USAGE

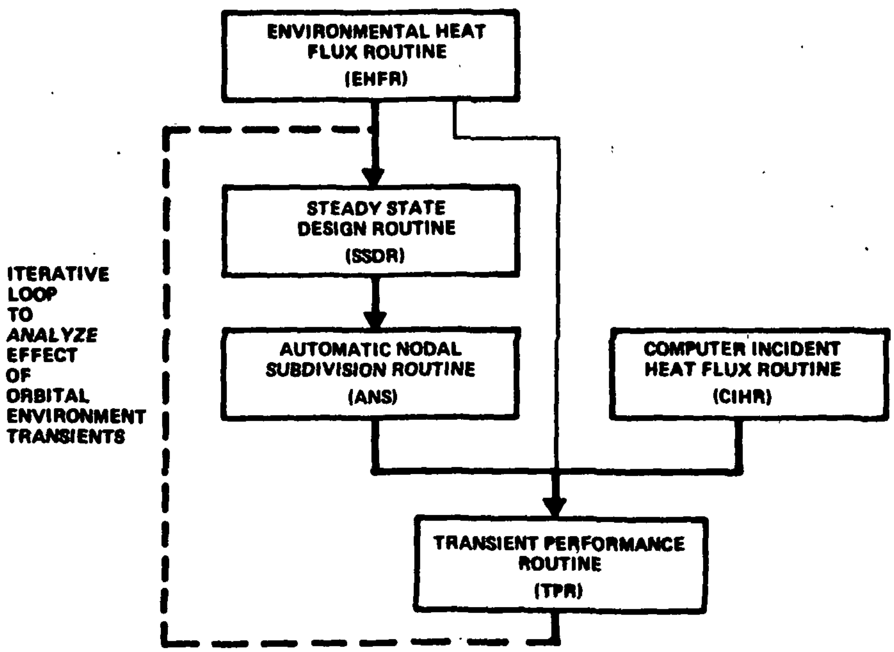


FIGURE 2.2 RADIATOR DESIGN SYSTEM

3.0 REFERENCE COORDINATE SYSTEM

The groundrules, analytical techniques, and the approach used to develop a reference coordinate system (RCS) for representation of a space system are discussed in this section of the report.

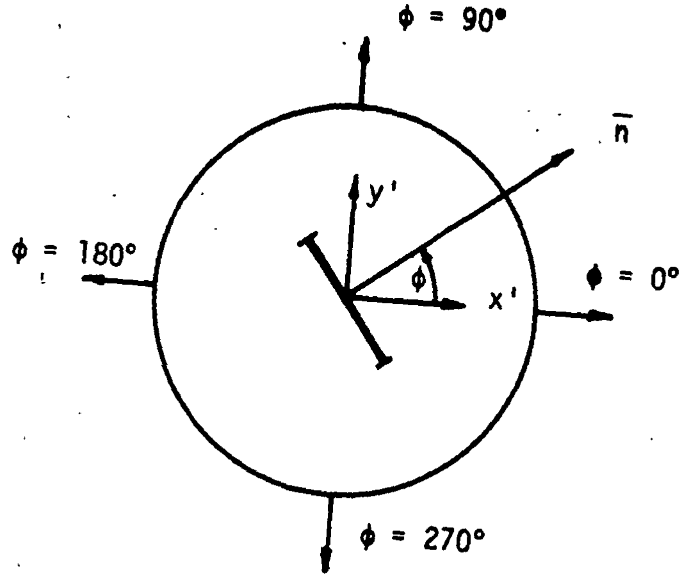
3.1 Description, Approach and Groundrules

The RCS is a geometric model of a space system that has the constituent nodes arranged in predetermined positions. Three such models are illustrated in Figure 1.1 and others may be generated by the user. Each model may have several nodal arrangements, called modes, which represent the various space system configurations anticipated during operation. By having the RCS nodes in predetermined modes, the ability to change the model configuration was achieved with straight-forward program logic and simplified data input. The user has the option to update an existing model or replace one of the existing models in its entirety.

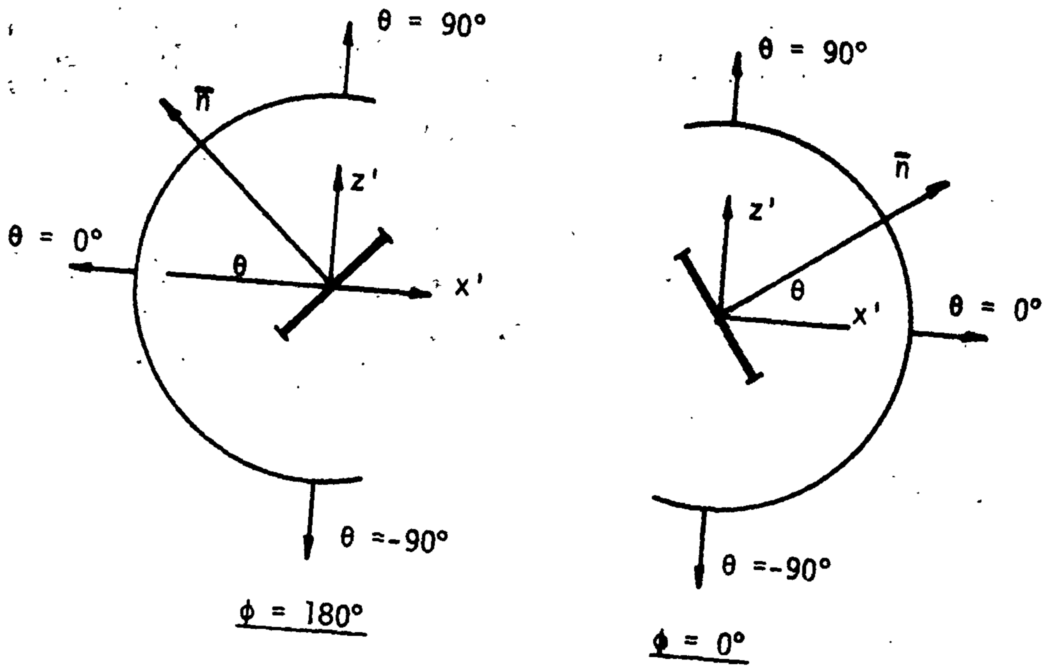
Nodes within a reference coordinate system are described in the geometrical sign convention shown in Figure 3.1. Each surface (or node) is described by coordinates, X, Y, and Z measured from the RCS origin to the center of node and by azimuth elevation angles measured with respect to the surface normal. Azimuth angles may have values from 0 to 360 degrees but the elevation angles must vary only between $\pm$ 90 degrees.

ϕ = Azimuth angle of normal vector

θ = Zenith (elevation) angle of normal vector



TOP VIEW



SIDE VIEW

FIGURE 3-1 GEOMETRICAL CONVENTIONS

3.2 Analytical Techniques

This section presents the governing equations and analytical techniques used in the EHFR to calculate the reference coordinate system thermal environments. These equations are presented in general form which is independent of the environment characterization. Derivation of the equation forms presented herein can be obtained from any of several competent heat transfer books. The equations used in the characterization of environment energy sources are described in Section 4.0. The equation symbols are defined in Section 7.0.

3.2.1 Absorbed and Incident Heat

The environmental heat absorbed by and incident on an RCS node consists of energies in the infrared and solar spectrum. These energies are calculated in the EHFR by:

$$Q = A_n \sum_s F_{n-s}[\alpha(T_s) B_{ir} + \alpha(T_{sol}) B_s] \tag{3-1}$$

$$H = A_n \sum_s F_{n-s}[B_{ir} + B_s] \tag{3-2}$$

The program calculates and prints out the various environment energy source contributions in addition to the total incident and absorbed energies. The equations/methods used to determine the geometric form factors (F_{n-s}), and RCS node absorptivity (α) are presented in the following subsections.

3.2.2 Coordinate Transformations

The EHFR timeline point input data locates and orients the reference coordinate system with respect to the environment origin. The RCS node coordinates and unit normal vector data are transformed to absolute values with respect to the environment origin for use in calculating geometric form factor data. The transformations are shown graphically in Figure 3-2 and the equations presented below:

$$X_{se} = X_r \cos \phi_o - Y_r \sin \phi_o + X_o \tag{3-3}$$

$$Y_{se} = Y_r \cos \phi_o + X_r \sin \phi_o + Y_o \tag{3-4}$$

$$Z_{se} = Z_r + Z_o \tag{3-5}$$

$$\phi_{se} = \phi_r + \phi_o \tag{3-6}$$

$$\theta_{se} = \theta_r \tag{3-7}$$

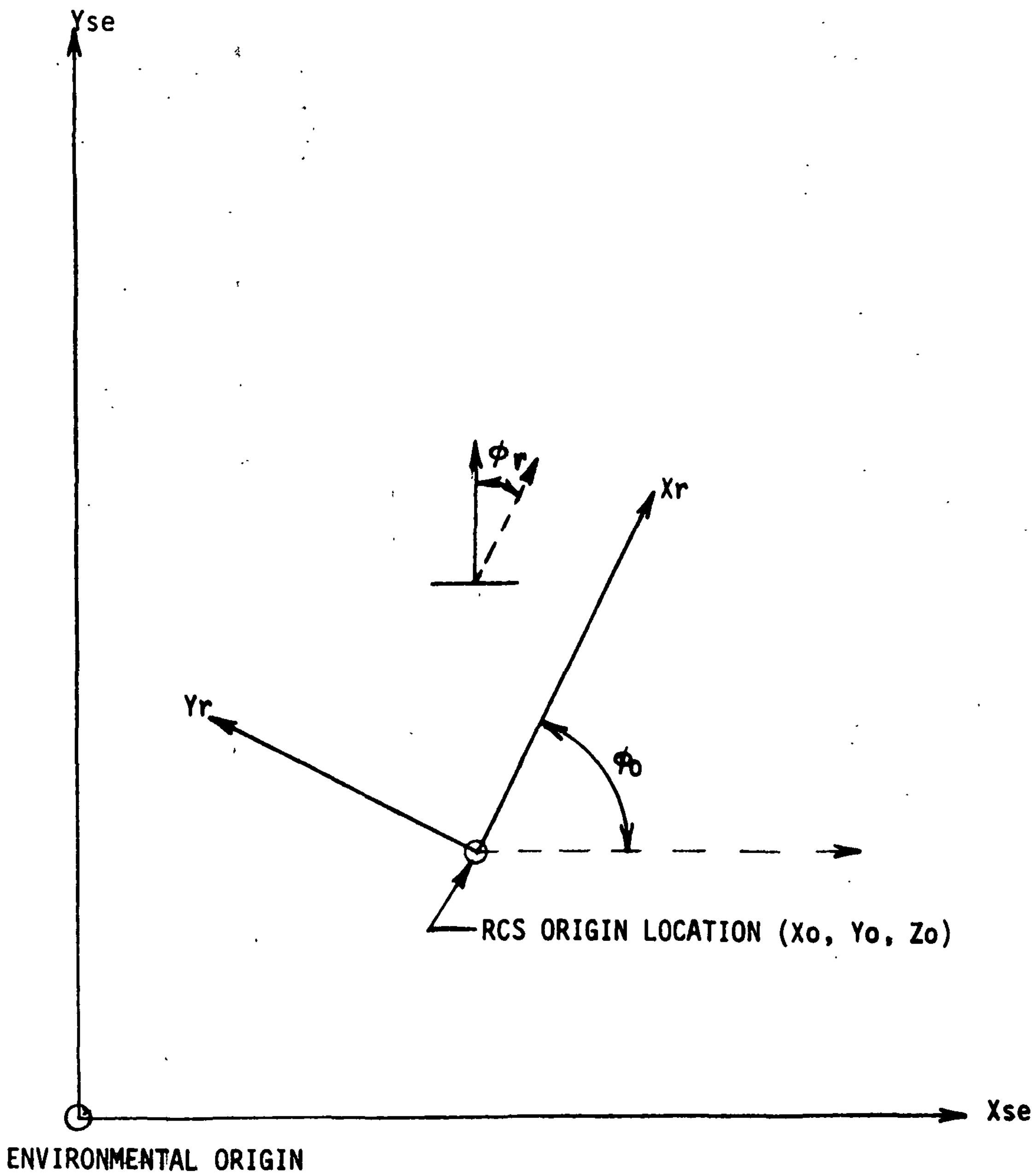


FIGURE 3-2 RCS NODE TRANSFORMATION SCHEMATIC

3.2.3 Form Factor Calculations

The EHFR employs numerical techniques in the calculation of the RCS node to heat source diffuse geometric form factors. This technique uses infinitesimal (differential) areas and numerical summations to evaluate the form factor integral equation. The EHFR automatically subdivides each environmental heat source into small areas for use in these calculations. The governing equation used by the EHFR is presented below with Figure 3-3 showing the geometric relationships.

$$F_{n-s} = \frac{1}{\pi} \sum_i \frac{Fubi \cos \theta_r \cos \theta_{si} \, dA_{si}}{R^2} \tag{3-8}$$

The RCS self blockage term, Fubi, is calculated using the techniques described in Section 3.2.4. The angle cosines are evaluated by the EHFR using vector analyses:

$$\cos \theta_r = \frac{\vec{N_r} \cdot \vec{R}}{|N_r| \; |R|} \tag{3-9}$$

$$\cos \theta_{si} = \frac{\vec{N}_{si} \cdot (-\vec{R})}{|N_{si}| \; |-R|} \tag{3-10}$$

with the vectors evaluated in the following form:

$$\vec{N}_r = (\cos \theta_{se} \cos \phi_{se})i + (\cos \theta_{se} \sin \phi_{se})j + (\sin \theta_{se})k \tag{3-11}$$

$$\vec{N}_{si} = (\cos \theta_{si} \cos \phi_{si})i + (\cos \theta_{si} \sin \phi_{si})j + (\sin \theta_{si})k \tag{3-12}$$

$$\vec{R} = (X_{si} - X_{se})i + (Y_{si} - Y_{se})j + (Z_{si} - Z_{se})k \tag{3-13}$$

The EHFR automatically checks the calculated form factors to assure that the resulting summation is within 3% of those determined using analytical integration methods. This form factor check criteria was developed in Appendix A of Reference 3:

$$\frac{dA_{si}}{R^2} < 0.04 \tag{3-14}$$

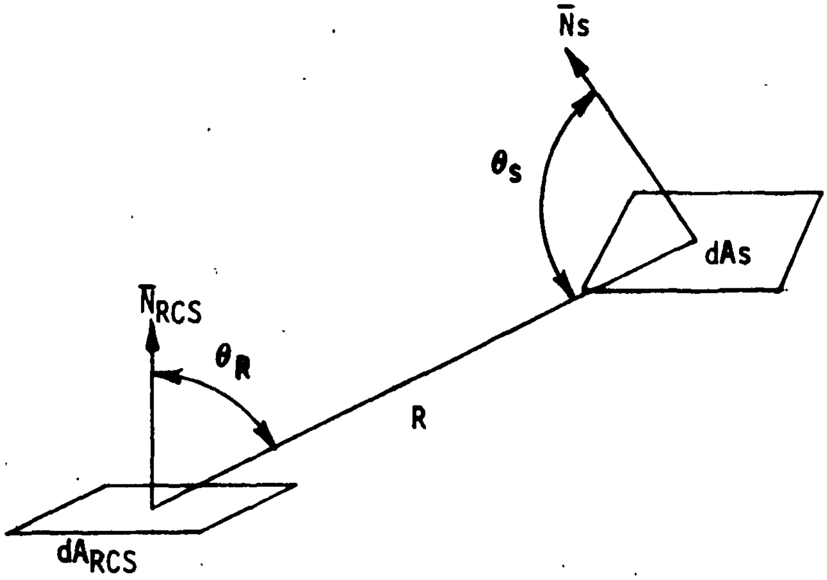


FIGURE 3-3 FORM FACTOR GEOMETRIC RELATIONSHIP

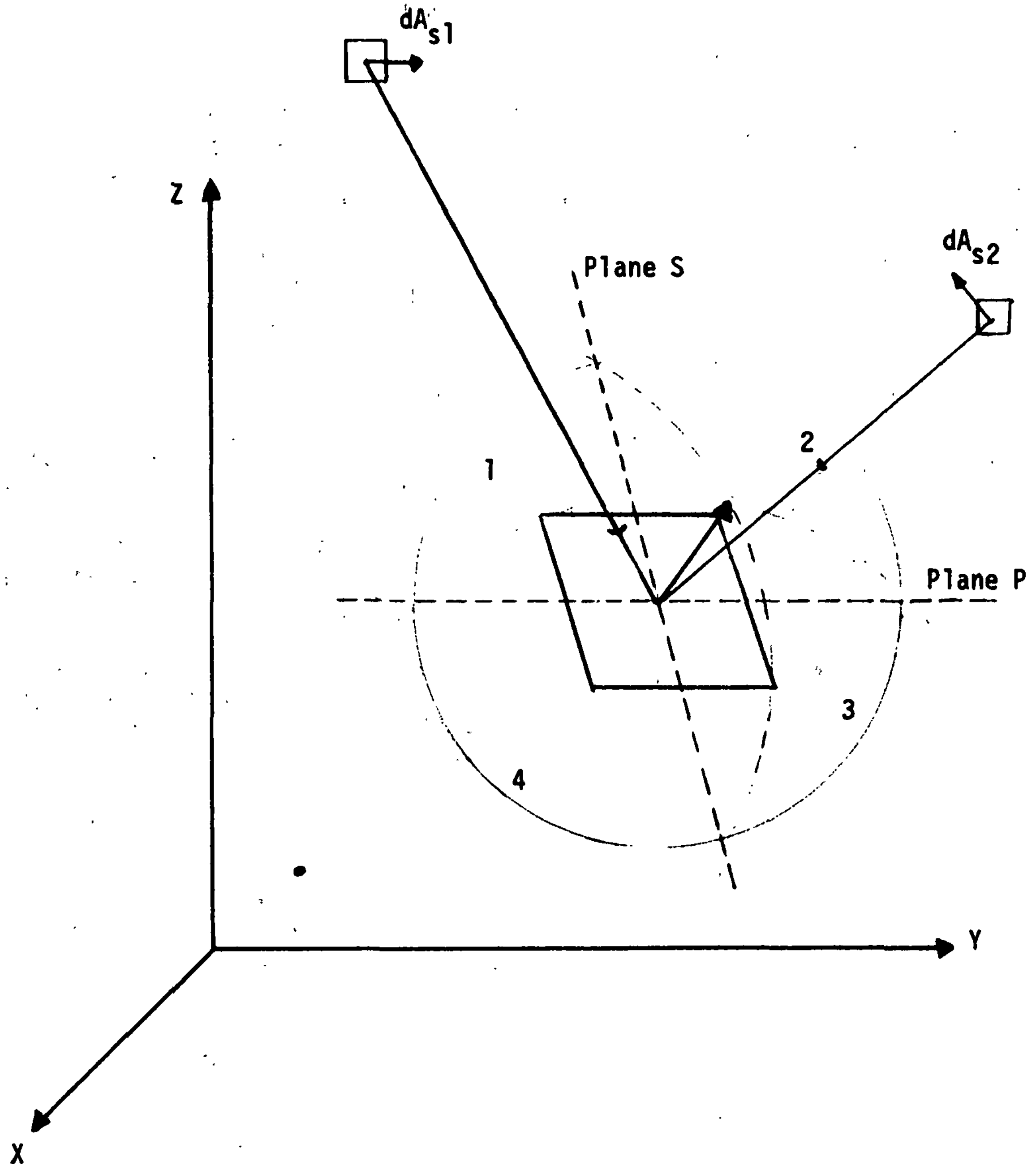


FIGURE 3-4 RCS SELF-BLOCKAGE QUADRANTS

If this equation is not satisfied during EHFR calculations, the EHFR either further subdivides the environmental heat source area or ends environmental computation with a printed diagnostic.

3.2.4 RCS Self-Blockage

Environment energy blockage by other RCS nodes is approximated by the EHFR considering the direction of energy source and the location of the blocking RCS nodes. The RCS node unblocked view to space in four directions is stored input to the routine. The routine calculates the direction of the energy source incoming radiation and alters the quantity of energy incident on the RCS node by the percentage of unblocked view to space in that direction. The remainder of this subsection explains the details of self-blockage analyses.

Figure 3-4 shows schematically the four directions or quadrants used for self blockage analysis. Quadrants 1 and 2 are separated from quadrants 3 and 4 by the imaginary plane (plane P) formed by a line on the RCS node parallel to the X-Y plane and the RCS node normal vector. Quadrants 1 and 4 are separated from quadrants 2 and 3 by an imaginary plane (plane S) which is perpendicular to plane P and includes the RCS node normal vector. Two energy sources are shown in Figure 3-4: energy source 1 (dA_{s1}) which is located in the quadrant 4 direction, and energy source 2 (dA_{s2}) which is located in the quadrant 2 direction.

The quadrant number from which direction environment energy originates and the unblocked RCS node view of space in that quadrant are used to modify the geometric form factor (via Fubi in equation 3-8) and thus the incident energy on the RCS node.

$$\text{Fubi} = \frac{F_{se}\,(i\,)}{.25} \qquad (3\text{-}15)$$

The quadrant number of the energy source, i , is determined from the azimuth and inclination angles between the RCS node normal and RCS node to energy source vectors. The angles are defined in Figure 3-5. The quadrant is determined from the algebraic sign of these angles:

Energy Source / Quadrant	1	2
1	+, o	+, o
2	-	+, o
3	-	-
4	+, o	-

Vector analysis is used by the EHFR to determine the sign of these angles. For the azimuth angle:

$$\sin A' = \frac{|\vec{R}' \times \vec{N}_r|}{|\vec{N}_r|\ |\vec{R}'|} = \frac{|\vec{A}|}{|\vec{N}_r'||\vec{R}'|}$$

where

$$\vec{N}_r' = (\cos\phi_{se})i + (\sin\phi_{se})j$$

$$\vec{R}' = (X_{si} - X_{se})i + (Y_{si} - Y_{se})j$$

$$\vec{A} = \vec{R}' \times \vec{N}_r'$$

now substituting

$$\vec{A} = [(Y_{si} - Y_{se})(\cos\phi_{se}) - (X_{si} - X_{se})(\sin\phi_{se})]k = (A_z)k$$

By definition of the azimuth angle we find that

$$\text{sign}[A'] = \text{sign}[\sin A'] = \text{sign}[A_z]$$

For the inclination angle:

$$\sin B' = \frac{|\vec{N}_r'' \times \vec{R}''|}{|\vec{N}_r''|\ |\vec{R}''|}$$

where

$$\vec{N}_r'' = (\cos\theta_{se})j + \sin\theta_{se}\ k$$

$$\vec{R}'' = \vec{R}'j + (Z_{si} - Z_{se})k$$

$$\vec{B} = \vec{N}_r'' \times \vec{R}''$$

substituting

$$\vec{B} = [(\cos\theta_{se})(Z_{si} - Z_{se}) - R'(\sin\theta_{se})]\ i$$

$$\vec{B} = (B_z)\ i$$

By definition of the inclination angle, we find that

$$\text{sign}[B'] = \text{sign}[\sin B'] = \text{sign}[B_z]$$

The RCS node unblocked view to space for each quadrant, F_{se} (iq), is determined prior to initiating EHFR analysis. The unblocked view to space is calculated by

$$F_{se}(iq) = .25 - \sum_n F_{n-iq}$$

The quadrant location of RCS node i is determined using the vector analyses described above. For no blockage to a particular quadrant, $F_{se}(iq)$ is 0.25. For full blockage (no energy incident on RCS node n), $F_{se}(iq)$ is 0.0.

3.2.5 Coatings/Materials Absorptivity

The absorptivity-temperature curves stored in the EHFR are interpolated to determine the RCS node absorptivity to incident environment energy. Infrared energy absorptivity is calculated using the emission temperature of the energy source with simple linear interpolation of the tabulated absorptivity temperature values. Solar energy (either direct or reflected) absorptivity is interpolated using an assumed energy source temperature of 10,460°R.

The EHFR has the capability for storing 10 absorptivity-temperature values for each of the twenty coatings/materials that are available for the reference coordinate system. In the event that the specified energy source temperature is less than the minimum temperature on the absorptivity-temperature curve, the EHFR extrapolates to find the absorptivity. For the case where the source temperature is greater than the maximum curve temperature, the routine uses absorptivity value that corresponds to maximum curve temperature.

3.2.6 Adiabatic Wall Temperature

The adiabatic wall temperature is calculated by the EHFR for quick comparisons of test/flight data with expected RCS node surface temperatures. The EHFR assumes for these calculations that all environment energy absorbed is re-radiated by the RCS node with no radiant interchange taking place with other RCS nodes: The EHFR equations are developed as follows:

$$Q_{net} = A_n \varepsilon \ \sigma \sum F_{n-i} \ (T^4_{abw} - T^4_i) + A_n[(1 - \sum F_{n-i}) \ (\varepsilon \ \sigma \ T^4_{abw} - Q)]$$

where:

$Q_{net} = 0$ for an adiabatic surface

$F_{n-i}(T^4_{abw} - T^4_i) = 0$ for no radiant interchange with other RCS nodes

$$\varepsilon = \alpha = \alpha\ (T_{abw})$$

$$(1 - \sum F_{n-i}) = F_{ubs}$$

Therefore:

$$0 = F_{ubs}\ \alpha\ (T_{abw})\ \sigma\ T_{abw}^{4} - Q$$

Rearranging

$$T_{abw} = \sqrt[4]{\frac{Q}{\alpha\ (T_{abw})\ \sigma\ F_{ubs}}}$$

4.0 ENVIRONMENT CHARACTERIZATION

4.1 Intravehicular Environment

The intravehicular environment consists of the energy emitted by the interior of a spacecraft. This interior is represented by a six sided enclosure; the size of which is determined by user input data. Each surface of the enclosure may be set at a different temperature. If the width, height, and depth are not input, the program logic defines the enclosure as a 4 ft x 7 ft x 6.5 ft parallelepiped. The user may also enter a thermal emissivity for the enclosure or use the value stored in the program. It is important when using the intravehicular environment option that the enclosure be large enough to enclose the model without intersecting any part of that model. The routine prints an error message when the model surface to enclosure form factor calculation indicates the surfaces are too close for the assumptions used in the form factor calculation to remain valid.

4.2 Lunar Plain

The lunar plain environment consists of the infrared energy emitted by the lunar surface and the solar energy reflected from the lunar surface. Lunar plain radiosity is calculated from the following equations:

$$(B_{ir})_p = \alpha S \sin \delta = \varepsilon_m \sigma T_p^4$$

$$(B_s)_p = (1-\alpha) S \sin \delta$$

Best available data indicate that the solar absorptivity of the lunar surface is approximately 0.93; therefore $(B_S)_p$ is the smaller of the two terms. The angle, δ, is the sun elevation angle measured from the lunar plain and S is the solar constant , 442 BTU/hr-ft^2.

In the event a lunar shadow is to be analyzed, the radiosity equations become

$$(B_{ir})_{sh} = \varepsilon_m \sigma T_{sh}^4$$

$$(B_s)_{sh} = 0$$

The shadow temperature, T_{sh}, is input by the user. Lunar plain shadow areas are rectangular shaded with sides parallel to the X and Y axes. A total of ten such lunar plain shadow areas may be set up by the user. These shadow areas are automatically broken up into elemental areas by the routine for form factor calculations between the model and shadow. An adjustment of the total lunar plain energy is made to account for any shadow areas input.

4.3 Lunar Crater

The lunar crater environment consists of the surface radiosity incident upon the reference coordinate system. Basic program logic for calculating the lunar crater environment originated from Reference 2. Slight modifications were made to the crater logic to improve calculation efficiency and reduce computer time requirements. The lunar crater radiosities are calculated from the following equations:

Shaded Areas -

$$B_{s,c} = \rho_s \left\{ I + \frac{\rho_s \, S \, \mathrm{Sin}\, \delta \, (\mathrm{Sin}^2 \theta)}{2[2-\rho_s(1-\mathrm{Cos}\,\theta)]} \right\}$$

Lighted Areas -

$$B_{ir,c} = \frac{\alpha_s}{\rho_s} B_{s,c} + \frac{\alpha_s \, S \, \mathrm{Cos}\, \alpha \, (1-\mathrm{Cos}\,\theta)}{[2-\rho_s \, (1-\mathrm{Cos}\,\theta)]}$$

$$\sigma \, T_c^4 = \frac{\rho_{ir}\alpha_s}{\varepsilon_{ir}\rho_s} B_{s,c} + B_{ir,c}$$

The crater is broken into 10,000 nodes formed by a series of radial lines and concentric circle lines when viewed from above. Form factors are calculated for each crater node to reference coordinate system node. If the crater nodes are too large for accurate form factor calculations, the routine subdivides the nodes that are too large.

4.4 Thermal Vacuum Chamber

This option allows the user to model the heat flux environment of the NASA-JSC thermal vacuum chamber B and the LTV-VSD ten-foot diameter thermal vacuum chamber. The chamber environment consists of the flux from the chamber floor, lunar surface thermal simulator (LSTS), solar screen, and chamber background. Thermocouple data is input to the routine and establishes the floor temperature. Various lunar surface thermal simulators have been used which are composed of tiers of moveable lamps (or heaters). The routine accepts temperature and position data for the lamps to calculate the LSTS flux contribution. Solar screen data is obtained by calibrating the test volume flux with chamber solar lamp setting and then inputting the data into the EHFR. Background flux is obtained by subtracting all known source contributions from the flux incident on the test volume. Once the chamber has been calibrated and the heat flux data on the test volume is known, the EHFR can generate the incident and absorbed heat flux on a reference coordinate system.

The EHFR has the capability of determining the required LSTS lamp temperatures and positions to give a specified heat flux on a test volume. A least squares numerical technique is used to match LSTS lamp power to give the test volume flux environment desired. This capability has been used numerous times to establish LSTS settings to simulate the lunar plain and various aspect ratio lunar craters.

4.5 Deep Space

The deep space environment consists of incident direct solar energy only. Fourteen spacecraft surfaces may be created and input by the user to interact with the reference coordinate system (RCS). One-bounce reflected energy is taken into account in spacecraft surface to RCS interaction. The sun angle is input in a manner similar to that used in the Lunar Plain Option.

5.0 EHFR Users Manual

The Environmental Heat Flux Routine Version 4, (EHFR-4), was written in Fortran V for use on the NASA-MSC Univac 1108 computer employing an Exec II Processor. The users manual presented in the following subsections contains the necessary information to prepare input data, to submit computer runs, and to successfully execute the various environmental timelines and program options.

5.1 NASA-MSC Run Submission Requirements

For operation on the MSC Univac 1108 system, using overlay provisions, the EHFR-4 program is stored on magnetic tape with the input data deck and appropriate monitor controls submitted on punched cards. The Univac 1108 peripheral equipment (tape units and high speed drums) required by the EHFR, shown in Table 5-1, must be specified by monitor control cards. The order of monitor control and data deck card set up is as follows:

$\frac{7}{8}$ Z - RUN

$\frac{7}{8}$ N - MSG - - - - - FILE - REQ. - - TAPE - - 2 - FH432 - 2 - - -

$\frac{7}{8}$ - ASG - A = XXXXX (Program Tape Number)

$\frac{7}{8}$ - ASG - C = SAVE (Environmental Output Tape to be Saved)

$\frac{7}{8}$ - XQT - CUR

\- - TRW - A

\- - IN - A

\- - TRI - A

$\frac{7}{8}$ E - XQT - PROG

DATA CARDS (See Section 5.4)

$\frac{7}{8}$ - EOF

Additional "$\frac{7}{8}$ - ASG" cards to specify other peripheral equipment may be required when the tape manipulation options are exercised.

The data deck and control card set up must be accompanied by a MSC Form 588 run request card for submittal. The input tape numbers, output tapes necessary, problem run time and output required are designated on the run request card. If output tapes are to be saved, a separate tape reel label (MSC Form 874) for each tape must also be submitted with the run. A method for estimating problem run time and program output (required on the MSC Form 588) is presented in the following section.

TABLE 5-1

INPUT/OUTPUT UNITS REFERENCED BY EHFR

File Name	Logical Unit No.	Unit Type	Unit Use	Program Use
A	1	Tape	Input	Program Tape
B	2	FH432	Scratch	EHFR Scratch file
C	3	Tape	Output	EHFR tape output
D	4	FH432	Scratch	EHFR Scratch file
-	5	- - - -	Input	Data Card Input
-	6	- - - -	Output	Printed Output
E	7	Tape	Input	Parametric Properties Evaluation Input Tape

5.2 Run Time and Output Estimation

The run time of the EHFR-4 may be estimated for Univac 1108 execution by using the following equation:

$$RTIME = 4 + N_{IV} + \frac{1}{3}(1 + N_s) \times N_{LP} + 35 \times N_{LC} \times N_c$$

$$+ 2 \times N_{TV} + \frac{1}{3} \times N_{TC} + \frac{1}{3} N_{DS}$$

where:

RTIME = Computer run time, minutes.

N_{IV} = Number of intravehicular timeline points.

N_s = Number of space craft surfaces and lunar plain shadow areas.

N_{LP} = Number of lunar plain timeline points (number of card B2's for the lunar plain environment).

N_{LC} = Number of lunar crater timeline points.

N_{TV} = Number of thermal vacuum chamber timeline points. (Include number of LESTER* option points to be run.)

N_{TC} = Number of tape combining option points specified or the number of timeline points on the parametric properties evaluated input tape.

N_c = Number of lunar craters.

N_{DS} = Number of deep space timeline points.

The printed output from the EHFR-4 may be estimated by:

$$NPAGES = 9 \times (N_{IV} + N_{LP} + N_{LC} + N_{TV} + N_{TC}) + 55$$

where:

NPAGES = Number of pages of printed output.

The number of pages of printed output may be somewhat less than estimated above if the print out of the reference coordinate system data, node-material composition data, material absorptivity data, and/or stored chamber data are omitted.

* LESTER - Least Squares fit of LSTS zone temperature requirements, Section 4.4.

5.3 Output Tape Manipulation Options

Three tape manipulation options are available to the EHFR user to permit maximum utilization of previously generated environment output tapes. These options consist of the output tape combining option, the parametric properties evaluation option, and the tape read and print option. Descriptions of the three options are presented in the subsections that follow.

5.3.1 Output Tape Combining Option

A tape combining option (TCO) capable of assembling a new environment heat flux timeline from one or several previously generated timelines is available to the EHFR user. This option enables the user to eliminate the lengthy program run times associated with the generation of lunar crater environmental timeline conditions which have been run previously and are available on magnetic tapes.

The tape combining option selects a user specified timeline point from a designated logical tape unit, assigns the mission time desired for the new timeline, and writes the selected environmental heat flux and mission time on the new flux output tape. The tape combining option can be used in conjunction with the other EHFR environment options to generate an output tape with a mixture of new environmental conditions and previously generated environmental conditions.

As an example of the option use, consider the output tape generated during the pre-mission analysis of the EMU operating in a lunar crater environment. During post mission analyses, mission anomalies and different sequencing of events than originally analyzed would necessitate the generation of a new environmental heat flux timeline. By re-sequencing the events of the pre-mission environment output tape (using the tape combining option) and generating additional timeline points, the post mission environmental timeline can be assembled at a fraction of the computer time necessary to generate it without the TCO.

Any number of output tapes may be used during TCO utilization with the limit being the number of Univac 1108 tape drives available for use. The following tape drives are not available for TCO use due to EHFR program requirements and Univac 1108 system restrictions (also see Table 5-1):

File Name	Logical Unit No.
A	1
B	2
C	3
D	4
-	5
-	6

Each tape required for TCO input must also be specified by a "$\frac{7}{8}$ - ASG" monitor control card (as discussed in Section 5.1).

5.3.2 Parametric Properties Evaluation Option

The parametric properties evaluation option (PPEO) permits the EHFR user to parametrically evaluate the effects of different material absorptivities (infrared and solar spectra) on the thermal performance of a system without having to regenerate the given environmental timeline. As with the TCO, the availability and use of environments from previously generated output tapes enables the user to not repeat the lengthy program run times associated with the generation of lunar crater or other environments.

From an existing environment timeline tape the PPEO reads the solar and infrared incident energies, multiplies them by the new absorptivities (which are user input), and calculates a new absorbed heat flux. The output tape generated by the PPEO consists of the new absorbed heat flux combined with the existing activity timeline and incident energies of the input tape. The PPEO input tape must be mounted on logical tape unit 7 (file E) and must be specified by a "7/8-ASG" monitor control card (see Section 5.1).

5.3.3 Output Tape Read and Print Option

The tape read and print option (TRPO) enables the EHFR user to print the nodal absorbed and incident energies, the environment conditions, and activity timelines from a previously generated output tape. The TRPO will permit the efficient use of a library of environmental output tapes by many different EHFR users due to readily available timeline printouts which are necessary for setting up/running the tape combining and parametric properties evaluation options.

The environment tape which is to be input and printed by the TRPO must be mounted on logical tape unit 7 (file E) and must be specified by a "7/8-ASG" monitor control card (see Section 5.1).

5.4 Data Card Preparation

An explanation of the data card input required by the EHFR-4 is presented in this section of the report. The data input can be described in terms of ten sets of cards specifying the various environments, options, and timelines available to the program user:

Card No. Prefix	Input Data or Option	Section
A	Updating of Stored Program Data	5.4.1
B	Environment Selection and Time-line Specification	5.4.2
C	Intravehicular Environment	5.4.3
D	Lunar Plain Environment	5.4.4
E	Lunar Crater Environment	5.4.5
F	Thermal Vacuum Chamber Environment	5.4.6
G	Tape Combining Option	5.4.7
H	Parametric Properties Evaluation Option	5.4.8
I	Output Tape Read and Print Option	5.4.9
J	Deep Space	5.4.10

The flow chart of Figure 5-1, showing the data card order and requirements, is intended to supplement the input card descriptions of the following subsections.

Floating point data input is designated by the format specification "F". The decimal point for this data may be written in any column of the field and its position will override the indicated position in the format specification. Integer data input, as designated by the Format "I", must be right adjusted within the specified field.

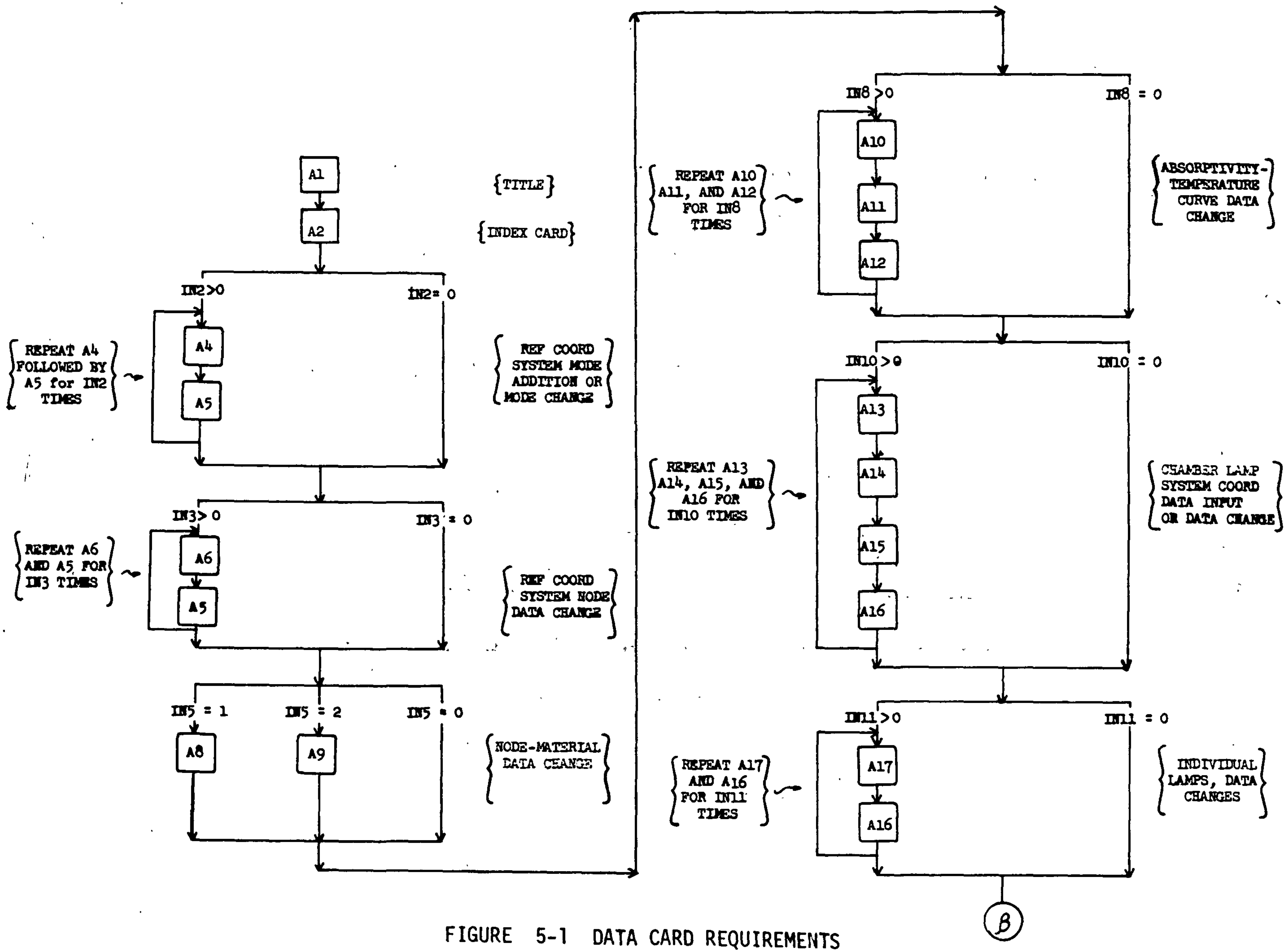


FIGURE 5-1 DATA CARD REQUIREMENTS

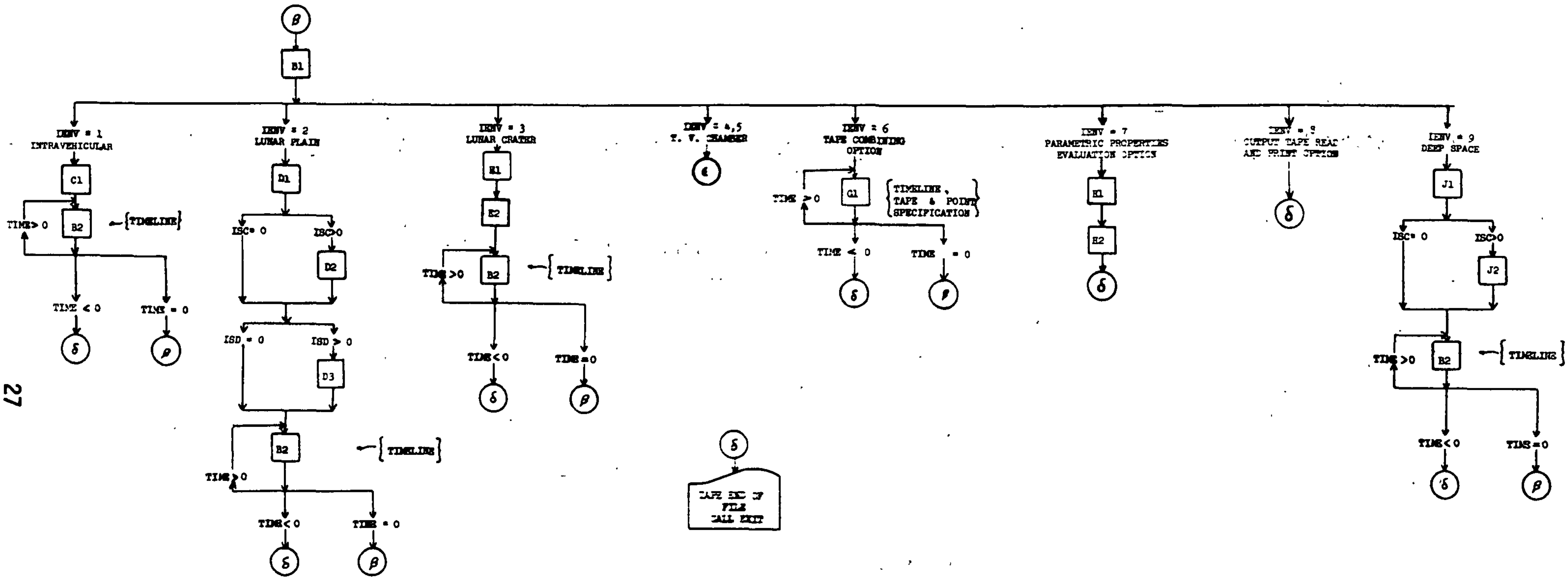


FIGURE 5-1 CONTINUED

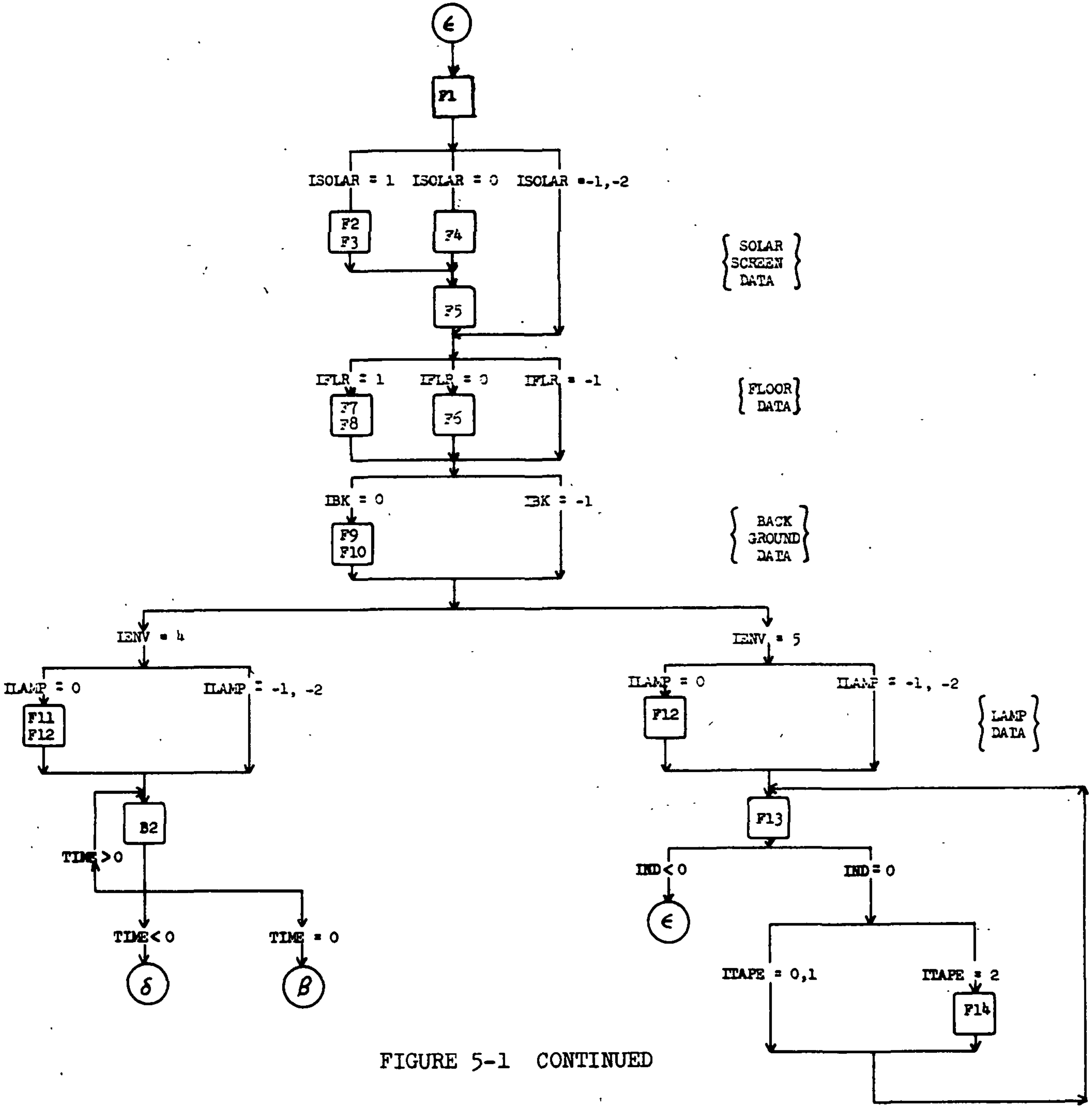


FIGURE 5-1 CONTINUED

5.4.1 Updating Stored Program Data

Columns	Format	Nomenclature	Description
Card A1	Title Card		
1-70	14A5	TITLE	Any alphameric characters to be printed as a page title.
Card A2	Stored data specification indices		
1-4	I4	IREF	Reference coordinate system model index*. = -1, New coordinate system. System to be input** = 0, 1, EMU Model = 2, EMU-LRV Model = 3, EMU-SIM Model
5-8	I4	IN2	Number of modes to be input (as mode additions and/or complete mode changes).**
9-12	I4	IN3	Number of individual nodes for which changes in data are to be input**
13-16	I4	IN4	Reference coordinate system print index. = 1, Print all coordinate data for each mode = 0, Omit coordinate data print.
17-20	I4	IN5	Node - Material composition data change index** = 0, No changes. = 1, Individual node materials to be changed. = 2, Node-material composition data for all nodes to be input
21-24	I4	IN6	Number of individual nodes for which new material composition data is to be input (needed only for IN5 = 1).
25-28	I4	IN7	Node material composition print index. = 1, Print node composition data. = 0, Omit printing this data.

* See Table 5-2 and Appendix A thru C for mode, node data:
** For IREF = -1; IN2 must be $>$ 0, IN3 must be = 0,
IN5 must be = 2, IN8 must be $>$0,
NODEM must be$>$0.

TABLE 5-2

REFERENCE COORDINATE SYSTEM, MODE DATA

REFERENCE COORDINATE SYSTEM	DESCRIPTION IN APPENDIX	IREF INDEX	NUMBER OF MODES	NUMBER OF NODES	MODE NUMBER	MODE NAME
EMU	A	0	3	349	1 2 3	Bending Walking Kneeling
EMU	A	1	2	349	1 2	Standing Floating
EMU-LRV	B	2	3	408	1 2 3	Driving Parking 1 Parking 2
EMU-SIM	C	3	2	406	1 2	Egressing Retrieving

Columns	Format	Nomenclature	Description
Card A2 (Continued)			
29-32	I4	IN8	Number of absorptivity-temperature data curves to be added or changed, (maximum allowed is 20).
33-36	I4	IN9	Absorptivity-temperature data print index. = 1, Print data. = 0, Omit printing this data.
37-40	I4	IN10	Number of new LSTS IR lamp systems to be input, (maximum allowed is 3).
41-44	I4	IN11	Number of individual IR lamps for which new coordinate data is to be input.
45-48	I4	IN12	LSTS IR lamp system print index. = -1, All LSTS systems to be printed. = 0, Omit printing this data. = 1, MSC LSTS data to be printed. = 2, LTV LSTS data to be printed.
49-52	I4	NODEM	The number of nodes for the new reference coordinate system. (For IREF = -1 only). Maximum is 420.

Columns	Format	Nomenclature	Description

Card A4 Mode addition/change (Omit for IN2 = 0)

1-4	I4	M	Mode number to be input.
5-8			Blank
9-13	A5	MODE	Mode name.

Repeat Card A4 followed by the appropriate number of Card A5's for IN2 number of times, (Figure 5-1).

Card A5 Node data input (for use with mode addition/change or with node data change).

1-8	F8.3	XR	X position of node center, in.
9-16	F8.3	YR	Y position of node center, in.
17-24	F8.3	ZR	Z position of node center, in.
25-32	F8.3	ØR	Azimuth angle of node surface normal, degrees.
33-40	F8.3	θR	Inclination angle of node surface normal, degrees.
41-48	F8.3	A	Area of node, ft^2.
49-56	F8.3	FSE(1)	Node unblocked view to space from quadrant 1.
57-64	F8.3	FSE(2)	Node unblocked view to space from quadrant 2.
65-72	F8.3	FSE(3)	Node unblocked view to space from quadrant 3.
73-80	F8.3	FSE(4)	Node unblocked view to space from quadrant 4.

Card A5 must be supplied for each node.

Card A6 Node Data Change Specification. (Omit for IN3 = 0).

1-4	I4	M	Mode Number
5-8	I4	N	Node Number

Repeat Card A6 followed by one Card A5 for IN3 number of times, (Figure 5-1).

Columns	Format	Nomenclature	Description
Card A8	Individual Node Material Change Specification. (Omit for IN5 = 0, 2).		
1-4	I4	N	Node Number
5-8	I4	MTRL(N)	Node N material composition number.
	Repeat Card A8 for IN6 number of times		
Card A9			
1-60	20I4	MTRL(N)	Node N Material composition number.
	Repeat Card A9 the appropriate number of times to supply the composition data for each node.		
Card A10	Material Absorptivity Curve Change Specification. (Omit for IN8 = 0).		
1-4	I4	J	Material number for absorptivity versus temperature curve change.
5-8			Blank
9-13	A5	MAT(J)	Material name - Alphameric characters
Card A11	(Omit for IN8 = 0)		
1-80	10F8.3	TEMAT (L)	Temperature, °R, of curve point L, material J. 10 Curve points required. Temperatures must be input in ascending order.
Card A12	(Omit for IN8 = 0)		
1-80	10F8.3	ALFMAT (L)	Material absorptivity of curve point L, material J. 10 curve points required. Absorptivities must correspond to the appropriate temperatures on Card A11.

Repeat Card A10 followed by Card A11 and Card A12 for IN8 number of times (Figure 5-1) to describe the absorptivity-temperatures curve changes/ additions.

Columns	Format	Nomenclature	Description
Card A13	New LSTS IR Heater System Input. (Omit for IN10 = 0).		
1-4	I4	IC	Chamber index number to be input.
5-8	I4	NZ	Number of LSTS power zones, (Maximum allowed is 6).
9-12	I4	NTIER(IC,1)	Number of heater element tiers in zone 1, (Maximum allowed is 3).
13-16	I4	NTIER(IC,2)	In zone 2.
17-20	I4	NTIER(IC,3)	
21-24	I4	NTIER(IC,4)	
25-28	I4	NTIER(IC,5)	
29-32	I4	NTIER(IC,6)	
Card A14	(Omit for IN10 = 0).		
1-4	I4	NLAMP(IC,1,1)	Number of heater elements in tier 1 of zone 1.
5-8	I4	NLAMP(IC,1,2)	Number elements in tier 2 of zone 1.
9-12	I4	NLAMP(IC,1,3)	Number elements in tier 3 of zone 1.

Repeat Card A14 for NZ number of times to describe the number of heater elements in each tier for the number of zones.

Card A15	(Omit for IN10 = 0)		
1-8	F8.3	EPSLMP(IC)	Heater element emissivity.
9-16	F8.3	ALAMP(IC)	Perpendicular distance of pivot from element center, in.
17-24	F8.3	BLAMP(IC)	Parallel distance of pivot from element center, in.

Columns	Format	Nomenclature	Description
Card A16	Heater Element Coordinate Data		
1-8	F8.3	XL(IC,IZ,IT,IL)	X position of element center from chamber origin, in.
9-16	F8.3	YL(IC,IZ,IT,IL)	Y position of element center from chamber origin, in.
17-24	F8.3	ZL(IC,IZ,IT,IL)	Z position of element center from chamber origin, in.
25-32	F8.3	ØL(IC,IZ,IT,IL)	Azimuth angle of element surface normal, degrees.
33-40	F8.3	ΘL(IC,IZ,IT,IL)	Inclination angle of element normal at zero degree tier angle, degrees.
41-48	F8.3	AL(IC,IZ,IT,IL)	Heater element area, ft^2.

For Card A16 following Card A15, repeat Card A16 to describe the lamp coordinates in the following order, each element, in each tier, and then in each zone, (Figure 5-1).

Card A17 Individual Heater Element Change Specification. (Omit for IN11 = 0)

1-4	I4	IC	Chamber index number.
5-8	I4	IZ	Zone number.
9-12	I4	IT	Tier number.
13-16	I4	IL	Heater element number

Repeat Card A17 followed by one Card A16 for IN11 number of times, (Figure 5-1).

5.4.2 Environment Selection and Timeline Specification.

Columns	Format	Nomencalture	Description
Card B1	Environment Selection		
1-4	I4	IENV	Environment index = 1 Intravehicular = 2 Lunar Plain = 3 Lunar Crater = 4 Thermal Vacuum Chamber = 5 Thermal Vacuum Chamber LESTER Option = 6 Tape Combining Option = 7 Parametric Properties Evaluation Option = 8 Output tape read and print option = 9 Deep Space Environment
Card B2	Position - Mode - Timeline Specification		
1-4	I4	IPRINT	Print index = 1 Full print = 0 Short print = -1 Summary print
5-8	I4	M	Mode Index (See Table 5-2 and Appendix A).
9-16	F8.3	TIME	Mission time, hrs. TIME > 0, Compute environment TIME < 0, Tape end of file and program end. TIME = 0, Change the environment, new card B1 to be read
17-24	F8.3	DTIME	Length of time reference coordinate system remains in this position, hrs. (must be less than next time point)
25-32	F8.3	X	RCS*X position, ft.

*REFERENCE COORDINATE SYSTEM

Card B2 (Continued)

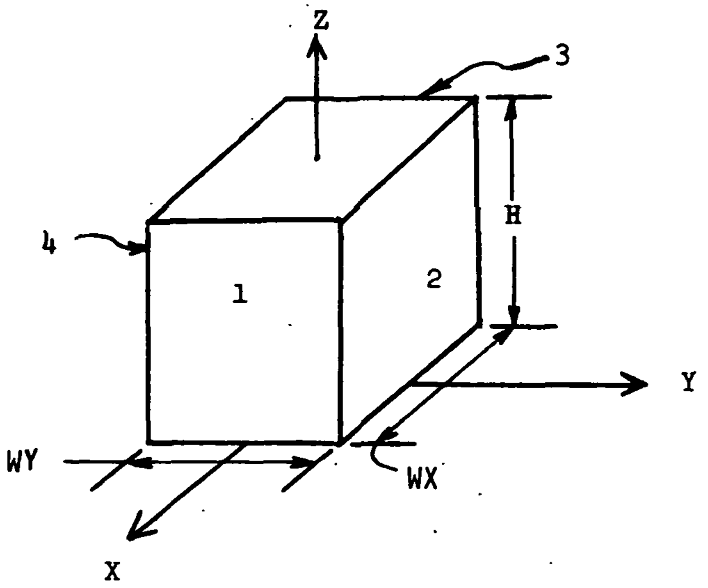
Columns	Format	Nomenclature	Description
33-40	F8.3	Y	RCS Y position, ft.
41-48	F8.3	Z	RCS height above local surface, ft.
49-56	F8.3	PHI	RCS azimuth position, degrees. = 0 back to sun =$\pm$180 front to sun
57-72			Blank
73-80	F8.3	TCONT	RCS optional thermal contact temperature $^{\circ}$R. If blank, the program calculates the RCS contact temperature based on local surface conditions.

Repeat Card B2 as many times as necessary to describe the RCS position - mode - time for a particular environment.

5.4.3 Intravehicular Environment

IENV = 1 on Card B1

Columns	Format	Nomenclature	Description
Card C1			
1-8	F8.3	TSC(1)	Temperature of vehicle interior surface 1, °F
9-16	F8.3	TSC(2)	Temperature of vehicle interior surface 2,°F
17-24	F8.3	TSC(3)	Temperature of vehicle interior surface 3, °F
25-32	F8.3	TSC(4)	Temperature of vehicle interior surface 4, °F
33-40	F8.3	TSC(5)	Temperature of vehicle interior deck, °F
41-48	F8.3	TSC(6)	Temperature of vehicle interior overhead, °F
49-56	F8.3	WX	Vehicle width in x direction, ft. If blank, program sets WX = 4.0
57-64	F8.3	WY	Vehicle width in Y direction, Ft. If blank, program sets WY = 7.0
65-72	F8.3	H	Vehicle interior height, ft. If blank, program sets H = 6.5
73-80	F8.3	E	Thermal emissivity of vehicle interior. If blank, program sets E = 0.85



5.4.4 Lunar Plain Environment

IENV = 2 on Card B1.

Columns	Format	Nomenclature	Description
Card D1			
1-4	I4	ISC	Number of space craft surfaces, (Maximum of 14 allowed).
5-8	I4	ISD	Number of lunar plain shadow areas. (Maximum of 10 allowed).
9-16	F8.3	SUND	Sun angle above the -X axis horizon, deg. If SUND < 0, program uses lunar night conditions of -290°F lunar surface temperature.
17-24	F8.3	AMOON	Lunar surface solar absorptivity. If blank, the program sets AMOON = 0.93.
25-32	F8.3	EMOON	Lunar surface I.R. emissivity. If blank, the program sets EMOON = 0.93.
Card D2	Spacecraft Surface Specification. (Omit for ISC = 0)		
1-8	F8.3	XC(I)	X position of surface i, ft.
9-16	F8.3	YC(I)	Y position of surface i, ft.
17-24	F8.3	ZC(I)	Z position of surface i, ft.
25-32	F8.3	PHIC(I)	Azimuth angle of surface i normal, deg.
33-40	F8.3	THTC(I)	Inclination angle of surface i normal, deg.
41-48	F8.3	W(I)	Width of surface i, ft.
49-56	F8.3	H(I)	Height of surface i, ft.
57-64	F8.3	EC(I)	I.R. emissivity of surface i.
65-72	F8.3	AC(I)	Solar absorptivity of surface i.
73-80	F8.3	TSC(I)	Temperature of surface i, $^{\circ}$F. If = -460., the program assumes that the surface is adiabatic and calculates the adiabatic surface temperature.

Repeat Card D2 for ISC number of times to describe each spacecraft surface. Maximum number of surfaces allowed is 14.

Columns	Format	Nomenclature	Description
Card D3	Lunar Plain Shadow Areas Specification (Omit for ISD = 0)		
1-8	F8.3	XS(I)	X position of shadow area center i, ft.
9-16	F8.3	YS(I)	Y position of shadow area center i, ft.
17-24	F8.3	WX(I)	Shadow width in X direction, Ft.
25-32	F8.3	WY(I)	Shadow width in Y direction, Ft.
33-40	F8.3	TSH(I)	Shadow Temperature, °F.
41-48	F8.3	XS(I + 1)	X position of shadow area center i + 1, Ft.
49-56	F8.3	XS(I + 1)	Y position of shadow area center i + 1, Ft.
57-64	F8.3	WX (I + 1)	Shadow width in X direction, Ft.
65-72	F8.3	WY (I + 1)	Shadow width in Y direction, Ft.
73-80	F8.3	TSH (I + 1)	Shadow Temperature, °F

Repeat Card D3 as many times as necessary to describe ISD number of shadow areas.

5.4.5 Lunar Crater Environment

IENV = 3 on Card B1.

Columns	Format	Nomenclature	Description
Card E1			
1-8	I8	ISC	Number of craters (Maximum of 100 allowed)
9-16	F8.3	SUND	Sun angle above the -X axis horizon, deg.
17-24	F8.3	AMOON	Lunar surface solar absorptivity. If blank, the program sets AMOON = 0.93.
25-32	F8.3	EMOON	Lunar surface I.R. absorptivity. If blank, the program sets EMOON = 0.93.
Card E2			
1-8	F8.3	DIA(I)	Crater i diameter, ft.
9-16	F8.3	DEPTH(I)	Crater i depth, ft.
17-24	F8.3	XC(I)	Crater i X position of crater center, ft.
25-32	F8.3	YC(I)	Crater i Y position of crater center, ft.

Repeat Card E2 as many times as necessary to describe ISC Number of craters.

5.4.6 Thermal Vacuum Chamber Environment

IENV = 4, 5 on Card B1.

Columns	Format	Nomenclature	Description
Card F1			
1-4	I4	IC	Chamber Index = 1 MSC LSTS = 2 LTV LSTS = 3 General Chamber
5-8	I4	ISOLAR	Solar Input Index = -2 Solar lamps off = -1 Use last solar data input (-2 and -1: Do not use for first time point) = 0 Solar data to be input, use stored solar screen data.* = 1 Solar data and solar screen data to be input
9-12	I4	IFLR	Floor input index = -1 Use last floor data input. = 0 Thermocouple data to be input. Stored floor node data to be used. * = 1 Node and Node temperatures to be input.
13-16	I4	ILAMP	LSTS IR heater data input index = -1 Use last heater data input. = 0 Tier angle and tier temperature to be input. = -2 LSTS heaters are off.
17-20	I4	IBK	Background input index. = -1 Use last B.G. data input. = 0 Input I.R. and solar B.G data.
21-24	I4	ITAPE	LESTER option (IENV = 5), timeline tape input index. = 0 Use currently generated output tape as timeline. = 1 Use previously generated output tape as timeline (Tape mounted on UNIT C, See Section 5.1) = 2 Use data card input

* Stored Data Presented in Appendix D.

Columns	Format	Nomenclature	Description
Card F2	(Omit for ISOLAR = -2, -1, 0)		
1-4	I4	ML	Number of solar screen lengths.
5-8	I4	NW	Number of solar screen widths.
	(ML X NW is the number of solar screen nodes. ML X NW must be less than 280)		
9-16	F8.3	SUND	Sun angle above the -X axis horizon, degrees.
17-24	F8.3	HEIGS	Height of solar screen, ft.
25-32	F8.3	WIDTHS	Width of solar screen, ft.
33-40	F8.3	ALFSOL	Set equal to 1.0.
Card F3	(Omit for ISOLAR = -2, -1, 0)		
1-80	10F8.3	ALFS(I)	Absorptivity of material i to the solar lamps.
Card F4	(Omit for ISOLAR = -2, -1, 1)		
1-8	F8.3	SUND	Solar lamp vector angle above the -X axis horizon, degrees.
Card F5	(Omit for ISOLAR = -2,-1)		
1-80	10F8.3	SOL(I)	Solar lamp energy on screen node I, BTU/hr ft^2.

Repeat Card F5 as needed to describe the solar lamp flux on each solar screen node.

Columns	Format	Nomenclature	Description
Card F6	(Omit for IFLR = -1,+1)		
1-80	10F8.3	TEMTC(I)	Thermocouple measured temperature, °F.

Repeat Card F6 as needed to supply thermocouple data for each T.C. (do not leave any T.C. readings blank).

MSC, IC = 1, 32 T.C. values are required
LTV, IC = 2, 8 T.C. values are required

Columns	Format	Nomenclature	Description
Card F7	(Omit for IFLR =-1, 0)		
1-4	I4	NUMZNS	Number of radial floor increments desired.
5-8	I4	NB	Number of angular divisions, desired.
9-16	F8.3	EPSFLR	Floor emissivity.
17-24	F8.3	RADIUS	Floor radius, ft.
Card F8	Floor Node Temperatures (Omit for IFLR = -1,0)		
1-80	10F8.3	TEMP(I)	Floor node temperature, °R.

Repeat Card F8 as needed to supply floor node temperatures for NB x NUMZNS floor nodes.

Card F9 (Omit for IBK = -1)

Chamber I.R. background description. 6 cards required to input this data.

1-80	10F8.3	((QBR(I,J,K), K = 1,5), J = 1,4), I = 1, 3), BTU/hr ft2.

I - Height Index		J - Azimuth Index		K - Inclination Index	
I = 1	h = 1'	J = 1	$\phi = 0$	K = 1	$\theta = -90$
I = 2	h = 3'	J = 2	$\phi = 90$	K = 2	$\theta = -45$
I = 3	h = 5'	J = 3	$\phi = 180$	K = 3	$\theta = 0$
		J = 4	$\phi = 270$	K = 4	$\theta = 45$
				K = 5	$\theta = 90$

Card F10 (Omit for IBK = -1)

Chamber solar albedo background description 6 cards required to input this data.

1-80	10F8.3	((QBS(I,J,K),K=1,5),J=1,4),I=1,3) (Same indices as the I.R. data)

Card F11 (Omit for ILAMP = -1,or IENV = 5)

1-48	6F8.3	T(IZ)	LSTS lamp zone average temperature, °F.

Columns	Format	Nomenclature	Description
Card F12	(Omit for ILAMP = -1)		
1-8	F8.3	ANG(J,1)	Zone J, tier 1, LSTS lamp inclination angle, degrees.
9-16	F8.3	ANG(J,2)	Zone J, tier 2, LSTS lamp inclination angle, degrees.
17-24	F8.3	ANG(J,3)	Zone J, tier 3, LSTS lamp inclination angle, degrees.

Repeat Card F12 for each power zone. For chambers with only 2 tiers/zone, input ANG(J,1) and ANG(J,2) only.

Card F13 LESTER Option Timeline

Columns	Format	Nomenclature	Description
1-4	I4	IND	LESTER option chamber environment change or update index. = 0 no change = -1 T.V. chamber environment change. No calculation at this time. Read in a new Card F1.
5-8	I4	M	(Omit for ITAPE =0,1) Reference coordinate system (RCS) mode, (See Table 5-2 and Appendix A).
9-16	F8.3	TIME	Mission time, hrs. (Set time = 2.0 for ITAPE = 0,1)
17-24			Blank
25-32	F8.3	X	RCS X chamber position, ft.
33-40	F8.3	Y	RCS Y chamber position, ft.
41-48	F8.3	Z	RCS Z chamber position, ft.
49-56	F8.3	PHI	RCS azimuth position, deg. (Omit for ITAPE = 0,1)

Card F14 LESTER Card Input of Absorbed Heats (Omit for ITAPE = 0,1)

Columns	Format	Nomenclature	Description
1-80	10F8.3	QA(I)	Absorbed heat on each reference coordinate system node, BTU/hr.

Repeat Card F14 as many times as required to furnish the absorbed heat for each node.

5.4.7 Tape Combining Option

IENV = 6 on Card Bl.

Columns	Format	Nomenclature	Description
Card Gl	Tape and Point Specification Timeline		
1-4	I4	IT	Tape unit number of original tape, (see Section 5.3).
5-8	I4	IP	Environment timeline point number from tape IT to be put on output tape.
9-16	F8.3	TIME	Mission time, hrs, to be printed on the output tape for the environment point IP on tape IT. TIME > 0, write the environment on output tape. TIME < 0, tape end of file and program end. TIME = 0, read in a new Card Bl for other environment calculations.
17-24	F8.3	DTIME	Length of time the reference coordinate system (RCS) remains in this position, hrs.

Repeat Card Gl as many times as necessary to define a new timeline on the output tape.

5.4.8 Parametric Properties Evaluation Option

IENV = 7 on Card B1.

Columns	Format	Nomenclature	Description
Card H1			
1-80	10F8.3	A(L)	Solar absorptivity for each material L, (20 materials total).
Card H2			
1-80	10F8.3	E(L)	Thermal emissivity for each material L, (20 materials total).

Mount the input tape on logical unit 7, (file E).

5.4.9 Output Tape Read and Print Option

IENV = 8 on Card B1.

No data cards are required for this option. Mount input tape on logical unit 7, (file E).

5.4.10 Deep Space Environment

IENV = 9 on Card B1.

Columns	Format	Nomenclature	Description
Card J1			
1-4	I4	ISC	Number of spacecraft surfaces, (maximum of 14 allowed)
5-8	Blank		
9-16	F8.3	SUND	Sun angle from the -X axis horizon, deg. Sun angle may be positive or negative.

Card J2 Spacecraft Surface Specification. (Omit for ISC = 0)

1-8	F8.3	XC(I)	X position of surface i, ft.
9-16	F8.3	YC(I)	Y position of surface i, ft.
17-24	F8.3	ZC(I)	Z position of surface i, ft.
25-32	F8.3	PHIC(I)	Azimuth angle of surface i normal, deg.
33-40	F8.3	THTC(I)	Inclination angle of surface i normal, deg.
41-48	F8.3	W(I)	Width of surface i, ft.
49-56	F8.3	H(I)	Height of surface i, ft.
57-64	F8.3	EC(I)	I.R. emissivity of surface i.
65-72	F8.3	AC(I)	Solar absorptivity of surface i.
73-80	F8.3	TSC(I)	Temperature of surface i, °F. If = -460., the program assumes that the surface is adiabatic and calculates the adiabatic surface temperature.

Repeat Card J2 for ISC number of times to describe each spacecraft surface. Maximum number of surfaces allowed is 14.

5.5 Run Failure Analysis

A resume of errors found during data card input will be printed by the EHFR. Any errors detected will cause the program to end further data processing and will generate an "end of file" mark on the output tape. Diagnostic messages printed by the EHFR will contain the name of the input variable and the card number on which the data is located. (First data card is A1).

Typically, input errors will result from specifying variables and indices that are unrealistic or out of the range of program operation. For example: on Card A13, IC $>$ 3 or NZ $>$ 6 would cause the program to end since these indices are not within the program range; or on Card D2, W(I) $<$ 0 or EC(I) $>$ 1.0 would cause the program to terminate operation since a negative spacecraft surface width or IR emissivity greater than 1.0 are unrealistic.

On the position timeline specification card, Card B2, care should be exercised to assure that mission time between the various positions is always positive, and that the reference coordinate system mode is not zero or greater than the maximum stated in Table 5-2. The differential time variable, DTIME, should result in positive non-zero time increments between time points. Failure to do these will result in a program termination and a diagnostic message.

6.0 MULTIPLE REFLECTIONS ROUTINE

The multiple reflections routine (MRR) was developed as a companion program to the EHFR to account for the solar and infrared spectra energy reflections and absorption between the various nodes of a reference coordinate system employed by the EHFR. The analytical techniques and governing equations used by MRR, and the MRR Users Manual are presented in this section.

6.1 MRR Analytical Techniques

The total absorbed heat due to the multiple reflections of environmental incident energy is calculated in the MRR by performing radiosity energy balances for each RCS node. The radiosity technique results in two sets of linear equations describing the RCS node surface radiosities in the solar and infrared spectra. The N linear equations with N unknowns (N is the number of RCS nodes) are then solved by the MRR.

RCS node incident energy, H, in terms of surface radiosities, can be written for the infrared and solar spectra as follows:

$$H_i = G_i + \sum_{j=1}^{n} B_j F_{i-j}$$

where:

G = the direct environmental incident energy in either the solar or infrared spectra calculated by the EHFR.

The radiosity of any RCS node surface (B) must be equal to the reflected incident energy of that surface (the emitted energy is considered in thermal simulator employed later).

therefore

$$B_i = (1 - \alpha_i)H_i \qquad (6\text{-}1)$$

The absorbed energy of any RCS node surface is:

$$Q_1 = A_i(B_i - H_i) \qquad (6\text{-}2)$$

From 6-1 and 6-2:

$$Q_i = - A_i \ \alpha_i \ H_i$$

The above equations can now be rearranged and written in the following form:

$$G_i = \sum_{j=1}^{n} \frac{Q_j}{A_j \alpha_j} \left[\delta_{ij} - (1-\alpha_j) \ F_{i-j}\right] \qquad (6\text{-}3)$$

where: $\delta_{ij} = 0$ for $i \neq j$

$\delta_{ij} = 1$ for $i = j$

In matrix notation, equation 6-4 can be written as:

$$G = Q \cdot C \qquad (6\text{-}4)$$

where:

$$C_{ij} = \frac{1}{A_j \alpha_j} \left[\delta_{ij} - (1-\alpha_j) F_{i-j} \right]$$

The MRR program solves the above radiosity network to find the absorbed heat due to direct and reflected energy in the solar and infrared spectra by inverting the C matrix defined by equation 6-4.

$$Q_s = C_s^{-1} \ G_s$$

$$Q_{ir} = C_{ir}^{-1} \ G_{ir}$$

Before running the MRR, the user must calculate accurately the form factors between each of the RCS nodes. For large RCS systems, such as the EMU-LRV with 408 nodes, this can be a considerable effort. Additionally, the run time of the MRR is a cubic function of the number of RCS nodes which can view each other ($F_{ij} > 0$). It is therefore recommended that only those nodes which experience a significant amount of reflections be considered for the multiple reflections analyses.

6.2 MRR Users Manual

The Multiple Reflections Routine (MRR) was written in Fortran V for use on the NASA-MSC Univac 1108 computer employing an Exec II Processor. This users manual contains the necessary information to prepare input data, to submit computer runs, and to successfully execute the various environmental timelines and program options.

For operation on the MSC Univac 1108 system, using overlay provisions, the MRR program is stored on magnetic tape with the input data deck and appropriate monitor controls submitted on punched cards. The Univac 1108 peripheral equipment (tape units, Fastran units, and high speed drums) required by the EHFR, must be specified by monitor control cards. The order of monitor control and data deck card set up is as follows:

```
7
8Z  RUN

7
8N  MSG     FILE REQ.  TAPE  6 FH432 4  FSTRN 2

7
8   ASG A=XXXXX   (PROGRAM TAPE NUMBER)

7
8   ASG D=XXXXX   (ENVIRONMENTAL HEAT FLUX INPUT TAPE)
                  This is the flux output tape from EHFR version 4
```

```
7
8S  ASG E=IEHN    (FLUX OUTPUT TAPE TO BE SAVED)
                  This is an environmental heat flux tape in the same format
                  as the EHFR heat flux tape with the fluxes modified to
                  include multiple reflections.

7
8   ASG F=XXXX    (MODE 1 FORM FACTOR INPUT TAPE)

7
8   ASG G=XXXX    (MODE 2 & 3 FORM FACTOR INPUT TAPE)

7
8   ASG H=IT1
                  (WORKING TAPES)
7
8   ASG I=IT2

7
8   ASG Q,T,X     (FASTRAN UNITS)

7
8   XQT CUR

    TRW A

    IN A

    TRI A

    TOC

7
8   XQT MAIN
        DATA CARD
        COL.  1-10    F10.0     TIME  = 0.0 INITIAL RUN
                                      > 0.0 LAST TIME POINT COMPLETED ON
                                            PREVIOUS RUN

7
8   EOF
```

The data deck and control card set up must be accompanied by a MSC Form 588 run request card for submittal. The input tape numbers, output tapes necessary, problem run time and output required are designated on the run request card. If output tapes are to be saved, a separate tape reel label (MSC Form 874) for each tape must also be submitted with the run.

The run time of MRR may be estimated for Univac 1108 execution by using the following:

$$RTIME = 15 + N_{tp}$$

where:

$RTIME$ = Computer run time, minutes
N_{tp} = Number of time points

7.0 NOMENCLATURE

Alphabetic

A_n	RCS node area, Ft^2
B	Radiosity of energy source, BTU/hr-ft^2
dA_{si}	Differential environment source node i area, ft^2
F_{a-b}	Geometric form factor from surface a to surface b
F_{n-i}	Geometric form factor from RCS node n to RCS node i
F_{n-iq}	Geometric form factor from RCS node n to RCS node i located in quadrant q
$F_{se(q)}$	Unblocked RCS node view to space in quadrant q
F_{ubi}	RCS node decimal percentage of unblocked view to energy source node i
F_{ubs}	Unblocked RCS node view to space
G	RCS node environmental incident energy, BTU/hr-ft^2
H	Incident energy, BTU/hr-ft^2
N_r	RCS node unit normal vector
N_{si}	Environment source node unit normal vector
Q	RCS node total absorbed energy, BTU/hr
q	Quadrant number of energy
R	RCS node to energy source node vector
T	Temperature of energy source, °R
T_{abw}	Adiabatic wall temperature of RCS node, °R

Greek

$\alpha(T)$	Absorptivity of RCS node to energy at source temperature, T
ϕ	Azimuth angle
θ	Inclination angle
σ	Stefan-Boltzmann constant
ω_r	Angle between RCS node normal vector and the RCS node to energy source node vector
ω_{si}	Angle between energy source node normal vector and the energy source node to RCS node vector

Subscripts

i	Node of RCS system
ir	Infrared spectra
j	Node of RCS system
o	Location of RCS origin with respect to the environment origin
r	RCS node data with respect to RCS origin
s	Solar spectra
se	RCS node data with respect to environment origin
si	Environment source node data with respect to environment origin

8.0 REFERENCES

1. Finch, H. L., Sommerville, D., Development of a Computer Program for Determining External Radiation Absorbed by The Apollo Spacecraft, Midwest Research Institute, June 1966.

2. Adorjan, A. S., Transmittal of Fortran Listings of General Electric Developed Thermal Analyzers LETA I, LETA II and SUTA 1, General Electric TIR 580-S-8014, January 1968.

3. Hester, J. C., et.al., Performance of the Apollo Block II Environmental Control System Radiators of Earth Orbital AAP Mission, LTV Report 361.02, October 1967.

APPENDIX A

APOLLO EXTRAVEHICULAR MOBILITY UNIT REFERENCE COORDINATE SYSTEM

1.0 SUMMARY

The Apollo Extra-Vehicular Mobility Unit (EMU) reference coordinate system employed in the Environmental Heat Flux Routine (EHFR) consists of a geometric nodal model which is arranged in several different nodal configurations (called modes). The modes define the expected positions that the EMU will experience during the astronaut extra-vehicular activities on the lunar surface, in orbit, and during thermal vacuum chamber operations. The EMU reference coordinate system (RCS) data employed by and stored within the EHFR are described in this appendix. These data consist of: geometric model and nodal nomenclature definition; nodal coordinate data for each of the five EMU modes; nodal self blockage data; node-material composition data; and curves of material absorptivity as a function of source temperature.

2.0 EMU GEOMETRIC MODEL DEFINITION

The external configuration of the Apollo EMU, shown schematically in Figure A-1, consists of: the space suit (integrated thermal-meteoroid protection garment, ITMG); the Extra-Vehicular (EV) Boots and Gloves; the Portable Life Support System (PLSS) with its associated Remote Control Unit (RCU); the Oxygen Purge System (OPS); the umbilicals and connector hardware; and the Lunar Extra-Vehicular Visor Assembly (LEVA). Basic geometric nodal models of these components previously developed by G.E. in References A-1 and A-2, have been used with considerable modification in the development of the EMU reference coordinate system described herein.

The component geometric models which have been developed are presented in Figures A-2 through A-8. These models were generated by subdividing the exterior surfaces of the components into finite nodal areas with planer surfaces. Planes of common intersection exist at all points of possible body movement (i.e., ankles, knees, hips, etc.) so that the nodal distribution need only be relocated about these planes to simulate different body positions. A summary of the EMU nodal distribution for each component is presented in Table A-1.

The component geometric models in Figures A-2 through A-8 employ a four digit identification number to locate the various nodal surfaces. The first two digits (or node prefix number) represent a particular region of the EMU with the third digit representing a particular section of that region. As an example, 04-25 identifies a node on the left leg (the 04 prefix number) with the exact location being the back of the thigh area, (Figure A-2).

TABLE A-1

SUMMARY OF THE EMU NODAL DISTRIBUTION

Node Prefix Number	Location	Number of Nodes
01	Right Boot	11
02	Left Boot	11
03	Right Leg	16
04	Left Leg	16
05	Midsection	30
06	Lower Torso	12
07	Upper Torso	15
08	Neck Area	8
09	Right Shoulder	16
10	Left Shoulder	16
11	Right Arm	16
12	Left Arm	16
13	Right Glove	4
14	Left Glove	4
15	Helmet	38
16	Visors	24
17	Portable Life Support System	13
18	Oxygen Purge System	8
19	Remote Control Unit	7
20	Suit Hardware	8
21	Umbilicals	60
	TOTAL	349

3.0 REFERENCE COORDINATE SYSTEM DATA

The basic nodal geometric models defined above were arranged into five different modes that describe the expected EMU EV activity body positions. These modes define standing, kneeling, floating, bending, and walking positions of the EMU.

RCS INDEX *	MODE NUMBER	MODE NAME	MODE FIGURE
0	1	Bending	A-10
0	2	Walking	A-11
0	3	Kneeling	A-12
1	1	Standing	A-13
1	2	Floating	A-14

The nodal geometric data consist of the node midpoint coordinates, the surface normal-vectors, and node surface areas. The coordinate system is right handed system with its origin at the ground or feet of the EMU. The front of the EMU is oriented in the positive X direction as seen in Figure A-10. Figure A-9 shows the geometrical convention used to define the surface normal vectors: the azimuth angle being measured in the X-Y plane (counter clockwise from the positive X axis), and the elevation angle being measured from the X-Y plane.

The self blockage data consist of the node's unblocked view of the environment from each of the four "viewing quadrants", (details of the quadrant method of self blockage used by the EHFR are discussed in Section 3.3).

The nodal thermal property data consist of the node-material composition and curves of material absorptivity as a function of temperatures. Node-material composition data describe the material covering each node: teflon coated beta cloth, Chromel R, Boot and glove rubber, polysulfone, blue and red connectors, hard point (anodized aluminum), and holes. The material absorptivity curves used within the EHFR were obtained from Figure 5 of Reference A-3 and from References A-4 and A-5. These data are presented in Figure A-15. EHFR solar absorptivity is calculated from these curves at a source temperature of 10460°R.

A detailed listing of the nodal geometric data, self blockage data, and nodal thermal property data that comprise the EMU reference coordinate system may be obtained from the EHFR by inputing the proper print indices on Card A-2 (Section 5.4 of the report) during EHFR execution.

*RCS index prescribes EMU models to be used during EHFR execution (Card A2, Section 5.4.1).

4.0 REFERENCES

A-1 Webb, C. M., "Geometrical Model of the Apollo Space Suit", General Electric Apollo Systems Department, TIR 580-S-7190, 13 December 1967.

A-2 Webb, C. M., "Geometrical Models of EVVA, EV-Boots, EV-Gloves, PLSS and OPS for Thermal Analysis Program", General Electric Apollo Systems Department, TIR 580-S-8140, 27 May 1968.

A-3 Jordan, W. D., and Martin, D. M.; "An Analysis of the Lunar Surface Thermal Simulator (LSTS) Calibration", LTV Aerospace Corporation, Missiles and Space Division, Report T 104-RP-004, 27 June 1969.

A-4 McKinney, P. H., "Thermal Response of the Oxygen Life Support Connectors of the Spacesuit in Severe Orbital and Test Environments", General Electric Apollo Systems Department, TIR-727-S-8246(s), 26 September 1968

A-5 Gubareff, Janssen, and Torborg, "Thermal Radiation Properties Survey", Minneapolis-Honeywell Regulator Company, Honeywell Research Center, 1960.

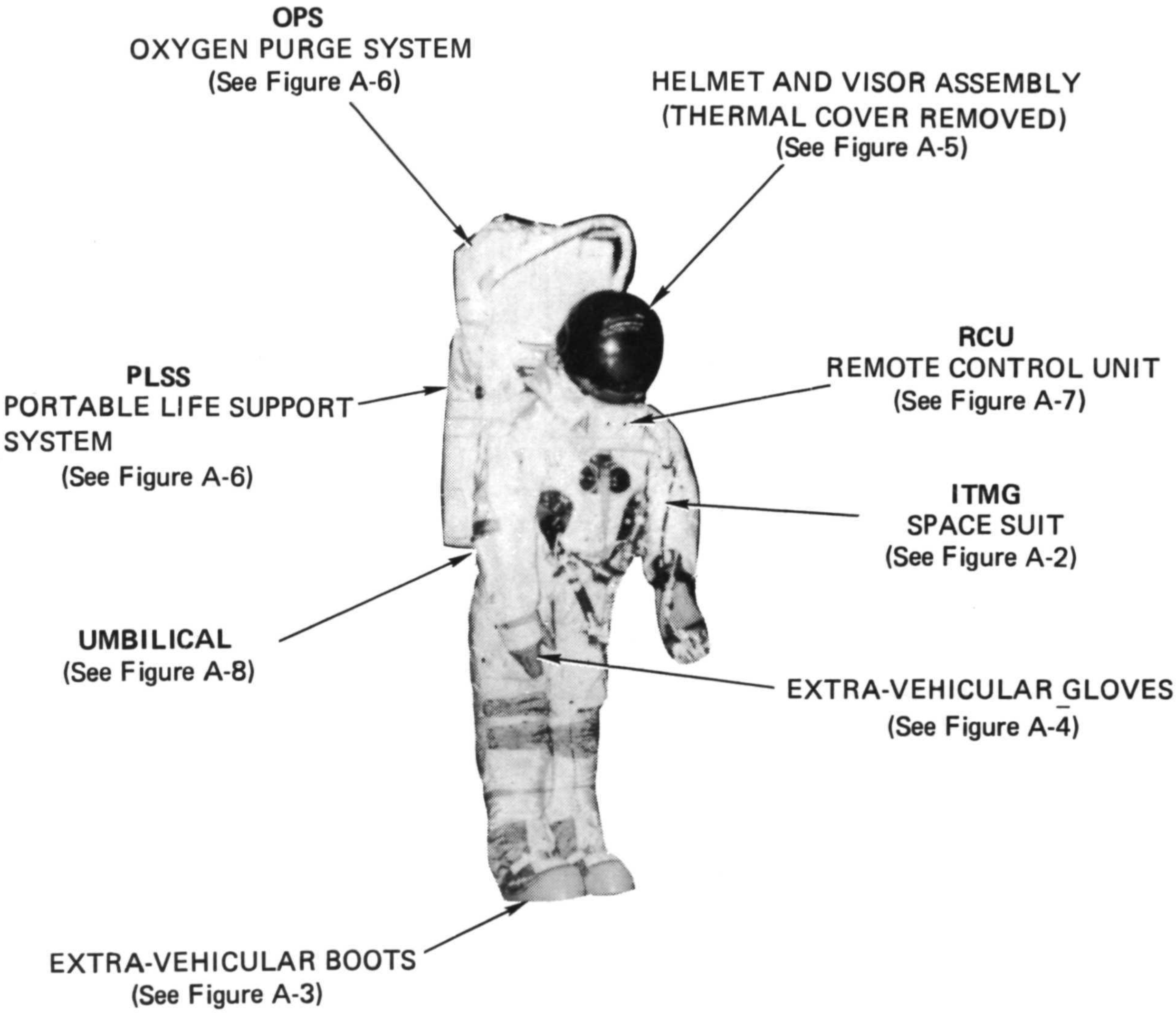


FIGURE A–1 SCHEMATIC OF THE EXTRA-VEHICULAR MOBILITY UNIT

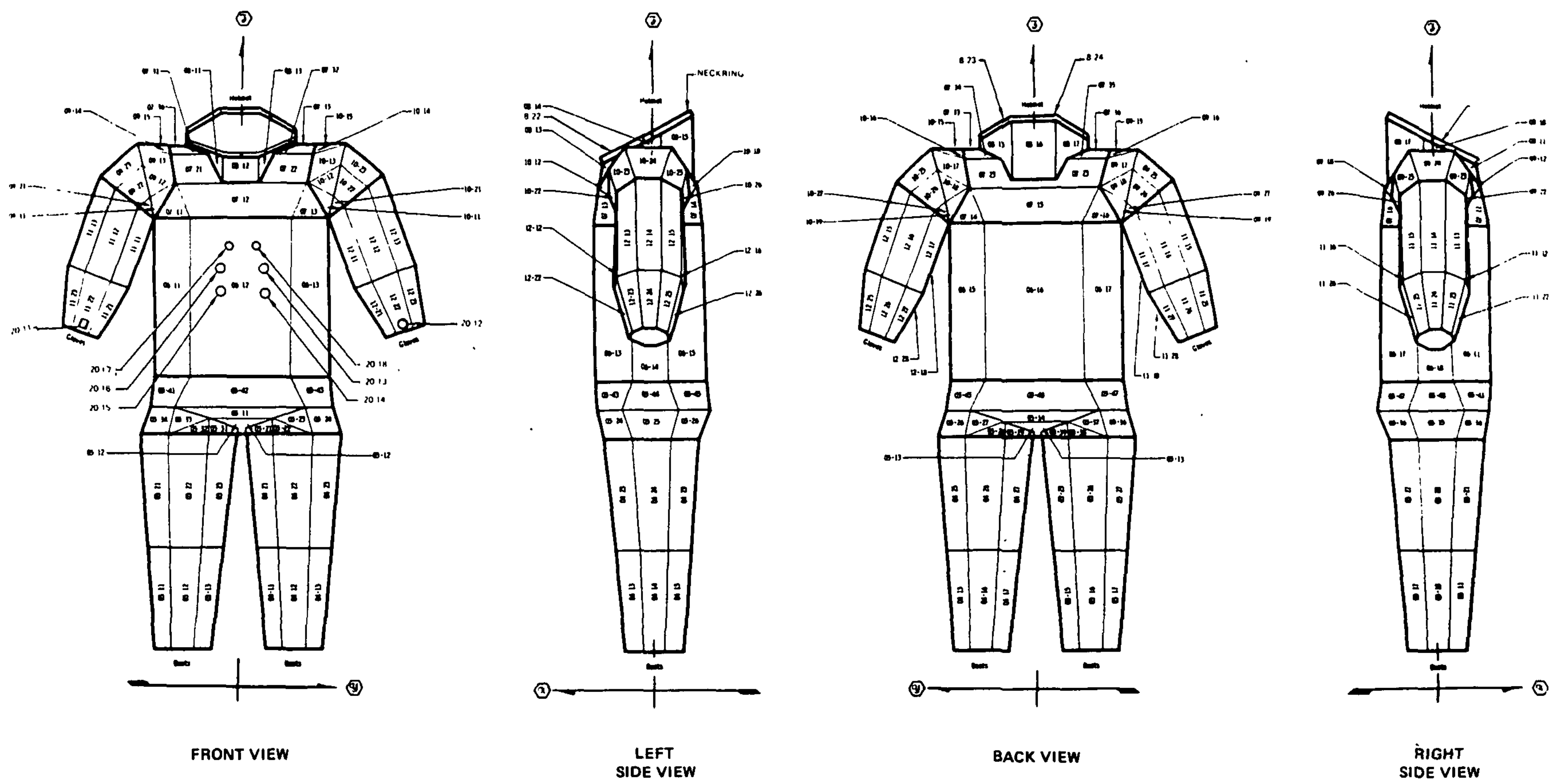
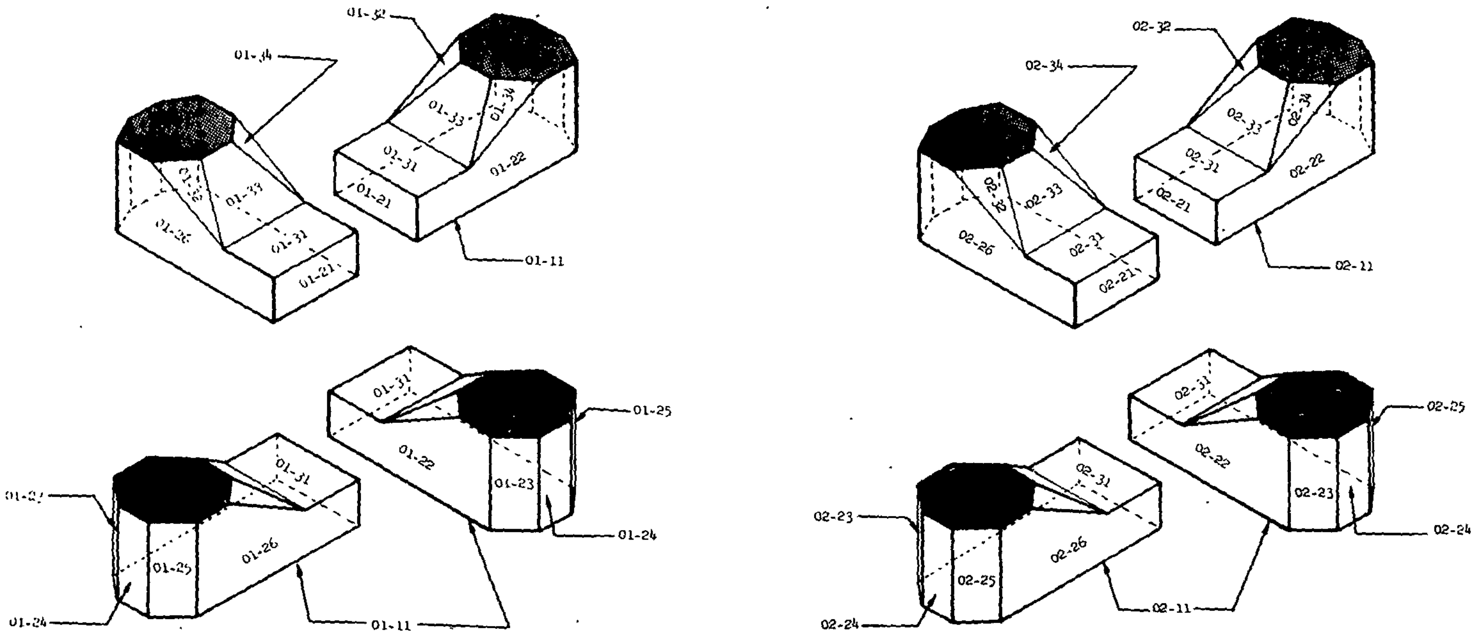


FIGURE A–2 GEOMETRICAL MODEL OF THE APOLLO ITMG



RIGHT BOOT

LEFT BOOT

FIGURE A–3 GEOMETRICAL MODEL FOR THE EXTRA-VEHICULAR BOOTS

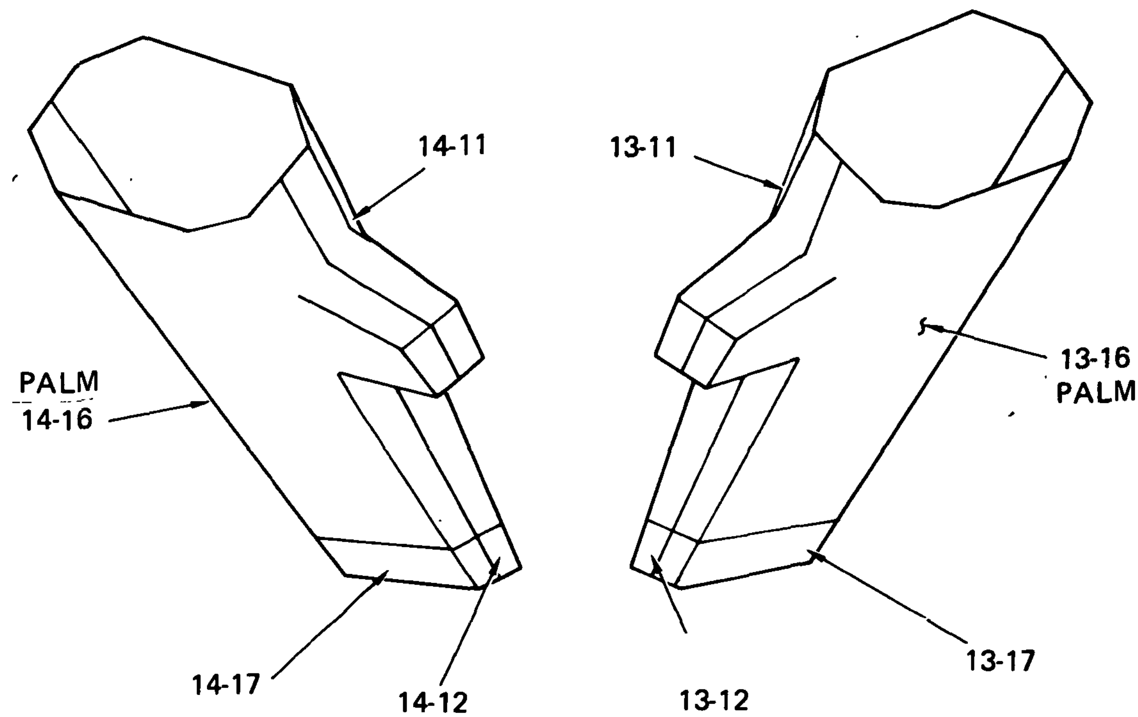


FIGURE A-4 GEOMETRICAL MODEL FOR GLOVES

NOTE

This figure shows the sections for the Lunar Extra-Vehicular Visor Assembly. Section 16 is the transparent visors and Section 15 is the insulated pressure helmet

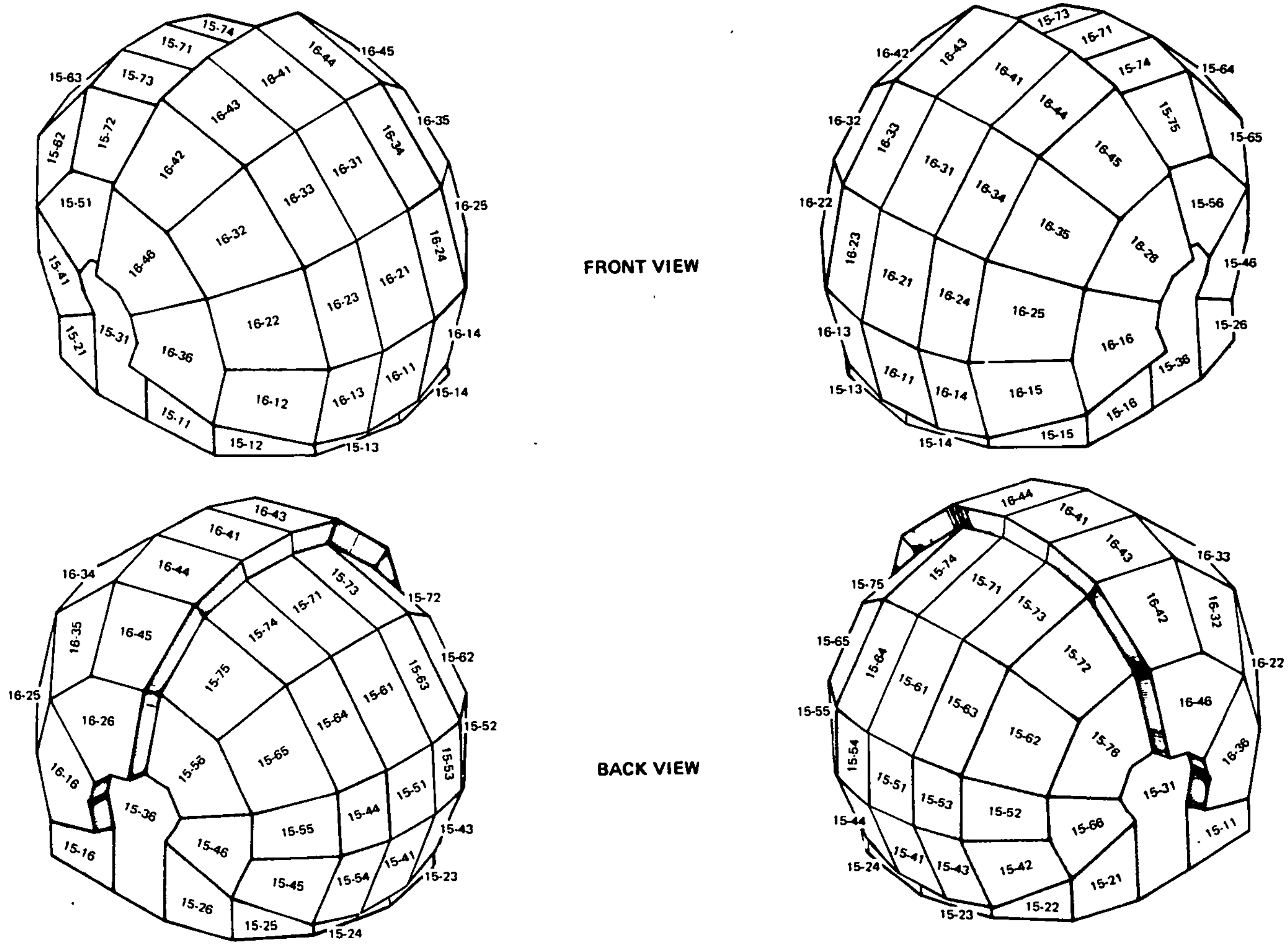


FIGURE A–5 GEOMETRICAL MODEL FOR THE LUNAR EXTRA-VEHICULAR VISOR ASSEMBLY

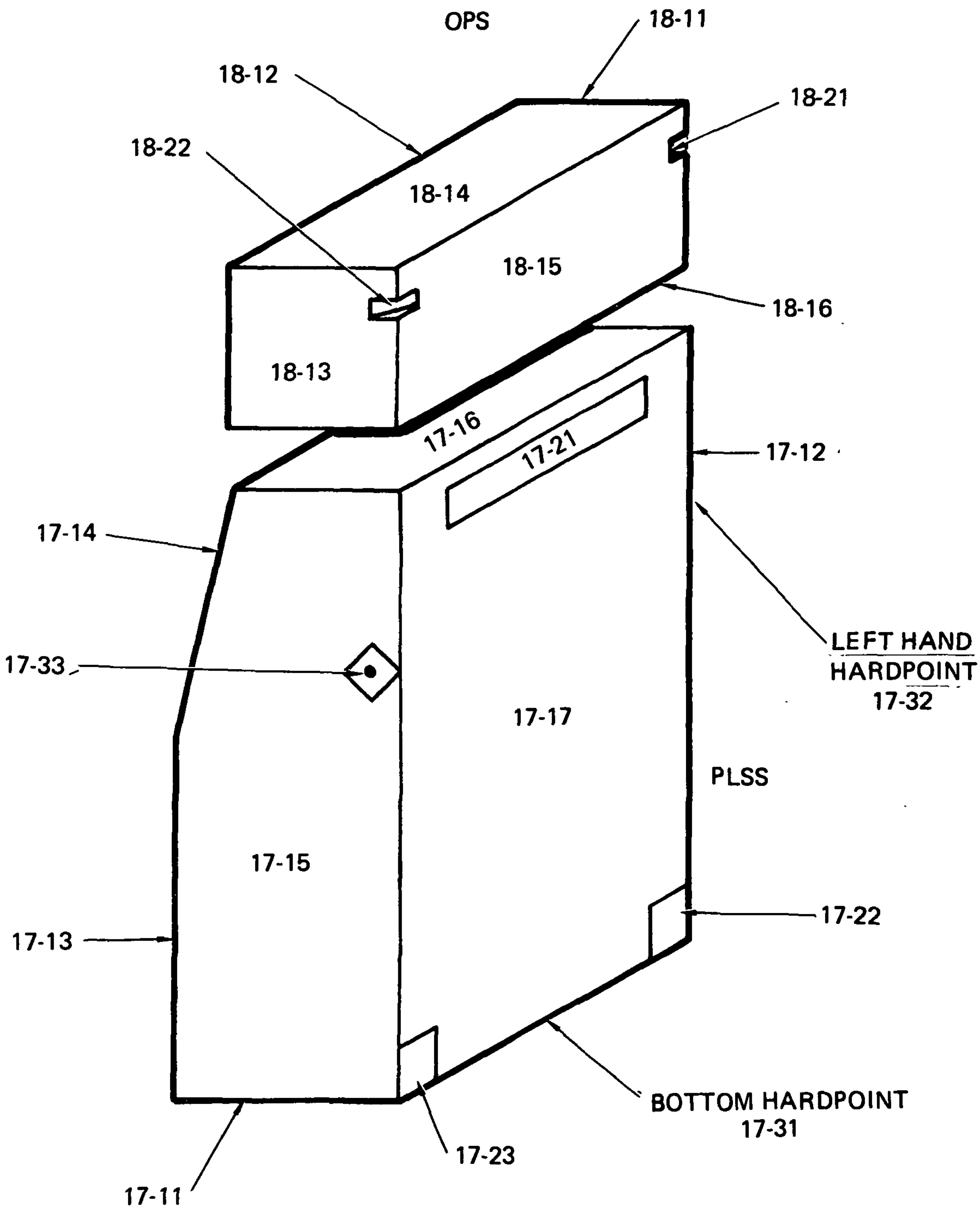


FIGURE A-6 GEOMETRICAL MODELS FOR THE OXYGEN PURGE SYSTEM AND PORTABLE LIFE SUPPORT SYSTEM

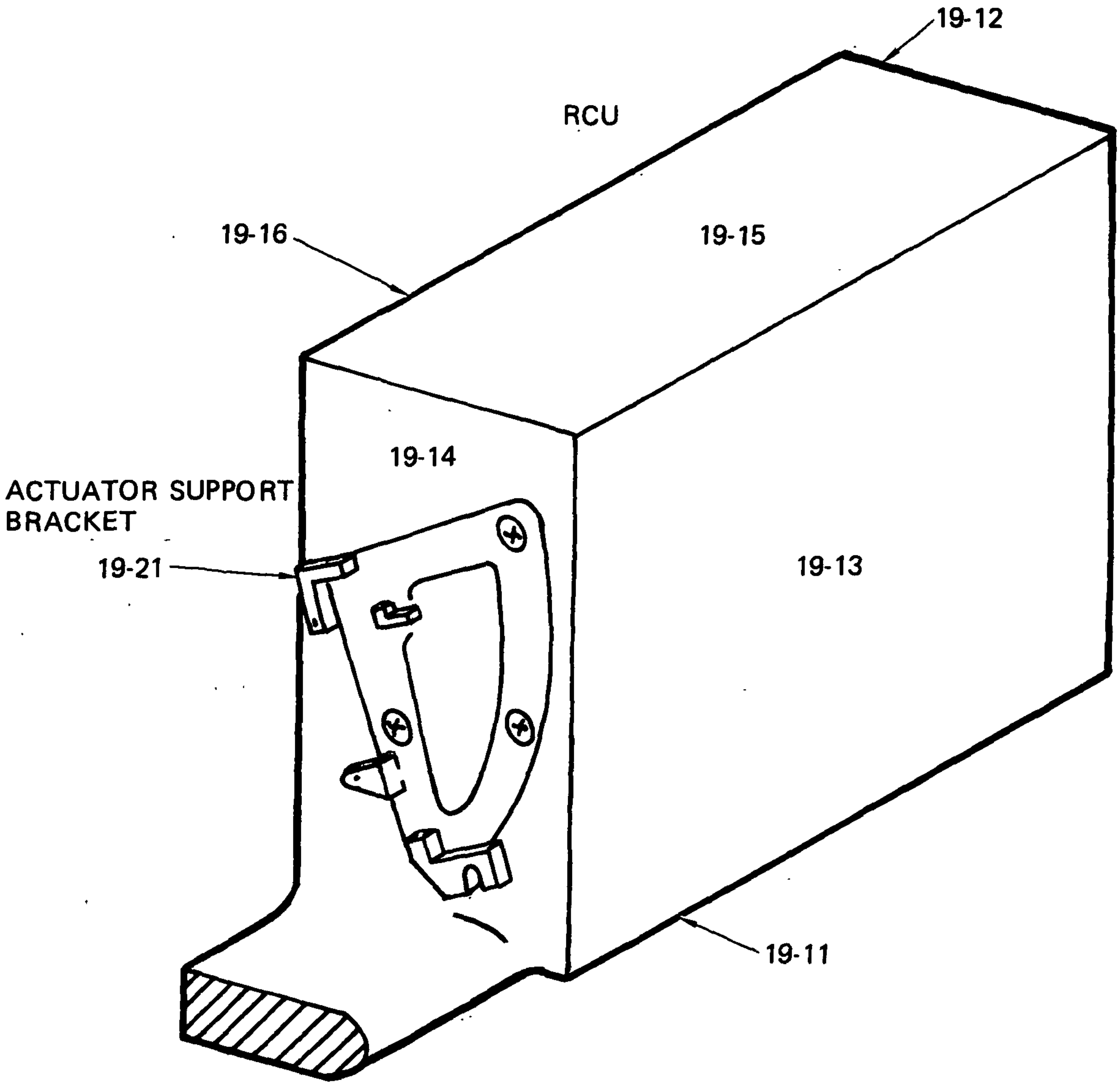


FIGURE A-7 GEOMETRICAL MODEL FOR REMOTE CONTROL UNIT

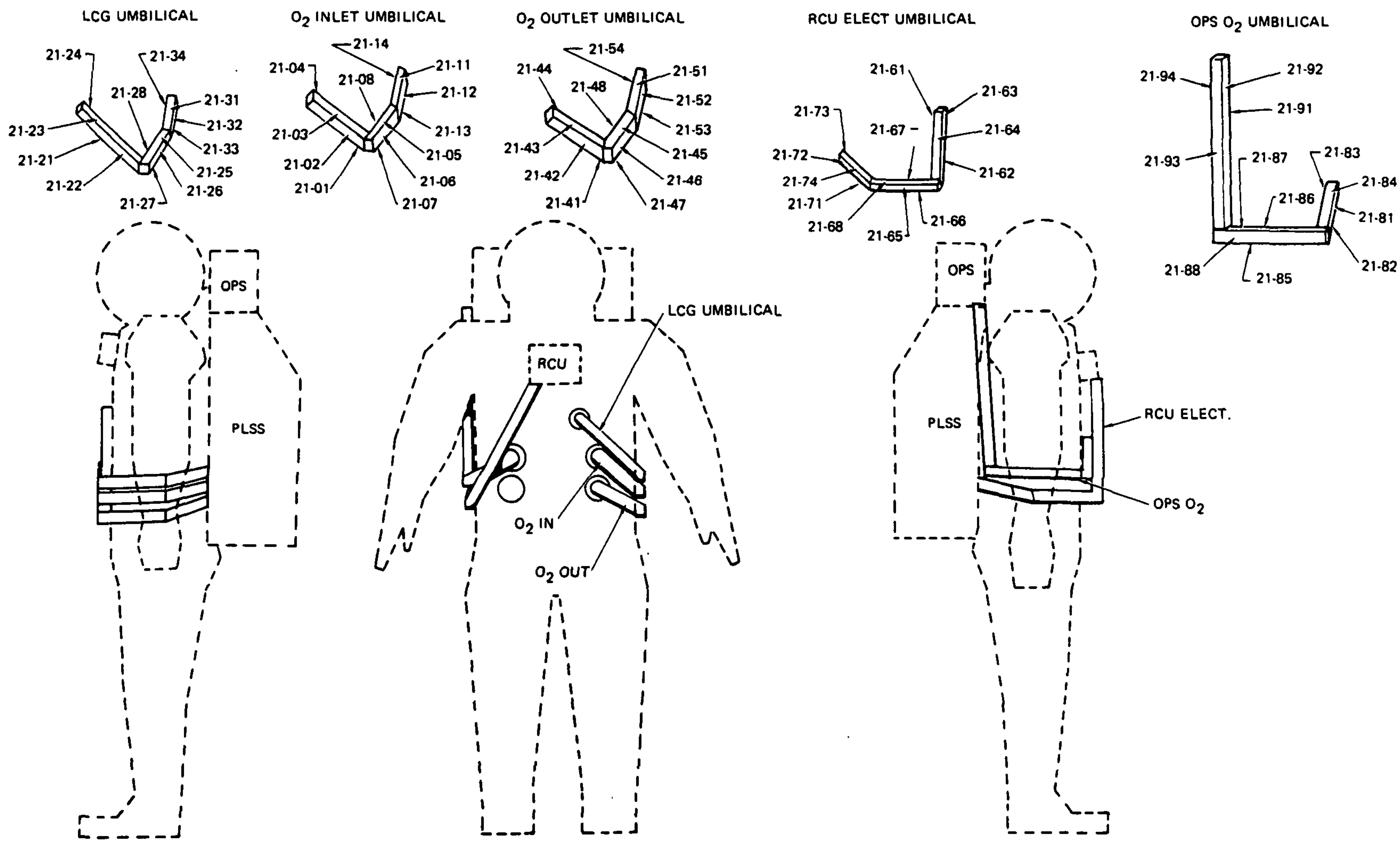
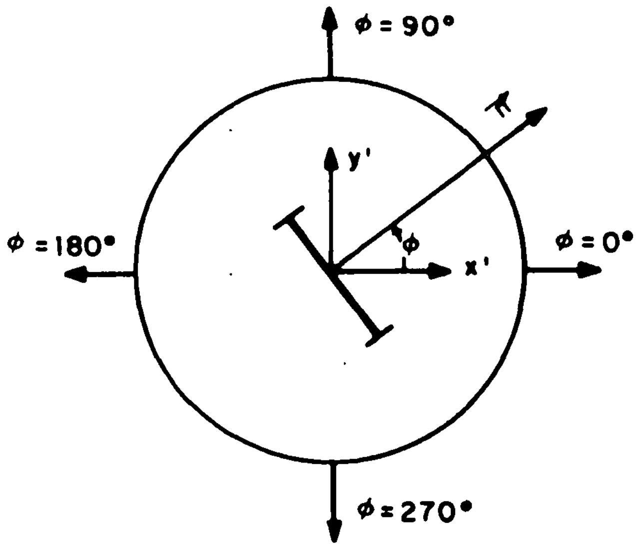
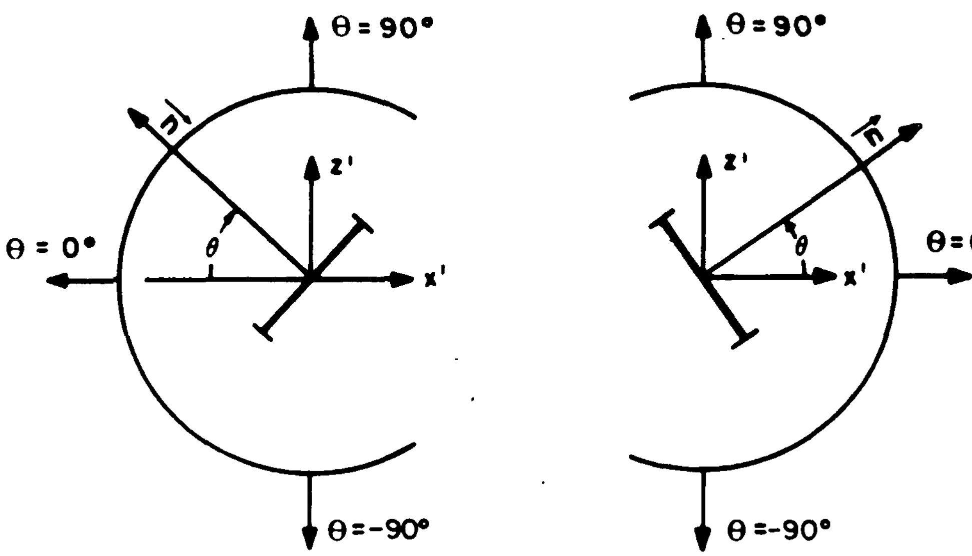


FIGURE A-8 GEOMETRICAL MODELS FOR UMBILICALS

ϕ = Azimuth angle of normal vector
θ = Zenith (elevation) angle of normal vector



TOP VIEW



ϕ = 180° ϕ = 0°

SIDE VIEW

FIGURE A-9 GEOMETRICAL CONVENTIONS

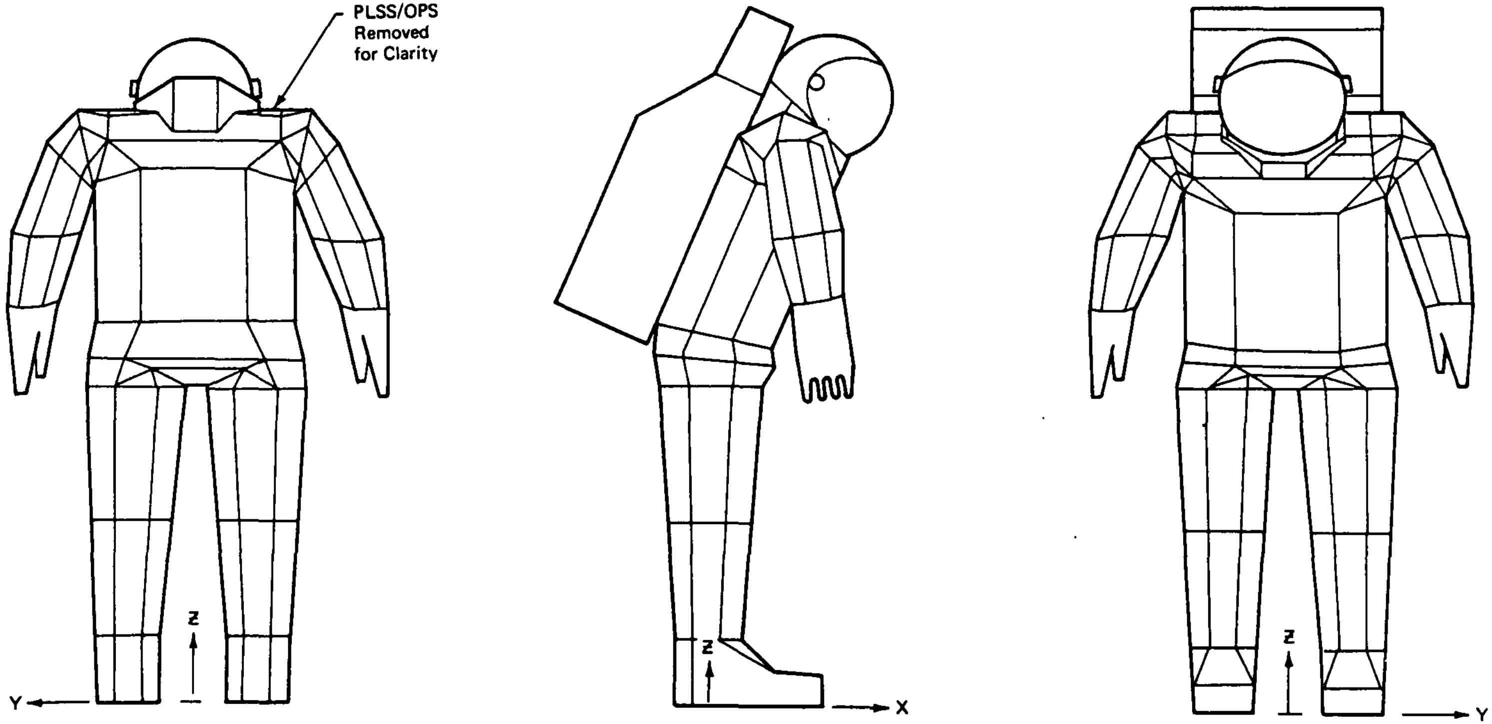


FIGURE A-10 EMU BENDING MODE (MODE 1)

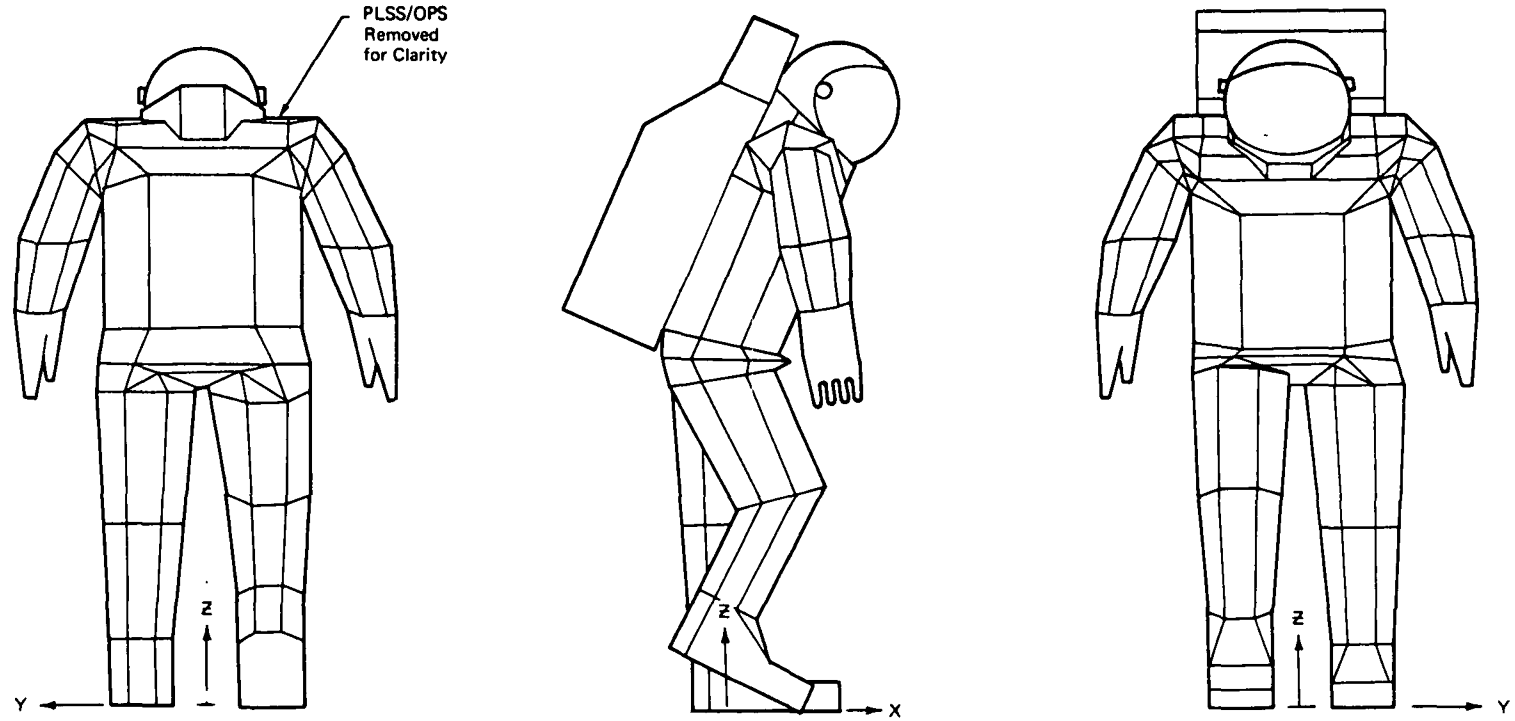


FIGURE A-11 EMU WALKING MODE (MODE 2)

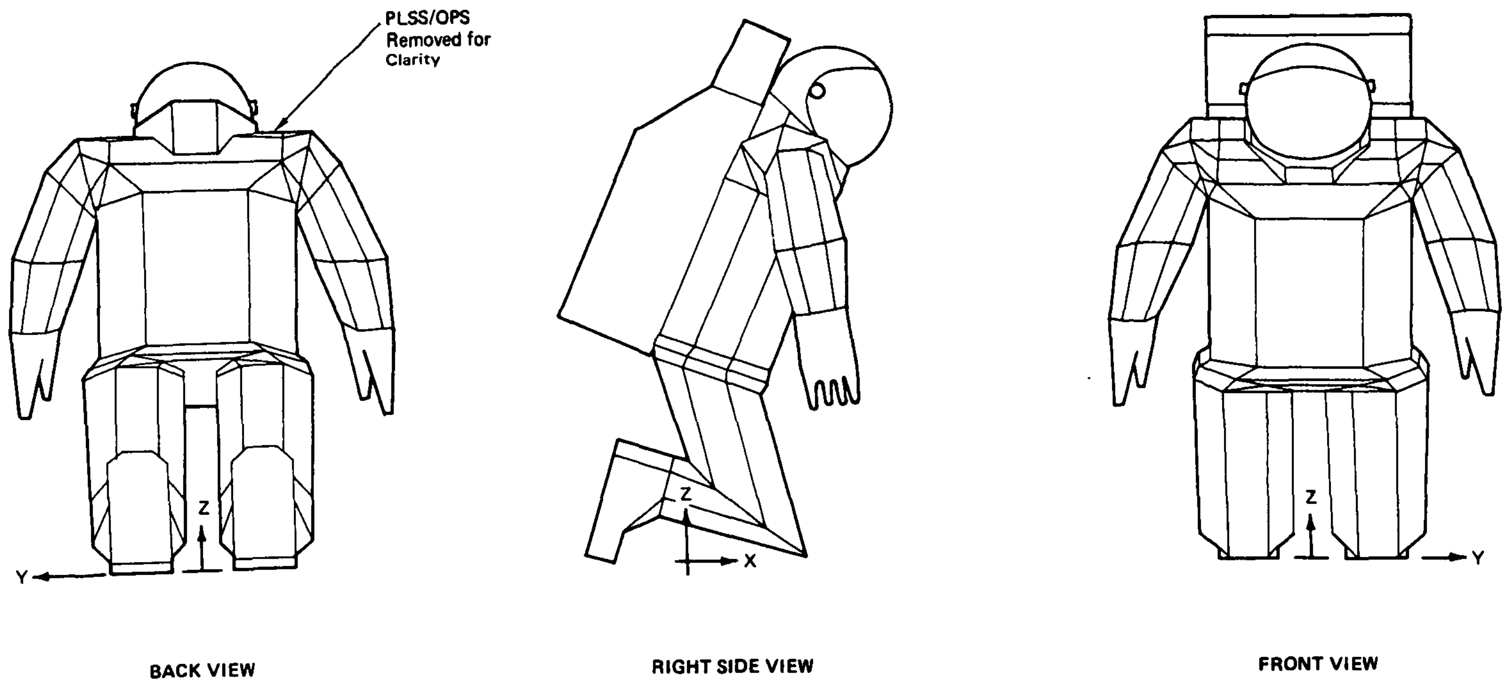


FIGURE A-12 EMU KNEELING MODE (MODE 3)

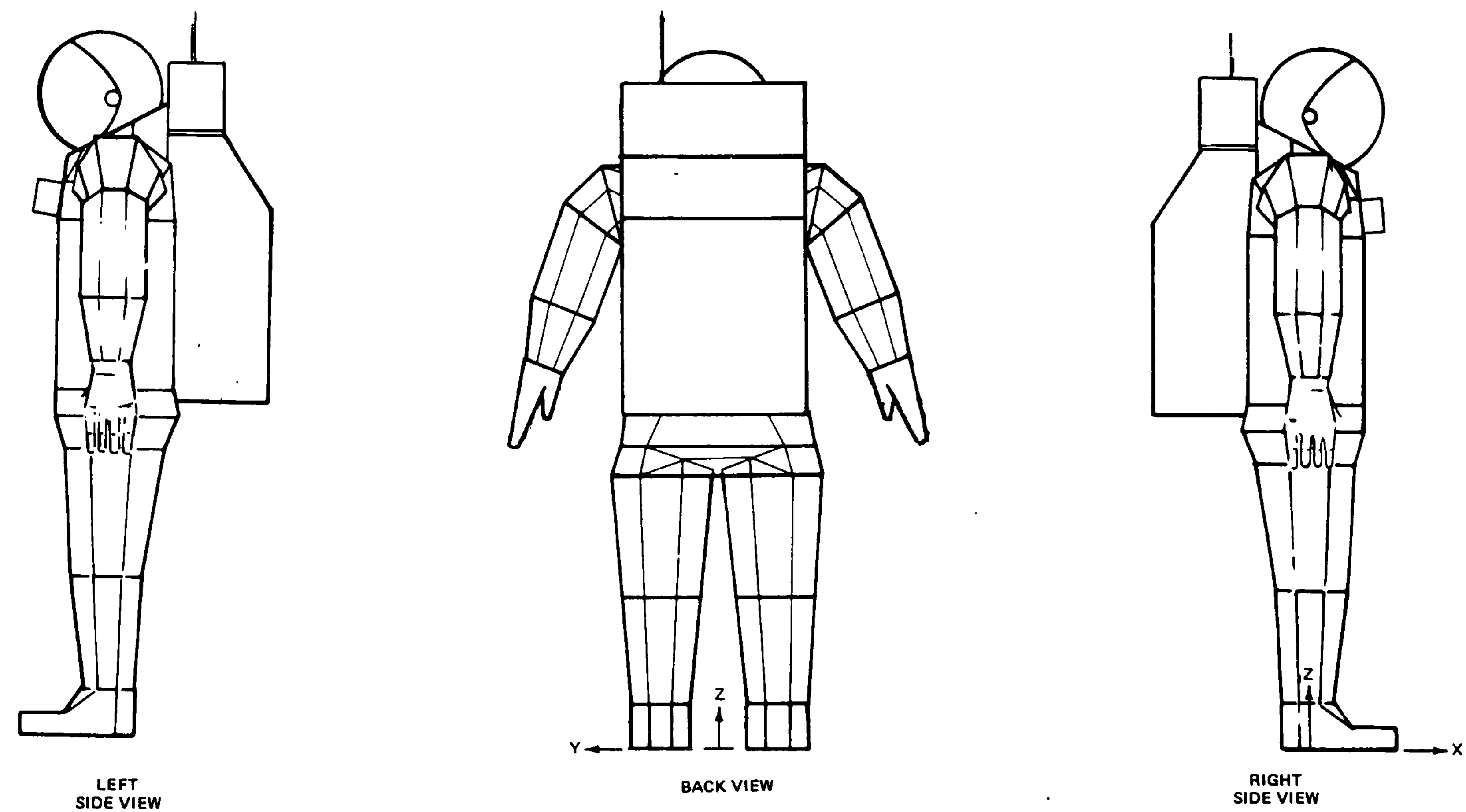


FIGURE A-13 EMU STANDING MODE (MODE 1)

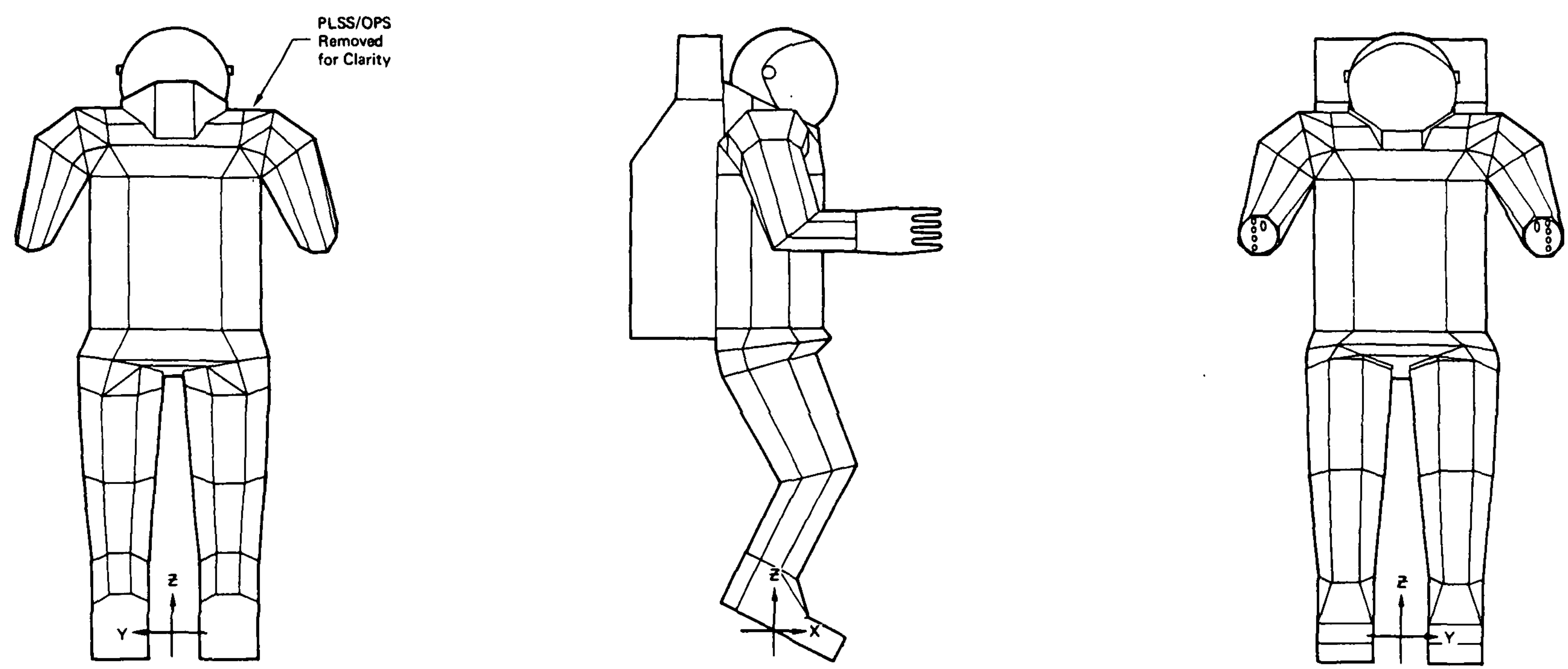


FIGURE A-14 EMU FLOATING MODE (MODE 2)

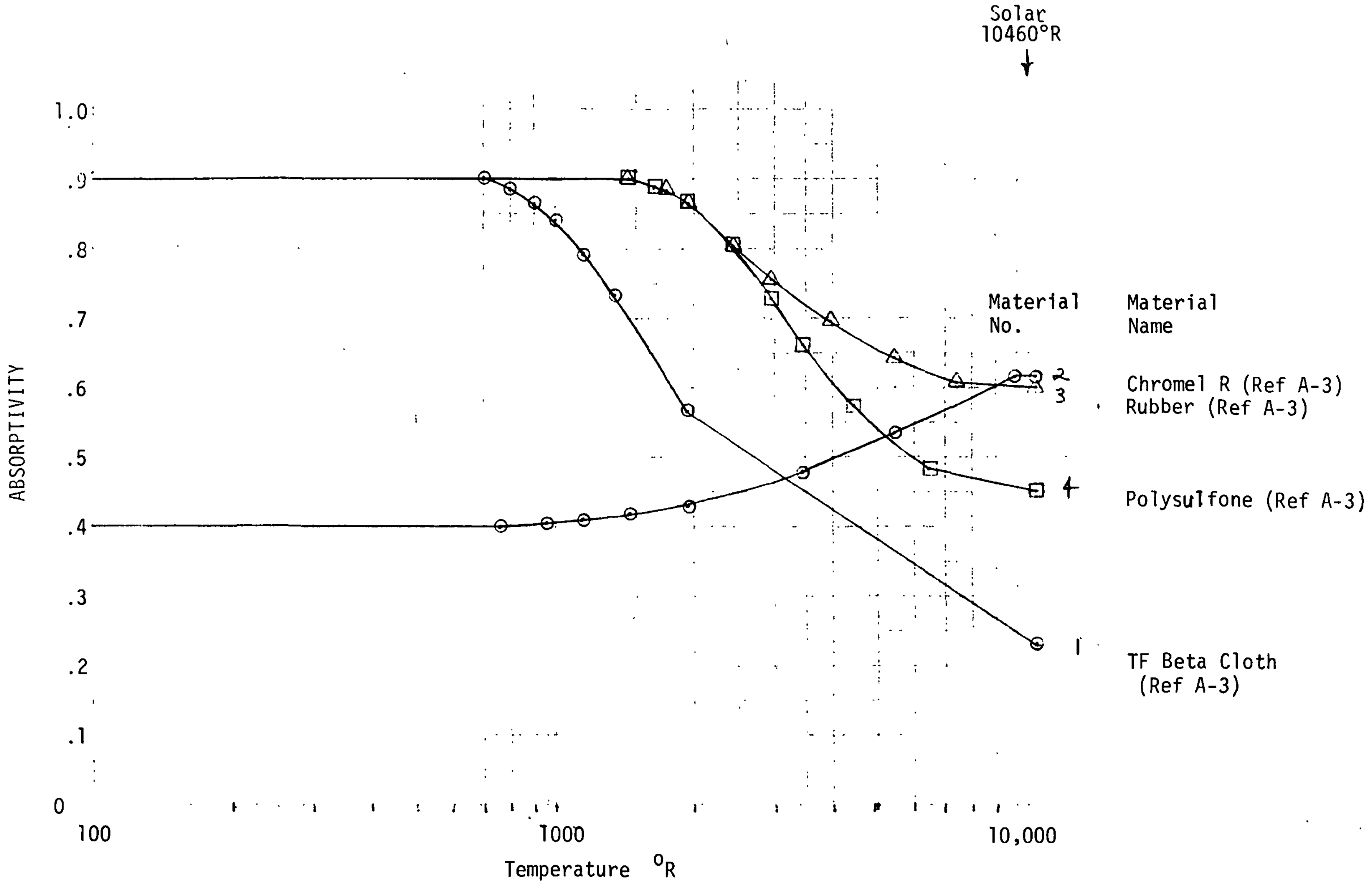


FIGURE A-15 - EMU MATERIAL PROPERTIES CURVES

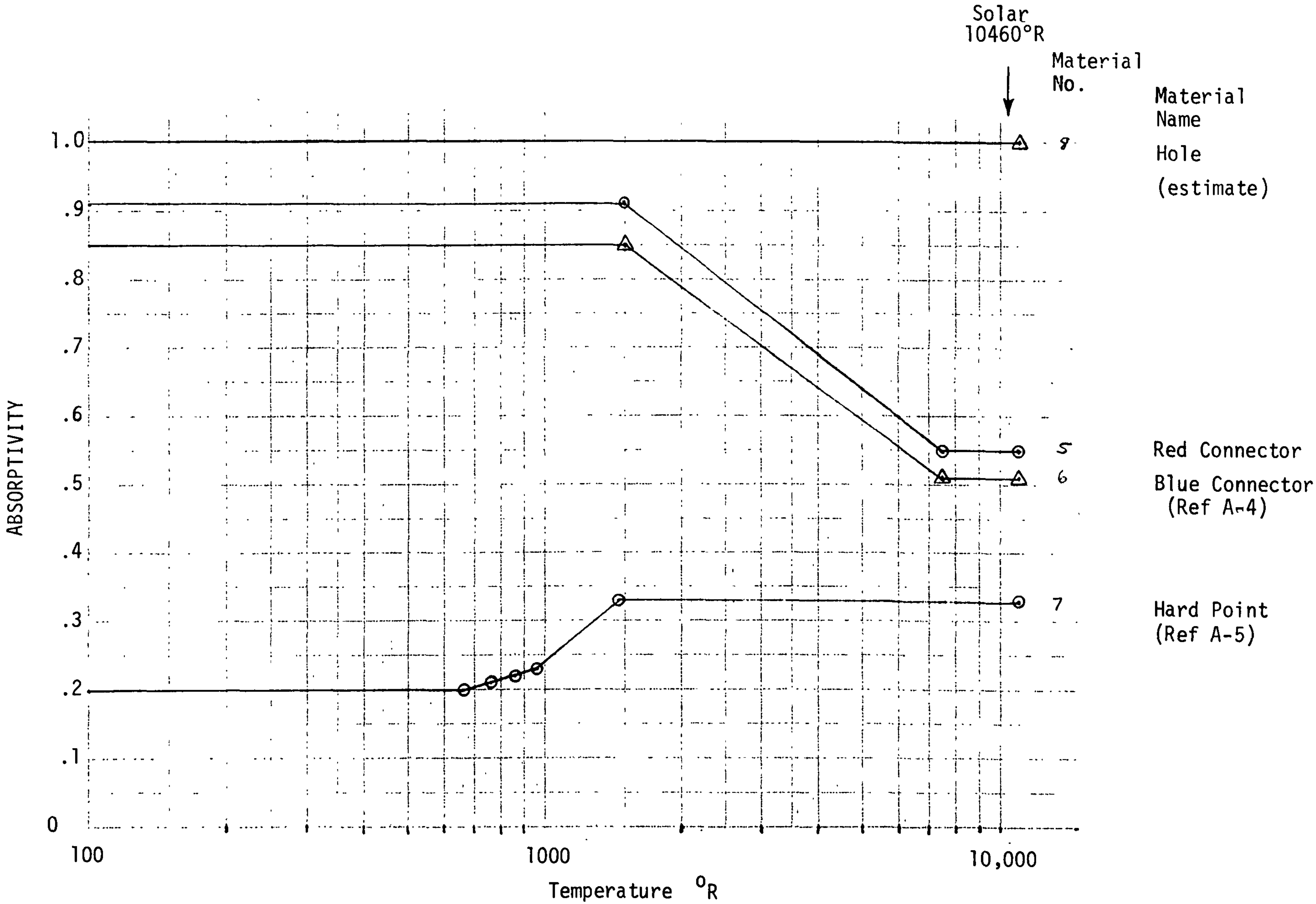


FIGURE A-15 (Continued) - EMU MATERIAL PROPERTIES CURVES

APPENDIX B

APOLLO EXTRAVEHICULAR MOBILITY UNIT/LUNAR ROVING VEHICLE REFERENCE COORDINATE SYSTEM

1.0 SUMMARY

The Apollo Extra-Vehicular Mobility Unit/Lunar Roving Vehicle (EMU/LRV) reference coordinate system employed in the Environmental Heat Flux Routine (EHFR) consists of a geometric nodal model which is arranged in three different nodal configurations (modes). These modes define the expected configurations that the EMU and LRV will experience during the astronaut extra-vehicular activities on the lunar surface and during thermal vacuum chamber operation. The EMU/LRV reference coordinate system (RCS) data employed by and stored within the EHFR are described in this appendix. These data consist of: geometric mode and node nomenclature definition; node coordinate data for each of the EMU/LRV modes; node self blockage data; node-material composition data; and curves of material absorptivity as a function of source temperature. The unique EMU/LRV timeline input requirements allowing the EMU to move independently from the LRV are also described.

2.0 EMU/LRV GEOMETRIC MODEL DEFINITION

The external configuration of the Apollo EMU/LRV is shown schematically in Figure B-1 with the two EMU's seated on the LRV. A detailed model of EMU #1 (seated on the left side of the LRV) is used in the EMU/LRV reference coordinate system since EMU/LRV interface analyses are of primary interest. The LRV and EMU #2 geometric models consist basically of those nodes which thermally affect the EMU #1.

For EMU #1 the detailed EMU 349 node geometric model and nodal nomenclature developed in Appendix A are employed in the EMU/LRV reference coordinate system model. The EMU #1 component geometric models are shown in Figures A-2 through A-8 of Appendix A. The EMU #1 nodal distribution for each component is presented in Table A-1.

The 59 node geometric model developed for the LRV and EMU #2 is shown in Figure B-2. Component models of the LRV and EMU #2 are presented in Figures B-3 through B-6. These figures are drawn in pictorial detail for clarity as the nodes are only in the faces of the indicated surfaces.

The EMU/LRV reference coordinate system node-component description and nomenclature are presented in Table B-1.

3.0 REFERENCE COORDINATE SYSTEM DATA

The basic nodal geometric model defined above was arranged into three different modes that describe the expected EMU/LRV lunar surface and thermal vacuum chamber activity positions. The modes, which define the driving and two parking configurations of the EMU/LRV, are described in Table B-2. The driving mode (mode 1), which has both EMU's seated on the

LRV, is shown schematically in Figure B-1. The LRV has the antenna and TV camera deployed, and dust covers down. The parking modes (modes 2 and 3) have both EMU's off of the LRV. For these modes, the EMU # 1 model is in the bending position (Figure B-8) and may move independently of the LRV-EMU #2. Figure B-9 shows the #1 parking configuration (mode 2) where the LRV is in the long term storage condition (i.e., between sorties) with the antenna and TV camera stowed, and the dust covers up. The #2 parking conditions (mode 3), shown in Figure B-10, simulates the short term sortie parking condition where the LRV remains in basically the driving configuration.

The nodal geometric data consist of node midpoint coordinates, the surface normal-vectors, and node surface areas. The coordinate system is right handed system with its origin at the ground and under the seat of the EMU/LRV in the driving mode (Figure B-2). For the parking modes, the LRV coordinate origin remains at the ground, under the seat with EMU # 1 coordinate origin being at the ground between the feet of the EMU (Figure B-8). The front of the EMU/LRV is oriented in the positive X direction as seen in the figures. The geometrical convention used for the surface normal vectors defines the vector azimuth angle being measured in the X-Y plane (counter clockwise from the positive X axis), and the elevation angle being measured from the X-Y plane (see Figure A-9 of Appendix A).

The self blockage data consist of the node unblocked view of the environment from each of the four "viewing quadrants", (details of the quadrant method of self blockage used by the EHFR are discussed in Section 3.3). For the driving mode, the EMU #2 and LRV produce significant self blockage effects on the EMU #1 and vice versa. For the parking modes (modes 2 and 3), the EMU #1 is assumed to be thermally disconnected from the LRV and EMU #2. This permits simulation of independent movement of the EMU #1 with respect to the LRV-EMU #2 for conditions where there are only small thermal effects between them. Thus, there is no self-blockage between the EMU # 1 and the LRV-EMU #2 nodes for modes 2 and 3.

The nodal thermal property data consists of the node-material composition and curves of material absorptivity as a function of temperature. Node-material composition data describe the material covering each node. For the EMU, the materials consist of teflon coated beta cloth, Chromel R, Boot and glove rubber, polysulfone, blue and red connectors, hard point (anodized aluminum), and holes. The absorptivity - temperature curve data presented in Figure A-15 of Appendix A is stored in the EHFR and used for these EMU/LRV materials. For the LRV, the materials consist of fiberglass, wire mesh (wheels), black anodized aluminum, clear anodized aluminum, white paint, white webbing, green webbing, and mylar backed beta cloth. The absorptivity curve data, stored in the EHFR for these materials, are presented in Figure B-11.

A detailed listing of the nodal geometric data, self blockage data, and node thermal property data that comprise the EMU/LRV reference coordinate system may be obtained from the EHFR by inputing the proper print indices on Card A-2 (Section 5.4 of the report) during EHFR execution.

4.0 EMU/LRV COORDINATE SYSTEM TIMELINE INPUT

The EMU/LRV reference coordinate system timeline input to the EHFR (Card B-2) differs slightly from other RCS models since the EMU #1 can have independent movement with respect to the remainder of the EMU/LRV nodes for the parking modes.

For the driving mode (mode 1), the EMU/LRV timeline input (Card B-2) specifies the position/orientation of the entire EMU/LRV model. For the parking modes, the timeline input on Card B2 specifies the EMU #1 position/orientation data with the EHFR assuming that the LRV-EMU #2 position/orientation data are identical to the last driving mode timeline point input into the EHFR. This allows the EMU #1 to move independently with respect to the remainder of the EMU/LRV model. The first timeline point input into the EHFR for the EMU/LRV must specify the driving mode in order to obtain LRV-EMU #2 position/orientation data to be used for later parking mode calculations. In the event that the user specifies a parking mode for the first timeline point, the EHFR assumes the LRV-EMU #2 to have the following X, Y, Z position and azimuth: 0, 0, 0, 0.

5.0 REFERENCES

B-1 Personal Communication Between D. A. DeLaughter of VMSC and P. H. McKinney of General Electric Apollo Systems Department, 27 July 1970.

TABLE B-1 LRV/EMU GEOMETRIC MODEL DESCRIPTION

NODE NUMBER	NODE NAME	DESCRIPTION
1 to 349	-	EMU #1 (See Appendix A)
350	LR-01	Wheel right front, facing LRV
351	LR-02	Wheel right rear, facing LRV
352	LR-03	Wheel left rear, facing LRV
353	LR-04	Wheel left front, facing LRV
354	LR-05	Fender right front, facing LRV
355	LR-06	Fender right rear, facing LRV
356	LR-07	Fender left rear, facing LRV
357	LR-08	Fender left front, facing LRV
358	LR-09	Display console, forward top
359	LR-10	Display console, back
360	LR-11	Display console, left side
361	LR-12	Display console, right side
362	LR-13	Control box, top
363	LR-14	Control box, left side
364	LR-15	Control box, right side
365	LR-16	Control box, back
366	LR-17	Forward equip. Section, left side
367	LR-18	Forward equip. section, back
368	LR-19	Forward equip. section, right side
369	LR-20	Forward equip. section, top
370	LR-21	Display console handhold
271	LR-22	Left Seat handhold
372	LR-23	Foot rest
373	LR-24	TV camera, top
374	LR-25	TV camera, left side
375	LR-26	TV camera, back
376	LR-27	T-handle
377	LR-28	Arm rest
378	LR-29	LCRU, right side
379	LR-30	LCRU, left side
380	LR-31	LCRU, top
381	LR-32	Panel center chassis, top
382	LR-33	Panel rear chassis, top
383	LR-34	Tool box, front, man #1
384	LR-35	Tool box, top, man #1
385	LR-36	EMU #2, PLSS-OPS, left side
386	LR-37	EMU #2, PLSS back
387	LR-38	EMU #2, visor
388	LR-39	EMU #2, leva
389	LR-40	EMU #2, shoulder
390	LR-41	EMU #2, chest
391	LR-42	EMU #2, arm and side
392	LR-43	EMU #2, lap

TABLE B-1 LRV/EMU GEOMETRIC MODEL DESCRIPTION (Continued)

NODE NUMBER	NODE NAME	DESCRIPTION
393	LR-44	EMU #2, leg
394	LR-45	EMU #2, shin
395	LR-46	EMU #2, calf
396	LR-47	EMU #2, toes
397	LR-48	Payload, top
398	LR-49	Payload, front
399	LR-50	Payload, left side
400	LR-51	Antenna
401	LR-52	Seat belt, side
402	LR-53	Seat belt, top
403	LR-54	B-SLSS, rear surface
404	LR-55	EMU seat top, surface
405	LR-56	EMU seat back, rear surface
406	LR-57	EMU seat back, front surface
407	LR-58	EMU seat, bottom surface
408	LR-59	EMU #2 seat back, rear surface

TABLE B-2 EMU/LRV MODE CONFIGURATION DESCRIPTION

MODE NUMBER	MODE NAME	EMU #1 POSITION	EMU #2 POSITION	LRV CONFIGURATION			
				ANTENNA	TV CAMERA	DUST COVERS	BSLSS
1	Driving (Figure B-1)	Seated on LRV (Figure B-1 and B-7)	Seated (Figure B-1 and B-6)	Deployed (Figure B-2)	Deployed (Figure B-3)	Down	In Place (Figure B-4)
2	#1 Parking (Figure B-9)	Off of LRV, Bending (Figure B-8)	Off of LRV	Stowed (Figure B-9)	Stowed (Figure B-9)	Up	Removed (Figure B-9)
3	#2 Parking (Figure B-10)	Off of LRV, Bending (Figure B-8)	Off of LRV	Deployed (Figure B-2)	Deployed (Figure B-3)	Down	In Place (Figure B-4)

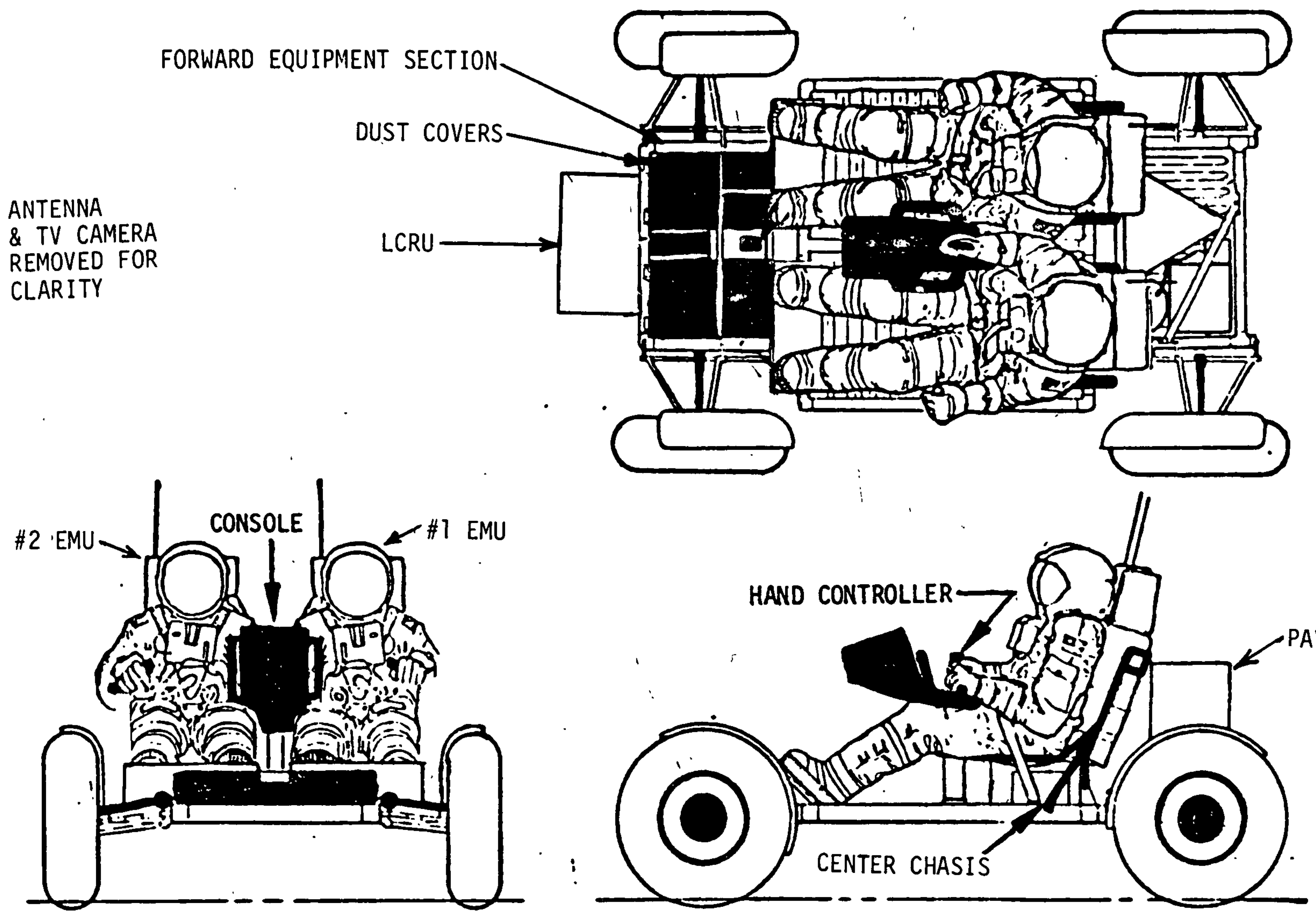


FIGURE B-1 EMU/LRV SCHEMATIC

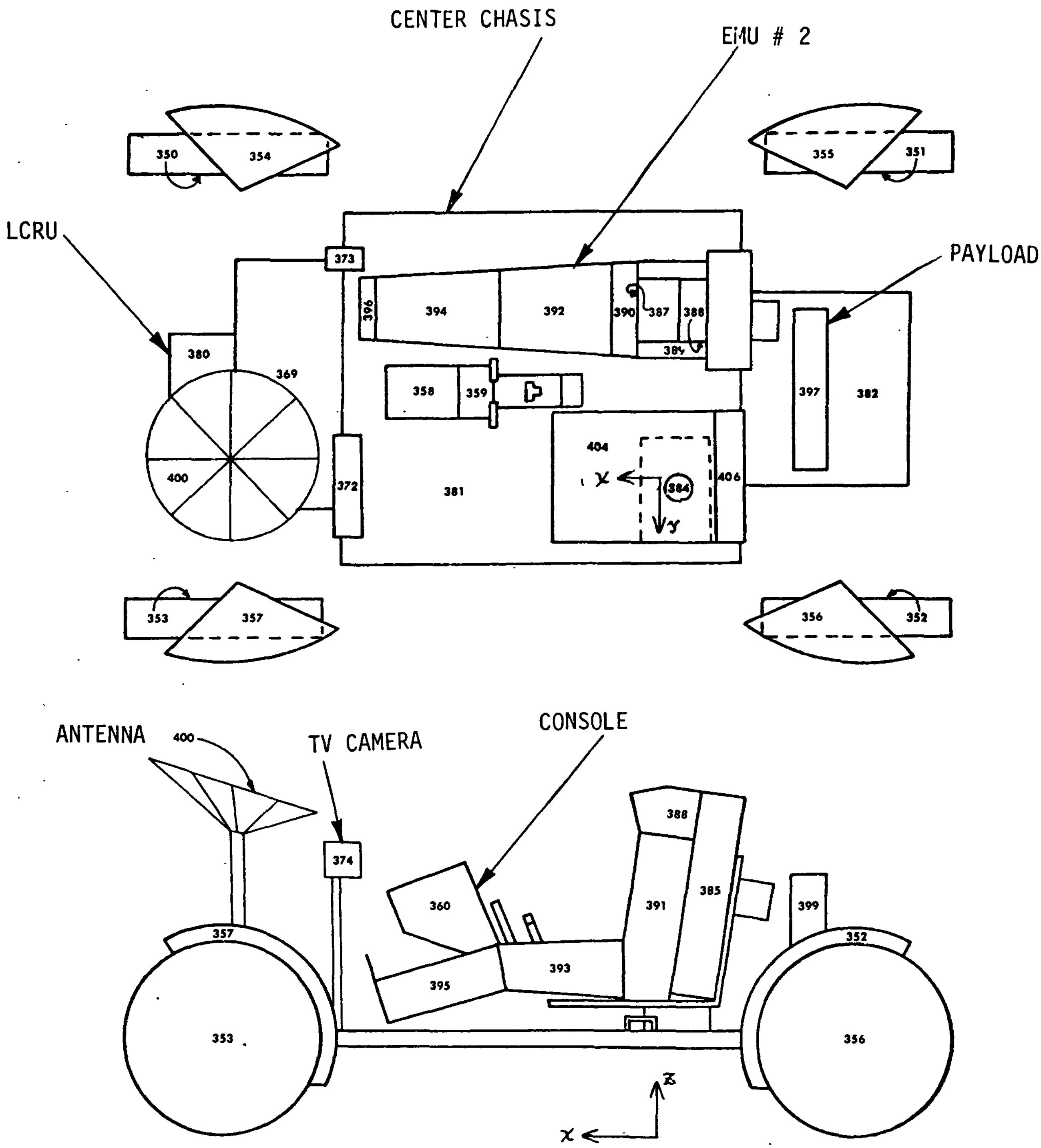


FIGURE B-2 LUNAR ROVING VEHICLE GEOMETRIC NODAL NETWORK (MODE 1)

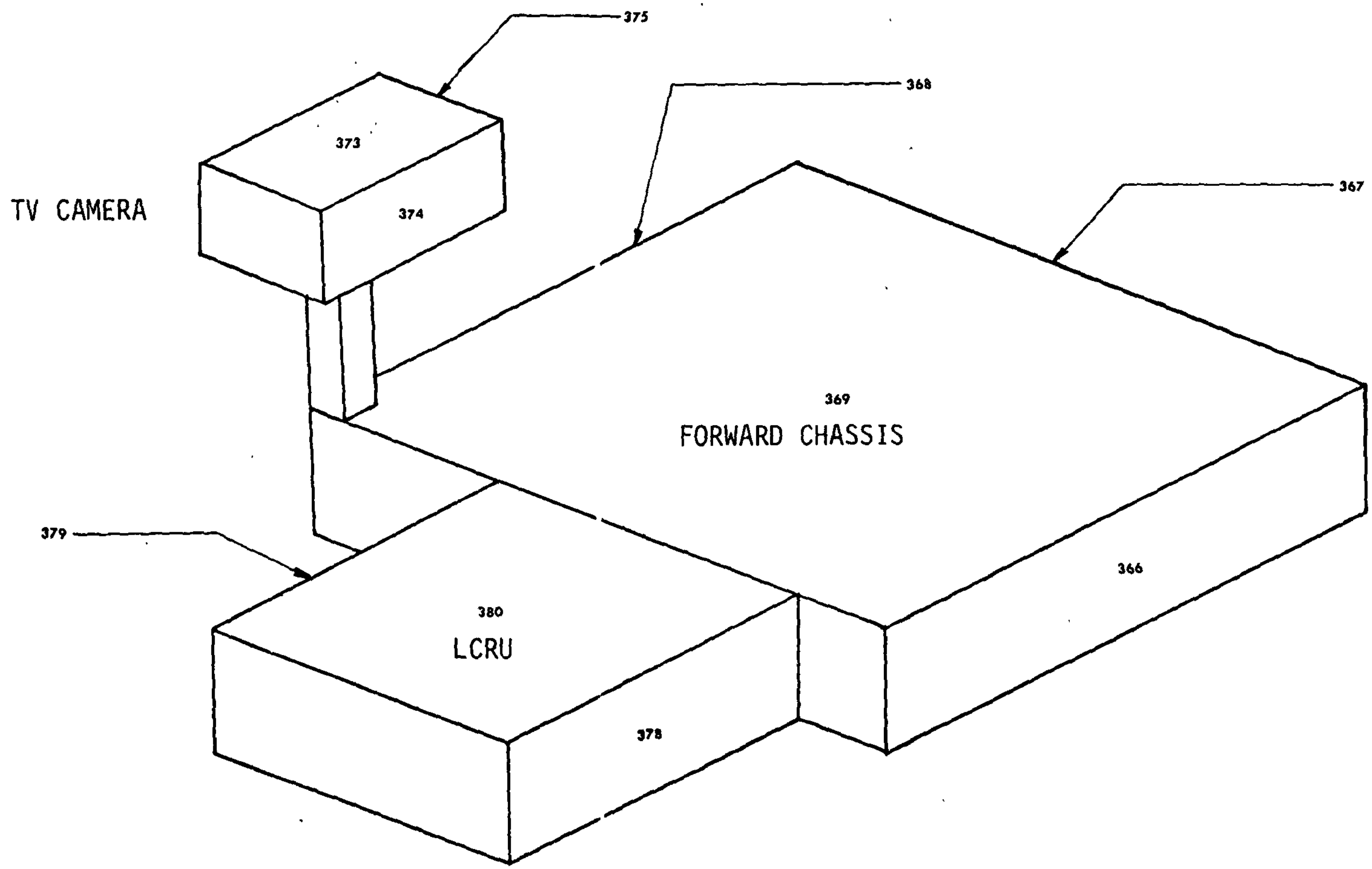


FIGURE B-3 - LRV FORWARD EQUIPMENT SECTION GEOMETRIC NODAL NETWORK

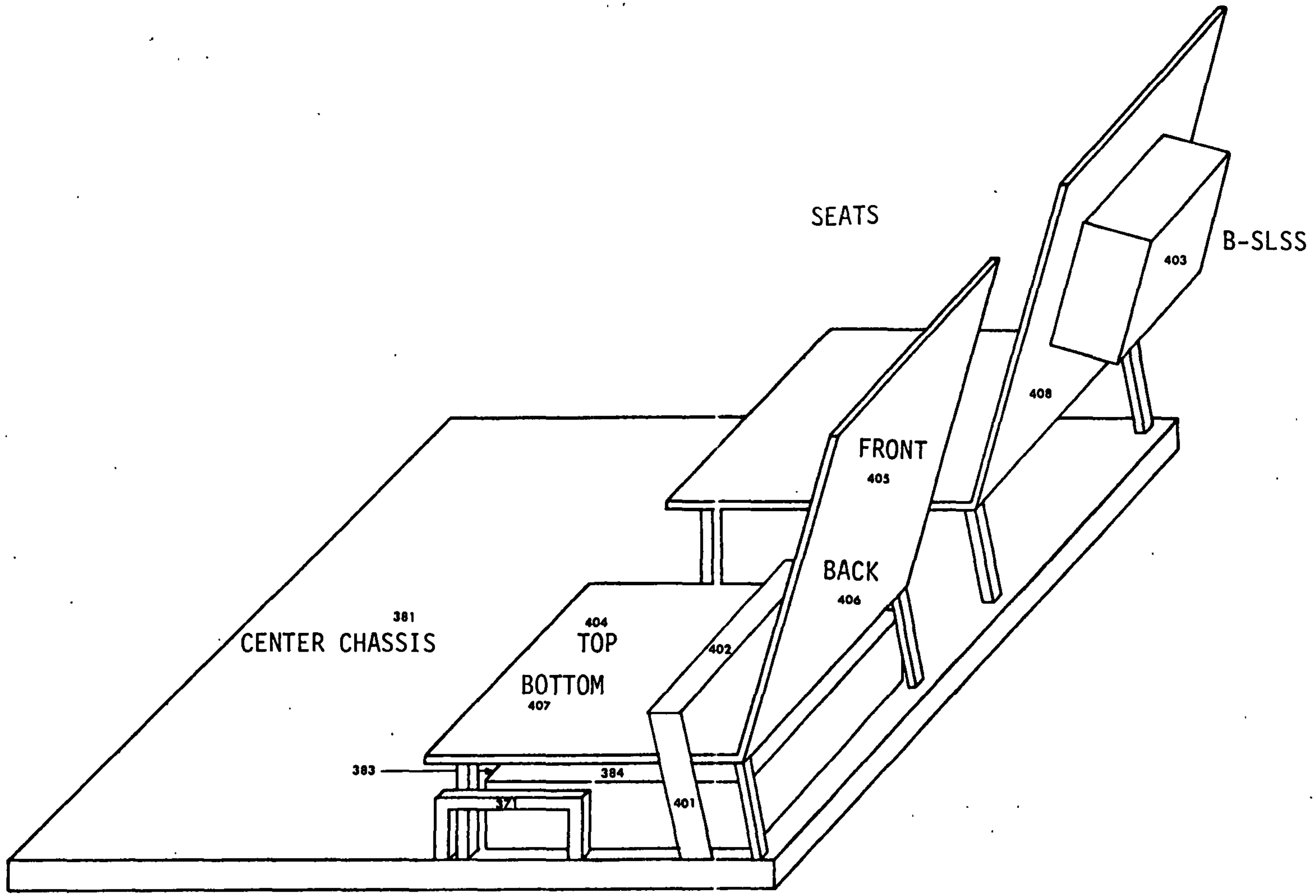


FIGURE B-4 - LRV CENTER CHASSIS GEOMETRIC NODAL NETWORK

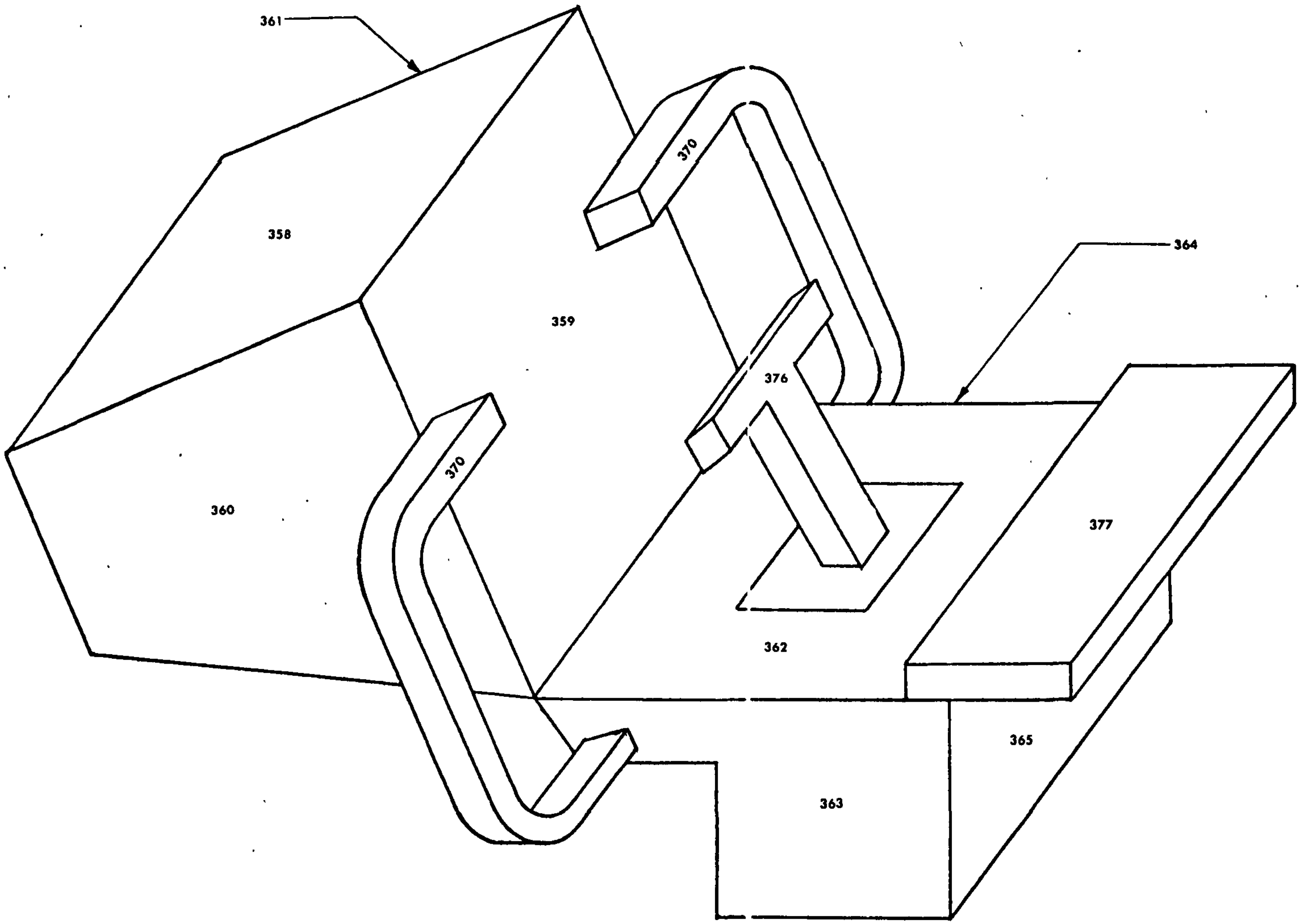


FIGURE B-5 - LRV CONSOLE AND CONTROL BOX GEOMETRIC NODAL NETWORK

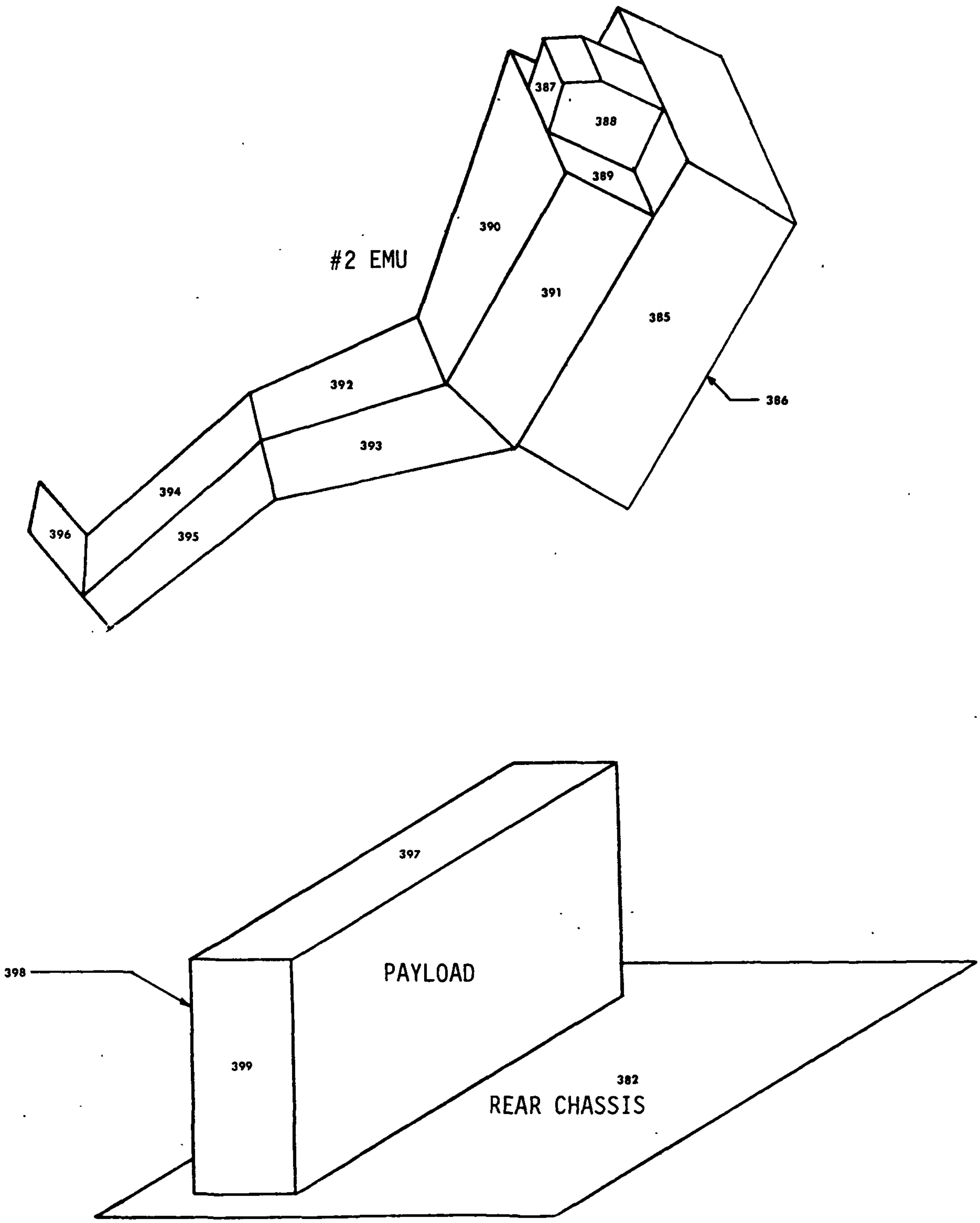


FIGURE B-6 - LRV REAR CHASSIS AND #2 EMU GEOMETRIC NODAL NETWORK

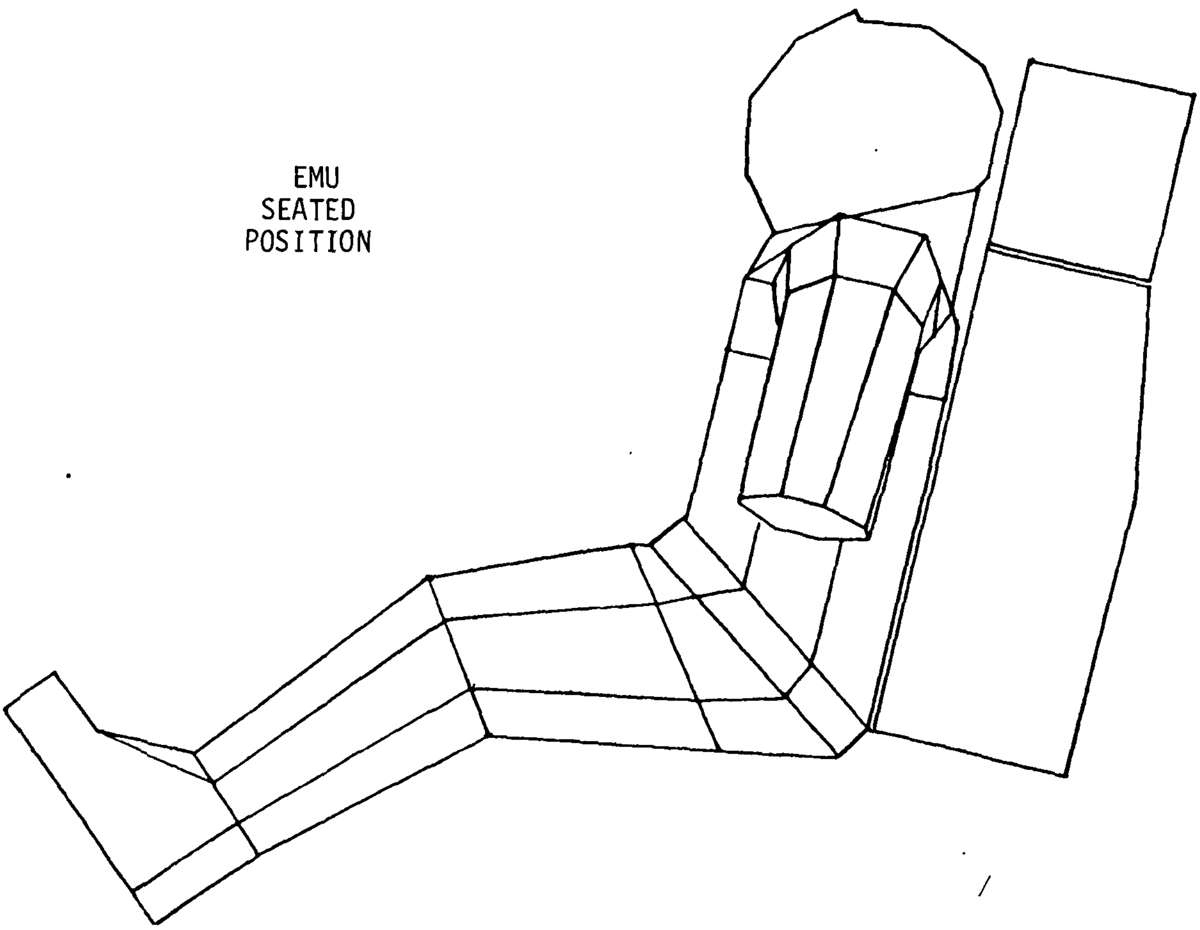


FIGURE B-7 EMU #1, DRIVING MODE CONFIGURATION (MODE 1)

EMU BENDING POSITION

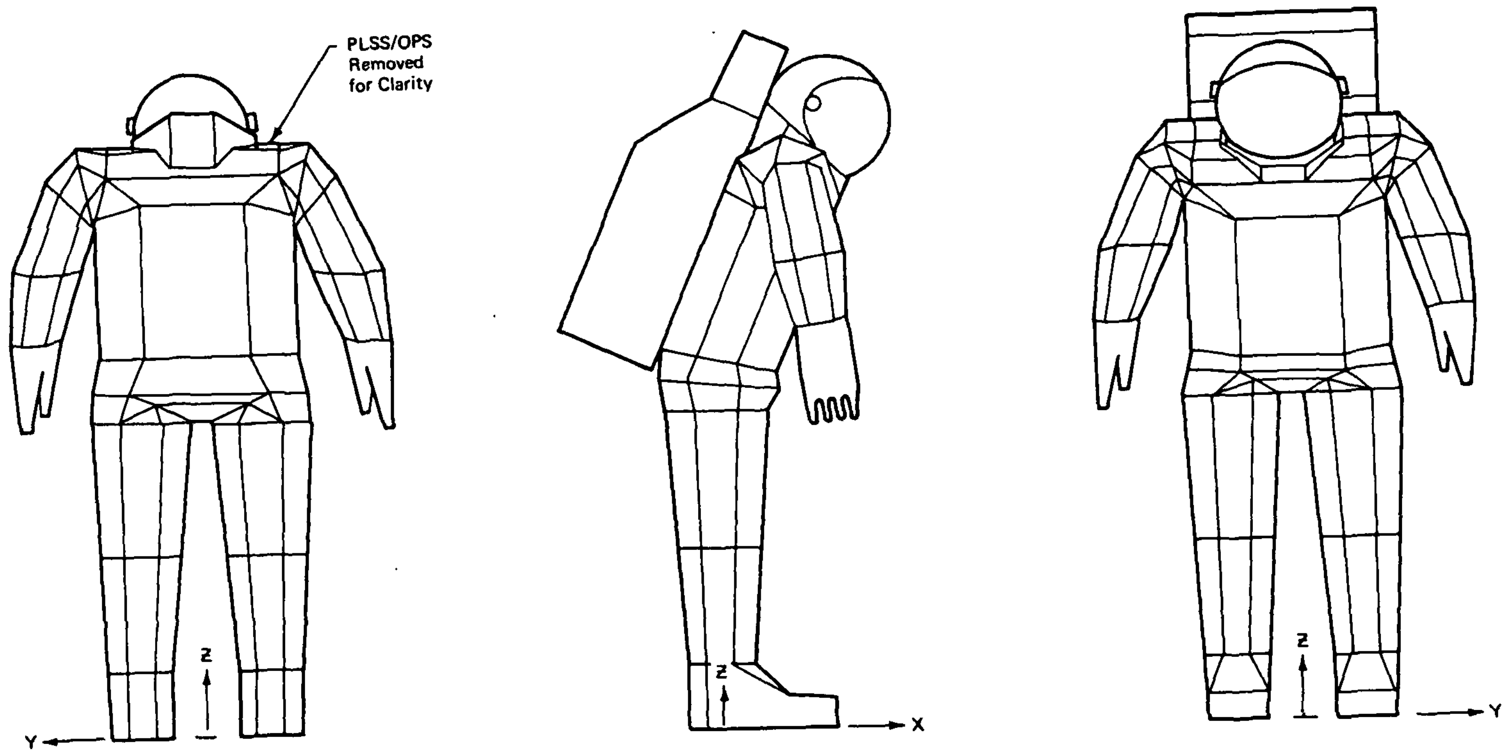


FIGURE B-8 EMU #1, PARKING MODE CONFIGURATION (MODE 2 AND 3)

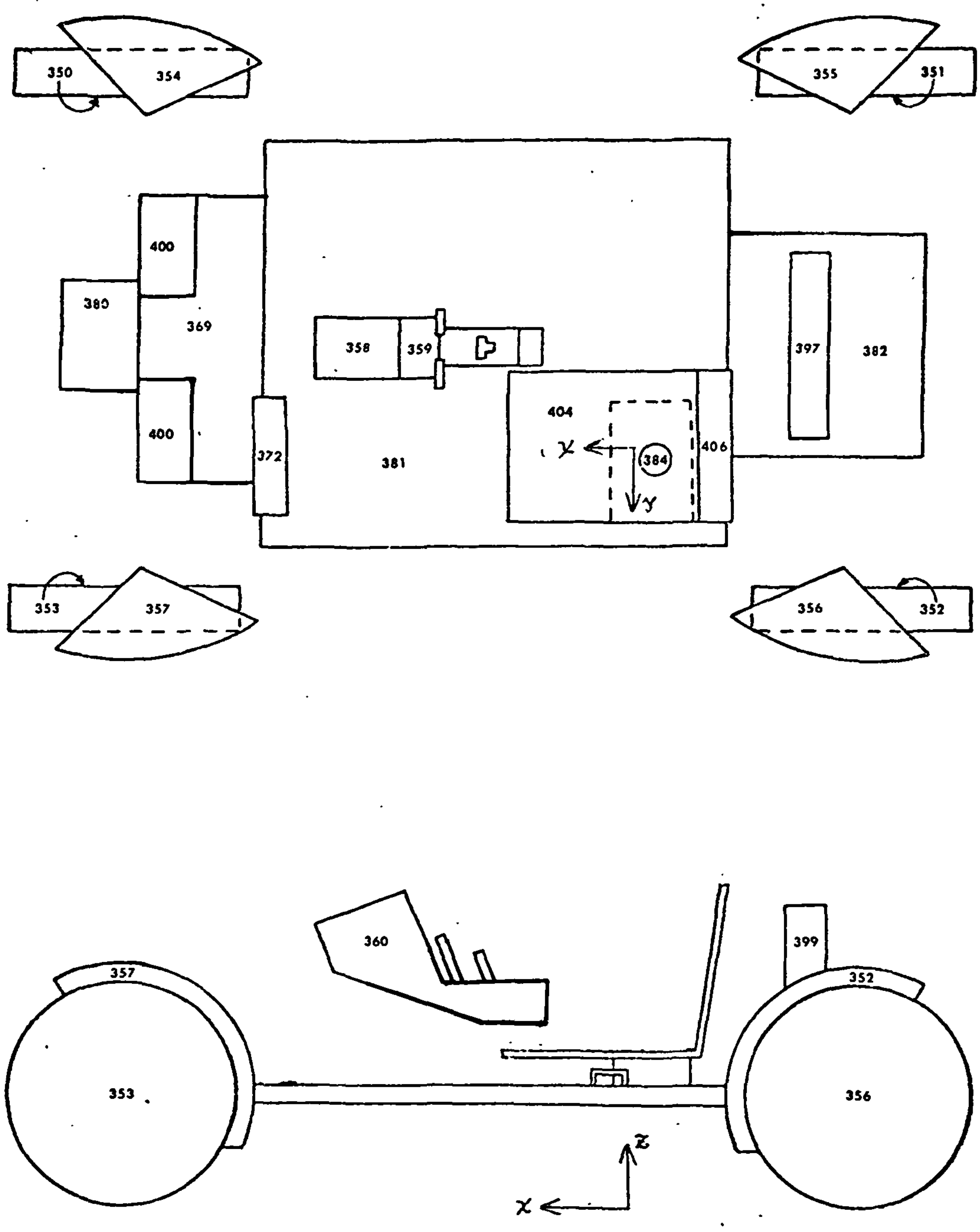


FIGURE B-9 LUNAR ROVING VEHICLE, MODE 2

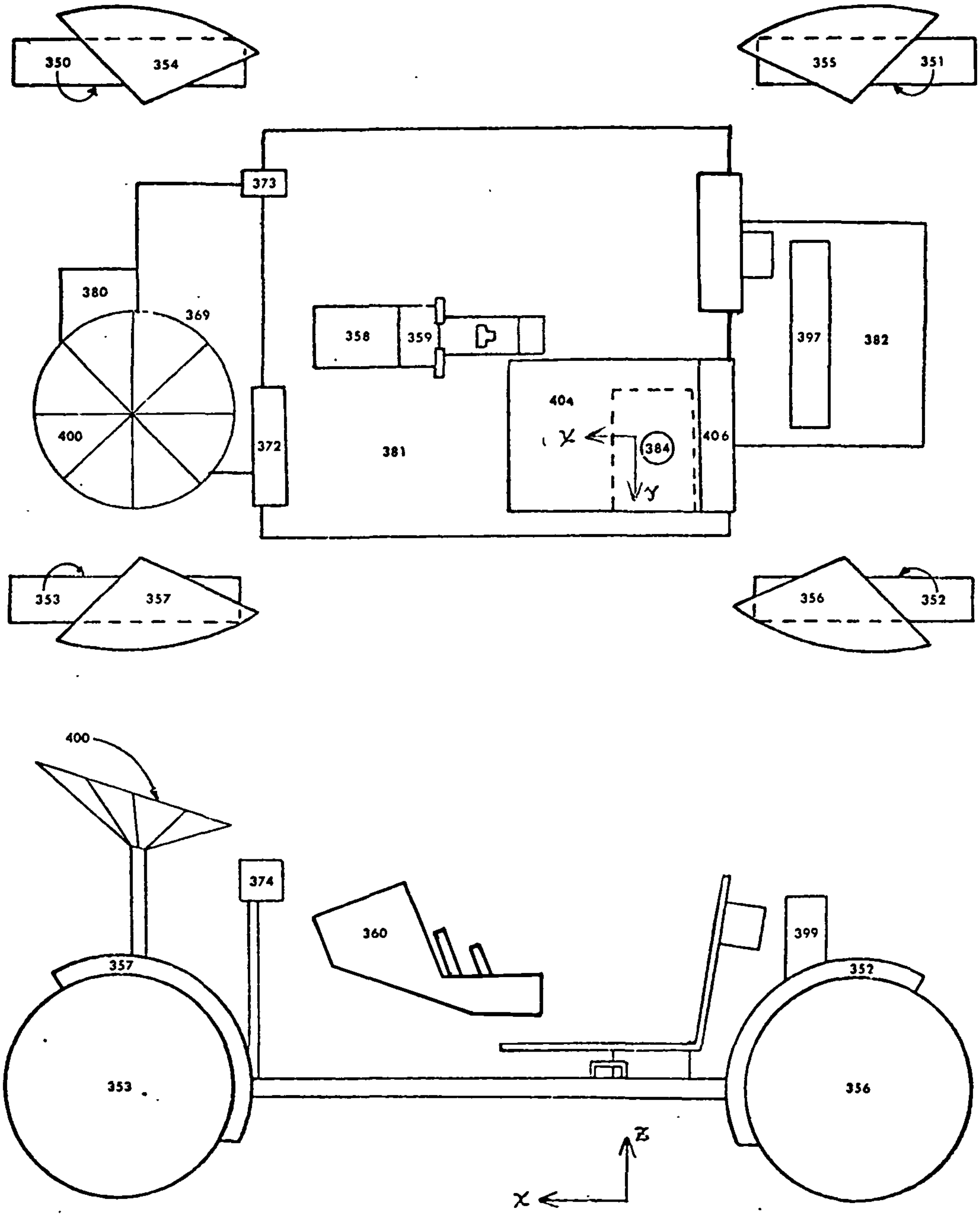


FIGURE B-10 LUNAR ROVING VEHICLE, MODE 3

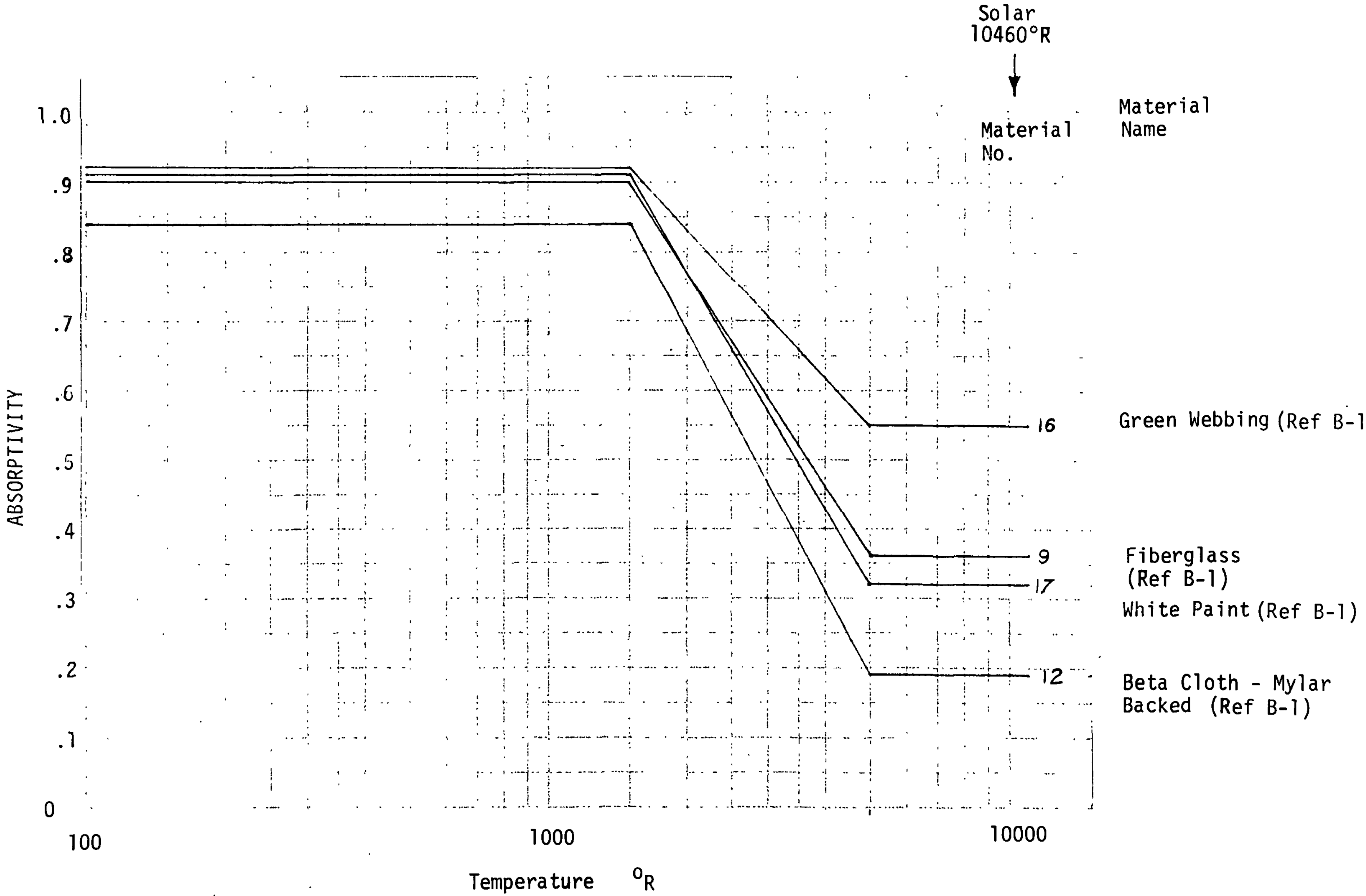


FIGURE B-11 - LRV MATERIAL PROPERTIES CURVES

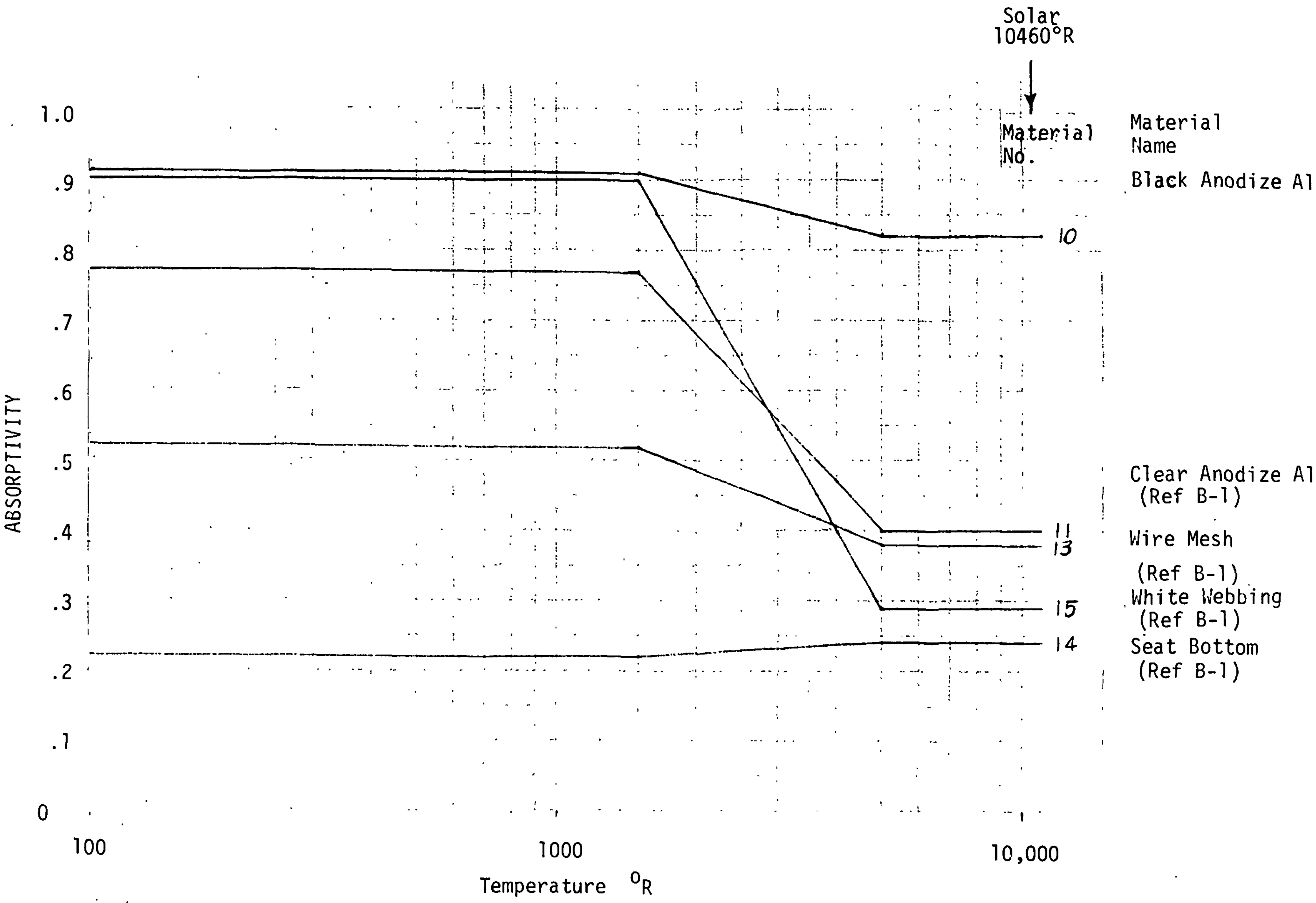


FIGURE B-11(Continued) - LRV MATERIAL PROPERTIES CURVES

APPENDIX C

APOLLO EXTRAVEHICULAR MOBILITY UNIT/ SCIENTIFIC INSTRUMENTS MODULE BAY REFERENCE COORDINATE SYSTEM

1.0 SUMMARY

The Apollo Extra-Vehicular Mobility Unit/ Scientific Instruments Module Bay (EMU/SIM) reference coordinate system employed in the Environmental Heat Flux Routine (EHFR) consists of a geometric nodal model which is arranged in two different nodal configurations (herein called modes). The modes define the expected positions that the EMU will experience during the Apollo J mission extra-vehicular activity in the vicinity of the Command Module and SIM Bay. The EMU/SIM Bay reference coordinate system data employed by and stored within the EHFR are described in this appendix. These data consist of geometric mode and node nomenclature definition; nodal coordinate data for the two EMU/SIM modes; nodal self blockage data; node-material composition data; and curves of material absorptivity as a function of source temperature.

2.0 EMU/SIM GEOMETRIC MODEL DEFINITION

The external configuration of the Apollo EMU, Command and Service Module (CSM), and SIM Bay are schematically shown in Figures C-1 and C-2. A detailed model of the EMU was selected for the EMU/SIM reference coordinate system since EMU-CSM-SIM interface analyses are of primary interest. The CSM and SIM Bay geometric model consists, therefore, of basically those nodes which have a thermal effect on the EMU.

The detailed 349 node EMU model and nodal nomenclature developed in Appendix A has been used with some modification for employment in the EMU/SIM reference coordinate system. The EMU component geometric models are shown in Figures A-2 through A-8 of Appendix A. The EMU J mission RCS configuration required the following changes to the EMU model of Appendix A: the PLSS (Figure A-6) is deleted; the RCU (Figure A-7) is deleted; and the LCG, O_2 inlet, O_2 outlet, and RCU umbilicals (Figure A-8) are deleted. The EMU configuration used is shown schematically in Figure C-3.

The 57 node geometric model developed for the CSM and SIM Bay is shown in Figure C-4. The EMU/SIM reference coordinate system node-component description and nomenclature are presented in Table C-1.

3.0 REFERENCE COORDINATE SYSTEM DATA

The basic nodal geometric model defined above was arranged into two different modes that describe the EMU EV activity body positions expected during trans-earth flight: the egressing and retrieving modes. The egressing mode (mode 1) shown in Figure C-1 depicts the EMU/SIM configuration during astronaut familiarization, T.V. camera deployment, cassette transfer and rest periods. Figure C-2 shows the EMU/SIM in the retrieving mode

(mode 2) during which the astronaut retrieves the two film cassettes from the SIM Bay.

The nodal geometric data consist of the node midpoint coordinates, the surface normal-vectors, and node surface areas. The coordinate system is right handed system with its origin between the feet of the EMU. The front of the EMU is oriented in the positive X direction as seen in Figure C-3. Figure A-9 of Appendix A shows the geometrical convention used to define the surface normal vectors: the azimuth angle being measured in the X-Y plane (counter clockwise from the positive X axis), and the elevation angle being measured from the X-Y plane.

The self blockage data consist of the node unblocked view of the environment from each of the four "viewing quadrants". Details of the quadrant method of self blockage used by the EHFR are discussed in Section 3.

The nodal thermal property data consists of the node-material composition and curves of material absorptivity as a function of temperature. Node-material composition data describe the material covering each node. For the EMU the materials are: teflon coated beta cloth, Chromel R, Boot and glove rubber, polysulfone, blue and red connectors, hard point (anodized aluminum), and holes. The EMU material absorptivity curves presented in Figure A-15 of Appendix A are stored in the EHFR for use in the EMU/SIM reference coordinate system. The nine absorptivity temperature curves used for the SIM Bay and Command Module materials/coatings are presented in Figure C-5.

A detailed listing of the nodal geometric data, self blockage data, and node thermal property data that comprise the EMU/SIM reference coordinate system may be obtained from the EHFR by inputing the proper print indices on Card A-2 (Section 5.4 of the report) during EHFR execution.

4.0 EMU/SIM TIMELINE INPUT

Analyses of the EMU/SIM environments during Apollo J mission trans-earth flight using the EHFR requires that solar angle data (Card J1) and RCS azimuth angle (Card B2) be input data. Currently NASA-MSC specifies the "solar look angles" which are measured with respect to CSM coordinates for use in J mission analyses. These "solar look angles" are defined in Figure C-6. The correspondence between the NASA-MSC solar look angles and the EHFR solar and azimuth angles for the two EMU/SIM modes are tabulated in Table C-2 for the range of values expected during the J mission flight.

5.0 REFERENCES

C-1 Data collected by P. B. Scheps, VMSC Houston Technical Representative.

TABLE C-1 EMU/SIM GEOMETRIC MODEL DESCRIPTION

EHFR NODE NUMBER	NODE DESCRIPTION
EMU:	
1 to 349	EMU (See Appendix A)
Command Module:	
350	Command Module Skin
351	Command Module Skin
352	Command Module Skin
353	Command Module Skin
354	Command Module Skin
406	Command Module Skin
EPS Radiators:	
355	Skin between EPS radiators
356	Skin between EPS radiators
357	Skin between EPS radiators
358	EPS radiator panel
359	EPS radiator panel
360	EPS radiator panel
361	EPS radiator panel
Service Module:	
362	Skin above ECS radiator
363	Skin above ECS radiator
364	Skin above SIM bay
365	Skin above ECS radiator
366	Skin above ECS radiator
367	ECS radiator panel
368	ECS radiator panel
369	ECS radiator panel
370	ECS radiator panel
371	Skin below ECS radiator
372	Skin below ECS radiator
373	Skin below SIM bay
374	Skin below ECS radiator
375	Skin below ECS radiator
SIM Bay:	
376	Compartment 1
377	Compartment 1
378	Floor of Compartment 2
379	Wall of Compartment 2
380	Upper Bulkhead - Compartment 2
381	Slanted Rear Bulkhead - Compartment 2
382	Wall of Compartment 2
383	Vertical Rear Bulkhead - Compartment 2
384	Compartment 3

TABLE C-1 (Continued)

NODE NUMBER	NODE DESCRIPTION
Hatch Detail:	
385	Open Hatch Door
386	Hatch Opening
387	LMP in Hatch Opening
RCS Quads:	
388	Quad A Thruster Surface
389	Quad A Thruster Surface
390	Quad A Thruster Surface
391	Quad A Thruster Surface
392	Quad B Thruster Surface
393	Quad B Thruster Surface
394	Quad B Thruster Surface
395	Quad B Thruster Surface
Experiments:	
396	Subsatellite Box
397	Subsatellite Box
398	Subsatellite Box
399	Subsatellite Box
400	Foot restraint
401	Pan Camera
402	Pan Camera
403	Pan Camera
404	Pan Camera
405	Pan Camera

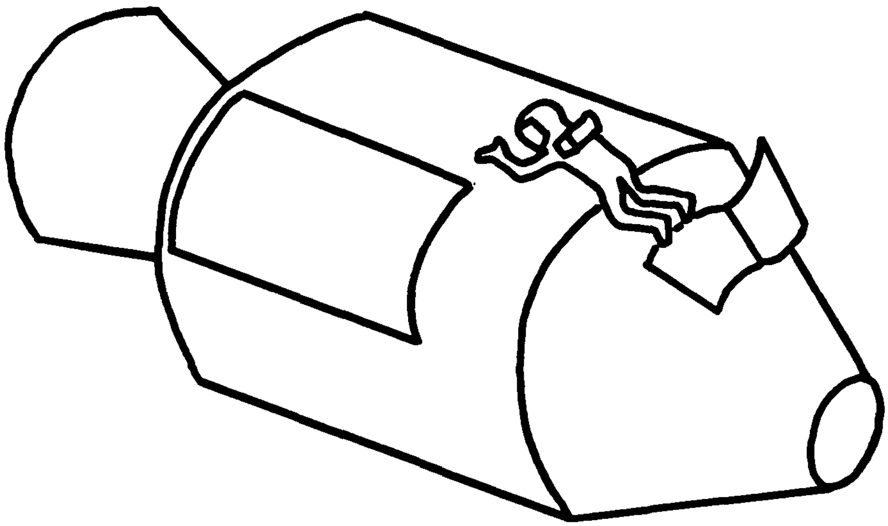


FIGURE C-1 EGRESSING MODE (MODE 1)

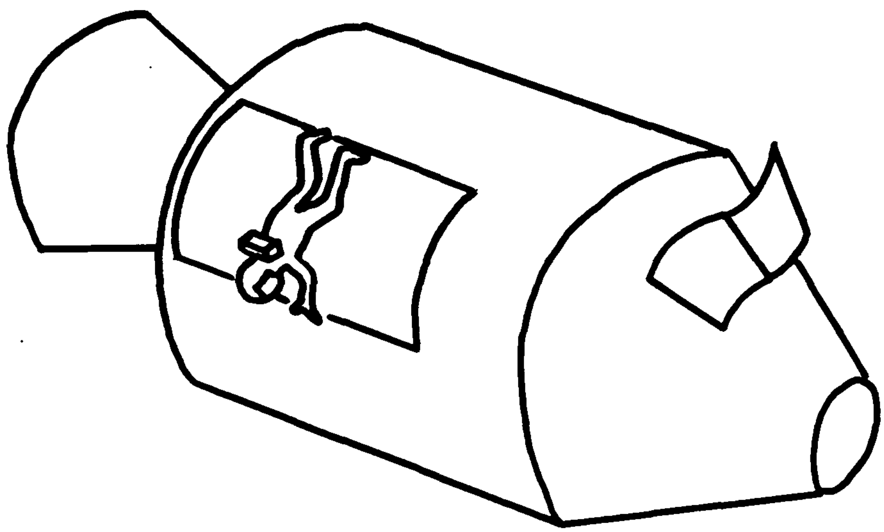


FIGURE C-2 RETRIEVING MODE (MODE 2)

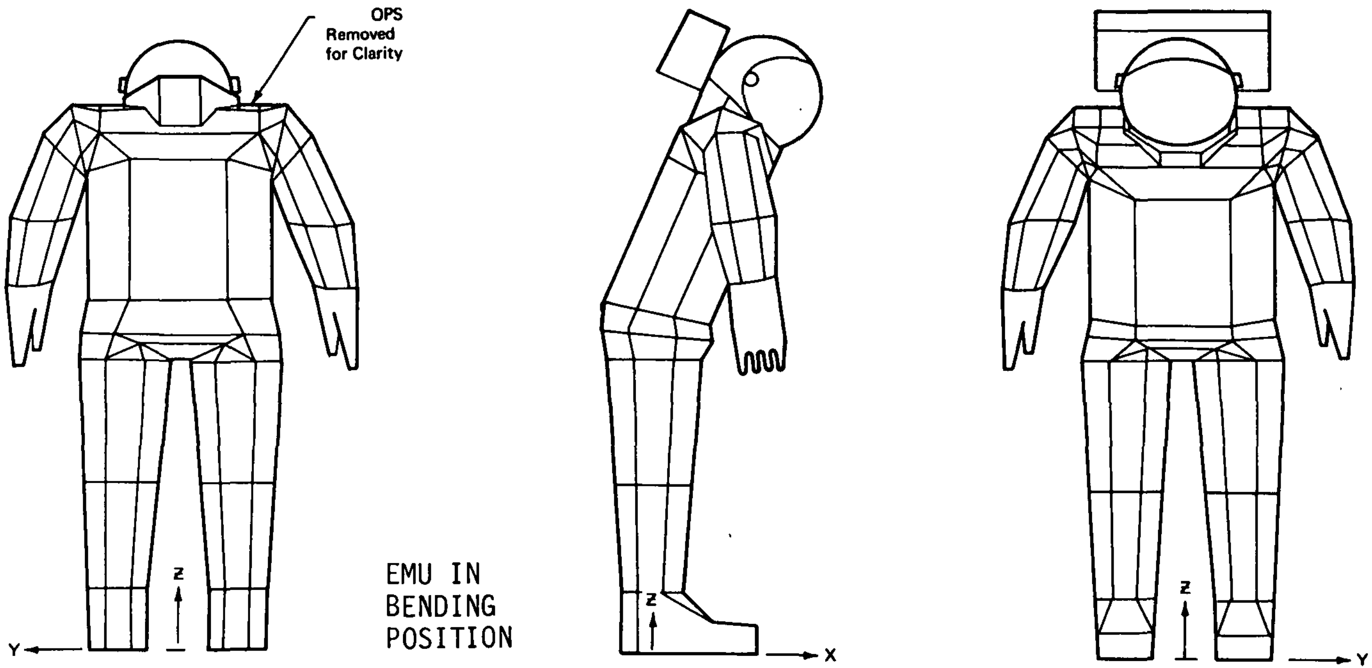


FIGURE C-3 EMU CONFIGURATION (MODES 1 AND 2)

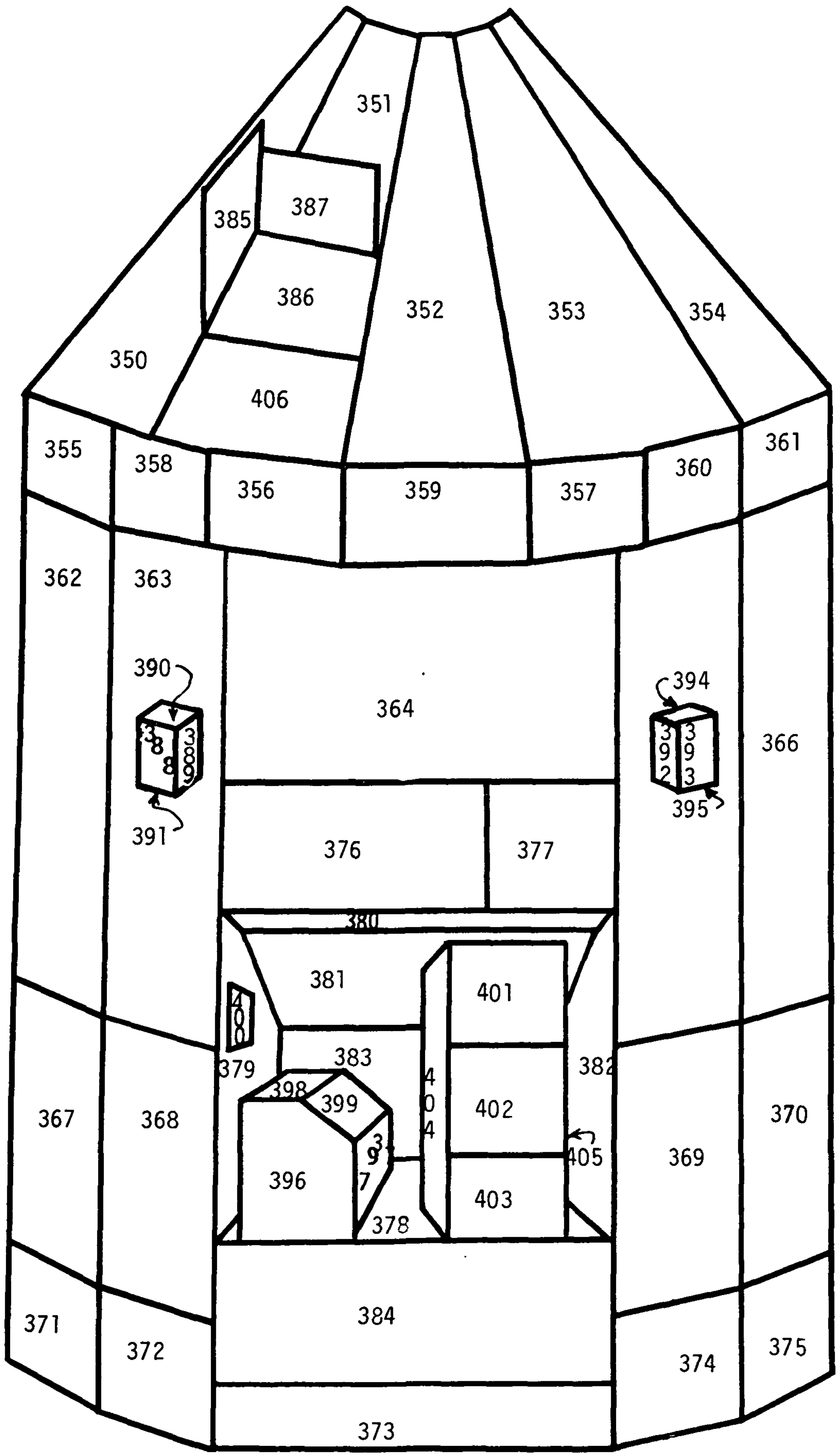


FIGURE C-4 NODAL DEFINITION OF THE CSM AND SIM BAY MODEL

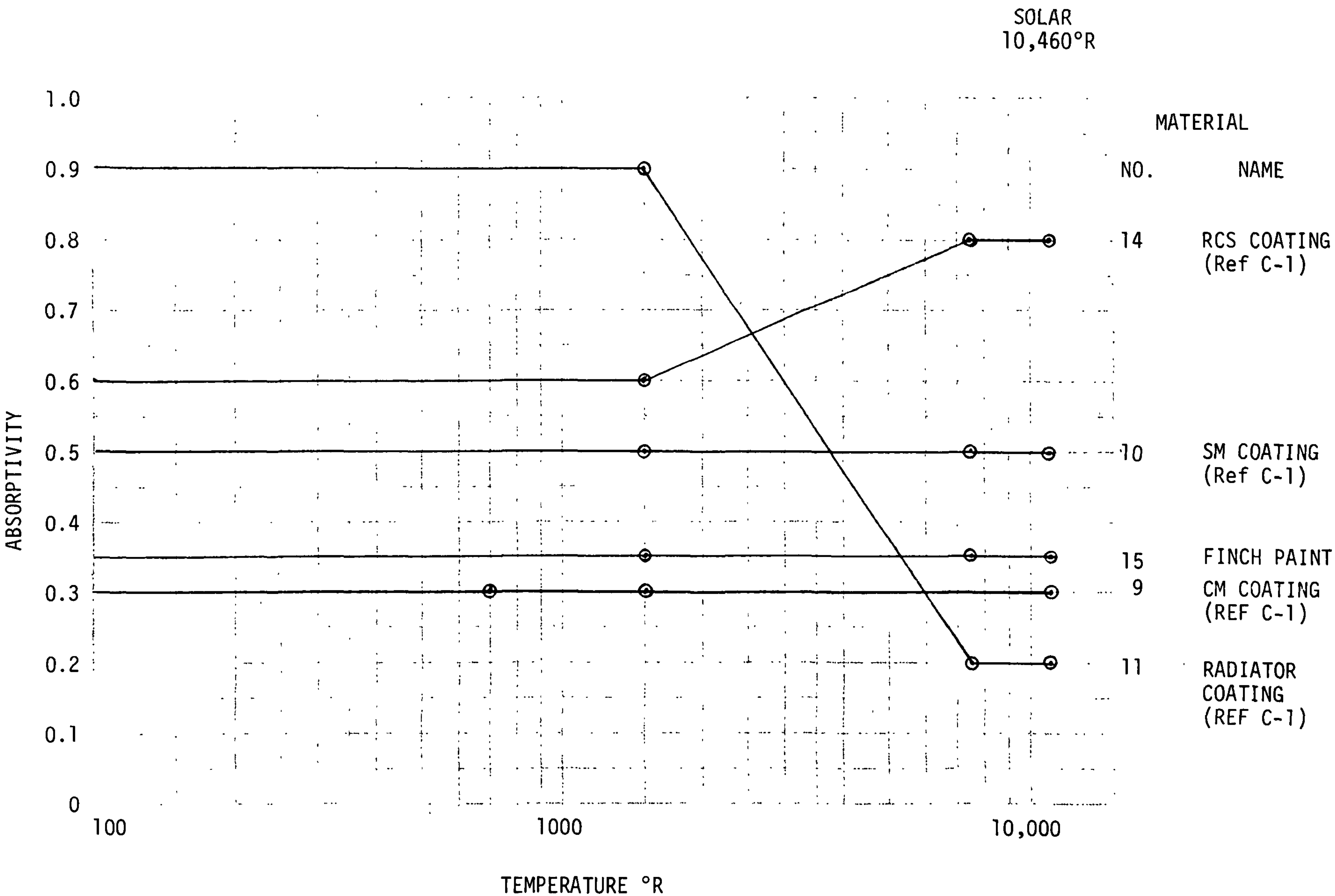


FIGURE C-5 - SIM BAY - CSM MATERIAL PROPERTIES CURVES

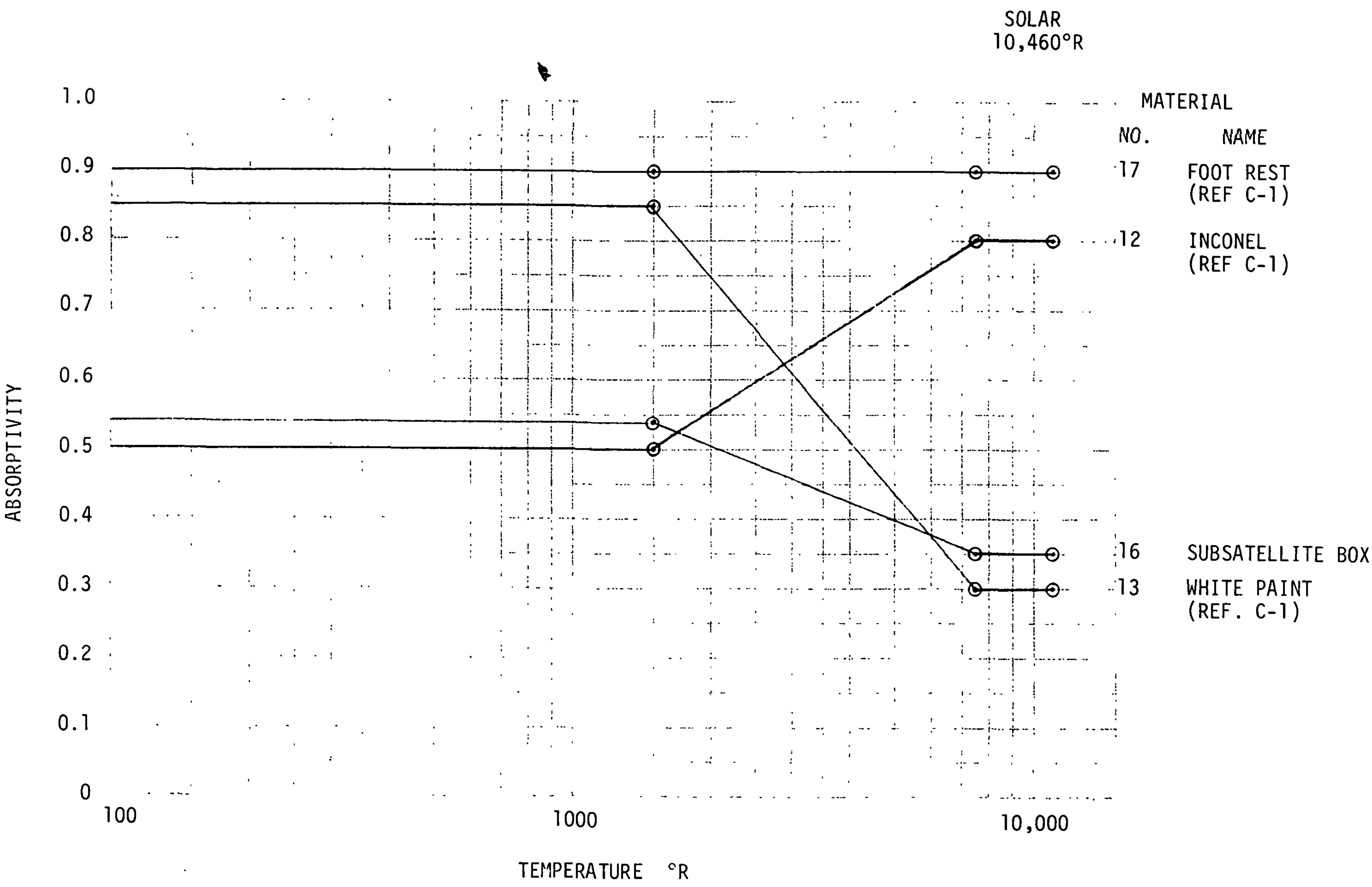


FIGURE C-5 (CONTINUED) - SIM BAY - CSM MATERIAL PROPERTIES CURVES

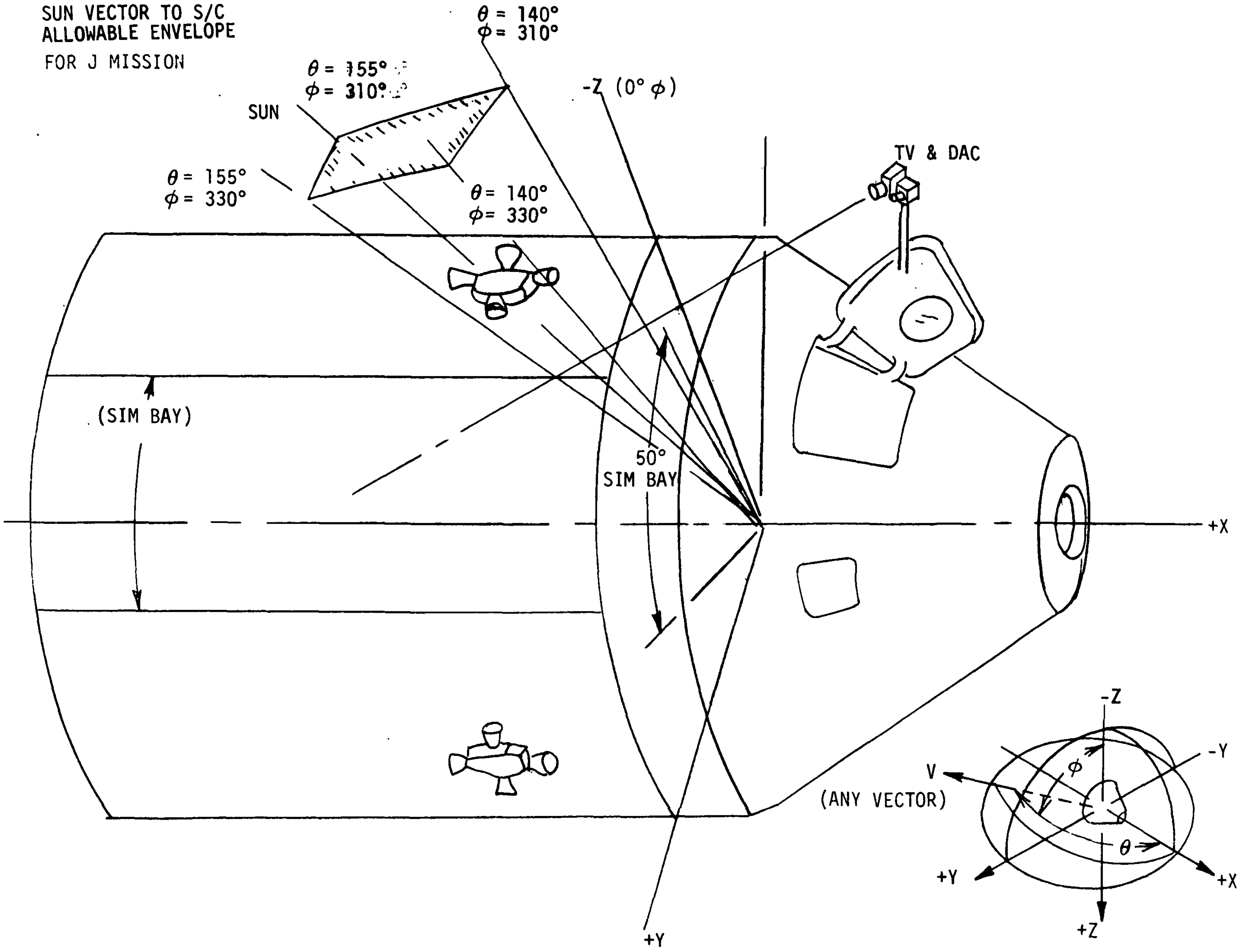


FIGURE C-6 NASA-MSC SOLAR LOOK ANGLE ϕ AND θ DEFINITION

TABLE C-2 MSC AND EHFR SOLAR ANGLE CORRESPONDENCE

MSC SOLAR LOOK ANGLES (DEG)		EGRESSING MODE (MODE 1) EHFR ANGLES (DEG)		RETRIEVING MODE (MODE 2) EHFR ANGLES (DEG)	
θ	ϕ	RCS AZIMUTH	SOLAR ELEVATION	RCS AZIMUTH	SOLAR ELEVATION
140.000	310.000	298.001	49.993	291.517	-34.598
140.000	311.000	299.001	49.993	292.152	-34.227
140.000	312.000	300.001	49.993	292.777	-33.895
140.000	313.000	301.001	49.993	293.389	-33.453
140.000	314.000	302.001	49.993	293.990	-33.052
140.000	315.000	303.001	49.993	294.578	-32.641
140.000	316.000	304.001	49.993	295.155	-32.221
140.000	317.000	305.001	49.993	295.719	-31.792
140.000	318.000	306.001	49.993	296.272	-31.354
140.000	319.000	307.001	49.993	296.812	-30.907
140.000	320.000	308.001	49.993	297.340	-30.452
140.000	321.000	309.001	49.993	297.857	-29.989
140.000	322.000	310.001	49.993	298.361	-29.519
140.000	323.000	311.001	49.993	298.853	-29.040
140.000	324.000	312.001	49.993	299.334	-28.554
140.000	325.000	313.001	49.993	299.802	-26.061
140.000	326.000	314.001	49.993	300.259	-27.561
140.000	327.000	315.001	49.993	300.704	-27.054
140.000	328.000	316.001	49.993	301.137	-26.541
140.000	329.000	317.001	49.993	301.559	-26.021
140.000	330.000	318.001	49.993	301.970	-25.495
141.000	310.000	298.001	50.993	290.831	-33.775
141.000	311.000	299.001	50.993	291.451	-33.415
141.000	312.000	300.001	50.993	292.059	-33.044
141.000	313.000	301.001	50.993	292.656	-32.664
141.000	314.000	302.001	50.993	293.242	-32.275
141.000	315.000	303.001	50.993	293.817	-31.876
141.000	316.000	304.001	50.993	294.380	-31.468
141.000	317.000	305.001	50.993	294.932	-31.051
141.000	318.000	306.001	50.993	295.472	-30.625
141.000	319.000	307.001	50.993	296.001	-30.192
141.000	320.000	308.001	50.993	296.518	-29.750
141.000	321.000	309.001	50.993	297.024	-29.299
141.000	322.000	310.001	50.993	297.518	-28.842
141.000	323.000	311.001	50.993	298.001	-28.376
141.000	324.000	312.001	50.993	298.472	-27.903
141.000	325.000	313.001	50.993	298.932	-27.423
141.000	326.000	314.001	50.993	299.380	-26.937
141.000	327.000	315.001	50.993	299.818	-26.443
141.000	328.000	316.001	50.993	300.244	-25.943
141.000	329.000	317.001	50.993	300.658	-25.436
141.000	330.000	318.001	50.993	301.062	-24.924
142.000	310.000	298.001	51.993	290.158	-32.947
142.000	311.000	299.001	51.993	290.762	-32.598
142.000	312.000	300.001	51.993	291.354	-32.239
142.000	313.000	301.001	51.993	291.936	-31.871
142.000	314.000	302.001	51.993	292.508	-31.493
142.000	315.000	303.001	51.993	293.068	-31.106
142.000	316.000	304.001	51.993	293.618	-30.710
142.000	317.000	305.001	51.993	294.157	-30.305
142.000	318.000	306.001	51.993	294.685	-29.892
142.000	319.000	307.001	51.993	295.202	-29.471
142.000	320.000	308.001	51.993	295.708	-29.042
142.000	321.000	309.001	51.993	296.202	-28.604
142.000	322.000	310.001	51.993	296.686	-28.159
142.000	323.000	311.001	51.993	297.159	-27.707
142.000	324.000	312.001	51.993	297.621	-27.247
142.000	325.000	313.001	51.993	298.072	-26.780

MSC SOLAR LOOK ANGLES (DEG)		EGRESSING MODE (MODE 1) EHFR ANGLES (DEG)		RETRIEVING MODE (MODE 2) EHFR ANGLES (DEG)	
θ	ϕ	RCS AZIMUTH	SOLAR ELEVATION	RCS AZIMUTH	SOLAR ELEVATION
142.000	326.000	314.001	51.993	298.512	-26.307
142.000	327.000	315.001	51.993	298.941	-25.826
142.000	328.000	316.001	51.993	299.359	-25.340
142.000	329.000	317.001	51.993	299.766	-24.847
142.000	330.000	318.001	51.993	300.163	-24.348
143.000	310.000	298.001	52.993	289.498	-32.117
143.000	311.000	299.001	52.993	290.085	-31.778
143.000	312.000	300.001	52.993	290.662	-31.431
143.000	313.000	301.001	52.993	291.229	-31.073
143.000	314.000	302.001	52.993	291.786	-30.707
143.000	315.000	303.001	52.993	292.332	-30.332
143.000	316.000	304.001	52.993	292.868	-29.948
143.000	317.000	305.001	52.993	293.394	-29.556
143.000	318.000	306.001	52.993	293.909	-29.155
143.000	319.000	307.001	52.993	294.414	-28.746
143.000	320.000	308.001	52.993	294.908	-28.329
143.000	321.000	309.001	52.993	295.392	-27.904
143.000	322.000	310.001	52.993	295.865	-27.472
143.000	323.000	311.001	52.993	296.328	-27.032
143.000	324.000	312.001	52.993	296.780	-26.586
143.000	325.000	313.001	52.993	297.221	-26.132
143.000	326.000	314.001	52.993	297.652	-25.672
143.000	327.000	315.001	52.993	298.073	-25.205
143.000	328.000	316.001	52.993	298.483	-24.731
143.000	329.000	317.001	52.993	298.883	-24.252
143.000	330.000	318.001	52.993	299.272	-23.766
144.000	310.000	298.001	53.993	288.850	-31.282
144.000	311.000	299.001	53.993	289.421	-30.955
144.000	312.000	300.001	53.993	289.982	-30.618
144.000	313.000	301.001	53.993	290.533	-30.272
144.000	314.000	302.001	53.993	291.075	-29.917
144.000	315.000	303.001	53.993	291.607	-29.554
144.000	316.000	304.001	53.993	292.129	-29.182
144.000	317.000	305.001	53.993	292.642	-28.801
144.000	318.000	306.001	53.993	293.144	-28.413
144.000	319.000	307.001	53.993	293.637	-28.016
144.000	320.000	308.001	53.993	294.119	-27.612
144.000	321.000	309.001	53.993	294.592	-27.199
144.000	322.000	310.001	53.993	295.054	-26.780
144.000	323.000	311.001	53.993	295.506	-26.353
144.000	324.000	312.001	53.993	295.948	-25.920
144.000	325.000	313.001	53.993	296.380	-25.479
144.000	326.000	314.001	53.993	296.802	-25.032
144.000	327.000	315.001	53.993	297.214	-24.578
144.000	328.000	316.001	53.993	297.616	-24.118
144.000	329.000	317.001	53.993	298.007	-23.652
144.000	330.000	318.001	53.993	298.389	-23.179
145.000	310.000	298.001	54.993	288.214	-30.445
145.000	311.000	299.001	54.993	288.768	-30.128
145.000	312.000	300.001	54.993	289.313	-29.802
145.000	313.000	301.001	54.993	289.849	-29.467
145.000	314.000	302.001	54.993	290.376	-29.124
145.000	315.000	303.001	54.993	290.893	-28.772
145.000	316.000	304.001	54.993	291.402	-28.411
145.000	317.000	305.001	54.993	291.901	-28.043
145.000	318.000	306.001	54.993	292.390	-27.666
145.000	319.000	307.001	54.993	292.870	-27.282
145.000	320.000	308.001	54.993	293.341	-26.890

MSC SOLAR LOOK ANGLES (DEG)		EGRESSING MODE (MODE 1) EHFR ANGLES (DEG)		RETRIEVING MODE (MODE 2) EHFR ANGLES (DEG)	
θ	ϕ	RCS AZIMUTH	SOLAR ELEVATION	RCS AZIMUTH	SOLAR ELEVATION
145.000	321.000	309.001	54.993	293.801	-26.490
145.000	322.000	310.001	54.993	294.253	-26.083
145.000	323.000	311.001	54.993	294.694	-25.670
145.000	324.000	312.001	54.993	295.126	-25.249
145.000	325.000	313.001	54.993	295.548	-24.821
145.000	326.000	314.001	54.993	295.961	-24.387
145.000	327.000	315.001	54.993	296.363	-23.946
145.000	328.000	316.001	54.993	296.757	-23.500
145.000	329.000	317.001	54.993	297.140	-23.047
145.000	330.000	318.001	54.993	297.514	-22.588
146.000	310.000	298.001	55.993	287.588	-29.604
146.000	311.000	299.001	55.993	288.125	-29.298
146.000	312.000	300.001	55.993	288.654	-28.983
146.000	313.000	301.001	55.993	289.175	-28.659
146.000	314.000	302.001	55.993	289.687	-28.327
146.000	315.000	303.001	55.993	290.190	-27.986
146.000	316.000	304.001	55.993	290.684	-27.637
146.000	317.000	305.001	55.993	291.170	-27.281
146.000	318.000	306.001	55.993	291.646	-26.916
146.000	319.000	307.001	55.993	292.114	-26.544
146.000	320.000	308.001	55.993	292.572	-26.164
146.000	321.000	309.001	55.993	293.021	-25.777
146.000	322.000	310.001	55.993	293.461	-25.382
146.000	323.000	311.001	55.993	293.892	-24.981
146.000	324.000	312.001	55.993	294.313	-24.573
146.000	325.000	313.001	55.993	294.725	-24.159
146.000	326.000	314.001	55.993	295.128	-23.737
146.000	327.000	315.001	55.993	295.521	-23.310
146.000	328.000	316.001	55.993	295.906	-22.877
146.000	329.000	317.001	55.993	296.281	-22.437
146.000	330.000	318.001	55.993	296.646	-21.992
147.000	310.000	298.001	56.993	286.972	-28.761
147.000	311.000	299.001	56.993	287.493	-28.465
147.000	312.000	300.001	56.993	288.007	-28.161
147.000	313.000	301.001	56.993	288.512	-27.848
147.000	314.000	302.001	56.993	289.009	-27.526
147.000	315.000	303.001	56.993	289.497	-27.197
147.000	316.000	304.001	56.993	289.977	-26.860
147.000	317.000	305.001	56.993	290.449	-26.515
147.000	318.000	306.001	56.993	290.912	-26.162
147.000	319.000	307.001	56.993	291.367	-25.801
147.000	320.000	308.001	56.993	291.813	-25.434
147.000	321.000	309.001	56.993	292.250	-25.059
147.000	322.000	310.001	56.993	292.678	-24.677
147.000	323.000	311.001	56.993	293.098	-24.289
147.000	324.000	312.001	56.993	293.509	-23.894
147.000	325.000	313.001	56.993	293.910	-23.492
147.000	326.000	314.001	56.993	294.303	-23.084
147.000	327.000	315.001	56.993	294.687	-22.669
147.000	328.000	316.001	56.993	295.062	-22.249
147.000	329.000	317.001	56.993	295.429	-21.823
147.000	330.000	318.001	56.993	295.786	-21.391
148.000	310.000	298.001	57.993	286.367	-27.915
148.000	311.000	299.001	57.993	286.871	-27.629
148.000	312.000	300.001	57.993	287.369	-27.335
148.000	313.000	301.001	57.993	287.858	-27.033
148.000	314.000	302.001	57.993	288.340	-26.723
148.000	315.000	303.001	57.993	288.814	-26.405

TABLE C-2 (CONTINUED)

MSC SOLAR LOOK ANGLES (DEG)		EGRESSING MODE (MODE 1) EHFR ANGLES (DEG)		RETRIEVING MODE (MODE 2) EHFR ANGLES (DEG)	
θ	φ	RCS AZIMUTH	SOLAR ELEVATION	RCS AZIMUTH	SOLAR ELEVATION
148.000	316.000	304.001	57.993	289.280	-26.079
148.000	317.000	305.001	57.993	289.738	-25.745
148.000	318.000	306.001	57.993	290.188	-25.404
148.000	319.000	307.001	57.993	290.629	-25.056
148.000	320.000	308.001	57.993	291.063	-24.700
148.000	321.000	309.001	57.993	291.488	-24.338
148.000	322.000	310.001	57.993	291.905	-23.968
148.000	323.000	311.001	57.993	292.313	-23.592
148.000	324.000	312.001	57.993	292.713	-23.210
148.000	325.000	313.001	57.993	293.104	-22.821
148.000	326.000	314.001	57.993	293.487	-22.426
148.000	327.000	315.001	57.993	293.861	-22.024
148.000	328.000	316.001	57.993	294.227	-21.617
148.000	329.000	317.001	57.993	294.584	-21.205
148.000	330.000	318.001	57.993	294.932	-20.786
149.000	310.000	298.001	58.993	285.771	-27.066
149.000	311.000	299.001	58.993	286.259	-26.791
149.000	312.000	300.001	58.993	286.740	-26.507
149.000	313.000	301.001	58.993	287.214	-26.215
149.000	314.000	302.001	58.993	287.681	-25.916
149.000	315.000	303.001	58.993	288.140	-25.609
149.000	316.000	304.001	58.993	288.592	-25.294
149.000	317.000	305.001	58.993	289.036	-24.972
149.000	318.000	306.001	58.993	289.472	-24.643
149.000	319.000	307.001	58.993	289.901	-24.306
149.000	320.000	308.001	58.993	290.322	-23.963
149.000	321.000	309.001	58.993	290.734	-23.612
149.000	322.000	310.001	58.993	291.139	-23.255
149.000	323.000	311.001	58.993	291.536	-22.892
149.000	324.000	312.001	58.993	291.925	-22.522
149.000	325.000	313.001	58.993	292.306	-22.146
149.000	326.000	314.001	58.993	292.678	-21.764
149.000	327.000	315.001	58.993	293.042	-21.375
149.000	328.000	316.001	58.993	293.398	-20.981
149.000	329.000	317.001	58.993	293.746	-20.582
149.000	330.000	318.001	58.993	294.086	-20.177
150.000	310.000	298.001	59.993	285.183	-26.215
150.000	311.000	299.001	59.993	285.655	-25.950
150.000	312.000	300.001	59.993	286.121	-25.676
150.000	313.000	301.001	59.993	286.579	-25.395
150.000	314.000	302.001	59.993	287.031	-25.106
150.000	315.000	303.001	59.993	287.475	-24.810
150.000	316.000	304.001	59.993	287.912	-24.506
150.000	317.000	305.001	59.993	288.343	-24.196
150.000	318.000	306.001	59.993	288.765	-23.878
150.000	319.000	307.001	59.993	289.181	-23.553
150.000	320.000	308.001	59.993	289.589	-23.221
150.000	321.000	309.001	59.993	289.989	-22.883
150.000	322.000	310.001	59.993	290.382	-22.539
150.000	323.000	311.001	59.993	290.767	-22.188
150.000	324.000	312.001	59.993	291.145	-21.630
150.000	325.000	313.001	59.993	291.515	-21.467
150.000	326.000	314.001	59.993	291.877	-21.098
150.000	327.000	315.001	59.993	292.231	-20.722
150.000	328.000	316.001	59.993	292.577	-20.342
150.000	329.000	317.001	59.993	292.916	-19.955
150.000	330.000	318.001	59.993	293.246	-19.564
151.000	310.000	298.001	60.993	284.605	-25.362

TABLE C-2 (CONTINUED)

MSC SOLAR LOOK ANGLES (DEG)		EGRESSING MODE (MODE 1) EHFR ANGLES (DEG)		RETRIEVING MODE (MODE 2) EHFR ANGLES (DEG)	
θ	φ	RCS AZIMUTH	SOLAR ELEVATION	RCS AZIMUTH	SOLAR ELEVATION
151.000	311.000	299.001	60.993	285.060	-25.106
151.000	312.000	300.001	60.993	285.510	-24.843
151.000	313.000	301.001	60.993	285.953	-24.572
151.000	314.000	302.001	60.993	286.389	-24.294
151.000	315.000	303.001	60.993	286.819	-24.008
151.000	316.000	304.001	60.993	287.242	-23.716
151.000	317.000	305.001	60.993	287.658	-23.416
151.000	318.000	306.001	60.993	288.067	-23.110
151.000	319.000	307.001	60.993	288.469	-22.797
151.000	320.000	308.001	60.993	288.864	-22.477
151.000	321.000	309.001	60.993	289.252	-22.151
151.000	322.000	310.001	60.993	289.633	-21.818
151.000	323.000	311.001	60.993	290.006	-21.480
151.000	324.000	312.001	60.993	290.373	-21.135
151.000	325.000	313.001	60.993	290.731	-20.784
151.000	326.000	314.001	60.993	291.083	-20.428
151.000	327.000	315.001	60.993	291.426	-20.066
151.000	328.000	316.001	60.993	291.763	-19.698
151.000	329.000	317.001	60.993	292.091	-19.325
151.000	330.000	318.001	60.993	292.413	-18.947
152.000	310.000	298.001	61.993	284.034	-24.506
152.000	311.000	299.001	61.993	284.474	-24.260
152.000	312.000	300.001	61.993	284.907	-24.007
152.000	313.000	301.001	61.993	285.334	-23.746
152.000	314.000	302.001	61.993	285.756	-23.479
152.000	315.000	303.001	61.993	286.170	-23.204
152.000	316.000	304.001	61.993	286.579	-22.922
152.000	317.000	305.001	61.993	286.981	-22.634
152.000	318.000	306.001	61.993	287.377	-22.339
152.000	319.000	307.001	61.993	287.765	-22.037
152.000	320.000	308.001	61.993	288.147	-21.730
152.000	321.000	309.001	61.993	288.523	-21.415
152.000	322.000	310.001	61.993	288.891	-21.095
152.000	323.000	311.001	61.993	289.253	-20.769
152.000	324.000	312.001	61.993	289.607	-20.436
152.000	325.000	313.001	61.993	289.955	-20.098
152.000	326.000	314.001	61.993	290.295	-19.754
152.000	327.000	315.001	61.993	290.629	-19.405
152.000	328.000	316.001	61.993	290.955	-19.051
152.000	329.000	317.001	61.993	291.274	-18.691
152.000	330.000	318.001	61.993	291.585	-18.326
153.000	310.000	298.001	62.993	283.471	-23.648
153.000	311.000	299.001	62.993	283.895	-23.412
153.000	312.000	300.001	62.993	284.312	-23.168
153.000	313.000	301.001	62.993	284.724	-22.918
153.000	314.000	302.001	62.993	285.130	-22.661
153.000	315.000	303.001	62.993	285.530	-22.397
153.000	316.000	304.001	62.993	285.924	-22.126
153.000	317.000	305.001	62.993	286.312	-21.849
153.000	318.000	306.001	62.993	286.694	-21.565
153.000	319.000	307.001	62.993	287.069	-21.275
153.000	320.000	308.001	62.993	287.438	-20.979
153.000	321.000	309.001	62.993	287.801	-20.677
153.000	322.000	310.001	62.993	288.157	-20.368
153.000	323.000	311.001	62.993	288.506	-20.054
153.000	324.000	312.001	62.993	288.849	-19.734
153.000	325.000	313.001	62.993	289.185	-19.409
153.000	326.000	314.001	62.993	289.515	-19.078

TABLE C-2(CONTINUED)

MSC SOLAR LOOK ANGELS (DEG)		EGRESSING MODE (MODE 1) EHFR ANGLES (DEG)		RETRIEVING MODE (MODE 2) EHFR ANGLES (DEG)	
θ	φ	RCS AZIMUTH	SOLAR ELEVATION	RCS AZIMUTH	SOLAR ELEVATION
153.000	327.000	315.001	62.993	289.837	-18.741
153.000	328.000	316.001	62.993	290.153	-18.400
153.000	329.000	317.001	62.993	290.462	-18.053
153.000	330.000	318.001	62.993	290.764	-17.701
154.000	310.000	298.001	63.993	282.916	-22.788
154.000	311.000	299.001	63.993	283.323	-22.561
154.000	312.000	300.001	63.993	283.725	-22.328
154.000	313.000	301.001	63.993	284.121	-22.088
154.000	314.000	302.001	63.993	284.512	-21.841
154.000	315.000	303.001	63.993	284.897	-21.587
154.000	316.000	304.001	63.993	285.276	-21.327
154.000	317.000	305.001	63.993	285.650	-21.061
154.000	318.000	306.001	63.993	286.018	-20.789
154.000	319.000	307.001	63.993	286.380	-20.510
154.000	320.000	308.001	63.993	286.736	-20.225
154.000	321.000	309.001	63.993	287.086	-19.935
154.000	322.000	310.001	63.993	287.429	-19.639
154.000	323.000	311.001	63.993	287.766	-19.337
154.000	324.000	312.001	63.993	288.097	-19.029
154.000	325.000	313.001	63.993	288.422	-18.716
154.000	326.000	314.001	63.993	288.740	-18.398
154.000	327.000	315.001	63.993	289.052	-18.074
154.000	328.000	316.001	63.993	289.357	-17.746
154.000	329.000	317.001	63.993	289.656	-17.412
154.000	330.000	318.001	63.993	289.948	-17.074
155.000	310.000	298.001	64.993	282.368	-21.926
155.000	311.000	299.001	64.993	282.758	-21.709
155.000	312.000	300.001	64.993	283.144	-21.485
155.000	313.000	301.001	64.993	283.525	-21.255
155.000	314.000	302.001	64.993	283.900	-21.018
155.000	315.000	303.001	64.993	284.271	-20.775
155.000	316.000	304.001	64.993	284.636	-20.526
155.000	317.000	305.001	64.993	284.995	-20.271
155.000	318.000	306.001	64.993	285.349	-20.009
155.000	319.000	307.001	64.993	285.698	-19.742
155.000	320.000	308.001	64.993	286.040	-19.469
155.000	321.000	309.001	64.993	286.377	-19.190
155.000	322.000	310.001	64.993	286.708	-18.906
155.000	323.000	311.001	64.993	287.033	-18.616
155.000	324.000	312.001	64.993	287.352	-18.321
155.000	325.000	313.001	64.993	287.665	-18.020
155.000	326.000	314.001	64.993	287.972	-17.715
155.000	327.000	315.001	64.993	288.273	-17.404
155.000	328.000	316.001	64.993	288.568	-17.088
155.000	329.000	317.001	64.993	288.856	-16.768
155.000	330.000	318.001	64.993	289.138	-16.443

APPENDIX D

THERMAL VACUUM CHAMBER CONFIGURATION DATA

This Appendix describes the two thermal vacuum chamber (TVC) configurations that have been analyzed using the EHFR, tabulates the chamber model data stored in the EHFR, and references the available test data used for TVC EHFR simulation. The two chambers are the NASA-MSC Chamber B located in Houston, Texas, and the LTV Aerospace Corporation VMSC Space Environment Simulator chamber in Dallas, Texas. These two thermal vacuum chambers have been used for extensive manned and unmanned testing of the Apollo Extravehicular Mobility Unit with analysis of the test data performed using the EHFR. The MSC Chamber B and LTV VMSC chamber are described in Sections 1.0 and 2.0, respectively, of this Appendix.

The TVC energy sources analyzed by the EHFR include direct solar radiation, Lunar Surface Thermal Simulator (LSTS) heater element emission, solar albedo background, infrared background, and chamber floor energy. The analytical approach employed by the EHFR to obtain the thermal vacuum chamber environments are described in detail in Section 4.4 of the main report. The chamber model data used by and stored in the EHFR to simulate these energy sources, are summarized in Table D-1 and described in detail below.

Thermal vacuum chamber tests simulating lunar surface conditions have been performed with both the MSC and LTV chambers. EHFR analyses of test conditions has been performed using measured test data which includes: LSTS tier temperatures and tilt angles, chamber floor temperatures, albedo and infrared energy levels, and solar simulation intensity. A bibliography of references documenting this TVC test data is presented in Section 3.0 of this Appendix with a summary of the lunar surface conditions simulated by the MSC Chamber B and LTV-VMSC chambers presented in Section 1.0 and 2.0, respectively.

1.0 MSC CHAMBER B

The NASA-MSC Chamber B configuration is pictured in Figure D-1 and is shown schematically in Figure D-2. The major components consist of an LSTS, chamber floor, solar simulation modules, and a folding mirror.

The solar simulation modules consist of six carbon arc lamps located in the Chamber B overhead. The folding mirror is designed to reflect the Chamber B overhead collimated solar energy into the test area (chamber floor) at sun vector elevation angles of 33° or 48°. The mirror, consisting of a vapor deposited aluminum coating on glass, is mounted on a heavy aluminum plate structure. The structure is temperature controlled to about 60°F by a water flow loop.

The columinated solar flux reflected from the mirror passes through the LSTS heater element array causing shadows on the solar screen (see Section 4.4 for definition of solar screen). Figures D-3 and D-4 define the solar screen nodal and shadows areas, and also identifies the MSC solar module location relative to the screen node areas. Table D-2 defines the percentage of shadow area to total area for those nodes with LSTS shadows.

The lunar floor, schematically shown in Figure D-5, is a 10 foot diameter aluminum disc which is painted with high infrared emittance coating. It is composed of two halves which can be independently heated or cooled between the temperature limits of ± 300°F. A four by six foot area of the floor is painted with a reflective paint in order to reduce temperature gradients of the floor caused by solar flux impingements. The thirty-two thermocouples used to measure floor temperatures during testing are identified and located on Figure D-5. The 600 node floor model used for simulation in the EHFR is shown on Figure D-6. The routine automatically interpolates the input thermocouple data to assign the individual floor node temperatures.

The LSTS consists of a vertical strip heater array which, together with the controlled floor, simulates the infrared heat fluxes of a lunar plain or crater. The LSTS assembly, shown in Figure D-7, is approximately 11 feet in diameter and 9 feet high. A safety fence, fabricated from aluminum tubing and heavy gage wire, prohibits test subject contact with the LSTS heater elements during a test. The clear working diameter inside the simulator safety cage is 9 feet. A door is provided for test subject ingress-egress.

The heater array consists of 12 structural modules each having four tiers of tiltable heater elements. The array is divided into 4 power zones with each zone consisting of two tiers of heater elements on six structural modules. A common torque shaft connects the six modules so that the heater element tiers can be adjusted simultaneously anywhere between ±80° off the verticle. The zone and tier definition is shown on Figures D-2 and D-7. As seen by heater element stored data shown in Table D-1, each zone and tier have an identical number of heater elements. In addition to the zone/tier/heater element data specified on Table D-1, the EHFR also stores the individual heater element grometric data which includes the element coordinate,area, and azimuth/inclination angles. A detailed listing of this data for the MSC Chamber B configuration may be obtained from the EHFR by inputing the proper print index on Card A-2 (see Section 5.4 of the report).

Several manned lunar surface thermal environment tests in the NASA-MSC Chamber B have been conducted utilizing the LSTS. Calibration of the chamber has provided data for use in the EHFR for simulation of the test conditions. This data includes floor temperatures, background energy levels, and LSTS tier temperatures and tilt angles. The lunar surface conditions simulated and the appropriate references where the Chamber B data can be obtained are presented in Table D-3.

2.0 LTV-VMSC CHAMBER

The LTV-VMSC chamber configuration is pictured in Figure D-8 and is shown schematically in Figure D-9. The major components consist of an LSTS, chamber floor, solar simulation lamps, solar lamp shutters, and an LN_2 cooled shroud.

The solar flux is simulated with 20 Mercury-Xenon lamps located at one end of the chamber. A shutter and screen mechanism between the lamps and test area provides the capability for quick shut off of energy or light attenuation. The chamber configuration thus provides for only 0° solar vector elevation. Other solar vector elevations can be simulated only by adjusting the flux level of the solar lamps.

The lunar floor, schematically shown in Figure D-10, is a 5 foot diameter aluminum disc which is coated with a high emittance coating. Eight thermocouples used to measure floor temperatures during testing are identified and located on Figure D-10. The 150 node floor model used for EHFR floor analyses is shown in Figure D-11. The routine automatically interpolates the thermocouple data to assign the floor node temperatures. Since thermocouples are located in only one of the four floor quadrants, floor temperatures are assumed to be symetric about the X axis, Y axis, and the floor center point.

The LTV-VMSC LSTS consists of a strip heater array which, with the floor, simulate the infrared heat fluxes of the lunar surface. The heater elements consist of quartz lamps inside a cylindrical stainless steel sleeve. The sleeve backside (away from the test area) is insulated so that most heater element energy is emitted to the test area. The heater array is divided into 6 power zones with each zone having two tiers of tiltable heater elements. The zones are divided such that they are hemi-cylindrical in shape. The zone and tier definition is shown in Figure D-9. Tier tilt angles for the heater element must be set individually for each element. As seen in Table D-1, each zone and tier have a different number heater elements. The EHFR also stores the individual heater element geometric data which is not shown on Table D-1. This data consists of the heater element center point coordinates, area, and azimuth/inclination angles. A detailed listing of this data may be obtained from the EHFR by inputing the proper print index on Card A-2 (see Section 5.4 of the report).

Unmanned EMU lunar surface environment tests run in the LTV-VMSC Chamber have provided data which has been used in the EHFR for simulation of the test conditions. The lunar surface conditions simulated are: lunar night, 10:1 crater with a 33° solar elevation, 10:1 crater with a 48° solar elevation. The chamber test data can be obtained from References D-4 and D-5 which are listed in Section 3.0 of this Appendix.

3.0 CHAMBER TEST DATA REFERENCES

D-1 Jordan, W. D., Martin, D. M., "An Analysis of the Lunar Surface Thermal Simulator (LSTS) Calibration", LTV Aerospace Corporation, Missiles and Space Division, Report No. T104-RP-0004, 27 June 1969.

D-2 Cox, R. L, DeLaughter, D. A., Jordan, W. D., "A Quick-Look Summary Report of the Second Lunar Surface Thermal Simulator (LSTS) Calibration", LTV Aerospace Corporation, Missiles and Space Division, Report 00.1364, 1 October 1970.

D-3 DeLaughter, D. A., Pearce, J. E, "Pre-Test Analysis to Determine Lunar Surface Thermal Simulator Settings and Absorbed Heat Flux for Calibration Test," LTV Aerospace Corporation, Missiles and Space Division, 00-DIR-261, 25 January 1971.

D-4 Mulcahy, E. L., "A7L Part III Solar Simulator Flux Calibration," Test Information Release No. 000TIR-0073, LTV Aerospace Corporation, Missiles and Space Division, April 1969.

D-5 Mulcahy, E. L., "A7L Part III Lunar Crater Flux Calibration," Test Information Release No. 000TIR-0074, LTV Aerospace Corporation, Missiles and Space Division, April 1969.

TABLE D-1

EHFR STORED THERMAL VACUUM CHAMBER DATA

CHAMBER LOCATION		MSC IC=1	LTV IC=2
Chamber Data	Variable		
Solar Screen			
Number of Lengths	ML	10	18
Number of Widths	NW	10	12
S.C.Height, Ft.	HEIGS	13.4	9.0
S.C. Width, Ft.	WIDTHS	10.0	6.0
Modulation	ALFSOL	1.0	1.0
Material Absorptivity to Solar Lamps			
Material	ALFS(i)	-	-
Teflon Cloth	1	0.24	0.29
Chro. R.	2	0.615	0.64
Rubber	3	0.60	0.60
Polyselfone	4	0.45	0.62
Red Conn.	5	0.55	0.55
Blue Conn.	6	0.51	0.51
Hard Pt.	7	0.33	0.33
Hole	8	1.00	1.00
Fiberglass	9	0.36	0.36
Black Ann. Al.	10	0.91	0.91
Clear Ann. Al.	11	0.77	0.77
Mular Backed Cloth	12	0.88	0.88
Wire Mech	13	0.52	0.52
Seat Matrl.	14	0.24	0.24
While Webbing	15	0.90	0.90
Green Webbing	16	0.92	0.92
White Paint	17	0.91	0.91
-	18	.1	.1
-	19	.1	.1
-	20	.1	.1
Floor Data			
Number of Rings	NUMZNS	10	5
Number of Ang. Div.	NB	60	30
Floor Emissivity	EPSFLR	0.95	0.92
Floor Radius, Ft.	RADIUS	5.0	2.5
Number thermocouples	NTC	32	8

TABLE D-1

(CONTINUED)

CHAMBER LOCATION		MSC IC=1	LTV IC=2
Chamber Data	Variable		
LSTS Data			
Heater Emissivity	EPSLMP	0.85	0.90
Number of Zones	NZ	4	6
Number Tiers/Zone	NT	2	2
Number of Heater Elements/Tier	NLAMP		
Zone Tier			
1 1		24	20
1 2		24	20
2 1		24	10
2 2		24	10
3 1		24	14
3 2		24	14
4 1		24	14
4 2		24	14
5 1		0	10
5 2		0	10
6 1		0	10
6 2		0	10
Perpendicular Distance of heater center from pivot, in.	ALAMP	6.617	0.0
Parallel Distance of heater center from pivot, in.	BLAMP	0.0	5.06

TABLE D-2 CHAMBER B LSTS SHADOWING OF THE SOLAR SCREEN

33° SUN

NODE	% SHADED BY LSTS
36	33
35	38
34	74
33	70
43	35
53	37
63	44
66	17
65	22
64	24

48° SUN

NODE	% SHADED BY LSTS
35	4
34	48
65	1
64	22
33	12.6
63	12.6

TABLE D-3 CHAMBER B CALIBRATION DATA AVAILABILITY

LUNAR SURFACE CONDITION	SOLAR ELEVATION ANGLE	REFERENCES		
		D-1	D-2	D-3
LUNAR NIGHT	-	X	X	X
Plain	33°	X		
10:1 Crater	33°	X	X	
10:1 Crater	48°	X	X	
6:1 Crater	48°	X		
5:1 Crater	48°	X		
4:1 Crater	60°		X	
8:1 Crater	48°			X
4:1 Crater	48°			X
Rough Lunar Plain	48°			X

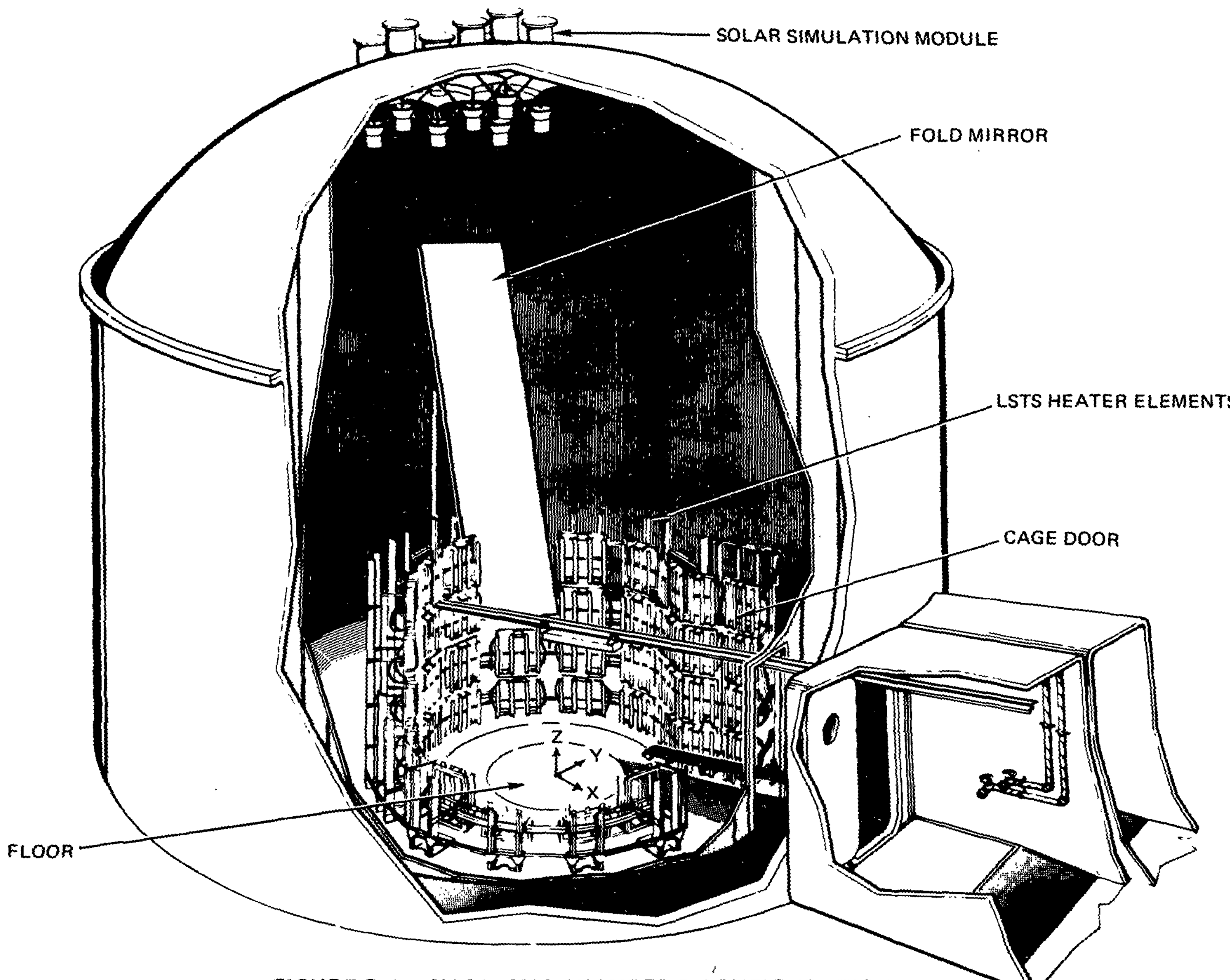


FIGURE D-1 NASA–MSC CHAMBER B CONFIGURATION

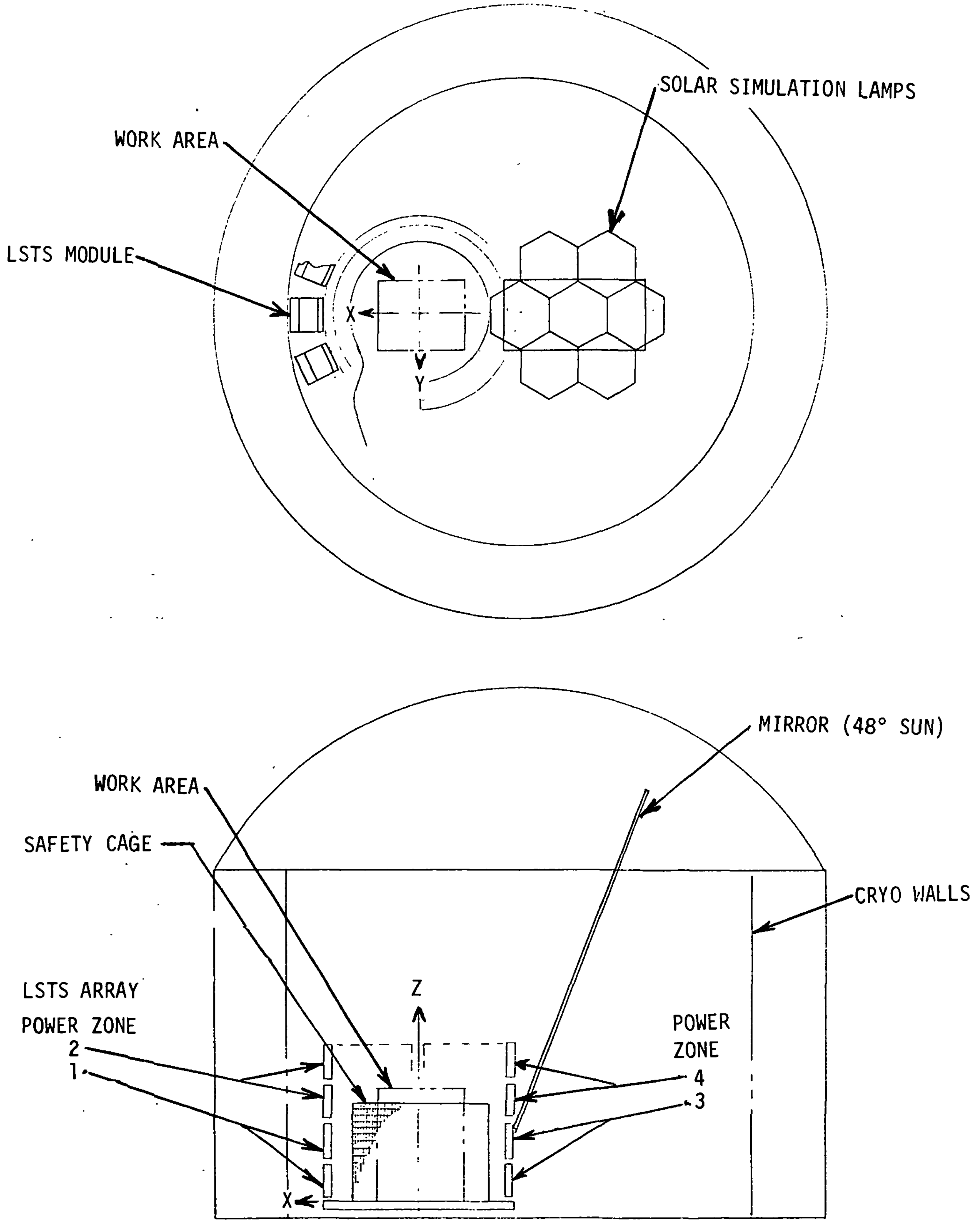


FIGURE D-2 MSC CHAMBER B SCHEMATIC

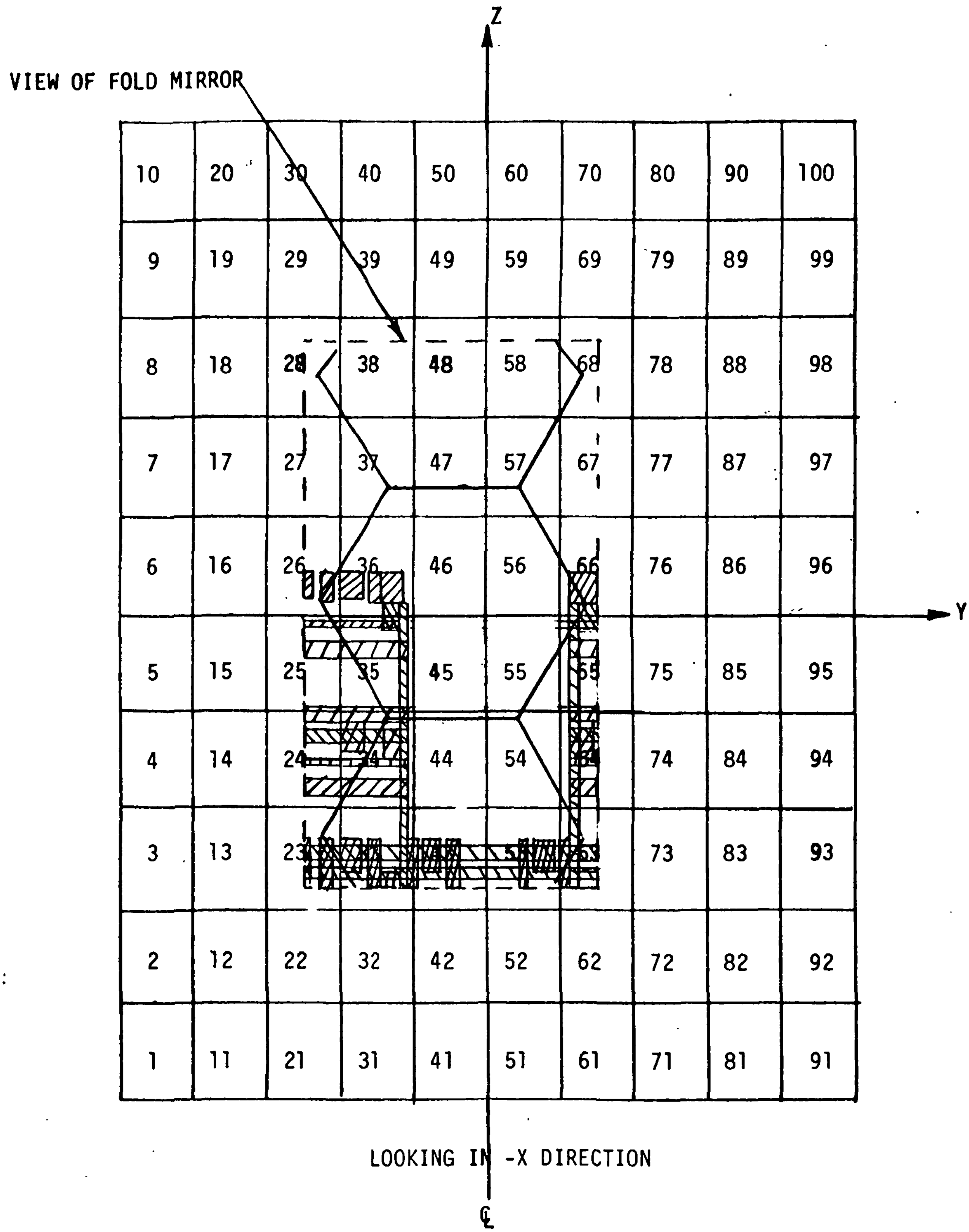
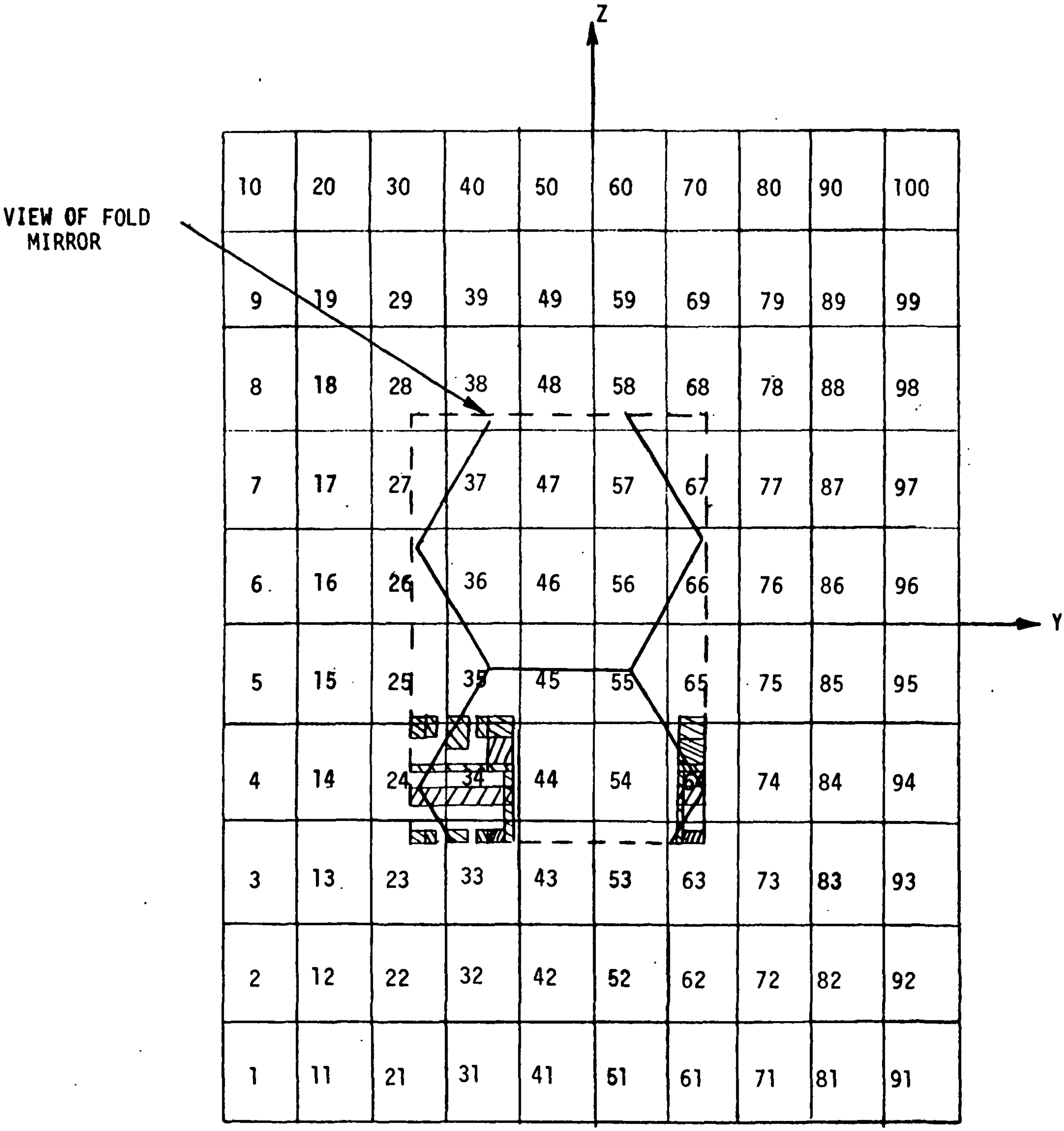
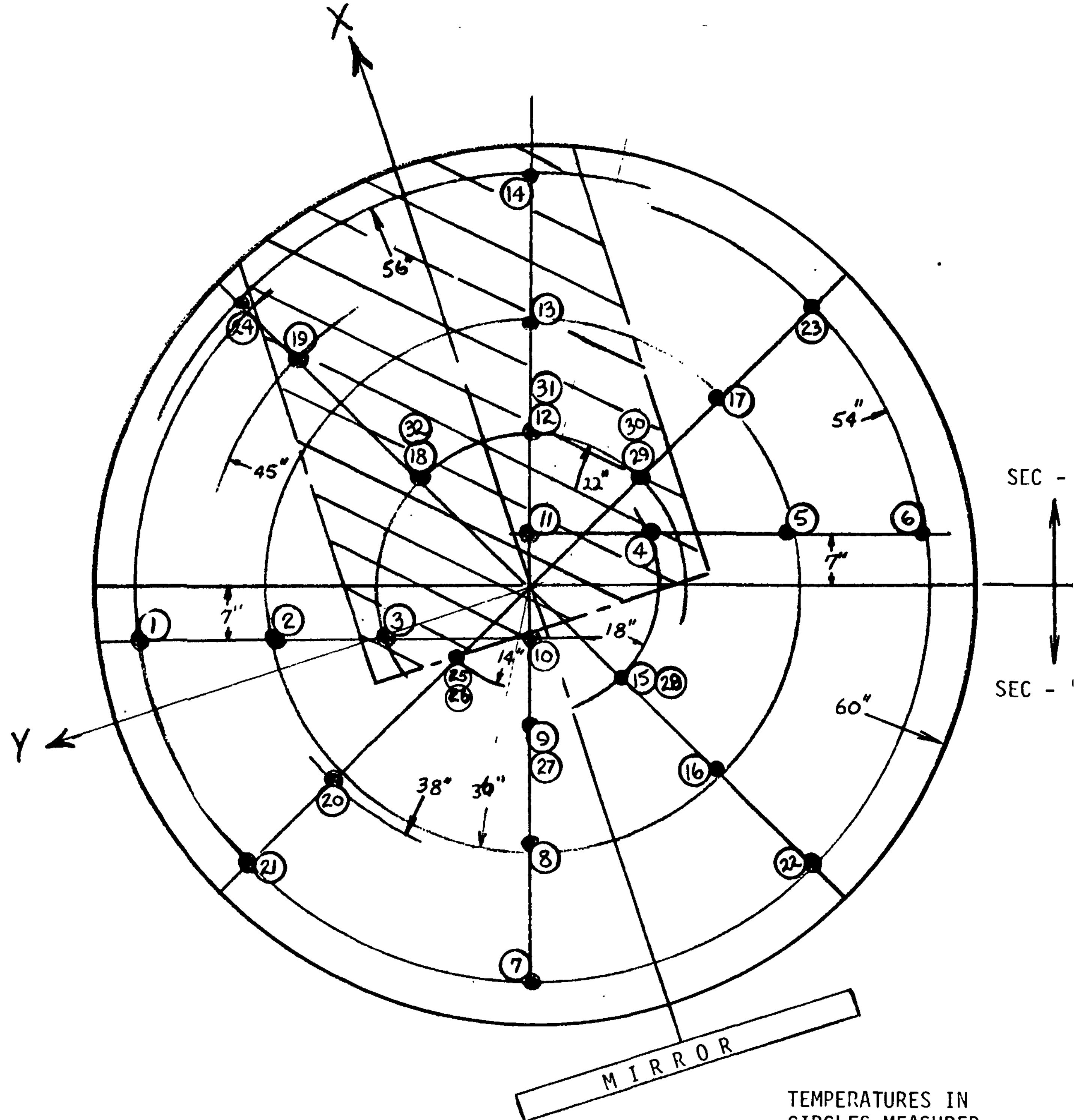


FIGURE D-3 SOLAR SCREEN SHADOWS FOR
MSC CHAMBER 33° SUN



VIEW IN -X DIRECTION

FIGURE D-4 SOLAR SCREEN SHADOWS FOR
FOR MSC CHAMBER 48° SUN



TEMPERATURES IN
CIRCLES MEASURED
DURING TESTING

FIGURE D-5 NASA-MSC CHAMBER B LUNAR FLOOR

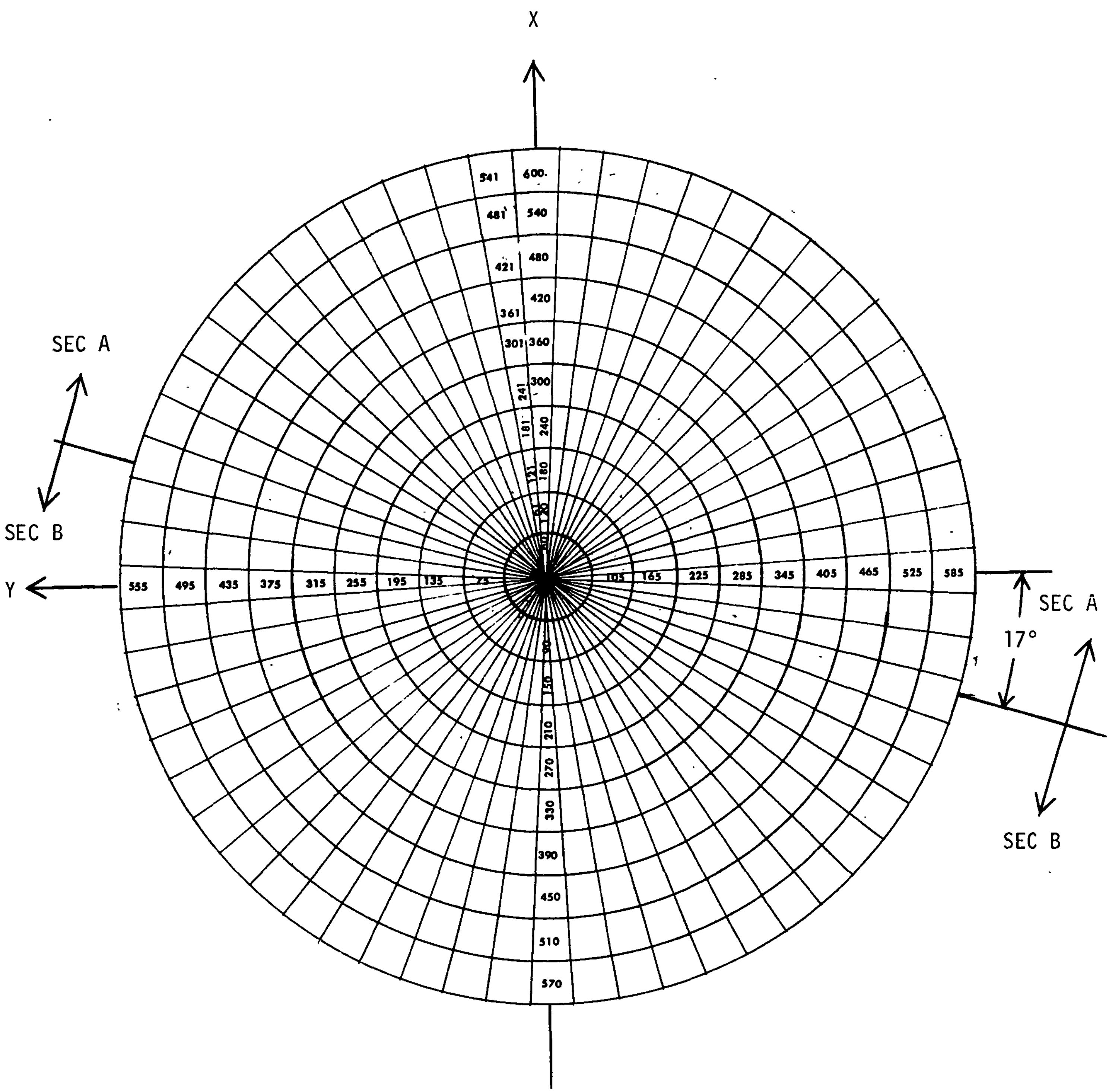
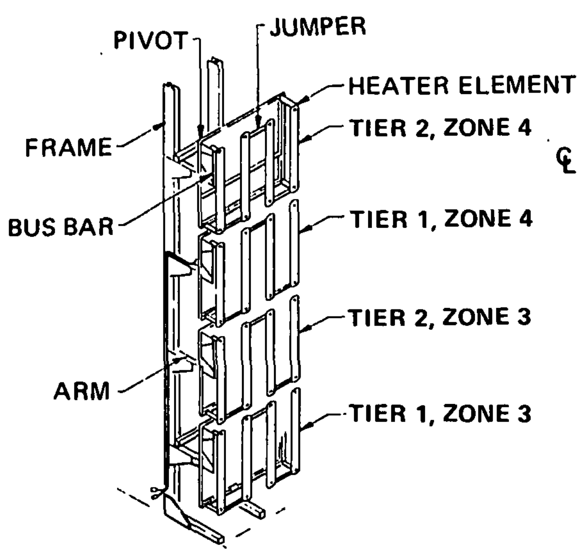
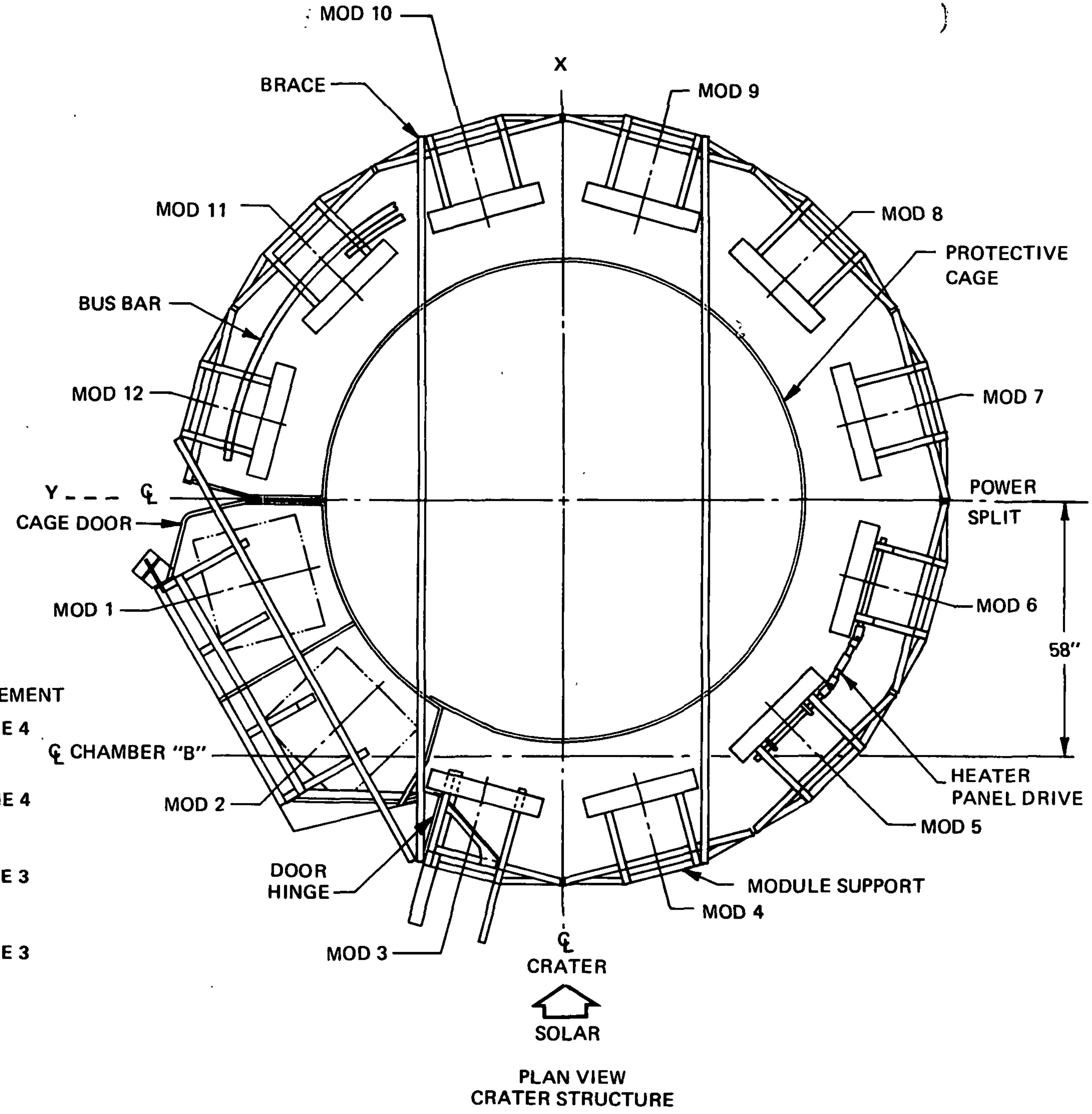


FIGURE D-6 MSC CHAMBER B LUNAR FLOOR NODAL MODEL





PLAN VIEW
CRATER STRUCTURE

FIGURE D-7 ILLUSTRATION OF MSC CHAMBER LSTS CONFIGURATION

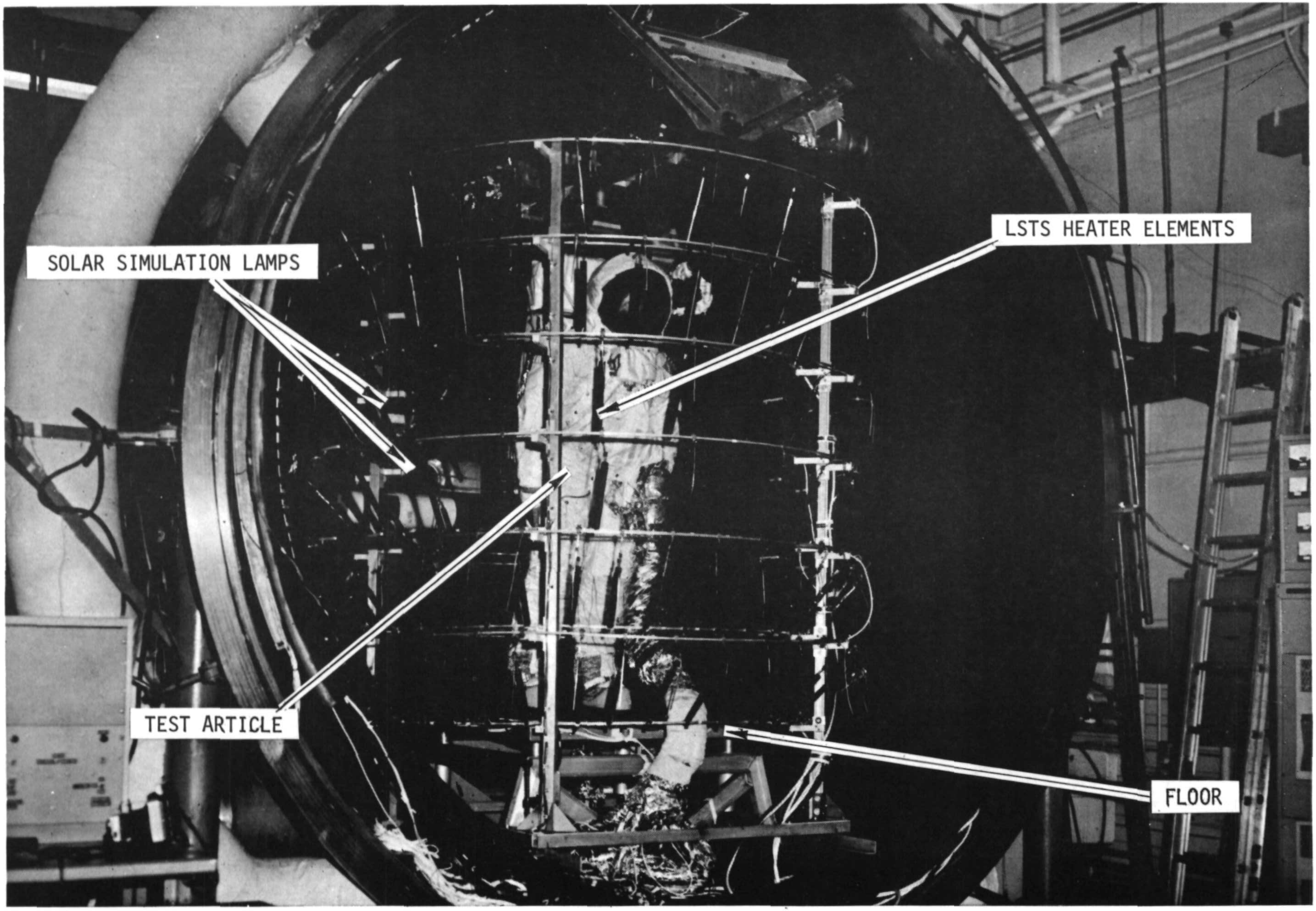


FIGURE D-8 LTV-VMSC CHAMBER CONFIGURATION

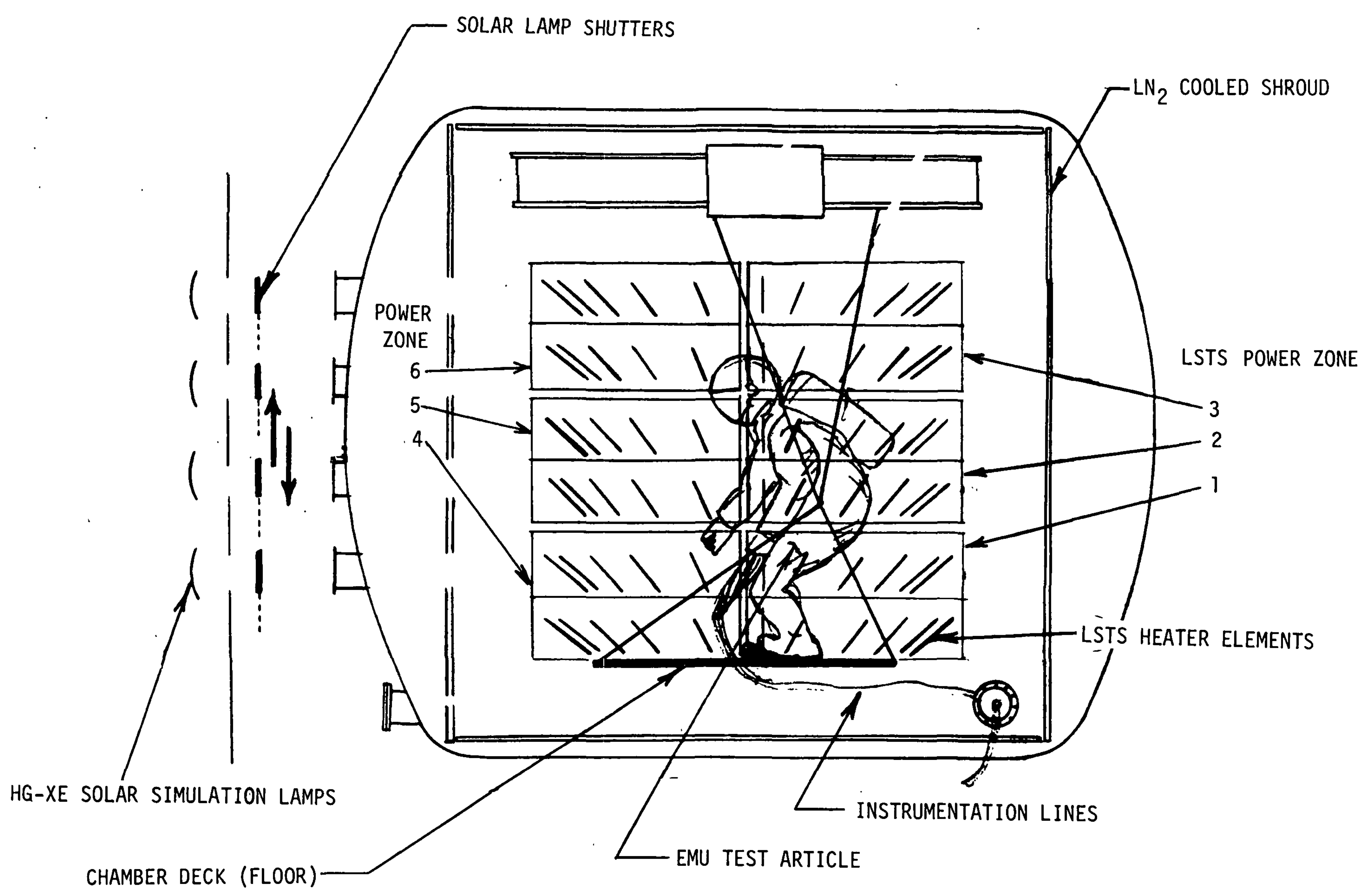


FIGURE D-9 LTV-VMSC CHAMBER SCHEMATIC

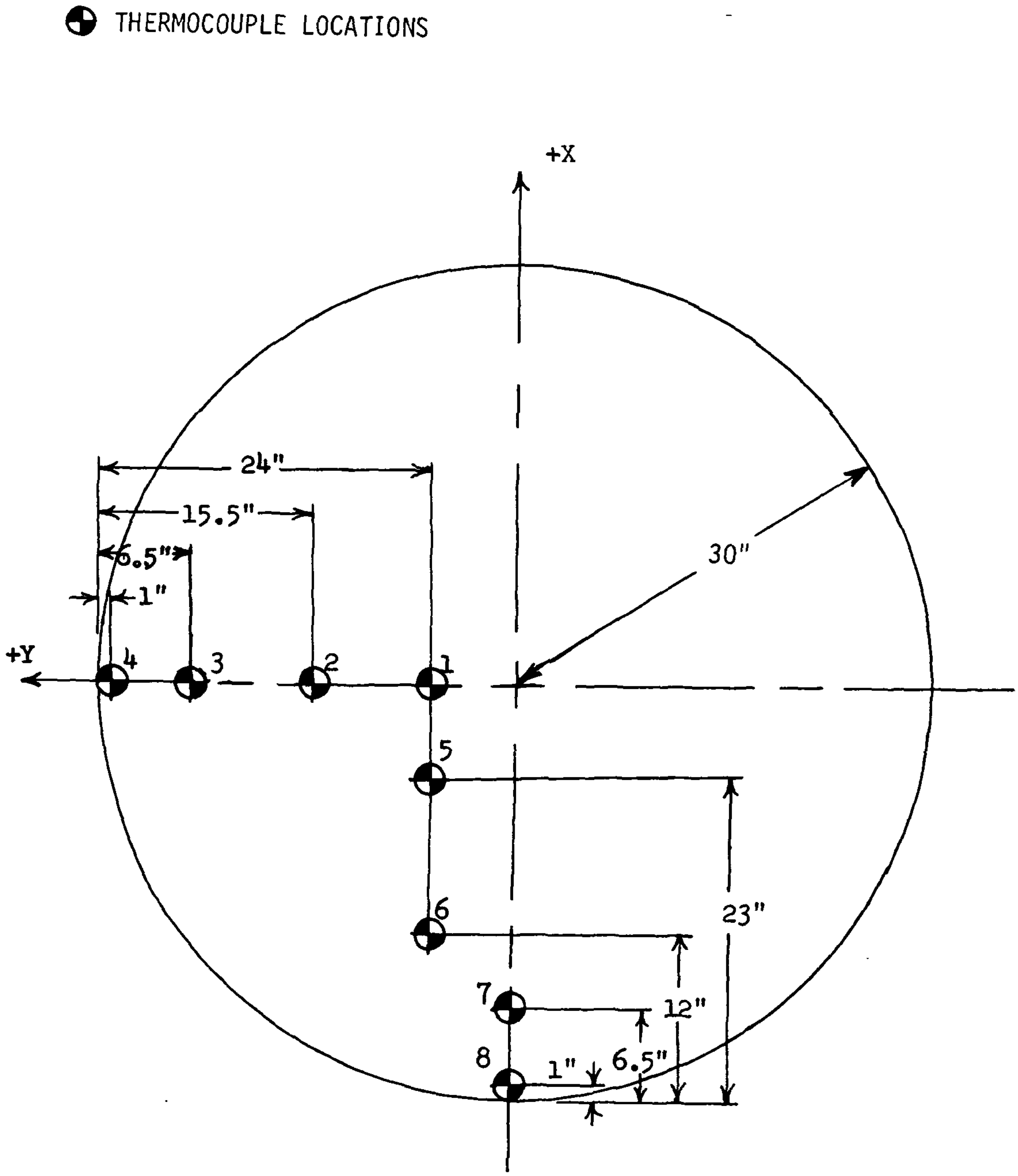


FIGURE D-10 LTV-VMSC LUNAR FLOOR

THERMOCOUPLE LOCATION

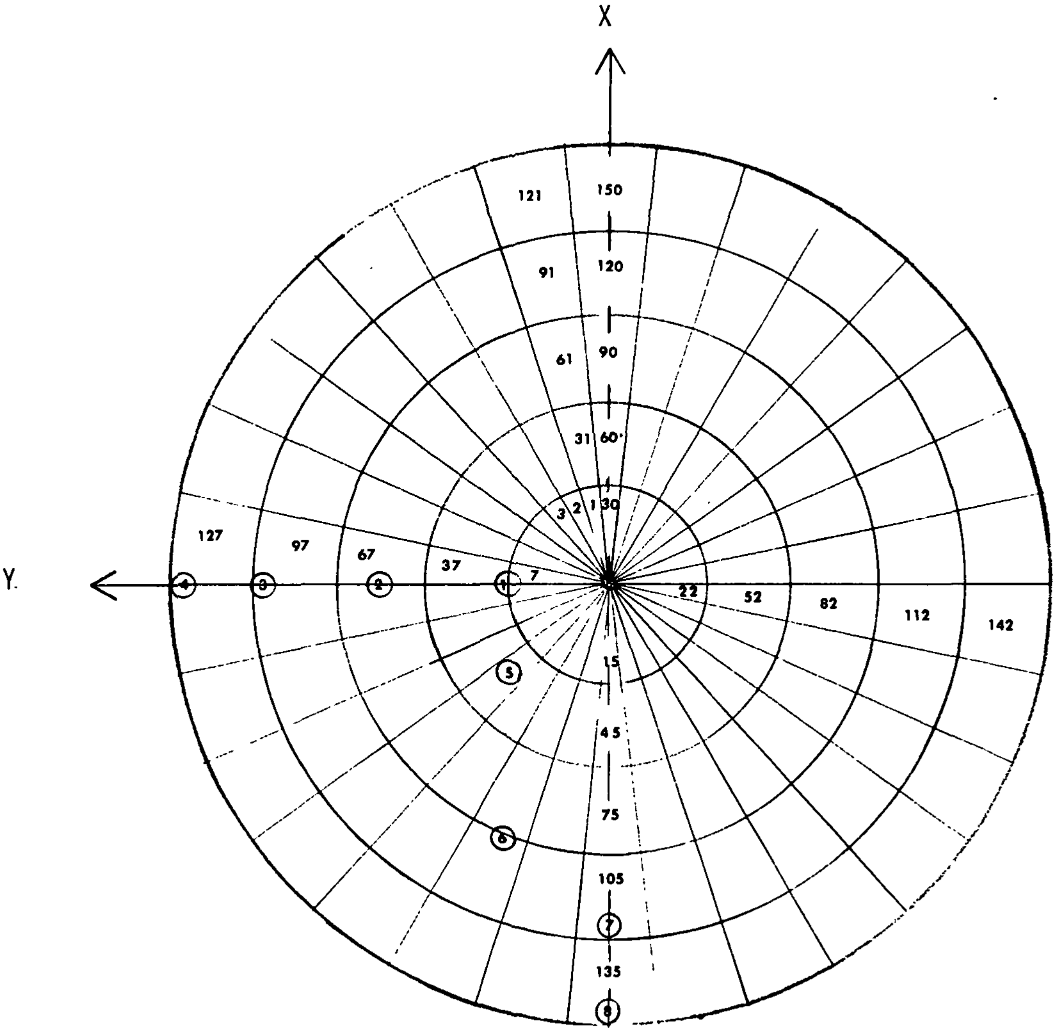


FIGURE D-11 LTV-VMSC LUNAR FLOOR NODAL MODEL

APPENDIX E

EHFR SAMPLE PROBLEMS

The results of two sample problems set up and run on the EHFR-4 to demonstrate the program capabilities are presented in this Appendix. Sample problem 1, discussed in Section 1.0, consists of the environment simulation of the Extravehicular Mobility Unit (EMU) manned qualification test, number 2. Sample problem 2, a demonstration type problem which exercises a great number of EHFR options, is described in Section 2.0. For each sample problem, the timeline desired for simulation is tabulated, the data cards input to the EHFR are listed, and the resulting EHFR output is shown. Due to the volume of EHFR output only selected pages of the output are presented.

1.0 EMU QUALIFICATION TEST ENVIRONMENT

Six manned qualification tests of the EMU were conducted during February and March 1969 in the MSC Space Environment Simulation Laboratory Chamber B. Environment analysis were performed with the EHFR program using measured test data and conditions. The partial analysis of the manned qualification test number 2 (lunar plain conditions with a 33° solar elevation) are presented herein as sample problem number 1. The results of the complete EMU test correlation analysis are documented by Hixon*.

The qualification test 2 timeline, from Hixon, is shown in Table E-1. EHFR-4 analysis was performed from the manlock pumpdown (15:55) thru approximately 45 minutes of "test time" (17:18). The data cards used for input to the EHFR-4 are listed on pages E-3 through E-6. Sample output is presented on pages E-7 through E-37.

2.0 SAMPLE PROBLEM 2

A demonstration type problem which exercises many of the EHFR environment options is presented herein as sample problem 2. The environments analyzed include: lunar plain with and without spacecraft surfaces nearby; multiple lunar crater; tape combining option with an MSC Chamber B TVC environment; intravehicular; and deep space conditions. The timeline run for the problem is tabulated in Table E-2 (Page E-38). Page E-39 presents the input data card listing, and pages E-40 through E-60 contain the sample problem output.

*Hixon, C. W., "Correlation No. I EMU Lunal Qualification Test," LTV Aerospace Corporation, Missiles and Space Division, Report 00.1314, 30 June 1970.

TABLE E-1 TEST 2 TIMELINE

REAL TIME	TEST TIME	EVENT
15:55		Begin manlock pumpdown
16:10		PLSS O_2 on, DIV. VLV. "MIN"
16:25		Pump on, fan on
16:26		Feedwater on
16:30		DIV. VLV. "INT"
16:31		Begin ingress
16:33		Crater & deck off
16:36		Middle of workstand (back to sun)
16:37		Sun visor down
16:40		Crater & deck power restored
16:41	0	Face to sun, sun turned on, start initial rest period at 550 BTU/HR nominal
16:51	00:10	Metabolic load = 1600 BTU/HR nominal
17:07	00:26	DIV. VLV. "MAX"
17:11	00:30	Metabolic load = 2000 BTU/HR nominal
17:26	00:45	End 2000 BTU/HR (CM side to sun)
17:29	00:48	Metabolic load = 1000 BTU/HR (Face to sun)
17:35	00:54	DIV. VLV. "INT"
17:40	00:59	DIV. VLV. "MAX"
17:43	1:02	Metabolic load = 550 BTU/HR nominal, right hand side to sun
17:44	1:03	DIV. VLV. "INT"
18:00	1:19	RIMS SCAN (for 13 min)
18:04	1:23	DIV. VLV. "MIN"
18:11	1:40	Back to sun

```
     TEST 2, 1POST TEST ANALYSIS.  LUNAR PLAIN, 33 DEG SUN.
                        1                 1         1
     4
     1   -2    1   -2    0
     2    5 0.95      1.0
   520.
   126.      126.      126.      126.      126.      126.      126.      126.      126.      126.
   126.      126.      126.      126.      126.      126.      126.      126.      126.      126.
   126.      126.      126.      126.      126.      126.      126.      126.      126.      126.
   126.      126.      126.      126.      126.      126.      126.      126.      126.      126.
   126.      126.      126.      126.      126.      126.      126.      126.      126.      126.
   126.      126.      126.      126.      126.      126.      126.      126.      126.      126.

     1    1 15.0      1.516
     0
     4
     1         1
    48.

    10   60 0.95      5.0
   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000
   620.000   620.000   620.000   620.000   620.000   624.000   624.000   624.000   624.000   624.000
   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000
   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000
   624.000   624.000   624.000   624.000   624.000   624.000   620.000   620.000   620.000   620.000
   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000
   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000
   620.000   620.000   620.000   620.000   620.000   624.000   624.000   624.000   624.000   624.000
   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000
   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000   624.000
   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000
   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000
   615.000   615.000   615.000   615.000   615.000   615.000   617.000   617.000   617.000   617.000
   617.000   617.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000
   620.000   620.000   620.000   620.000   620.000   620.000   622.000   622.000   622.000   622.000
   622.000   622.000   622.000   622.000   622.000   622.000   622.000   620.000   620.000   620.000
   620.000   617.000   617.000   617.000   617.000   617.000   617.000   615.000   615.000   615.000
   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000
   610.000   610.000   610.000   610.000   610.000   610.000   610.000   612.000   613.000   615.000
   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000
   615.000   615.000   615.000   615.000   620.000   620.000   620.000   620.000   620.000   620.000
   620.000   620.000   620.000   620.000   620.000   620.000   620.000   620.000   617.000   617.000
   617.000   617.000   617.000   617.000   615.000   615.000   615.000   610.000   610.000   610.000
   610.000   610.000   610.000   610.000   610.000   610.000   610.000   610.000   610.000   610.000
   605.000   605.000   605.000   605.000   605.000   605.000   605.000   607.000   607.000   610.000
   610.000   610.000   610.000   610.000   610.000   610.000   607.000   607.000   607.000   607.000
   610.000   610.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000
   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000   615.000
   615.000   615.000   615.000   615.000   612.000   610.000   607.000   605.000   605.000   605.000
```

605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.00
600.000	600.000	600.000	600.000	600.000	600.000	600.000	603.000	605.000	605.00
605.000	605.000	605.000	605.000	605.000	602.000	602.000	602.000	602.000	602.00
605.000	605.000	607.000	610.000	612.000	612.000	612.000	612.000	612.000	612.00
612.000	612.000	612.000	612.000	612.000	612.000	612.000	612.000	612.000	612.00
612.000	612.000	610.000	607.000	605.000	600.000	597.000	595.000	595.000	595.00
595.000	595.000	597.000	600.000	600.000	600.000	600.000	600.000	600.000	600.00
595.000	595.000	595.000	595.000	595.000	595.000	595.000	597.000	600.000	600.00
600.000	600.000	602.000	602.000	600.000	598.000	595.000	595.000	598.000	598.00
597.000	600.000	602.000	605.000	605.000	605.000	605.000	605.000	605.000	605.00
605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.00
605.000	605.000	605.000	605.000	600.000	595.000	590.000	590.000	590.000	590.00
590.000	590.000	590.000	590.000	590.000	593.000	593.000	593.000	593.000	593.00
587.000	587.000	587.000	587.000	587.000	587.000	590.000	590.000	592.000	595.00
595.000	597.000	597.000	597.000	595.000	592.000	592.000	590.000	590.000	590.00
590.000	595.000	595.000	595.000	597.000	600.000	600.000	600.000	600.000	600.00
600.000	600.000	600.000	600.000	600.000	600.000	600.000	600.000	600.000	600.00
600.000	600.000	597.000	595.000	592.000	587.000	585.000	583.000	580.000	580.00
580.000	583.000	583.000	583.000	585.000	585.000	585.000	585.000	585.000	585.00
580.000	580.000	580.000	580.000	580.000	580.000	580.000	583.000	585.000	588.00
590.000	592.000	593.000	593.000	590.000	587.000	587.000	585.000	585.000	585.00
585.000	585.000	588.000	590.000	592.000	593.000	595.000	595.000	595.000	595.00
595.000	595.000	595.000	595.000	595.000	595.000	595.000	595.000	595.000	590.00
590.000	590.000	590.000	588.000	585.000	583.000	577.000	575.000	575.000	575.00
575.000	575.000	575.000	575.000	575.000	575.000	575.000	577.000	577.000	577.00
570.000	570.000	570.000	570.000	570.000	570.000	575.000	575.000	580.000	585.00
588.000	590.000	588.000	588.000	585.000	585.000	583.000	580.000	580.000	577.00
577.000	580.000	580.000	585.000	585.000	590.000	590.000	590.000	590.000	590.00
590.000	590.000	590.000	590.000	590.000	590.000	590.000	587.000	585.000	585.00
582.000	580.000	580.000	580.000	575.000	573.000	570.000	567.000	567.000	567.00
568.000	567.000	568.000	567.000	567.000	567.000	568.000	568.000	567.000	570.00
0.	0.	13.	37.	54.	0.	1.	22.5	45.5	55.5
0.	2.	32.	54.	57.	0.	1.	22.5	45.5	55.5
1.5	1.5	16.5	28.5	51.5	2.3	7.3	27.3	38.8	49.5
3.	13.	38.	49.	47.5	2.3	7.3	27.3	38.8	49.5
3.	3.	20.	20.	49.	4.5	13.5	32.	32.	43.5
6.	24.	44.	44.	38.	4.5	13.5	32.	32.	43.5
4.	4.	8.	16.	20.	5.	2.	1.	12.	25.
12.	12.	8.	16.	30.	5.	2.	1.	12.	25.
4.	5.5	19.	39.	30.	3.5	2.5	5.	13.5	19.5
8.5	9.5	9.	18.5	35.	3.5	2.5	5.	13.5	19.5
4.	7.	30.	62.	40.	2.	3.	9.	15.	14.
5.	7.	10.	19.	40.	2.	3.	9.	15.	14.
395.	106.	316.	258.						
50.	60.								
50.	60.								
60.	60.								
40.	60.								
1 1	16.6	0.083				180.			
0									
4									
1	-1	0							
33.									
0.									
0.									
0.	0.	54.	100.6	94.	98.	133.	84.5		
		4.8	49.	270.	250.	299.	172.		
			62.5	471.	344.	318.	169.		
			188.	462.	317.	332.	181.		
0.		9.	74.	64.	111.	164.	46.5		
0.									
0.									
0.									

~~130.~~	~~144.~~	~~158.~~	~~156.~~	~~150.~~	~~122.~~	~~130.~~	~~152.~~	~~162.~~	~~164.~~
160.	152.	135.	108.	163.	150.	131.	151.	126.	135.
120.	133.	110.	108.	160.	160.	162.	163.	152.	150.
152.	150.								
0.	0.	13.	37.	54.	0.	1.	22.5	45.5	55.5
0.	2.	32.	54.	57.	0.	1.	22.5	45.5	55.5
1.5	1.5	16.5	28.5	51.5	2.3	7.3	27.3	38.8	49.5
3.	13.	38.	49.	47.5	2.3	7.3	27.3	38.8	49.5
3.	3.	20.	20.	49.	4.5	13.5	32.	32.	43.5
6.	24.	44.	44.	38.	4.5	13.5	32.	32.	43.5
24.	19.	18.	21.	20.	5.	2.	1.	12.	25.
12.	12.	8.	16.	30.	5.	2.	1.	12.	25.
24.	20.5	29.	44.	30.	3.5	2.5	5.	13.5	19.5
8.5	9.5	9.	18.5	35.	3.5	2.5	5.	13.5	19.5
24.	22.	40.	67.	40.	2.	3.	9.	15.	14.
5.	7.	10.	19.	40.	2.	3.	9.	15.	14.
1 1	16.684	0.149				180.			
0									
4									
1 1	-1 -1	-1							
10 10	33.	13.4	10.	1.0					
0.24	0.615	0.6	.45	0.55	0.51	0.33	1.0	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.									
0.									
0.		54.	100.6	94.	98.	133.	84.5		
		96.	89.	271.	250.	299.	172.		
		117.	313.	471.	344.	318.	169.		
		145.	376.	462.	317.	332.	181.		
0.		54.	74.	64.	111.	164.	46.5		
0.									
0.									
0.									
1 1	16.834	0.131				180.			
0									
4									
1 1	-1 -1	-1							
10 10	33.	13.4	10.	1.0					
0.24	0.615	0.6	.45	0.55	0.51	0.33	1.0	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.									
0.									
0.		54.	100.6	94.	98.	133.	84.5		
		96.	85.	54.	62.	290.	172.		
		117.	250.			264.	169.		
		145.	338.	46.	42.	316.	181.		
0.		54.	74.	64.	111.	164.	46.5		
0.									
0.									
0.									
1 1	16.966	0.033				180.			
0									
4									
1 1	-1 -1	-1							
10 10	33.	13.4	10.	1.0					
0.24	0.615	0.6	.45	0.55	0.51	0.33	1.0	0.1	0.1
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0.									
0.									
0.		54.	100.6	94.	98.	133.	84.5		
		96.	89.	271.	250.	299.	172.		
		117.	313.	471.	344.	318.	169.		
		145.	376.	462.	317.	332.	181.		

```
0.               54.    74.    64.    111.   164.   46.5
0.
0.
0.
1   1 17.0       0.09                        180.
 0
4
1   1  -1   -1   -1
10  10 33.       13.4   10.    1.0
0.24     0.615   0.6     .45     0.55  0.51  0.33   1.0   0.1   0.
0.1      0.1     0.1    0.1      0.1   0.1   0.1    0.1   0.1   0.
0.
0.
0.               54.    100.6  94.    98.    133.   84.5
                 96.    85.    54.    62.    290.   172.
                 117.   250.                 264.   169.
                 145.   338.   46.    42.    316.   181.
0.               54.    74.    64.    111.   164.   46.5
0.
0.
0.
1   1 17.1       0.19                        180.
      -22.
00212
```

THE ENVIRONMENTAL HEAT FLUX ROUTINE

VERSION 4

(EHFR =4)

FOR THE CALCULATION OF

RADIANT ENERGY ABSORPTION

BY THE

APOLLO EXTRAVEHICULAR MOBILITY UNIT

APOLLO EMU REFERENCE COORDINATE SYSTEM.

APOLLO EMU IN A BENDING MODE, (MODE NUMBER 1). THERE ARE 349 NODES FOR THIS MODE.

NODE NUMBER	NODE NAME	X (IN)	Y (IN)	Z (IN)	AZIMUTH (DEG)	INCLN (DEG)	AREA (FT**2)	VIEW QUAD 1	VIEW QUAD 2	VIEW QUAD 3	VIEW QUAD 4
1	01.11	4,200	-6.000	.000	.000	-90.000	.5940	.250	.250	.250	.250
2	01.21	11,000	-6.000	1.500	.000	.000	.1312	.250	.249	.250	.250
3	01.22	3,850	-2.850	2.410	90.000	.000	.3765	.001	.147	.250	.250
4	01.23	-2,200	-3.800	3.130	135.000	.000	.1166	.153	.242	.250	.202
5	01.24	-3,150	-6.000	3.130	180.000	.000	.1085	.241	.250	.250	.250
6	01.25	-2,200	-8.200	3.130	225.000	.000	.1166	.249	.250	.250	.250
7	01.26	3,850	-9.150	2.410	270.000	.000	.3765	.250	.249	.250	.250
8	01.31	9,000	-6.000	3.000	.000	90.000	.1750	.250	.250	.003	.156
9	01.32	3,800	-8.520	5.170	315.000	51.400	.0486	.162	.178	.248	.250
10	01.33	5,350	-6.000	4.390	.000	49.800	.1539	.228	.125	.230	.186
11	01.34	3,800	-3.480	5.170	45.000	51.400	.0486	.207	.097	.082	.250
12	02.11	4,200	6.000	.000	.000	-90.000	.5940	.250	.250	.250	.250
13	02.21	11,000	6.000	1.500	.000	.000	.1312	.249	.250	.250	.250
14	02.22	3,850	9.150	2.410	90.000	.000	.3765	.249	.250	.250	.250
15	02.23	-2,200	8.200	3.130	135.000	.000	.1166	.250	.249	.250	.250
16	02.24	-3,150	6.000	3.130	180.000	.000	.1085	.250	.241	.250	.250
17	02.25	-2,200	3.800	3.130	225.000	.000	.1166	.242	.154	.202	.250
18	02.26	3,850	2.850	2.410	270.000	.000	.3765	.000	.241	.250	.250
19	02.31	9,000	6.000	3.000	.000	90.000	.1750	.250	.250	.198	.000
20	02.32	3,800	3.480	5.170	315.000	51.400	.0486	.105	.200	.250	.082
21	02.33	5,350	6.000	4.390	.000	49.800	.1539	.131	.222	.250	.167
22	02.34	3,800	8.520	5.170	45.000	51.400	.0486	.177	.162	.250	.248
23	03.11	2,560	-8.510	11.830	315.000	-4.900	.2278	.246	.248	.216	.250
24	03.12	3,650	-5.950	11.900	.000	-5.100	.2211	.246	.243	.231	.183
25	03.13	2,560	-3.380	11.830	45.000	-5.600	.2281	.245	.074	.170	.216
26	03.14	,000	-2.300	11.900	90.000	-5.600	.2213	.000	.177	.239	.173
27	03.15	-2,560	-3.380	11.830	135.000	-5.600	.2281	.085	.237	.249	.223
28	03.16	-3,650	-5.950	11.900	180.000	-5.100	.2211	.238	.250	.249	.250
29	03.17	-2,560	-8.510	11.830	225.000	-4.900	.2278	.250	.250	.249	.250
30	03.18	,000	-9.600	11.900	270.000	-4.500	.2209	.250	.248	.249	.250
31	03.21	3,330	-9.150	23.500	315.000	-4.900	.3357	.224	.239	.246	.250
32	03.22	4,700	-5.820	23.520	.000	-5.300	.3400	.229	.233	.245	.243
33	03.23	3,330	-2.490	23.500	45.000	-5.800	.3363	.243	.003	.213	.246
34	03.24	,000	-1.120	23.520	90.000	-5.900	.3404	.000	.139	.200	.161
35	03.25	-3,330	-2.490	23.500	135.000	-5.800	.3363	.027	.203	.250	.225
36	03.26	-4,700	-5.820	23.520	180.000	-5.300	.3400	.198	.250	.250	.250
37	03.27	-3,330	-9.150	23.500	225.000	-4.900	.3357	.250	.250	.250	.250
38	03.28	,000	-10.520	23.520	270.000	-4.600	.3396	.250	.240	.250	.250
39	04.11	2,560	3.380	11.830	315.000	-5.600	.2281	.077	.245	.216	.170
40	04.12	3,650	5.950	11.900	.000	-5.100	.2211	.244	.245	.183	.231
41	04.13	2,560	8.510	11.830	45.000	-4.900	.2278	.248	.246	.250	.216
42	04.14	,000	9.600	11.900	90.000	-4.500	.2209	.248	.250	.250	.249
43	04.15	-2,560	8.510	11.830	135.000	-4.900	.2278	.250	.250	.250	.249
44	04.16	-3,650	5.950	11.900	180.000	-5.100	.2211	.250	.238	.250	.249
45	04.17	-2,560	3.380	11.830	225.000	-5.600	.2281	.237	.085	.223	.249

APOLLO EMU REFERENCE COORDINATE SYSTEM.

APOLLO EMU IN A WALKING MODE. (MODE NUMBER 2). THERE ARE 349 NODES FOR THIS MODE.

NODE NUMBER	NODE NAME	X (IN)	Y (IN)	Z (IN)	AZIMUTH (DEG)	INCLN (DEG)	AREA (FT**2)	VIEW QUAD 1	VIEW QUAD 2	VIEW QUAD 3	VIEW QUAD 4
1	01.11	.680	-6.000	1.560	180.000	-62.500	.5940	.250	.250	.250	.250
2	01.21	7.400	-6.000	-.250	.000	-27.500	.1312	.250	.249	.250	.250
3	01.22	1.480	-2.850	3.860	90.000	.000	.3765	.001	.147	.250	.250
4	01.23	-3.550	-3.800	7.290	131.600	19.100	.1166	.153	.242	.250	.202
5	01.24	-4.400	-6.000	7.730	180.000	.000	.1085	.241	.250	.250	.250
6	01.25	-3.550	-8.200	7.290	-131.600	19.100	.1166	.249	.250	.250	.250
7	01.26	1.480	-9.150	3.860	-90.000	.000	.3765	.250	.249	.250	.250
8	01.31	6.320	-6.000	2.000	.000	62.500	.1750	.250	.250	.003	.156
9	01.32	2.710	-8.520	6.330	-30.400	29.300	.0486	.162	.178	.248	.250
10	01.33	3.730	-6.000	4.920	.000	22.300	.1539	.228	.125	.230	.186
11	01.34	2.710	-3.480	6.330	30.400	29.300	.0486	.207	.097	.082	.250
12	02.11	4.200	6.000	.000	.000	-90.000	.5940	.250	.250	.250	.250
13	02.21	11.000	6.000	1.500	.000	.000	.1312	.249	.250	.250	.250
14	02.22	3.850	9.150	2.410	90.000	.000	.3765	.249	.250	.250	.250
15	02.23	-2.200	8.200	3.130	135.000	.000	.1166	.250	.249	.250	.250
16	02.24	-3.150	6.000	3.130	180.000	.000	.1085	.250	.241	.250	.250
17	02.25	-2.200	3.800	3.130	225.000	.000	.1166	.242	.154	.202	.250
18	02.26	3.850	2.850	2.410	270.000	.000	.3765	.000	.241	.250	.250
19	02.31	9.000	6.000	3.000	.000	90.000	.1750	.250	.250	.198	.000
20	02.32	3.800	3.480	5.170	315.000	51.400	.0486	.105	.200	.250	.082
21	02.33	5.350	6.000	4.390	.000	49.800	.1539	.131	.222	.250	.167
22	02.34	3.800	8.520	5.170	45.000	51.400	.0486	.177	.162	.250	.248
23	03.11	4.690	-8.510	12.810	-50.300	-23.700	.2278	.246	.248	.216	.250
24	03.12	5.680	-5.950	12.370	.000	-32.600	.2211	.246	.243	.231	.183
25	03.13	4.690	-3.380	12.810	50.300	-23.700	.2281	.245	.074	.170	.216
26	03.14	2.450	-2.300	14.050	92.100	-4.000	.2213	.000	.177	.239	.173
27	03.15	.140	-3.380	15.170	133.300	14.500	.2281	.085	.237	.249	.223
28	03.16	-.790	-5.950	15.740	180.000	22.400	.2211	.238	.250	.249	.250
29	03.17	.140	-8.510	15.170	-133.300	14.500	.2278	.250	.250	.249	.250
30	03.18	.450	-9.600	14.050	-92.100	-4.000	.2209	.250	.248	.249	.250
31	03.21	6.260	-9.150	25.710	-46.400	13.400	.3357	.224	.239	.246	.250
32	03.22	7.480	-5.820	26.330	.000	20.700	.3400	.229	.233	.245	.243
33	03.23	6.260	-2.490	25.710	46.400	13.400	.3363	.243	.003	.213	.246
34	03.24	3.260	-1.120	24.270	87.900	-4.100	.3404	.000	.139	.200	.161
35	03.25	.270	-2.480	22.790	130.200	-22.700	.3363	.027	.203	.250	.225
36	03.26	-.970	-5.820	22.210	180.000	-31.300	.3400	.198	.250	.250	.250
37	03.27	.270	-9.150	22.790	-130.200	-22.700	.3357	.250	.250	.250	.250
38	03.28	3.260	-10.520	24.270	-87.900	-4.100	.3396	.250	.240	.250	.250
39	04.11	2.560	3.380	11.830	315.000	-5.600	.2281	.077	.245	.216	.170
40	04.12	3.650	5.950	11.900	.000	-5.100	.2211	.244	.245	.183	.231
41	04.13	2.560	8.510	11.830	45.000	-4.900	.2278	.248	.246	.250	.216
42	04.14	.000	9.600	11.900	90.000	-4.500	.2209	.248	.250	.250	.249
43	04.15	-2.560	8.510	11.830	135.000	-4.900	.2278	.250	.250	.250	.249
44	04.16	-3.650	5.950	11.900	180.000	-5.100	.2211	.250	.238	.250	.249
45	04.17	-2.560	3.380	11.830	225.000	-5.600	.2281	.237	.085	.223	.249

APOLLO EMU REFERENCE COORDINATE SYSTEM.

APOLLO EMU IN A KNEELING MODE, (MODE NUMBER 3). THERE ARE 349 NODES FOR THIS MODE.

NODE NUMBER	NODE NAME	X (IN)	Y (IN)	Z (IN)	AZIMUTH (DEG)	INCLN (DEG)	AREA (FT**2)	VIEW QUAD 1	VIEW QUAD 2	VIEW QUAD 3	VIEW QUAD 4
1	01•11	-10.790	-6.000	4.910	180.000	17.000	.5940	.250	.250	.250	.250
2	01•21	-11.340	-6.000	.000	180.000	-73.000	.1312	.250	.249	.250	.250
3	01•22	-8.380	-2.850	4.540	90.000	.000	.3765	.001	.147	.250	.250
4	01•23	-5.930	-3.800	10.110	73.700	42.600	.1166	.153	.242	.250	.202
5	01•24	-5.650	-6.000	11.020	.000	73.000	.1085	.241	.250	.250	.250
6	01•25	-5.930	-8.200	10.110	-73.700	42.500	.1166	.249	.250	.250	.250
7	01•26	-8.380	-9.150	4.540	-90.000	.000	.3765	.250	.249	.250	.250
8	01•31	-9.330	-6.000	.000	.000	-17.000	.1750	.250	.250	.003	.156
9	01•32	-5.730	-8.520	3.780	35.500	-40.600	.0486	.162	.178	.248	.250
10	01•33	-6.930	-6.000	2.520	.000	-57.200	.1539	.228	.125	.230	.186
11	01•34	-5.730	-3.480	3.780	35.500	-40.600	.0486	.207	.097	.082	.250
12	02•11	-10.790	6.000	4.910	180.000	17.000	.5940	.250	.250	.250	.250
13	02•21	-11.340	6.000	.000	180.000	-73.000	.1312	.249	.250	.250	.250
14	02•22	-8.380	9.150	4.540	90.000	.000	.3765	.249	.250	.250	.250
15	02•23	-5.390	8.200	10.110	73.700	42.600	.1166	.250	.249	.250	.250
16	02•24	-5.650	6.000	11.020	.000	73.000	.1085	.250	.241	.250	.250
17	02•25	-5.930	3.800	10.110	-73.700	42.600	.1166	.242	.154	.202	.250
18	02•26	-8.380	2.850	4.540	-90.000	.000	.3765	.000	.241	.250	.250
19	02•31	-9.330	6.000	.000	.000	-17.000	.1750	.250	.250	.198	.000
20	02•32	-5.730	3.480	3.780	35.500	-40.600	.0486	.105	.200	.250	.082
21	02•33	-6.930	6.000	2.520	.000	-57.200	.1539	.131	.222	.250	.167
22	02•34	-5.730	8.520	3.780	35.500	-40.600	.0486	.177	.162	.250	.248
23	03•11	1.000	-3.380	3.020	-112.200	-40.500	.2278	.246	.248	.216	.250
24	03•12	.750	-5.950	1.950	180.000	-67.900	.2211	.246	.243	.231	.183
25	03•13	1.000	-8.510	3.020	112.200	-40.500	.2281	.245	.074	.170	.216
26	03•14	1.820	-9.600	5.440	94.300	1.300	.2213	.000	.177	.239	.173
27	03•15	2.500	-8.510	7.910	80.000	44.300	.2281	.085	.237	.249	.223
28	03•16	2.880	-5.950	8.940	.000	78.100	.2211	.238	.250	.249	.250
29	03•17	2.500	-3.380	7.910	-80.000	44.300	.2278	.250	.250	.249	.250
30	03•18	1.820	-2.300	5.440	-94.300	1.300	.2209	.250	.248	.249	.250
31	03•21	4.900	-2.490	11.940	-45.000	4.500	.3357	.224	.239	.246	.250
32	03•22	6.230	-5.820	12.270	.000	8.000	.3400	.229	.233	.245	.243
33	03•23	4.900	-9.150	11.940	45.000	4.500	.3363	.243	.003	.213	.246
34	03•24	1.660	-10.520	11.190	88.900	-4.500	.3404	.000	.139	.200	.161
35	03•25	-1.580	-9.150	10.410	133.400	-14.200	.3363	.027	.203	.250	.225
36	03•26	-2.920	-5.820	10.110	180.000	-18.600	.3400	.198	.250	.250	.250
37	03•27	-1.580	-2.490	10.410	-133.400	-14.200	.3357	.250	.250	.250	.250
38	03•28	1.660	-1.120	11.190	-88.900	-4.500	.3396	.250	.240	.250	.250
39	04•11	1.000	3.380	3.020	-112.200	-40.500	.2281	.077	.245	.216	.170
40	04•12	.750	5.950	1.950	180.000	-67.900	.2211	.244	.245	.183	.231
41	04•13	1.000	8.510	3.020	112.200	-40.500	.2278	.248	.246	.250	.216
42	04•14	1.820	9.600	5.440	94.300	1.300	.2209	.248	.250	.250	.249
43	04•15	2.500	8.510	7.910	80.000	44.300	.2278	.250	.250	.250	.249
44	04•16	2.880	5.950	8.940	.000	78.100	.2211	.250	.238	.250	.249
45	04•17	2.500	3.380	7.910	-80.000	44.300	.2281	.237	.085	.223	.249

NODE MATERIAL NUMBER DATA.

NODE NUMBER	NODE NAME	MATERIAL NUMBER	NODE NUMBER	NODE NAME	MATERIAL NUMBER	NODE NUMBER	NODE NAME	MATERIAL NUMBER	NODE NUMBER	NODE NAME	MATERIAL NUMBER	NODE NUMBER	NODE NAME	MATERIAL NUMBER
1	01.11	3	2	01.21	3	3	01.22	3	4	01.23	3	5	01.24	3
6	01.25	3	7	01.26	3	8	01.31	3	9	01.32	2	10	01.33	1
11	01.34	2	12	02.11	3	13	02.21	3	14	02.22	3	15	02.23	3
16	02.24	3	17	02.25	3	18	02.26	3	19	02.31	3	20	02.32	2
21	02.33	1	22	02.34	2	23	03.11	1	24	03.12	1	25	03.13	1
26	03.14	1	27	03.15	1	28	03.16	1	29	03.17	1	30	03.18	1
31	03.21	1	32	03.22	1	33	03.23	1	34	03.24	1	35	03.25	1
36	03.26	1	37	03.27	1	38	03.28	1	39	04.11	1	40	04.12	1
41	04.13	1	42	04.14	1	43	04.15	1	44	04.16	1	45	04.17	1
46	04.18	1	47	04.21	1	48	04.22	1	49	04.23	1	50	04.24	1
51	04.25	1	52	04.26	1	53	04.27	1	54	04.28	1	55	05.11	1
56	05.12	1	57	05.13	1	58	05.14	1	59	05.21	1	60	05.22	1
61	05.23	1	62	05.24	1	63	05.25	1	64	05.26	1	65	05.27	1
66	05.28	1	67	05.29	1	68	05.31	1	69	05.32	1	70	05.33	1
71	05.34	1	72	05.35	1	73	05.36	1	74	05.37	1	75	05.38	1
76	05.39	1	77	05.41	1	78	05.42	1	79	05.43	1	80	05.44	1
81	05.45	1	82	05.46	1	83	05.47	1	84	05.48	1	85	06.11	1
86	06.12	1	87	06.13	1	88	06.14	1	89	06.15	1	90	06.16	1
91	06.17	1	92	06.18	1	93	07.11	1	94	07.12	1	95	07.13	1
96	07.14	1	97	07.15	1	98	07.16	1	99	07.21	1	100	07.22	1
101	07.23	1	102	07.31	1	103	07.32	1	104	07.33	1	105	07.34	1
106	07.35	1	107	07.36	1	108	08.11	1	109	08.12	1	110	08.13	1
111	08.14	1	112	08.15	1	113	08.16	1	114	08.17	1	115	08.18	1
116	08.21	1	117	08.22	1	118	08.23	1	119	08.24	1	120	09.11	1
121	09.12	1	122	09.13	1	123	09.14	1	124	09.15	1	125	09.16	1
126	09.17	1	127	09.18	1	128	09.19	1	129	09.21	1	130	09.22	1
131	09.23	1	132	09.24	1	133	09.25	1	134	09.26	1	135	09.27	1
136	10.11	1	137	10.12	1	138	10.13	1	139	10.14	1	140	10.15	1
141	10.16	1	142	10.17	1	143	10.18	1	144	10.19	1	145	10.21	1
146	10.22	1	147	10.23	1	148	10.24	1	149	10.25	1	150	10.26	1
151	10.27	1	152	11.11	1	153	11.12	1	154	11.13	1	155	11.14	1
156	11.15	1	157	11.16	1	158	11.17	1	159	11.18	1	160	11.21	1
161	11.22	1	162	11.23	1	163	11.24	1	164	11.25	1	165	11.26	1
166	11.27	1	167	11.28	1	168	12.11	1	169	12.12	1	170	12.13	1
171	12.14	1	172	12.15	1	173	12.16	1	174	12.17	1	175	12.18	1
176	12.21	1	177	12.22	1	178	12.23	1	179	12.24	1	180	12.25	1
181	12.26	1	182	12.27	1	183	12.28	1	184	13.11	2	185	13.12	3
186	13.16	2	187	13.17	3	188	14.11	2	189	14.12	3	190	14.16	2
191	14.17	3	192	15.11	1	193	15.12	1	194	15.13	1	195	15.14	1
196	15.16	1	197	15.16	1	198	15.21	1	199	15.22	1	200	15.23	1
201	15.24	1	202	15.25	1	203	15.26	1	204	15.31	1	205	15.36	1
206	15.41	1	207	15.42	1	208	15.43	1	209	15.44	1	210	15.45	1
211	15.46	1	212	15.51	1	213	15.52	1	214	15.53	1	215	15.54	1
216	15.55	1	217	15.56	1	218	15.61	1	219	15.62	1	220	15.63	1
221	15.64	1	222	15.65	1	223	15.66	1	224	15.71	1	225	15.72	1

ABSORPTIVITY - TEMPERATURE CUFVE DATA.

TEMP (DEG R)	TF BTA MATRL 1	TEMP (DEG R)	CHRO R MATRL 2	TEMP (DEG R)	RUBBER MATRL 3	TEMP (DEG R)	POLYSL MATRL 4	TEMP (DEG R)	RED CN MATRL 5
.0	.9000	.0	.4000	.0	.9000	.0	.9000	.0	.9100
700.0	.9000	760.0	.4000	1460.0	.9000	1460.0	.9000	1500.0	.9100
800.0	.8850	960.0	.4050	1760.0	.8840	1660.0	.8900	7500.0	.5500
900.0	.8620	1160.0	.4100	1960.0	.8650	1960.0	.8650	11000.0	.5500
1000.0	.8400	1460.0	.4200	2460.0	.8020	2460.0	.8020	11000.0	.5500
1150.0	.7930	1960.0	.4300	2960.0	.7560	2960.0	.7280	11000.0	.5500
1350.0	.7340	3460.0	.4800	3960.0	.6950	3460.0	.6620	11000.0	.5500
1750.0	.6180	5460.0	.5330	5460.0	.6420	4460.0	.5720	11000.0	.5500
1950.0	.5650	9960.0	.6150	7460.0	.6080	6460.0	.4830	11000.0	.5500
11000.0	.2300	11000.0	.6150	11000.0	.6000	11000.0	.4500	11000.0	.5500

APOLLO EMU IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

PRINT OF CHAMBER DATA INPUT OR DATA UPDATE.

SOLAR LAMPS ARE NOT ON. NO SOAR SCREEN CALCULATIONS ARE TO BE MADE.

CHAMBER FLOOR DATA.

FLOOR RADIUS (FT) = 1.00
NUMBER OF RADIAL FLOOR NODES = 2
NUMBER OF ANGULAR FLOOR NODES = 5
FLOOR EMISSIVITY = .950

FLOOR NODE TEMPERATURES, DEG R.

520.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

BACKGROUND DATA.

	I.R. BACKGROUND, BTU/HR*FT2					SOLAR BACKGROUND, BTU/HR*FT2				
Z=1.0 THETA =	-90.0	-45.0	.0	45.0	90.0	-90.0	-45.0	.0	45.0	90.0
PHI = .0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
PHI = 90.0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
PHI =180.0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
PHI =270.0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
Z=3.0 THETA =	-90.0	-45.0	.0	45.0	90.0	-90.0	-45.0	.0	45.0	90.0
PHI = .0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
PHI = 90.0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
PHI =180.0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
PHI =270.0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
Z=5.0 THETA =	-90.0	-45.0	.0	45.0	90.0	-90.0	-45.0	.0	45.0	90.0
PHI = .0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
PHI = 90.0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
PHI =180.0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00
PHI =270.0	126.00	126.00	126.00	126.00	126.00	.00	.00	.00	.00	.00

LSTS HEATERS ARE NOT ON. NO LSTS HEAT CALCULATIONS ARE TO BE MADE.

TIME (HR) 15.000

TEST 2, IPOST TEST ANALYSIS. LUNAR PLAIN, 33 DEG SUN.

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = .00

AVERAGE FLOOR TEMPERATURE (DEG F) =-408.00 FLOOR EMISSIVITY = .950

LSTS HEATERS ARE NOT ON. NO LSTS HEAT CALCULATIONS ARE TO BE MADE.

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	.0	520.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE	ZONE	ZONE
	ITMG		2294.1	2549.0	.0	.0	1.4	2292.8				
	VISOR		134.2	149.1	.0	.0	.0	134.2				
	HELMT		149.1	165.6	.0	.0	.0	149.1				
	PLSS		957.3	1064.6	.0	.0	.5	956.8				
	OPS		475.0	527.3	.0	.0	.1	475.0				
	RCU		46.6	53.9	.0	.0	.0	46.6				
	BOOTS		452.4	512.7	.0	.0	9.2	443.2				
	GLOVS		60.1	124.9	.0	.0	.0	60.1				
	UMBIL		206.1	229.0	.0	.0	.1	206.0				
	HARD		23.8	27.2	.0	.0	.0	23.8				
	TOTAL		4798.8	5403.4	.0	.0	11.3	4787.6				

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE	ZONE	ZONE
1	01*11	522.4	68.2	75.8	.0	.0	.8	67.4				
2	01*21	520.8	14.9	16.5	.0	.0	.0	14.9				
3	01*22	527.8	29.2	32.4	.0	.0	1.5	27.7				
4	01*23	522.1	11.3	12.6	.0	.0	.1	11.2				
5	01*24	520.8	12.2	13.6	.0	.0	.0	12.2				
6	01*25	520.8	13.2	14.7	.0	.0	.0	13.2				
7	01*26	520.8	42.6	47.4	.0	.0	.0	42.6				
8	01*31	520.8	13.1	14.5	.0	.0	.0	13.1				
9	01*32	520.8	2.1	5.1	.0	.0	.0	2.1				
10	01*33	520.8	13.4	14.9	.0	.0	.0	13.4				

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = .00

AVERAGE FLOOR TEMPERATURE (DEG F) =-408.00 FLOOR EMISSIVITY = .950

LSTS HEATERS ARE NOT ON. NO LSTS HEAT CALCULATIONS ARE TO BE MADE.

APOLLO EMU	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
LOCATION	.00	.00	.00	.0	520.0

SUMMARY OF THE THERMAL ENVIRONMENT.

					ABSORBED HEAT, BTU/HR							
NO.	NODE NAME	AO WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE	ZONE	ZONE
	ITMG		2294.1	2549.0	.0	.0	1.4	2292.8				
	VISOR		134.2	149.1	.0	.0	.0	134.2				
	HELMT		149.1	165.6	.0	.0	.0	149.1				
	PLSS		957.3	1064.6	.0	.0	.5	956.8				
	OPS		475.0	527.3	.0	.0	.1	475.0				
	RCU		46.6	53.9	.0	.0	.0	46.6				
	BOOTS		452.4	512.7	.0	.0	9.2	443.2				
	GLOVS		60.1	124.9	.0	.0	.0	60.1				
	UMBIL		206.1	229.0	.0	.0	.1	206.0				
	HARD		23.8	27.2	.0	.0	.0	23.8				
	TOTAL		4798.8	5403.4	.0	.0	11.3	4787.6				

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

APOLLO EMU IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

PRINT OF CHAMBER DATA INPUT OR DATA UPDATE.

SOLAR SCREEN DATA.

SOLAR LAMP COLUMNATION ANGLE (DEG) = 48.00   SOLAR SCREEN MODULATION = 1.000

SCREEN HEIGHT (FT) = 13.40   NUMBER OF SCREEN HEIGHT NODES = 10
SCREEN WIDTH (FT) = 10.00   NUMBER OF SCREEN WIDTH NODES = 10

COATING ABSORPTIVITY TO SOLAR LAMPS.

COATING	ABSORPTIVITY
1	.240
2	.615
3	.600
4	.450
5	.550
6	.510
7	.330
8	1.000
9	.000
10	.000
11	.000
12	.000
13	.000
14	.000
15	.000
16	.000
17	.000
18	.000
19	.000
20	.000

SOLAR SCREEN NODE DATA.

SOLAR SCREEN NODE DATA.

.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

CHAMBER FLOOR DATA.

FLOOR RADIUS (FT) = 5.00
NUMBER OF RADIAL FLOOR NODES - 10
NUMBER OF ANGULAR FLOOR NODES - 60

FLOOR EMISSIVITY = .950

FLOOR NODE TEMPERATURES, DEG R.

620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000
620.000	620.000	620.000	620.000	620.000	624.000	624.000	624.000	624.000	624.000
624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000
624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000
624.000	624.000	624.000	624.000	624.000	624.000	620.000	620.000	620.000	620.000
620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000
620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000
620.000	620.000	620.000	620.000	620.000	624.000	624.000	624.000	624.000	624.000
624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000
624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000	624.000
620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000
620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000
615.000	615.000	615.000	615.000	615.000	615.000	617.000	617.000	617.000	617.000
617.000	617.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000
620.000	620.000	620.000	620.000	620.000	620.000	622.000	622.000	622.000	622.000
622.000	622.000	622.00C	622.000	622.000	622.000	622.000	620.000	620.000	620.000
620.000	617.000	617.000	617.000	617.000	617.000	617.000	615.000	615.000	615.000
615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000
610.000	610.000	610.000	610.000	610.000	610.000	610.000	612.000	613.000	615.000
615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000
615.000	615.000	615.000	615.000	620.000	620.000	620.000	620.000	620.000	620.000
620.000	620.000	620.000	620.000	620.000	620.000	620.000	620.000	617.000	617.000
617.000	617.000	617.000	617.000	615.000	615.000	615.000	610.000	610.000	610.000
610.000	610.000	610.000	610.000	610.000	610.000	610.000	610.000	610.000	610.000
605.000	605.000	605.000	605.000	605.000	605.000	605.000	607.000	607.000	610.000
610.000	610.000	610.000	610.000	610.000	610.000	607.000	607.000	607.000	607.000
610.000	610.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000
615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000	615.000
615.000	615.000	615.000	615.000	612.000	610.000	607.000	605.000	605.000	605.000
605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000
600.000	600.000	600.000	600.000	600.000	600.000	600.000	603.000	605.000	605.000
605.000	605.000	605.000	605.000	605.000	602.000	602.000	602.000	602.000	602.000
605.000	605.000	607.000	610.000	612.000	612.000	612.000	612.000	612.000	612.000
612.000	612.000	612.000	612.000	612.000	612.000	612.000	612.000	612.000	612.000
612.000	612.000	610.000	607.000	605.000	600.000	597.000	595.000	595.000	595.000
595.000	595.000	597.000	600.000	600.000	600.000	600.000	600.000	600.000	600.000
595.000	595.000	595.000	595.000	595.000	595.000	595.000	597.000	600.000	600.000
600.000	600.000	602.000	602.000	600.000	598.000	595.000	595.000	598.000	598.000
597.000	600.000	602.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000
605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000	605.000
605.000	605.000	605.000	605.000	600.000	595.000	590.000	590.000	590.000	590.000
590.000	590.000	590.000	590.000	590.000	593.000	593.000	593.000	593.000	593.000
587.000	587.000	587.000	587.000	587.000	587.000	590.000	590.000	592.000	595.000
595.000	597.000	597.000	597.000	595.000	592.000	592.000	590.000	590.000	590.000
590.000	595.000	595.000	595.000	597.000	600.000	600.000	600.000	600.000	600.000
600.000	600.000	600.000	600.000	600.000	600.000	600.000	600.000	600.000	600.000
600.000	600.000	597.000	595.000	598.000	587.000	585.000	583.000	580.000	580.000
580.000	583.000	583.000	583.000	585.000	585.000	585.000	585.000	585.000	585.000
580.000	580.000	580.000	580.000	580.000	580.000	580.000	583.000	585.000	588.000
590.000	592.000	593.000	593.000	590.000	587.000	587.000	585.000	585.000	585.000
585.000	585.000	588.000	590.000	592.000	593.000	595.000	595.000	595.000	595.000
595.000	595.000	595.000	595.000	595.000	595.000	595.000	595.000	595.000	590.000
590.000	590.000	590.000	588.000	585.000	583.000	577.000	575.000	575.000	575.000
575.000	575.000	575.000	575.000	575.000	575.000	575.000	577.000	577.000	577.000

570.000	570.000	570.000	570.000	570.000	570.000	575.000	575.000	580.000	585.000
588.000	590.000	588.000	588.000	585.000	585.000	583.000	580.000	580.000	577.000
577.000	580.000	580.000	585.000	585.000	590.000	590.000	590.000	590.000	590.000
590.000	590.000	590.000	590.000	590.000	590.000	590.000	587.000	585.000	585.000
582.000	580.000	580.000	580.000	575.000	573.000	570.000	567.000	567.000	567.000
568.000	567.000	568.000	567.000	567.000	567.000	568.000	568.000	567.000	570.000

BACKGROUND DATA.

	I.R. BACKGROUND, BTU/HR*FT2					SOLAR BACKGROUND, BTU/HR*FT2				
Z=1.0 THETA =	-90.0	-45.0	.0	45.0	90.0	-90.0	-45.0	.0	45.0	90.0
PHI = .0	.00	.00	13.00	37.00	54.00	4.00	4.00	8.00	16.00	20.00
PHI = 90.0	.00	1.00	22.50	45.50	55.50	5.00	2.00	1.00	12.00	25.00
PHI =180.0	.00	2.00	32.00	54.00	57.00	12.00	12.00	8.00	16.00	30.00
PHI =270.0	.00	1.00	22.50	45.50	55.50	5.00	2.00	1.00	12.00	25.00
Z=3.0 THETA =	-90.0	-45.0	.0	45.0	90.0	-90.0	-45.0	.0	45.0	90.0
PHI = .0	1.50	1.50	16.50	28.50	51.50	4.00	5.50	19.00	39.00	30.00
PHI = 90.0	2.30	7.30	27.30	38.80	49.50	3.50	2.50	5.00	13.50	19.50
PHI =180.0	3.00	13.00	38.00	49.00	47.50	8.50	9.50	9.00	18.50	35.00
PHI =270.0	2.30	7.30	27.30	38.80	49.50	3.50	2.50	5.00	13.50	19.50
Z=5.0 THETA =	-90.0	-45.0	.0	45.0	90.0	-90.0	-45.0	.0	45.0	90.0
PHI = .0	3.00	3.00	20.00	20.00	49.00	4.00	7.00	30.00	62.00	40.00
PHI = 90.0	4.50	13.50	32.00	32.00	43.50	2.00	3.00	9.00	15.00	14.00
PHI =180.0	6.00	24.00	44.00	44.00	38.00	5.00	7.00	10.00	19.00	40.00
PHI =270.0	4.50	13.50	32.00	32.00	43.50	2.00	3.00	9.00	15.00	14.00

LSTS DATA.

LSTS ZONE TEMPERATURES (DEG F).

ZONE	TEMP.
1	395.0
2	106.0
3	316.0
4	258.0

LSTS TIER INCLINATION ANGLES (DEG).

ZONE	TIER 1	TIER 2	TIER 3
1	50.00	60.00	
2	50.00	60.00	
3	60.00	60.00	
4	40.00	60.00	

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = 48.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.68 FLOOR EMISSIVITY = .950

LAMP ZONE	POWER PER LAMP	LAMP TEMP	LAMP INCLINATION ANGLES, (DEG) TIER	TIER	TIER
NO.	B/H/FT**2	DEG F	1	2	3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU	X	Y	Z	AZIMUTH	CONTACT
LOCATION	(FT)	(FT)	(FT)	(DEG)	TEMP
	.00	.00	.00	180.0	620.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
					ABSORBED HEAT, BTU/HR							
	ITMG		1994.7	2377.2	.0	48.1	924.5	425.9	285.1	7.8	256.3	47.1
	VISOR		127.2	146.2	.0	4.4	30.0	32.4	5.6	.3	42.7	11.8
	HELMT		89.1	119.6	.0	6.5	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		805.6	995.5	.0	31.0	259.6	178.2	225.5	10.9	82.5	18.0
	OPS		344.5	439.4	.0	17.9	51.1	114.6	66.3	7.3	59.0	28.4
	RCU		36.0	45.3	.0	1.2	9.2	11.4	1.4	.1	10.6	2.0
	BOOTS		590.4	678.2	.0	26.1	485.9	55.7	15.9	.0	6.6	.2
	GLOVS		55.9	114.0	.0	4.5	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		164.1	200.2	.0	5.4	52.5	46.7	27.5	.9	25.5	5.4
	HARD		24.3	28.7	.0	1.1	10.2	5.6	.0	.0	6.7	.7
	TOTAL		4231.9	5144.5	.0	196.1	1852.0	920.6	696.4	29.4	513.3	124.1

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
					ABSORBED HEAT, BTU/HR							
1	01*11	621.1	136.3	153.8	.0	4.3	132.0	.0	.0	.0	.0	.0
2	01*21	539.3	17.1	19.3	.0	.6	12.1	3.8	.0	.0	.6	.0
3	01*22	576.3	41.5	46.2	.0	.1	34.9	4.9	1.5	.0	.0	.0
4	01*23	537.2	12.7	14.2	.0	.3	9.6	1.6	1.2	.0	.1	.0
5	01*24	631.2	13.2	15.0	.0	.5	9.9	1.3	1.6	.0	.0	.0
6	01*25	521.2	13.3	15.2	.0	.8	10.0	.9	1.5	.0	.1	.0

TIME (HR) 16.600

TEST 2, IPOST TEST ANALYSIS. LUNAR PLAIN, 33 DEG SUN.

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

					ABSORBED HEAT, BTU/HR							
NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
7	01.26	512.8	40.1	46.4	.0	3.4	32.1	1.2	2.5	.0	.9	.0
8	01.31	466.7	8.4	10.5	.0	2.0	.0	5.9	.3	.0	.2	.0
9	01.32	483.7	1.5	3.3	.0	.6	.3	.5	.1	.0	.1	.0
10	01.33	473.6	9.2	11.7	.0	.5	2.1	5.8	.0	.0	.7	.0
11	01.34	493.2	1.3	2.9	.0	.3	.2	.6	.0	.0	.1	.0
12	02.11	620.7	135.9	153.4	.0	4.3	131.7	.0	.0	.0	.0	.0
13	02.21	539.7	17.2	19.4	.0	.6	12.2	3.8	.0	.0	.6	.0
14	02.22	522.9	43.3	48.3	.0	.2	32.1	7.6	2.5	.0	.9	.0
15	02.23	524.8	13.6	15.3	.0	.3	9.9	1.9	1.5	.0	.1	.0
16	02.24	530.8	13.2	14.9	.0	.5	9.8	1.3	1.6	.0	.0	.0
17	02.25	532.9	12.3	14.0	.0	.7	9.6	.7	1.2	.0	.1	.0
18	02.26	550.0	39.4	45.1	.0	2.5	34.9	.9	.0	.0	1.0	.1
19	02.31	467.9	9.0	11.2	.0	2.1	.0	6.3	.4	.0	.2	.0
20	02.32	479.8	1.1	2.4	.0	.5	.2	.3	.0	.0	.1	.0
21	02.33	473.5	9.2	11.7	.0	.5	2.1	5.8	.0	.0	.8	.0
22	02.34	497.2	1.7	3.9	.0	.4	.3	.8	.1	.0	.1	.0
23	03.11	492.6	19.9	23.1	.0	.3	17.4	-.3	.6	.0	1.8	.1
24	03.12	526.0	23.6	27.9	.0	.5	15.9	5.1	.0	.0	1.9	.1
25	03.13	538.3	20.8	23.6	.0	.1	15.8	3.5	.2	.0	1.1	.1
26	03.14	559.7	19.8	21.9	.0	-.0	16.0	2.3	1.5	.0	.0	.0
27	03.15	540.5	23.8	26.9	.0	.1	18.6	2.5	2.5	.0	.1	.0
28	03.16	521.3	24.9	28.3	.0	.2	18.2	2.3	4.3	.0	.0	.0
29	03.17	512.6	24.2	27.8	.0	.2	18.3	1.5	4.0	.0	.3	.0
30	03.18	501.6	21.5	24.8	.0	.3	17.3	.6	2.3	.0	1.0	.0
31	03.21	473.6	25.0	29.4	.0	.5	18.5	-.3	1.2	.0	4.7	.4
32	03.22	517.8	35.8	42.6	.0	.9	20.0	9.2	.0	.0	5.2	.5
33	03.23	527.7	28.4	32.0	.0	.1	19.7	5.7	.0	.0	2.5	.3
34	03.24	535.7	21.6	23.7	.0	-.1	15.5	3.4	2.8	.0	.0	.0
35	03.25	524.2	27.6	31.2	.0	.1	19.3	3.7	4.3	.0	.1	.0
36	03.26	507.3	32.9	37.7	.0	.3	19.3	3.8	9.6	.0	.0	.0
37	03.27	495.6	31.2	36.1	.0	.4	18.1	2.6	9.4	.0	.7	.0
38	03.28	482.5	28.1	32.8	.0	.4	18.0	1.2	5.5	.0	2.8	.2
39	04.11	513.0	17.3	19.9	.0	.2	15.8	-.2	.2	.0	1.2	.1
40	04.12	526.3	23.6	27.9	.0	.5	15.9	5.1	.0	.0	1.9	.1
41	04.13	521.7	25.0	28.4	.0	.2	17.6	4.8	.6	.0	1.8	.1
42	04.14	518.2	24.5	27.1	.0	-.1	17.3	4.0	2.3	.0	1.0	.0
43	04.15	519.5	25.6	28.9	.0	.1	17.9	3.3	4.0	.0	.3	.0
44	04.16	520.9	24.8	28.2	.0	.2	18.1	2.3	4.3	.0	.0	.0
45	04.17	533.6	22.7	25.8	.0	.2	18.7	1.2	2.5	.0	.1	.0
46	04.18	545.3	17.5	19.9	.0	.2	16.3	.3	.0	.0	.7	.1
47	04.21	499.2	22.5	26.1	.0	.4	19.6	-.2	.0	.0	2.5	.3
48	04.22	518.0	35.9	42.7	.0	.9	20.1	9.2	.0	.0	5.3	.5
49	04.23	507.9	33.1	37.4	.0	.2	18.8	7.9	1.2	.0	4.7	.4
50	04.24	502.4	33.0	36.2	.0	-.2	17.8	6.9	5.5	.0	2.8	.2
51	04.25	504.2	33.5	38.1	.0	.2	17.7	5.4	9.4	.0	.7	.1

TIME (HR) 16.683

TEST 2, IPOST TEST ANALYSIS. LUNAR PLAIN, 33 DEG SUN,

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT

SUN ANGLE (DEG) = 48.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.68

FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	620.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
					ABSORBED HEAT, BTU/HR							
	ITMG		1994.7	2377.2	.0	48.1	924.5	425.9	285.1	7.8	256.3	47.1
	VISOR		127.2	146.2	.0	4.4	30.0	32.4	5.6	.3	42.7	11.8
	HELMT		89.1	119.6	.0	6.5	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		805.6	995.5	.0	31.0	259.6	178.2	225.5	10.9	82.5	18.0
	OPS		344.5	439.4	.0	17.9	51.1	114.6	66.3	7.3	59.0	28.4
	RCU		36.0	45.3	.0	1.2	9.2	11.4	1.4	.1	10.6	2.0
	BOOTS		590.4	678.2	.0	26.1	485.9	55.7	15.9	.0	6.6	.2
	GLOVS		55.9	114.0	.0	4.5	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		164.1	200.2	.0	5.4	52.5	46.7	27.5	.9	25.5	5.4
	HARD		24.3	28.7	.0	1.1	10.2	5.6	.0	.0	6.7	.7
	TOTAL		4231.9	5144.5	.0	146.1	1852.0	920.6	646.4	29.4	513.3	124.1

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

APOLLO EMU IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

PRINT OF CHAMBER DATA INPUT OR DATA UPDATE.

SOLAR SCREEN DATA.

SOLAR LAMP COLUMNATION ANGLE (DEG) = 33.00 SOLAR SCREEN MODULATION = 1.000

SCREEN HEIGHT (FT) = 13.40 NUMBER OF SCREEN HEIGHT NODES = 10
SCREEN WIDTH (FT) = 10.00 NUMBER OF SCREEN WIDTH NODES = 10

COATING ABSORPTIVITY TO SOLAR LAMPS.

COATING	ABSORPTIVITY
1	.240
2	.615
3	.600
4	.460
5	.550
6	.510
7	.330
8	1.000
9	.000
10	.000

SOLAR SCREEN NODE DATA.

11	.000
12	.000
13	.000
14	.000
15	.000
16	.000
17	.000
18	.000
19	.000
20	.000

SOLAR SCREEN NODE DATA.

.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	54.000	100.600	94.000	98.000	133.000	84.500	.000	.000
.000	.000	4.800	49.000	270.000	250.000	299.000	172.000	.000	.000
.000	.000	.000	62.500	471.000	344.000	318.000	169.000	.000	.000
.000	.000	.000	188.000	462.000	317.000	332.000	181.000	.000	.000
.000	.000	9.000	74.000	64.000	111.000	164.000	46.500	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

CHAMBER FLOOR DATA.

FLOOR RADIUS (FT) = 5.00
NUMBER OF RADIAL FLOOR NODES = 10
NUMBER OF ANGULAR FLOOR NODES = 60

FLOOR EMISSIVITY = .950

FLOOR THERMOCOUPLE TEMPERATURE DATA, DEG F.

130.000	144.000	158.000	164.000	160.000	122.000	130.000	152.000	162.000	164.000
160.000	152.000	135.000	108.000	163.000	150.000	131.000	151.000	126.000	135.000
120.000	133.000	110.000	108.000	160.000	160.000	142.000	163.000	152.000	150.000
152.000	150.000								

BACKGROUND DATA.

	I.R. BACKGROUND, BTU/HR*FT2					SOLAR BACKGROUND, BTU/HR*FT2				
Z=1.0 THETA =	-90.0	-45.0	.0	45.0	90.0	-90.0	-45.0	.0	45.0	90.0
PHI = .0	.00	.00	13.00	37.00	54.00	24.00	19.00	18.00	21.00	20.00
PHI = 90.0	.00	1.00	22.50	45.50	55.50	5.00	2.00	1.00	12.00	25.00
PHI =180.0	.00	2.00	32.00	54.00	57.00	12.00	12.00	8.00	16.00	30.00
PHI =270.0	.00	1.00	22.50	45.50	55.50	5.00	2.00	1.00	12.00	25.00
Z=3.0 THETA =	-90.0	-45.0	.0	45.0	90.0	-90.0	-45.0	.0	45.0	90.0
PHI = .0	1.50	1.50	16.50	28.50	51.50	24.00	20.50	27.00	44.00	30.00
PHI = 90.0	2.30	2.30	27.30	38.80	49.50	3.50	2.50	5.00	13.50	19.50
PHI =180.0	3.00	13.00	38.00	49.00	47.50	8.50	9.50	9.00	18.50	35.00
PHI =270.0	2.30	7.30	27.30	38.80	49.50	3.50	2.50	5.00	13.50	19.50
Z=5.0 THETA =	-90.0	-45.0	.0	45.0	90.0	-90.0	-45.0	.0	45.0	90.0
PHI = .0	3.00	3.00	20.00	20.00	49.00	24.00	22.00	40.00	67.00	40.00
PHI = 90.0	4.50	13.50	32.00	32.00	43.50	2.00	3.00	9.00	15.00	14.00
PHI =180.0	6.00	24.00	49.00	44.00	38.00	5.00	7.00	10.00	19.00	40.00
PHI =270.0	4.50	13.50	32.00	32.00	43.50	2.00	3.00	9.00	15.00	14.00

LSTS DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
			ABSORBED HEAT, BTU/HR									
	ITMG		2323.0	3747.9	297.1	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		213.6	338.4	86.6	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		114.6	225.9	25.3	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		886.3	1316.8	68.9	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		458.9	903.8	111.5	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		50.2	104.9	14.1	1.4	9.1	11.4	1.4	.1	10.6	2.0
	BOOTS		607.7	704.3	.0	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		57.8	117.1	2.1	9.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		222.9	446.0	57.7	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		46.6	74.4	22.4	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		4981.7	7979.4	685.8	207.5	1854.5	920.6	646.4	29.4	513.3	124.1

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
			ABSORBED HEAT, BTU/HR									
1	01*11	622.6	137.6	155.3	.0	4.3	133.3	.0	.0	.0	.0	.0
2	01*21	539.3	17.1	19.4	.0	.6	12.1	3.8	.0	.0	.6	.0
3	01*22	577.8	41.9	46.6	.0	.1	35.3	4.9	1.5	.0	.0	.0
4	01*23	541.4	13.1	14.9	.0	.6	9.7	1.6	1.2	.0	.1	.0
5	01*24	538.6	14.0	16.1	.0	1.2	10.0	1.3	1.6	.0	.0	.0
6	01*25	532.8	14.5	17.1	.0	1.9	10.2	.9	1.5	.0	.1	.0

TIME (HR)	
16.833	TEST 2, IPOST TEST ANALYSIS. LUNAR PLAIN, 33 DEG SUN.

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
	ITMG		2323.0	3747.9	297.1	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		213.6	338.4	86.6	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		114.6	225.9	25.3	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		886.3	1316.8	68.9	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		458.9	903.8	111.5	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		50.2	104.9	14.1	1.9	9.1	11.4	1.4	.1	10.6	2.0
	BOOTS		607.7	704.3	.0	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		57.8	117.1	2.1	4.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		222.9	446.0	57.7	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		46.6	74.4	22.4	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		4981.7	7979.4	685.8	207.5	1854.5	920.6	646.4	29.4	513.3	124.1

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

TEST 2, (POST TEST ANALYSIS, LUNAR PLAIN, 33 DEG SUN.

APOLLO EMU IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

PRINT OF CHAMBER DATA INPUT OR DATA UPDATE.

SOLAR SCREEN DATA.

SOLAR LAMP COLUMNATION ANGLE (DEG) = 33.00 SOLAR SCREEN MODULATION = 1.000

SCREEN HEIGHT (FT) = 13.40 NUMBER OF SCREEN HEIGHT NODES = 10
SCREEN WIDTH (FT) = 10.00 NUMBER OF SCREEN WIDTH NODES = 10

COATING ABSORPTIVITY TO SOLAR LAMPS.

COATING	ABSORPTIVITY
1	.240
2	.615
3	.600
4	.450
5	.550
6	.510
7	.330
8	1.000
9	.100
10	.100

SOLAR SCREEN NODE DATA.

11	.100
12	.100
13	.100
14	.100
15	.100
16	.100
17	.100
18	.100
19	.100
20	.100

SOLAR SCREEN NODE DATA.

.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	54.000	100.600	94.000	98.000	133.000	84.500	.000	.000
.000	.000	96.000	89.000	271.000	250.000	299.000	172.000	.000	.000
.000	.000	117.000	313.000	471.000	344.000	318.000	169.000	.000	.000
.000	.000	145.000	376.000	462.000	317.000	332.000	181.000	.000	.000
.000	.000	54.000	74.000	64.000	111.000	164.000	46.500	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

FLOOR DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

BACKGROUND DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

TIME (HR)	TEST 2. IPOST TEST ANALYSIS. LUNAR PLAIN, 33 DEG SUN.	PAGE 65
16.834		

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT

SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
	ITMG		2437.5	4224.8	411.5	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		213.6	338.4	86.6	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		114.6	225.9	25.3	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		886.3	1316.8	68.9	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		458.9	903.8	111.5	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		50.2	104.9	14.1	1.4	9.1	11.4	1.4	.1	10.6	2.0
	BOOTS		649.1	789.3	41.5	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		58.5	118.2	2.8	4.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		222.5	446.0	57.7	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		46.6	74.5	22.4	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		5138.3	8542.5	842.4	207.5	1854.5	920.6	646.4	29.4	513.3	124.1

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
1	01*11	622.6	137.6	155.3	.0	4.3	133.3	.0	.0	.0	.0	.0
2	01*21	602.7	26.7	35.3	9.6	.6	12.1	3.8	.0	.0	.6	.0
3	01*22	577.8	41.9	46.6	.0	.1	35.3	4.9	1.5	.0	.0	.0
4	01*23	541.4	13.1	14.9	.0	.6	9.7	1.6	1.2	.0	.1	.0
5	01*24	538.6	14.0	16.1	.0	1.2	10.0	1.3	1.6	.0	.0	.0
6	01*25	532.8	14.5	17.1	.0	1.9	10.2	.9	1.5	.0	.1	.0

TIME (HR) 16.965

TEST 2, IPOST TEST ANALYSIS. LUNAR PLAIN, 33 DEG SUN.

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT

SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP. DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	4D WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
	ITMG		2437.5	4224.8	411.5	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		213.6	338.4	86.6	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		114.6	225.9	25.3	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		886.3	1316.8	68.9	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		458.9	903.8	111.5	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		50.2	104.9	14.1	1.4	9.1	11.4	1.4	.1	10.6	2.0
	BOOTS		649.1	789.3	41.5	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		58.5	118.2	2.8	4.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		222.9	446.0	57.7	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		46.6	74.5	22.4	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		5138.3	8542.5	842.4	207.5	1854.5	920.6	646.4	29.4	513.3	124.1

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

APOLLO EMU IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

PRINT OF CHAMBER DATA INPUT OR DATA UPDATE.

SOLAR SCREEN DATA.

SOLAR LAMP COLUMNATION ANGLE (DEG) = 33.00 SOLAR SCREEN MODULATION = 1.000

SCREEN HEIGHT (FT) = 13.40 NUMBER OF SCREEN HEIGHT NODES = 10
SCREEN WIDTH (FT) = 10.00 NUMBER OF SCREEN WIDTH NODES = 10

COATING ABSORPTIVITY TO SOLAR LAMPS.

COATING	ABSORPTIVITY
1	.240
2	.615
3	.600
4	.450
5	.550
6	.510
7	.330
8	1.000
9	.100
10	.100

SOLAR SCREEN NODE DATA.

11	.100
12	.100
13	.100
14	.100
15	.100
16	.100
17	.100
18	.100
19	.100
20	.100

SOLAR SCREEN NODE DATA.

.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	54.000	100.600	94.000	98.000	133.000	84.500	.000	.000
.000	.000	96.000	85.000	54.000	62.000	290.000	172.000	.000	.000
.000	.000	117.000	250.000	.000	.000	264.000	169.000	.000	.000
.000	.000	145.000	338.000	46.000	42.000	316.000	181.000	.000	.000
.000	.000	54.000	74.000	64.000	111.000	164.000	46.500	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

FLOOR DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

BACKGROUND DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

LSTS DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

TIME (HR) 16.966

TEST 2, IPOST TEST ANALYSIS. LUNAR PLAIN, 33 DEG SUN.

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT

SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/M/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	ABSORBED HEAT, BTU/HR SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
	ITMG		2196.5	3220.8	170.6	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		131.8	156.6	4.8	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		91.0	127.3	1.6	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		817.6	1044.9	.2	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		347.6	452.7	.3	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		36.1	45.9	.0	1.4	9.1	11.4	1.4	.1	10.6	2.0
	BOOTS		649.1	789.3	41.5	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		58.5	118.1	2.8	4.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		169.4	222.9	4.2	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		25.8	32.8	1.7	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		4523.4	6211.3	227.6	207.5	1854.6	920.6	646.4	29.4	513.3	124.1

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	ABSORBED HEAT, BTU/HR SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
1	01*11	622.6	137.6	155.3	.0	4.3	133.3	.0	.0	.0	.0	.0
2	01*21	602.7	26.7	35.3	9.6	.6	12.1	3.8	.0	.0	.6	.0
3	01*22	577.8	41.9	46.6	.0	.1	35.3	4.9	1.5	.0	.0	.0
4	01*23	541.4	13.1	14.9	.0	.6	9.7	1.6	1.2	.0	.1	.0
5	01*24	538.6	14.0	16.1	.0	1.2	10.0	1.3	1.6	.0	.0	.0
6	01*25	532.8	14.5	17.1	.0	1.9	10.2	.9	1.5	.0	.1	.0

TIME (HR) 16.999

TEST 2, IPOST TEST ANALYSIS. LUNAR PLAIN, 33 DEG SUN,

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT

SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NODE NO.	NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	ABSORBED HEAT, BTU/HR SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
	ITMG		2196.5	3220.8	170.6	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		131.8	156.6	4.8	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		91.0	127.3	1.6	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		817.6	1044.9	.2	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		347.6	452.7	.3	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		36.1	45.9	.0	1.4	9.1	11.9	1.4	.1	10.6	2.0
	BOOTS		649.1	789.3	41.5	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		58.5	118.1	2.8	4.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		169.4	222.9	4.2	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		25.8	32.8	1.7	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		4523.4	6211.3	227.6	207.5	1854.5	920.6	646.4	29.4	513.3	124.1

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

APOLLO EMU IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

PRINT OF CHAMBER DATA INPUT OR DATA UPDATE.

SOLAR SCREEN DATA.

SOLAR LAMP COLUMNATION ANGLE (DEG) = 33.00 SOLAR SCREEN MODULATION = 1.000

SCREEN HEIGHT (FT) = 13.40 NUMBER OF SCREEN HEIGHT NODES = 10
SCREEN WIDTH (FT) = 10.00 NUMBER OF SCREEN WIDTH NODES = 10

COATING ABSORPTIVITY TO SOLAR LAMPS.

COATING	ABSORPTIVITY
1	.240
2	.615
3	.600
4	.450
5	.550
6	.510
7	.330
8	1.000
9	.100
10	.100

SOLAR SCREEN NODE DATA.

11	.100
12	.100
13	.100
14	.100
15	.100
16	.100
17	.100
18	.100
19	.100
20	.100

SOLAR SCREEN NODE DATA.

.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	54.000	100.600	94.000	98.000	133.000	84.500	.000	.000
.000	.000	96.000	89.000	271.000	250.000	299.000	172.000	.000	.000
.000	.000	117.000	313.000	471.000	344.000	318.000	169.000	.000	.000
.000	.000	145.000	376.000	462.000	317.000	332.000	181.000	.000	.000
.000	.000	54.000	74.000	64.000	111.000	164.000	46.500	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

FLOOR DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

BACKGROUND DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

TIME (HR) 17.000

TEST 2, (POST TEST ANALYSIS, LUNAR PLAIN, 33 DEG SUN,

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
	ITMG		2437.5	4224.8	411.5	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		213.6	338.4	86.6	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		114.6	225.9	25.3	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		886.3	1316.8	68.9	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		458.9	903.8	111.5	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		50.2	104.9	14.1	1.4	9.1	11.4	1.4	.1	10.6	2.0
	BOOTS		649.1	789.3	41.5	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		58.5	118.2	2.8	4.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		222.9	446.0	57.7	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		46.6	74.5	22.4	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		5138.3	8542.5	842.4	207.5	1854.5	920.6	646.4	29.9	513.3	124.1

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
1	01*11	622.6	137.6	155.3	.0	4.3	133.3	.0	.0	.0	.0	.0
2	01*21	602.7	26.7	35.3	9.6	.6	12.1	3.8	.0	.0	.6	.0
3	01*22	577.8	41.9	46.6	.0	.1	35.3	4.9	1.5	.0	.0	.0
4	01*23	541.4	13.1	14.9	.0	.6	9.7	1.6	1.2	.0	.1	.0
5	01*24	538.6	14.0	16.1	.0	1.2	10.0	1.3	1.6	.0	.0	.0
6	01*25	532.8	14.5	17.1	.0	1.9	10.2	.9	1.5	.0	.1	.0

TIME (HR) 17.090

TEST 2, 1POST TEST ANALYSIS, LUNAR PLAIN, 33 DEG SUN,

APOLLO-EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT

SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	SOLAR LAMPS	ABSORBED HEAT, BTU/HR SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
	ITMG		2437.5	4224.8	411.5	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		213.6	338.4	86.6	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		114.6	225.9	25.3	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		886.3	1316.8	68.9	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		458.9	903.8	111.5	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		50.2	104.9	14.1	1.4	9.1	11.4	1.4	.1	10.6	2.0
	BOOTS		649.1	789.3	41.5	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		58.5	118.2	2.8	4.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		222.9	446.0	57.7	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		46.6	74.5	22.4	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		5138.3	8542.5	842.4	207.5	1854.5	920.6	646.4	29.4	513.3	124.1

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

APOLLO EMU IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

PRINT OF CHAMBER DATA INPUT OR DATA UPDATE.

SOLAR SCREEN DATA.

SOLAR LAMP COLUMNATION ANGLE (DEG) = 33.00 SOLAR SCREEN MODULATION = 1.000

SCREEN HEIGHT (FT) = 13.40 NUMBER OF SCREEN HEIGHT NODES = 10
SCREEN WIDTH (FT) = 10.00 NUMBER OF SCREEN WIDTH NODES = 10

COATING ABSORPTIVITY TO SOLAR LAMPS.

COATING	ABSORPTIVITY
1	.240
2	.615
3	.600
4	.450
5	.550
6	.510
7	.330
8	1.000
9	.100
10	.100

SOLAR SCREEN NODE DATA.

11	.100
12	.100
13	.100
14	.100
15	.100
16	.100
17	.100
18	.100
19	.100
20	.100

SOLAR SCREEN NODE DATA.

.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	54.000	100.600	94.000	98.000	133.000	84.500	.000	.000
.000	.000	96.000	85.000	54.000	62.000	290.000	172.000	.000	.000
.000	.000	117.000	250.000	.000	.000	264.000	169.000	.000	.000
.000	.000	145.000	338.000	46.000	42.000	316.000	181.000	.000	.000
.000	.000	54.000	74.000	64.000	111.000	164.000	46.500	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

FLOOR DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

BACKGROUND DATA NOT CHANGED OR UPDATED AT THIS TIME. PREVIOUS DATA INPUT USED.

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
	ITMG		2196.5	3220.8	170.6	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		131.8	156.6	4.8	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		91.0	127.3	1.6	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		817.6	1044.9	.2	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		347.6	452.7	.3	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		36.1	45.9	.0	1.4	9.1	11.4	1.4	.1	10.6	2.0
	BOOTS		649.1	789.3	41.5	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		58.5	118.1	2.8	4.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		169.4	222.9	4.2	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		25.8	32.8	1.7	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		4523.4	6211.3	227.6	207.5	1854.5	920.6	646.4	29.4	513.3	124.1

NO.	NODE NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
1	01*11	622.6	137.6	155.3	.0	4.3	133.3	.0	.0	.0	.0	.0
2	01*21	602.7	26.7	35.3	9.6	.6	12.1	3.8	.0	.0	.6	.0
3	01*22	577.8	41.9	46.6	.0	.1	35.3	4.9	1.5	.0	.0	.0
4	01*23	541.4	13.1	14.9	.0	.6	9.7	1.6	1.2	.0	.1	.0
5	01*24	538.6	14.0	16.1	.0	1.2	10.0	1.3	1.6	.0	.0	.0
6	01*25	532.8	14.5	17.1	.0	1.9	10.2	.9	1.5	.0	.1	.0

TIME (HR) 17.290

TEST 2, IPOST TEST ANALYSIS. LUNAR PLAIN, 33 DEG SUN.

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = 33.00

AVERAGE FLOOR TEMPERATURE (DEG F) = 144.92 FLOOR EMISSIVITY = .950

LAMP ZONE NO.	POWER PER LAMP B/H/FT**2	LAMP TEMP DEG F	LAMP INCLINATION ANGLES, (DEG) TIER 1	TIER 2	TIER 3
1	778.1	395.0	50.0	60.0	
2	149.4	106.0	50.0	60.0	
3	528.0	316.0	60.0	60.0	
4	387.0	258.0	40.0	60.0	

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	626.8

SUMMARY OF THE THERMAL ENVIRONMENT.

NODE NO.	NAME	AD WALL TEMP	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR SOLAR LAMPS	SOLAR ALBEDO	CHAMB FLOOR	I.R. BCK GND	ZONE 1	ZONE 2	ZONE 3	ZONE 4
	ITMG		2196.5	3220.8	170.6	80.2	923.5	425.9	285.1	7.8	256.3	47.1
	VISOR		131.8	156.6	4.8	4.4	29.8	32.4	5.6	.3	42.7	11.8
	HELMT		91.0	127.3	1.6	6.8	5.7	38.1	13.3	2.0	14.0	9.6
	PLSS		817.6	1044.9	.2	43.2	259.1	178.2	225.5	10.9	82.5	18.0
	OPS		347.6	452.7	.3	21.1	50.7	114.6	66.3	7.3	59.0	28.4
	RCU		36.1	45.9	.0	1.4	9.1	11.4	1.4	.1	10.6	2.0
	BOOTS		649.1	789.3	41.5	38.3	490.9	55.7	15.9	.0	6.6	.2
	GLOVS		58.5	118.1	2.8	4.3	23.2	11.9	6.0	.1	9.4	.8
	UMBIL		169.4	222.9	4.2	6.8	52.4	46.7	27.5	.9	25.5	5.4
	HARD		25.8	32.8	1.7	1.1	10.1	5.6	.0	.0	6.7	.7
	TOTAL		4523.4	6211.3	227.6	207.5	1854.5	920.6	696.4	29.4	513.3	124.1

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

TAPE END OF FILE HAS BEEN GENERATED FOF THE DATA CALCULATED.

TALBE E-2 SAMPLE PROBLEM 2 TIMELINE

TIME	ENVIRONMENT	SOLAR ELEVATION	EMU POSITION			
			X	Y	Z	AZIMUTH
2.2 to 2.3	Lunar Plain, EMU near a verticle Spacecraft surface	48.	10.	0.	0.	0.
2.4 to 2.41	Lunar Plain, Input EMU contact temperature is 520°R	48.	30.	0.	0.	180.
2.42	Lunar plain, EMU near a horizontal spacecraft surface	48.	0.	0.	1.5	180.
2.43	Lunar Plain, EMU near a lunar shadow	48.	0.	0.	1.5	180.
2.44	Lunar Plain With $\alpha_s = .95$ $\alpha_{ir} = .6$	48.	0.	0.	0.	180.
2.58	Lunar Crater With 3 craters, EMU between the craters	48.	260.	30.	0.	0.
2.6	MSC chamber	0.	0.	0.	0.	0.
2.7 to 2.71	(using tape combining option)	48.				180.
2.99 to 3.0	Intravehicular Environment	-	0.	0.	1.5	180.
3.1	Deep Space	48.	0.	0.	0.	0.
3.2	Deep Space	48.	0.	0.	0.	180.
3.3	Deep Space	48.	100.	0.	0.	180.
3.4	Deep Space	- 5.	100.	0.	0.	180.

```
  1
  2   1
  1     48.
-5.                15.                 10.       30.       .9       .9    520.
  2   1 2.2     0.1     10.

  2
        48.
  1   1 2.4     0.01    30.            1.5      180.                     520.

  2
  1     48.
                        90.      90.      5.     10.     0.93  1.
  1   1 2.42                           1.5      180.

  2
      1  48.
                 10.      5.
  1   1 2.43                           1.5      180.

  2
         48.    0.95    0.60
  1   1  2.44                                   180.

  2
      3   48.   1.       1.
 200.   99.9    352.     100.
 100.   20.     270.    -30.
 300.    30.0   100.    100.
  1   1   2.58           260.   30.

  6
 10   2 2.6
 10   4 2.7       0.01

  1
  0.
                                                5.0     10.     9.5      0.93
  1   1  2.99   0.01                    1.5     180.

  9
          48.
  1   1   3.1
  1   1   3.2                                    180.
  1   1   3.3           100.                     180.

  9
  0       -5.
  1   1   3.4           100.                     180.
           -100
 0050
```

EHFR SAMPLE PROBLEM 2 INPUT CARD LISTING

THE ENVIRONMENTAL HEAT FLUX ROUTINE

VERSION 4

(EHFR -4)

FOR THE CALCULATION OF

RADIANT ENERGY ABSORPTION

BY THE

APOLLO EXTRAVEHICULAR MOBILITY UNIT

TIME (HR) 2.200

APOLLO EMU IN A STANDING MODE IS LOCATED IN A LUNAR PLAIN ENVIRONMENT.

ENVIRONMENT	SUN ANGLE (DEG)	LUNAR SOLAR ABSOR	LUNAR I.R. ABSOR
	48.00	.930	.930

SPACE CRAFT SURFACE SPECIFICATION		TEMP DEG F	X (FT)	Y (FT)	Z (FT)	INCLN (DEG)	AZIMUTH (DEG)	WIDTH (FT)	HEIGHT (FT)	I.R EMISS	SOLAR ABSORB
	1	520.00	-5.00	.00	15.00	.00	.00	10.00	30.00	.900	.900

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	10.00	.00	.00	.0	661.7

SUMMARY OF THE THERMAL ENVIRONMENT.

			ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR					AD W
NO. NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	TEMP DEG R
ITMG	5222.4	6136.8	.0	71.7	3429.5	.4	1720.7	.0	286.8	3810.6	1.6	2037.8	
VISOR	180.1	207.3	.0	6.5	172.0	.0	1.6	.0	14.4	191.1	.0	1.8	
HELMT	303.4	357.7	.0	2.5	121.3	.0	179.6	.0	10.1	134.7	.2	212.7	
PLSS	2510.2	2946.6	.0	34.4	1510.1	.2	965.4	.0	126.1	1675.8	.9	1143.7	
OPS	1186.2	1394.1	.0	15.1	707.8	.1	463.2	.0	59.2	785.9	.4	548.6	
RCU	157.3	188.7	.0	2.1	97.3	.0	57.8	.0	8.4	111.4	.1	68.9	
BOOTS	881.2	1005.1	.0	33.9	676.2	.1	171.0	.0	56.8	755.0	.2	193.1	
GLOVS	122.7	251.3	.0	9.8	101.6	.0	11.3	.0	15.9	211.8	.0	23.5	
UMBIL	1035.4	1216.1	.0	15.0	719.3	.1	301.0	.0	60.2	799.2	.3	356.5	
HARD	37.2	43.9	.0	1.5	35.8	.0	.0	.0	3.1	40.9	.0	.0	
TOTAL	11636.2	13747.7	.0	192.5	7570.9	1.0	3871.8	.0	641.0	8516.4	3.7	4586.5	

			ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR					AD W
NO. NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	TEMP DEG R
1 01.11	171.5	195.1	.0	8.2	163.3	.0	.0	.0	13.7	181.5	.0	.0	657.9
2 01.21	18.9	21.5	.0	.9	18.0	.0	.0	.0	1.5	20.0	.0	.0	553.2
3 01.22	60.7	68.9	.0	2.6	51.8	.0	6.3	.0	4.3	57.6	.0	7.1	568.7
4 01.23	33.9	38.1	.0	.8	16.0	.0	17.0	.0	1.3	17.8	.0	18.9	658.8
5 01.24	37.8	42.4	.0	.7	14.9	.0	22.1	.0	1.2	16.6	.0	24.5	689.3
6 01.25	32.8	36.9	.0	.8	16.0	.0	16.0	.0	1.3	17.8	.0	17.8	653.7
7 01.26	58.6	66.6	.0	2.6	51.8	.0	4.3	.0	4.3	57.5	.0	4.7	563.8
8 01.31	17.2	19.1	.0	.0	.0	.0	17.2	.0	.0	.0	.0	19.1	502.3

TIME (HR)
2.300

APOLLO EMU IN A STANDING MODE IS LOCATED IN A LUNAR PLAIN ENVIRONMENT.

ENVIRONMENT	SUN ANGLE (DEG)	LUNAR SOLAR ABSOR	LUNAR I.R. ABSOR
	48.00	.930	.930

SPACE CRAFT SURFACE SPECIFICATION		TEMP DEG F	X (FT)	Y (FT)	Z (FT)	INCLN (DEG)	AZIMUTH (DEG)	WIDTH (FT)	HEIGHT (FT)	I.R EMISS	SOLAR ABSORB
	1	520.00	-5.00	.00	15.00	.00	.00	10.00	30.00	.900	.900

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	10.00	.00	.00	.0	661.7

SUMMARY OF THE THERMAL ENVIRONMENT.

				ABSORBED HEAT, BTU/HR				INCIDENT ENERGY, BTU/HR					
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
	ITMG	5222.4	6136.8	.0	71.7	3429.5	.4	1720.7	.0	286.8	3810.6	1.6	2037.8	
	VISOR	180.1	207.3	.0	6.5	172.0	.0	1.6	.0	14.4	191.1	.0	1.8	
	HELMT	303.4	357.7	.0	2.5	121.3	.0	179.6	.0	10.1	134.7	.2	212.7	
	PLSS	2510.2	2946.6	.0	34.4	1510.1	.2	965.4	.0	126.1	1675.8	.9	1143.7	
	OPS	1186.2	1394.1	.0	15.1	707.8	.1	463.2	.0	59.2	785.9	.4	548.6	
	RCU	157.3	188.7	.0	2.1	97.3	.0	57.8	.0	8.4	111.4	.1	68.9	
	BOOTS	881.2	1005.1	.0	33.9	676.2	.1	171.0	.0	56.8	755.0	.2	193.1	
	GLOVS	122.7	251.3	.0	9.8	101.6	.0	11.3	.0	15.9	211.8	.0	23.5	
	UMBIL	1035.4	1216.1	.0	15.0	719.3	.1	301.0	.0	60.2	799.2	.3	356.5	
	HARD	37.2	43.9	.0	1.5	35.8	.0	.0	.0	3.1	40.9	.0	.0	
	TOTAL	11636.2	13747.7	.0	192.5	7570.9	1.0	3871.8	.0	641.0	8516.4	3.7	4586.5	

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

TIME
(HR)
2.400

APOLLO EMU IN A STANDING MODE IS LOCATED IN A LUNAR PLAIN ENVIRONMENT.

ENVIRONMENT	SUN ANGLE (DEG)	LUNAR SOLAR ABSOR	LUNAR I.R. ABSOR
	48.00	.930	.930

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	30.00	.00	1.50	180.0	520.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	INCIDENT ENERGY, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
	ITMG	4272.1	6948.7	688.8	73.4	3510.0	.0	.0	2755.2	293.5	3900.0	.0	.0	
	VISOR	288.0	446.6	109.4	6.5	172.0	.0	.0	241.1	14.4	191.1	.0	.0	
	HELMT	164.2	280.2	31.1	2.7	130.4	.0	.0	124.4	10.9	144.9	.0	.0	
	PLSS	1949.8	3040.3	357.8	35.4	1556.7	.0	.0	1182.7	130.0	1727.6	.0	.0	
	OPS	921.4	1537.6	170.2	15.7	735.6	.0	.0	659.4	61.5	816.7	.0	.0	
	RCU	125.8	217.2	23.5	2.2	100.2	.0	.0	93.9	8.6	114.6	.0	.0	
	BOOTS	906.2	1215.6	196.1	33.9	676.2	.0	.0	403.8	56.8	755.0	.0	.0	
	GLOVS	141.1	276.6	29.1	9.8	102.2	.0	.0	47.5	16.0	213.1	.0	.0	
	UMBIL	891.9	1450.2	143.6	15.3	732.9	.0	.0	574.6	61.3	814.3	.0	.0	
	HARD	73.7	118.1	36.5	1.5	35.8	.0	.0	74.2	3.1	40.9	.0	.0	
	TOTAL	9734.2	15531.1	1786.0	196.4	7751.9	.0	.0	6156.7	656.2	8718.2	.0	.0	

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	INCIDENT ENERGY, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
1	01.11	171.5	195.1	.0	8.2	163.3	.0	.0	.0	13.7	181.5	.0	.0	657.9
2	01.21	42.3	60.4	23.3	.9	18.0	.0	.0	38.8	1.5	20.0	.0	.0	676.1
3	01.22	54.4	61.8	.0	2.6	51.8	.0	.0	.0	4.3	57.5	.0	.0	553.2
4	01.23	16.8	19.1	.0	.8	16.0	.0	.0	.0	1.3	17.8	.0	.0	553.2
5	01.24	15.7	17.8	.0	.7	14.9	.0	.0	.0	1.2	16.6	.0	.0	553.2
6	01.25	16.8	19.1	.0	.8	16.0	.0	.0	.0	1.3	17.8	.0	.0	553.2
7	01.26	54.4	61.8	.0	2.6	51.8	.0	.0	.0	4.3	57.5	.0	.0	553.2
8	01.31	34.6	57.5	34.6	.0	.0	.0	.0	57.5	.0	.0	.0	.0	598.2
9	01.32	12.3	20.6	11.6	.1	.6	.0	.0	18.8	.1	1.6	.0	.0	779.3

TIME (HR)
2.410

APOLLO EMU IN A STANDING MODE IS LOCATED IN A LUNAR PLAIN ENVIRONMENT.

ENVIRONMENT	SUN ANGLE (DEG)	LUNAR SOLAR ABSOR	LUNAR I.R. ABSOR
	48.00	.930	.930

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	30.00	.00	1.50	180.0	520.0

SUMMARY OF THE THERMAL ENVIRONMENT.

				ABSORBED HEAT, BTU/HR						INCIDENT ENERGY, BTU/HR					AD W
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.		TEMP DEG R
	ITMG	4272.1	6948.7	688.8	73.4	3510.0	.0	.0	2755.2	293.5	3900.0	.0	.0		
	VISOR	288.0	446.6	109.4	6.5	172.0	.0	.0	241.1	14.4	191.1	.0	.0		
	HELMT	164.2	280.2	31.1	2.7	130.4	.0	.0	124.4	10.9	144.9	.0	.0		
	PLSS	1949.8	3040.3	357.8	35.4	1556.7	.0	.0	1182.7	130.0	1727.6	.0	.0		
	OPS	921.4	1537.6	170.2	15.7	735.6	.0	.0	659.4	61.5	816.7	.0	.0		
	RCU	125.8	217.2	23.5	2.2	100.2	.0	.0	93.9	8.6	114.6	.0	.0		
	BOOTS	906.2	1215.6	196.1	33.9	676.2	.0	.0	403.8	56.8	755.0	.0	.0		
	GLOVS	141.1	276.6	29.1	9.8	102.2	.0	.0	47.5	16.0	213.1	.0	.0		
	UMBIL	891.9	1450.2	143.6	15.3	732.9	.0	.0	574.6	61.3	814.3	.0	.0		
	HARD	73.7	118.1	36.5	1.5	35.8	.0	.0	74.2	3.1	40.9	.0	.0		
	TOTAL	9734.2	15531.1	1786.0	196.4	7751.9	.0	.0	6156.7	656.2	8718.2	.0	.0		

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

TIME (HR)		PAGE 22
2.420		

APOLLO EMU IN A STANDING MODE IS LOCATED IN A LUNAR PLAIN ENVIRONMENT.

ENVIRONMENT	SUN ANGLE (DEG)	LUNAR SOLAR ABSOR	LUNAR I.R. ABSOR
	48.00	.930	.930

SPACE CRAFT SURFACE SPECIFICATION		TEMP DEG F	X (FT)	Y (FT)	Z (FT)	INCLN (DEG)	AZIMUTH (DEG)	WIDTH (FT)	HEIGHT (FT)	I.R EMISS	SOLAR ABSORB
	1	.00	.00	.00	.00	90.00	90.00	5.00	10.00	.930	1.000

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	1.50	180.0	661.7

SUMMARY OF THE THERMAL ENVIRONMENT.

				ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR					AD W
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	TEMP DEG R
	ITMG	3807.7	6397.1	688.8	61.1	2920.1	.0	137.7	2755.2	244.2	3244.6	.0	153.0	
	VISOR	275.8	432.4	109.4	6.0	156.9	.0	3.5	241.1	13.1	174.3	.0	3.9	
	HELMT	160.4	275.6	31.1	2.6	125.6	.0	1.1	124.4	10.5	139.5	.0	1.3	
	PLSS	1783.0	2843.0	357.8	30.6	1345.3	.0	49.4	1182.7	112.4	1493.2	.0	54.7	
	OPS	854.8	1458.5	170.2	13.9	651.0	.0	19.7	659.4	54.4	722.8	.0	21.9	
	RCU	115.6	204.8	23.5	1.9	87.2	.0	3.0	93.9	7.5	99.9	.0	3.4	
	BOOTS	555.6	814.1	196.1	12.3	247.1	.0	100.2	403.8	20.9	278.0	.0	111.4	
	GLOVS	120.7	235.7	29.1	7.6	78.5	.0	5.5	47.5	12.4	164.5	.0	11.3	
	UMBIL	783.1	1321.0	143.6	12.4	594.8	.0	32.2	574.6	49.7	660.9	.0	35.8	
	HARD	72.0	116.1	36.5	1.4	33.7	.0	.5	74.2	2.9	38.5	.0	.5	
	TOTAL	8528.9	14098.4	1786.0	149.7	6240.2	.0	353.0	6156.7	528.1	7016.2	.0	397.4	

				ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR					AD W
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	TEMP DEG R
1	01.11	60.0	67.4	.0	1.3	26.8	.0	31.9	.0	2.2	29.7	.0	35.4	505.9
2	01.21	38.2	55.7	23.3	.7	13.0	.0	1.2	38.8	1.1	14.5	.0	1.3	659.1
3	01.22	31.8	36.0	.0	1.2	24.1	.0	6.5	.0	2.0	26.8	.0	7.2	483.8
4	01.23	11.0	12.4	.0	.4	8.8	.0	1.7	.0	.7	9.8	.0	1.9	496.9
5	01.24	11.2	12.7	.0	.5	9.4	.0	1.3	.0	.8	10.4	.0	1.4	508.2
6	01.25	11.3	12.8	.0	.5	9.2	.0	1.6	.0	.8	10.2	.0	1.8	500.3
7	01.26	33.3	37.7	.0	1.3	26.0	.0	6.0	.0	2.2	28.9	.0	6.7	489.4
8	01.31	34.6	57.5	34.6	.0	.0	.0	.0	57.5	.0	.0	.0	.0	598.2

TIME (HR) 2.420

APOLLO EMU IN A STANDING MODE IS LOCATED IN A LUNAR PLAIN ENVIRONMENT.

				ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR					AD #
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	TEMP DEG R
9	01.32	12.3	20.5	11.6	.1	.6	.0	.0	18.8	.1	1.6	.0	.0	778.9
10	01.33	22.1	74.0	17.0	.1	5.0	.0	.0	68.0	.4	5.6	.0	.0	552.4
11	01.34	12.3	20.5	11.6	.1	.6	.0	.0	18.8	.1	1.5	.0	.0	778.8
12	02.11	60.0	67.4	.0	1.3	26.8	.0	31.9	.0	2.2	29.7	.0	35.4	505.9
13	02.21	38.2	55.7	23.3	.7	13.0	.0	1.2	38.8	1.1	14.5	.0	1.3	659.1
14	02.22	33.3	37.7	.0	1.3	26.0	.0	6.0	.0	2.2	28.9	.0	6.7	489.4
15	02.23	11.3	12.8	.0	.5	9.2	.0	1.6	.0	.8	10.2	.0	1.8	500.3
16	02.24	11.2	12.7	.0	.5	9.4	.0	1.3	.0	.8	10.4	.0	1.4	508.2
17	02.25	11.0	12.4	.0	.4	8.8	.0	1.7	.0	.7	9.8	.0	1.9	496.9
18	02.26	31.8	36.0	.0	1.2	24.1	.0	6.5	.0	2.0	26.8	.0	7.2	483.8
19	02.31	34.6	57.5	34.6	.0	.0	.0	.0	57.5	.0	.0	.0	.0	598.2
20	02.32	12.3	20.5	11.6	.1	.6	.0	.0	18.8	.1	1.5	.0	.0	778.8
21	02.33	22.1	74.0	17.0	.1	5.0	.0	.0	68.0	.4	5.6	.0	.0	552.4
22	02.34	12.3	20.5	11.6	.1	.6	.0	.0	18.8	.1	1.6	.0	.0	778.9
23	03.11	36.4	71.6	10.3	.5	23.2	.0	2.5	41.1	1.9	25.7	.0	2.8	567.6
24	03.12	41.4	89.9	14.7	.5	24.2	.0	2.1	58.7	2.0	26.8	.0	2.3	590.4
25	03.13	35.7	70.1	10.0	.5	22.4	.0	2.8	40.2	1.9	24.9	.0	3.1	564.6
26	03.14	23.2	26.9	.0	.4	19.5	.0	3.2	.0	1.6	21.7	.0	3.6	510.4
27	03.15	25.7	29.9	.0	.5	22.4	.0	2.8	.0	1.9	24.9	.0	3.1	519.9
28	03.16	26.8	31.2	.0	.5	24.2	.0	2.1	.0	2.0	26.8	.0	2.3	529.3
29	03.17	26.2	30.5	.0	.5	23.2	.0	2.5	.0	1.9	25.7	.0	2.8	522.5
30	03.18	23.9	27.8	.0	.4	20.6	.0	2.8	.0	1.7	22.9	.0	3.2	514.5
31	03.21	58.4	111.0	15.1	.8	40.1	.0	2.3	60.5	3.4	44.6	.0	2.6	579.6
32	03.22	68.1	143.1	22.5	.9	42.8	.0	1.9	89.8	3.6	47.5	.0	2.1	600.3
33	03.23	57.4	108.7	14.7	.8	39.2	.0	2.7	58.8	3.3	43.5	.0	3.0	576.9
34	03.24	41.0	47.8	.0	.8	36.8	.0	3.5	.0	3.1	40.8	.0	3.9	528.7
35	03.25	42.7	49.9	.0	.8	39.2	.0	2.7	.0	3.3	43.5	.0	3.0	535.8
36	03.26	45.6	53.3	.0	.9	42.8	.0	1.9	.0	3.6	47.5	.0	2.1	543.1
37	03.27	43.3	50.5	.0	.8	40.1	.0	2.3	.0	3.4	44.6	.0	2.6	537.7
38	03.28	41.8	48.8	.0	.8	38.2	.0	2.9	.0	3.2	42.4	.0	3.2	531.7
39	04.11	35.7	70.1	10.0	.5	22.4	.0	2.8	40.2	1.9	24.9	.0	3.1	564.6
40	04.12	41.4	89.9	14.7	.5	24.2	.0	2.1	58.7	2.0	26.8	.0	2.3	590.4
41	04.13	36.4	71.6	10.3	.5	23.2	.0	2.5	41.1	1.9	25.7	.0	2.8	567.6
42	04.14	23.9	27.8	.0	.4	20.6	.0	2.8	.0	1.7	22.9	.0	3.2	514.5
43	04.15	26.2	30.5	.0	.5	23.2	.0	2.5	.0	1.9	25.7	.0	2.8	522.5
44	04.16	26.8	31.2	.0	.5	24.2	.0	2.1	.0	2.0	26.8	.0	2.3	529.3
45	04.17	25.7	29.9	.0	.5	22.4	.0	2.8	.0	1.9	24.9	.0	3.1	519.9
46	04.18	23.2	26.9	.0	.4	19.5	.0	3.2	.0	1.6	21.7	.0	3.6	510.4
47	04.21	57.4	108.7	14.7	.8	39.2	.0	2.7	58.8	3.3	43.5	.0	3.0	576.9
48	04.22	68.1	143.1	22.5	.9	42.8	.0	1.9	89.8	3.6	47.5	.0	2.1	600.3
49	04.23	58.4	111.0	15.1	.8	40.1	.0	2.3	60.5	3.4	44.6	.0	2.6	579.6
50	04.24	41.8	48.8	.0	.8	38.2	.0	2.9	.0	3.2	42.4	.0	3.2	531.7
51	04.25	43.3	50.5	.0	.8	40.1	.0	2.3	.0	3.4	44.6	.0	2.6	537.7
52	04.26	45.6	53.3	.0	.9	42.8	.0	1.9	.0	3.6	47.5	.0	2.1	543.1
53	04.27	42.7	49.9	.0	.8	39.2	.0	2.7	.0	3.3	43.5	.0	3.0	535.8

TIME (HR) 2.430

APOLLO EMU IN A STANDING MODE IS LOCATED IN A LUNAR PLAIN ENVIRONMENT.

ENVIRONMENT	SUN ANGLE (DEG)	LUNAR SOLAR ABSOR	LUNAR I.R. ABSOR
	48.00	.930	.930

SHADOW SURFACE		TEMP DEG F	X (FT)	Y (FT)	X WIDTH (FT)	Y WIDTH (FT)
SPECIFICATION	1	.0	.0	.0	10.0	5.0

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	1.50	180.0	460.0

SUMMARY OF THE THERMAL ENVIRONMENT.

				ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR				
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
	ITMG	3791.0	6377.2	688.8	60.6	3041.6	.0	.0	2755.2	242.4	3379.6	.0	.0	
	VISOR	275.7	432.4	109.4	6.0	160.3	.0	.0	241.1	13.1	178.2	.0	.0	
	HELMT	161.7	277.2	31.1	2.7	127.9	.0	.0	124.4	10.6	142.2	.0	.0	
	PLSS	1769.4	2827.3	357.8	30.1	1381.5	.0	.0	1182.7	111.0	1533.6	.0	.0	
	OPS	850.0	1452.8	170.2	13.8	666.1	.0	.0	659.4	53.9	739.5	.0	.0	
	RCU	114.7	203.8	23.5	1.9	89.3	.0	.0	93.9	7.4	102.4	.0	.0	
	BOOTS	570.1	830.6	196.1	13.2	360.8	.0	.0	403.8	22.4	404.4	.0	.0	
	GLOVS	120.4	234.9	29.1	7.5	83.7	.0	.0	47.5	12.3	175.2	.0	.0	
	UMBIL	783.5	1321.4	143.6	12.4	627.4	.0	.0	574.6	49.8	697.1	.0	.0	
	HARD	70.4	114.2	36.5	1.3	32.6	.0	.0	74.2	2.7	37.3	.0	.0	
	TOTAL	8506.8	14071.8	1786.0	149.5	6571.3	.0	.0	6156.7	525.7	7389.4	.0	.0	

				ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR					
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
1	01.11	60.7	68.2	.0	1.4	59.3	.0	.0	.0	2.3	65.9	.0	.0	507.4
2	01.21	34.8	51.7	23.3	.4	11.0	.0	.0	38.8	.7	12.2	.0	.0	643.9
3	01.22	35.0	39.7	.0	1.4	33.6	.0	.0	.0	2.4	37.4	.0	.0	495.7
4	01.23	10.4	11.8	.0	.4	10.0	.0	.0	.0	.7	11.1	.0	.0	491.0
5	01.24	9.5	10.8	.0	.4	9.1	.0	.0	.0	.6	10.2	.0	.0	488.3
6	01.25	11.9	13.5	.0	.5	11.4	.0	.0	.0	.8	12.7	.0	.0	507.6
7	01.26	42.0	47.6	.0	1.8	40.1	.0	.0	.0	3.1	44.6	.0	.0	518.5
8	01.31	34.6	57.5	34.6	.0	.0	.0	.0	57.5	.0	.0	.0	.0	598.2

TIME (HR)
2.440

APOLLO EMU IN A STANDING MODE IS LOCATED IN A LUNAR PLAIN ENVIRONMENT.

ENVIRONMENT	SUN ANGLE (DEG)	LUNAR SOLAR ABSOR	LUNAR I.R. ABSOR
	48.00	.950	.600

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	742.3

SUMMARY OF THE THERMAL ENVIRONMENT.

				ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR				AD #
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	TEMP DEG R
	ITMG	4301.4	6948.7	688.8	52.4	3560.2	.0	.0	2755.2	209.7	3983.9	.0	.0	
	VISOR	289.8	446.6	109.4	4.7	175.7	.0	.0	241.1	10.3	195.2	.0	.0	
	HELMT	165.3	280.2	31.1	1.9	132.3	.0	.0	124.4	7.8	148.0	.0	.0	
	PLSS	1962.4	3040.3	357.8	25.3	1579.3	.0	.0	1182.7	92.9	1764.7	.0	.0	
	OPS	927.5	1537.6	170.2	11.2	746.1	.0	.0	659.4	43.9	834.3	.0	.0	
	RCU	126.7	217.2	23.5	1.6	101.6	.0	.0	93.9	6.2	117.1	.0	.0	
	BOOTS	911.0	1215.6	196.1	24.2	690.7	.0	.0	403.8	40.6	771.2	.0	.0	
	GLOVS	140.5	276.6	29.1	7.0	104.4	.0	.0	47.5	11.5	217.7	.0	.0	
	UMBIL	898.0	1450.2	143.6	10.9	743.4	.0	.0	574.6	43.8	831.9	.0	.0	
	HARD	74.0	118.1	36.5	1.0	36.5	.0	.0	74.2	2.2	41.7	.0	.0	
	TOTAL	9796.5	15531.1	1786.0	140.3	7870.3	.0	.0	6156.7	468.7	8905.7	.0	.0	

				ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR				AD #
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	TEMP DEG R
1	01.11	172.7	195.1	.0	5.9	166.8	.0	.0	.0	9.8	185.4	.0	.0	659.0
2	01.21	42.4	60.4	23.3	.6	18.4	.0	.0	38.8	1.1	20.5	.0	.0	676.6
3	01.22	54.7	61.8	.0	1.9	52.9	.0	.0	.0	3.1	58.7	.0	.0	554.1
4	01.23	16.9	19.1	.0	.6	16.4	.0	.0	.0	1.0	18.2	.0	.0	554.1
5	01.24	15.8	17.8	.0	.5	15.2	.0	.0	.0	.9	16.9	.0	.0	554.1
6	01.25	16.9	19.1	.0	.6	16.4	.0	.0	.0	1.0	18.2	.0	.0	554.1
7	01.26	54.7	61.8	.0	1.9	52.9	.0	.0	.0	3.1	58.7	.0	.0	554.1
8	01.31	34.6	57.5	34.6	.0	.0	.0	.0	57.5	.0	.0	.0	.0	598.2
9	01.32	12.3	20.6	11.6	.1	.7	.0	.0	18.8	.1	1.7	.0	.0	779.2

TIME (HR)	
2.580	

APOLLO EMU IN A STANDING MODE IS LOCATED IN A LUNAR CRATER ENVIRONMENT.

ENVIRONMENT	SUN ANGLE (DEG)	LUNAR SOLAR ABSOR	LUNAR I.R. ABSOR	CRATER NO.	CENTER PT. LOC. X (FT)	CENTER PT. LOC. Y (FT)	CRATER DIA (FT)	CRATER DEPTH (FT)	ASPECT
	48.00	1.000	1.000	1	352.00	100.00	200.00	99.90	2.00
				2	270.00	-30.00	100.00	20.00	5.00
				3	100.00	100.00	300.00	30.00	10.00

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	260.00	30.00	.00	.0	661.7

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR. DIRECT SOLAR	CRATER ALBEDO	CRATER I.R.	PLAIN ALBEDO	PLAIN I.R.	INCIDENT ENERGY, BTU/HR. DIRECT SOLAR	CRATER ALBEDO	CRATER I.R.	PLAIN ALBEDO	PLAIN I.R.	AD W TEMP DEG R
	ITMG	4370.8	6535.8	580.8	.0	592.3	.0	3197.7	2323.4	.0	659.5	.0	3553.0	
	VISOR	197.6	223.1	3.3	.0	62.7	.0	131.6	7.2	.0	69.6	.0	146.3	
	HELMT	217.9	474.5	80.4	.0	41.6	.0	95.8	321.8	.0	46.2	.0	106.5	
	PLSS	1997.0	3113.3	310.3	.0	300.7	.0	1386.0	1241.2	.0	334.0	.0	1538.1	
	OPS	966.5	1549.9	164.8	.0	166.8	.0	634.9	659.4	.0	185.5	.0	705.0	
	RCU	130.4	210.2	21.3	.0	21.0	.0	88.1	85.4	.0	24.5	.0	100.3	
	BOOTS	561.5	740.8	186.1	.0	4.6	.0	370.9	319.7	.0	5.4	.0	415.7	
	GLOVS	138.3	275.2	29.1	.0	15.1	.0	94.1	47.5	.0	32.0	.0	196.7	
	UMBIL	925.3	1418.0	134.9	.0	121.1	.0	669.3	539.4	.0	134.8	.0	743.7	
	HARD	40.8	46.7	.0	.0	11.2	.0	29.6	.0	.0	12.9	.0	33.8	
	TOTAL	9546.1	14587.4	1511.0	.0	1337.1	.0	6698.0	5544.8	.0	1504.5	.0	7538.0	

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR. DIRECT SOLAR	CRATER ALBEDO	CRATER I.R.	PLAIN ALBEDO	PLAIN I.R.	INCIDENT ENERGY, BTU/HR. DIRECT SOLAR	CRATER ALBEDO	CRATER I.R.	PLAIN ALBEDO	PLAIN I.R.	AD W TEMP DEG R
1	01.11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	01.21	19.4	21.6	.0	.0	.2	.0	19.2	.0	.0	.2	.0	21.4	556.7
3	01.22	55.6	61.8	.0	.0	.5	.0	55.1	.0	.0	.5	.0	61.2	556.3
4	01.23	31.9	43.5	14.7	.0	.1	.0	17.1	24.4	.0	.1	.0	19.0	648.8
5	01.24	35.3	49.8	19.3	.0	.1	.0	15.9	32.1	.0	.1	.0	17.6	677.7
6	01.25	31.8	43.4	14.7	.0	.2	.0	17.0	24.4	.0	.2	.0	18.9	648.6
7	01.26	55.6	61.7	.0	.0	.8	.0	54.8	.0	.0	.8	.0	60.9	556.2
8	01.31	34.6	57.5	34.6	.0	.0	.0	.0	57.5	.0	.0	.0	.0	598.2
9	01.32	4.5	7.9	3.8	.0	.1	.0	.6	6.1	.0	.2	.0	1.6	605.5
10	01.33	7.7	15.3	2.3	.0	.4	.0	5.0	9.2	.0	.4	.0	5.6	425.0
11	01.34	4.5	7.9	3.8	.0	.0	.0	.7	6.1	.0	.1	.0	1.6	605.3
12	02.11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
13	02.21	19.4	21.6	.0	.0	.2	.0	19.2	.0	.0	.2	.0	21.4	556.7

TIME
(HR)
2.600

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

TAPE COMBINING OPTION. TAPE 10 TIMELINE POINT 2

ENVIRONMENT SUN ANGLE (DEG) = .00

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	.0	520.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R
	ITMG	2266.5	.0	2518.3													
	VISOR	132.1	.0	146.8													
	HELMT	153.1	.0	170.1													
	PLSS	1066.2	.0	1184.9													
	OPS	452.1	.0	501.9													
	RCU	47.6	.0	55.1													
	BOOTS	386.7	.0	511.8													
	GLOVS	60.6	.0	126.0													
	UMBIL	210.8	.0	234.3													
	HARD	23.9	.0	27.3													
	TOTAL	4799.6	.0	5476.3													

NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R
1	01*11	68.2	.0	75.8	522.4	2	01*21	14.9	.0	16.5	520.8	3	01*22	17.7	.0	33.7	527.5
4	01*23	10.9	.0	12.1	522.1	5	01*24	12.2	.0	13.6	520.8	6	01*25	13.2	.0	14.7	520.8
7	01*26	24.9	.0	47.4	520.8	8	01*31	11.2	.0	14.4	520.8	9	01*32	2.1	.0	5.2	520.8
10	01*33	13.1	.0	14.6	520.8	11	01*34	1.5	.0	3.6	520.8	12	02*11	74.1	.0	82.3	533.3
13	02*21	14.9	.0	16.5	520.8	14	02*22	24.9	.0	47.4	520.8	15	02*23	13.1	.0	14.6	520.8
16	02*24	12.2	.0	13.6	520.8	17	02*25	10.8	.0	12.0	520.8	18	02*26	18.4	.0	35.1	520.8
19	02*31	12.0	.0	15.4	520.8	20	02*32	1.4	.0	3.5	520.8	21	02*33	13.1	.0	14.6	520.8
22	02*34	2.1	.0	5.2	520.8	23	03*11	25.1	.0	27.9	520.8	24	03*12	22.9	.0	25.5	520.8
25	03*13	18.1	.0	20.1	522.2	26	03*14	15.0	.0	16.6	523.6	27	03*15	20.6	.0	22.9	521.7
28	03*16	24.8	.0	27.6	520.8	29	03*17	25.8	.0	28.7	520.8	30	03*18	25.0	.0	27.8	520.8
31	03*21	36.5	.0	40.5	520.8	32	03*22	36.5	.0	40.6	520.8	33	03*23	26.8	.0	29.7	521.2

TIME
(HR)
2.600

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R
34	03.24	19.7	.0	21.9	521.4	35	03.25	26.3	.0	29.2	521.0	36	03.26	36.6	.0	40.7	520.8
37	03.27	38.1	.0	42.3	520.8	38	03.28	38.1	.0	42.4	520.8	39	04.11	18.0	.0	20.0	520.8
40	04.12	22.9	.0	25.4	520.8	41	04.13	25.1	.0	27.9	520.8	42	04.14	25.0	.0	27.8	520.8
43	04.15	25.7	.0	28.6	520.8	44	04.16	24.8	.0	27.6	520.8	45	04.17	20.3	.0	22.6	520.8
46	04.18	14.1	.0	15.7	520.8	47	04.21	26.4	.0	29.3	520.8	48	04.22	36.6	.0	40.7	520.8
49	04.23	36.6	.0	40.7	520.8	50	04.24	38.1	.0	42.3	520.8	51	04.25	38.1	.0	42.3	520.8
52	04.26	36.6	.0	40.7	520.8	53	04.27	26.4	.0	29.3	520.8	54	04.28	18.4	.0	20.4	520.8
55	05.11	9.4	.0	10.5	521.1	56	05.12	7.5	.0	8.3	522.1	57	05.13	8.6	.0	9.6	521.9
58	05.14	13.2	.0	14.7	520.8	59	05.21	2.6	.0	2.9	520.8	60	05.22	2.5	.0	2.8	520.8
61	05.23	4.6	.0	5.1	520.8	62	05.24	7.7	.0	8.6	520.8	63	05.25	12.0	.0	13.4	520.8
64	05.26	10.5	.0	11.7	520.8	65	05.27	4.2	.0	4.6	521.0	66	05.28	2.4	.0	2.7	520.8
67	05.29	3.1	.0	3.5	520.8	68	05.31	2.7	.0	3.0	520.8	69	05.32	2.4	.0	2.7	520.8
70	05.33	4.6	.0	5.1	520.8	71	05.34	7.6	.0	8.4	520.8	72	05.35	11.1	.0	12.4	520.8
73	05.36	10.1	.0	11.2	520.8	74	05.37	4.3	.0	4.7	521.0	75	05.38	2.4	.0	2.7	520.8
76	05.39	3.1	.0	3.4	520.9	77	05.41	7.7	.0	8.6	520.8	78	05.42	26.8	.0	29.8	520.8
79	05.43	9.4	.0	10.4	520.8	80	05.44	9.9	.0	11.0	520.8	81	05.45	11.3	.0	12.6	520.8
82	05.46	10.7	.0	11.9	520.8	83	05.47	4.8	.0	5.3	520.8	84	05.48	10.4	.0	11.6	520.8
85	06.11	49.6	.0	55.1	520.8	86	06.12	110.9	.0	123.2	520.9	87	06.13	50.4	.0	56.0	520.8
88	06.14	27.1	.0	30.1	520.8	89	06.15	65.3	.0	72.5	520.8	90	06.16	.0	.0	.0	520.8
91	06.17	62.7	.0	69.6	520.8	92	06.18	27.2	.0	30.2	520.8	93	07.11	5.7	.0	6.3	520.8
94	07.12	18.2	.0	20.2	520.8	95	07.13	4.6	.0	5.1	520.8	96	07.14	8.7	.0	9.6	520.8
97	07.15	.0	.0	.0	520.8	98	07.16	7.1	.0	7.9	520.8	99	07.21	11.8	.0	13.1	520.8
100	07.22	12.0	.0	13.4	520.8	101	07.23	.0	.0	.0	520.8	102	07.31	4.8	.0	5.3	520.8
103	07.32	4.2	.0	4.6	520.8	104	07.33	2.0	.0	2.2	520.8	105	07.34	4.4	.0	4.9	520.8
106	07.35	4.4	.0	4.9	520.8	107	07.36	2.2	.0	2.5	520.8	108	08.11	2.9	.0	3.2	520.8
109	08.12	3.3	.0	3.7	520.8	110	08.13	2.8	.0	3.1	520.8	111	08.14	.9	.0	1.1	520.8
112	08.15	3.7	.0	4.1	520.8	113	08.16	.0	.0	.0	520.8	114	08.17	12.8	.0	14.3	520.8
115	08.18	.7	.0	.8	520.8	116	08.21	4.8	.0	5.3	520.8	117	08.22	5.0	.0	5.5	520.9
118	08.23	5.6	.0	6.2	520.8	119	08.24	5.5	.0	6.1	520.8	120	09.11	2.9	.0	3.2	521.1
121	09.12	3.1	.0	3.4	520.8	122	09.13	7.9	.0	8.8	520.8	123	09.14	3.4	.0	3.7	520.8
124	09.15	8.4	.0	9.3	520.8	125	09.16	2.9	.0	3.2	520.8	126	09.17	5.3	.0	5.9	520.8
127	09.18	4.4	.0	4.9	520.8	128	09.19	1.4	.0	1.6	520.8	129	09.21	1.0	.0	1.1	521.1
130	09.22	4.7	.0	5.2	520.9	131	09.23	9.7	.0	10.7	520.8	132	09.24	16.6	.0	18.4	520.8
133	09.25	9.2	.0	10.2	520.8	134	09.26	3.2	.0	3.6	520.8	135	09.27	.3	.0	.4	520.8
136	10.11	2.8	.0	3.2	521.1	137	10.12	3.6	.0	4.0	520.8	138	10.13	7.7	.0	8.6	520.8
139	10.14	3.3	.0	3.6	520.8	140	10.15	8.2	.0	9.1	520.8	141	10.16	2.9	.0	3.2	520.8
142	10.17	5.3	.0	5.9	520.8	143	10.18	4.3	.0	4.8	520.8	144	10.19	2.8	.0	3.1	520.9
145	10.21	1.0	.0	1.1	521.1	146	10.22	4.7	.0	5.2	520.9	147	10.23	9.7	.0	10.7	520.8
148	10.24	15.1	.0	16.8	520.8	149	10.25	9.2	.0	10.2	520.8	150	10.26	3.4	.0	3.8	520.8
151	10.27	.9	.0	1.0	520.8	152	11.11	8.5	.0	9.5	520.8	153	11.12	24.4	.0	27.1	520.8
154	11.13	26.2	.0	29.1	520.8	155	11.14	30.5	.0	33.9	520.8	156	11.15	25.3	.0	28.1	520.8
157	11.16	15.9	.0	17.7	520.8	158	11.17	4.0	.0	4.4	520.8	159	11.18	3.2	.0	3.6	520.8
160	11.21	10.6	.0	11.7	520.9	161	11.22	10.5	.0	11.7	520.8	162	11.23	12.2	.0	13.6	520.8
163	11.24	13.1	.0	14.6	520.8	164	11.25	12.2	.0	13.6	520.8	165	11.26	11.2	.0	12.4	520.9
166	11.27	6.9	.0	7.6	521.0	167	11.28	7.8	.0	8.7	521.0	168	12.11	5.4	.0	6.0	520.8

TIME
(HR)
2.700

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

TAPE COMBINING OPTION. TAPE 10 TIMELINE POINT 4

ENVIRONMENT SUN ANGLE (DEG) = 48.00

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	620.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R
	ITMG	1976.1	193.6	2157.2	
	VISOR	124.8	9.6	133.9	
	HELMT	89.4	29.1	92.3	
	PLSS	925.7	135.1	1000.3	
	OPS	317.5	72.0	335.8	
	RCU	37.6	4.9	42.3	
	BOOTS	519.0	45.6	631.2	
	GLOVS	56.0	7.3	106.8	
	UMBIL	173.6	21.2	188.5	
	HARD	24.4	2.3	26.5	
	TOTAL	4244.3	520.6	4714.8	

NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R
1	01*11	136.3	7.1	146.7	621.1	2	01*21	17.1	1.0	18.3	539.3	3	01*22	24.4	.3	46.2	571.6
4	01*23	12.1	.4	13.3	536.5	5	01*24	13.0	.9	14.1	528.8	6	01*25	12.9	1.3	13.8	517.7
7	01*26	24.9	5.6	40.8	520.7	8	01*31	6.9	1.3	7.1	461.4	9	01*32	1.5	1.0	2.3	483.5
10	01*33	9.0	2.0	9.5	474.3	11	01*34	1.2	.5	2.2	494.1	12	02*11	135.9	7.1	146.3	620.7
13	02*21	17.2	1.0	18.4	539.7	14	02*22	25.4	.4	47.9	523.5	15	02*23	13.4	.5	14.7	523.8
16	02*24	12.9	.9	14.1	528.3	17	02*25	11.6	1.1	12.5	530.4	18	02*26	24.1	4.2	41.0	556.6
19	02*31	7.5	3.6	7.7	462.9	20	02*32	1.0	.7	1.6	481.8	21	02*33	9.0	2.0	9.5	474.1
22	02*34	1.7	.7	3.3	496.5	23	03*11	20.3	1.4	22.2	493.7	24	03*12	24.0	2.2	26.1	527.0
25	03*13	20.9	.6	23.1	541.4	26	03*14	19.7	.2	22.0	560.9	27	03*15	23.7	.4	26.3	540.3
28	03*16	24.9	.7	27.6	521.3	29	03*17	24.3	.9	26.8	512.7	30	03*18	21.5	1.1	23.7	501.6
31	03*21	25.0	2.0	27.3	473.6	32	03*22	35.8	1.7	38.9	518.1	33	03*23	28.1	.5	31.2	527.8

TIME
(HR)
2.710

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

TAPE COMBINING OPTION. TAPE 10 TIMELINE POINT 4

ENVIRONMENT SUN ANGLE (DEG) = 48.00

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	620.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R	NODE NO.	NODE NAME	Q TOTAL ABSOR	Q SOLAR INCID	Q I.R. INCID	AD W TEMP DEG R
	ITMG	1976.1	193.6	2157.2													
	VISOR	124.8	9.6	133.9													
	HELMT	89.4	29.1	92.3													
	PLSS	925.7	135.1	1000.3													
	OPS	317.5	72.0	335.8													
	RCU	37.6	4.9	42.3													
	BOOTS	519.0	45.6	631.2													
	GLOVS	56.0	7.3	106.8													
	UMBIL	173.6	21.2	188.5													
	HARD	24.4	2.3	26.5													
	TOTAL	4244.3	520.6	4714.8													

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

TIME
(HR)
2.990

APOLLO EMU IN A STANDING MODE IS LOCATED IN A INTRA VEHIC. ENVIRONMENT.

ENVIRONMENT	TEMP SURF 1	TEMP SURF 2	TEMP SURF 3	TEMP SURF 4	TEMP SURF 5	TEMP SURF 6	VEH X LENGTH	VEH Y LENGTH	VEH HEIGHT	SURF EMISS
	.0	.0	.0	.0	.0	.0	5.0	10.0	9.6	.930

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	1.50	180.0	460.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR. SURF 1	SURF 2	SURF 3	SURF 4	SURF 5	SURF 6	AD W TEMP DEG R
	ITMG	1628.7	1809.6	607.1	179.3	545.9	178.8	141.7	112.3	
	VISOR	81.5	90.6	4.7	7.5	45.1	7.5	3.7	14.7	
	HELMT	95.9	106.6	32.4	9.3	10.8	9.3	1.5	32.5	
	PLSS	728.5	808.7	821.2	61.4	197.8	61.3	54.8	72.1	
	OPS	344.5	382.5	220.6	24.6	82.2	24.6	17.9	73.5	
	RCU	46.8	53.5	16.6	3.1	16.9	3.6	3.3	6.4	
	BOOTS	281.7	320.7	60.9	24.3	66.4	24.3	100.8	11.2	
	GLOVS	43.0	89.7	9.6	8.1	9.6	8.1	5.4	2.2	
	UMBIL	341.2	379.1	100.2	35.4	102.3	35.8	31.7	42.6	
	HARD	16.2	18.5	1.3	.5	14.1	.5	.6	.6	
	TOTAL	3608.0	4059.5	1874.9	353.4	1091.2	353.8	361.3	368.2	

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR. SURF 1	SURF 2	SURF 3	SURF 4	SURF 5	SURF 6	AD W TEMP DEG R
1	01*11	38.1	42.4	2.0	.6	3.3	.3	31.9	.0	451.7
2	01*21	8.6	9.5	3.1	.2	6.9	.1	1.3	.0	453.4
3	01*22	24.2	26.9	4.6	.0	5.7	6.7	6.4	.8	451.7
4	01*23	7.5	8.3	4.1	.0	.1	1.4	1.7	.1	451.7
5	01*24	7.0	7.7	5.2	.2	.0	.2	1.4	.0	451.7
6	01*25	7.5	8.3	3.9	1.8	.1	.0	1.7	.1	451.7

TIME
(HR)
3.000

APOLLO EMU IN A STANDING MODE IS LOCATED IN A INTRA VEHIC. ENVIRONMENT.

ENVIRONMENT	TEMP SURF 1	TEMP SURF 2	TEMP SURF 3	TEMP SURF 4	TEMP SURF 5	TEMP SURF 6	VEH X LENGTH	VEH Y LENGTH	VEH HEIGHT	SURF EMISS
	.0	.0	.0	.0	.0	.0	5.0	10.0	9.5	.930

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	1.50	180.0	460.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR. SURF 1	SURF 2	SURF 3	SURF 4	SURF 5	SURF 6	AD W TEMP 0DEG R
	ITMG	1628.7	1809.6	607.1	179.3	545.9	178.8	141.7	112.3	
	VISOR	81.5	90.6	4.7	7.5	45.1	7.5	3.7	14.7	
	HELMT	95.9	106.6	12.4	9.3	10.8	9.3	1.5	32.5	
	PLSS	728.5	808.7	821.2	61.4	197.8	61.3	54.8	72.1	
	OPS	344.5	382.5	220.6	24.6	82.2	24.6	17.9	73.5	
	RCU	46.8	53.5	16.6	3.1	16.9	3.6	3.3	6.4	
	BOOTS	281.7	320.7	60.9	24.3	66.4	24.3	100.8	11.2	
	GLOVS	43.0	89.7	9.6	8.1	9.6	8.1	5.4	2.2	
	UMBIL	341.2	379.1	100.2	35.4	102.3	35.8	31.7	42.6	
	HARD	16.2	18.5	1.3	.5	14.1	.5	.6	.6	
	TOTAL	3608.0	4059.5	1874.4	353.4	1091.2	353.8	341.3	368.2	

APOLLO EMU ENVIRONMENT IS THE SAME AS THE PREVIOUS TIME POINT. SEE THAT PRINTOUT FOR DETAILED NODAL FLUX DATA.

TIME
(HR)
3.100

APOLLO EMU IN A STANDING MODE IS LOCATED IN A DEEP SPACE ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = 48.00

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	.0	1.0

SUMMARY OF THE THERMAL ENVIRONMENT.

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	INCIDENT ENERGY, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
	ITMG	580.8	2323.4	580.8	.0	.0	.0	.0	2323.4	.0	.0	.0	.0	
	VISOR	3.3	7.2	3.3	.0	.0	.0	.0	7.2	.0	.0	.0	.0	
	HELMT	80.4	321.8	80.4	.0	.0	.0	.0	321.8	.0	.0	.0	.0	
	PLSS	310.3	1241.2	310.3	.0	.0	.0	.0	1241.2	.0	.0	.0	.0	
	OPS	164.8	659.4	164.8	.0	.0	.0	.0	659.4	.0	.0	.0	.0	
	RCU	21.3	85.4	21.3	.0	.0	.0	.0	85.4	.0	.0	.0	.0	
	BOOTS	186.1	319.7	186.1	.0	.0	.0	.0	319.7	.0	.0	.0	.0	
	GLOVS	29.1	47.5	29.1	.0	.0	.0	.0	47.5	.0	.0	.0	.0	
	UMBIL	134.9	539.4	134.9	.0	.0	.0	.0	539.4	.0	.0	.0	.0	
	HARD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	
	TOTAL	1511.0	5544.8	1511.0	.0	.0	.0	.0	5544.8	.0	.0	.0	.0	

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	INCIDENT ENERGY, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
1	01*11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	01*21	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3	01*22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	16.6
4	01*23	14.7	24.4	14.7	.0	.0	.0	.0	24.4	.0	.0	.0	.0	534.4
5	01*24	19.3	32.1	19.3	.0	.0	.0	.0	32.1	.0	.0	.0	.0	582.8
6	01*25	14.7	24.4	14.7	.0	.0	.0	.0	24.4	.0	.0	.0	.0	539.4
7	01*26	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
8	01*31	34.6	57.5	34.6	.0	.0	.0	.0	57.5	.0	.0	.0	.0	598.2
9	01*32	3.8	6.1	3.8	.0	.0	.0	.0	6.1	.0	.0	.0	.0	580.2

TIME
(HR)
3.200

APOLLO EMU IN A STANDING MODE IS LOCATED IN A DEEP SPACE ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = 48.00

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	.00	.00	.00	180.0	1.0

SUMMARY OF THE THERMAL ENVIRONMENT.

		ABSORBED HEAT, BTU/HR							INCIDENT ENERGY, BTU/HR					
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
	ITMG	688.8	2755.2	688.8	.0	.0	.0	.0	2755.2	.0	.0	.0	.0	
	VISOR	109.4	241.1	109.4	.0	.0	.0	.0	241.1	.0	.0	.0	.0	
	HELMT	31.1	124.4	31.1	.0	.0	.0	.0	124.4	.0	.0	.0	.0	
	PLSS	357.8	1182.7	357.8	.0	.0	.0	.0	1182.7	.0	.0	.0	.0	
	OPS	170.2	659.4	170.2	.0	.0	.0	.0	659.4	.0	.0	.0	.0	
	RCU	23.5	93.9	23.5	.0	.0	.0	.0	93.9	.0	.0	.0	.0	
	BOOTS	196.1	403.8	196.1	.0	.0	.0	.0	403.8	.0	.0	.0	.0	
	GLOVS	29.1	47.5	29.1	.0	.0	.0	.0	47.5	.0	.0	.0	.0	
	UMBIL	143.6	574.6	143.6	.0	.0	.0	.0	574.6	.0	.0	.0	.0	
	HARD	36.5	74.2	36.5	.0	.0	.0	.0	74.2	.0	.0	.0	.0	
	TOTAL	1786.0	6156.7	1786.0	.0	.0	.0	.0	6156.7	.0	.0	.0	.0	

		ABSORBED HEAT, BTU/HR							INCIDENT ENERGY, BTU/HR					
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
1	01.11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	01.21	23.3	38.8	23.3	.0	.0	.0	.0	38.8	.0	.0	.0	.0	582.8
3	01.22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	01.23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	01.24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	01.25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	01.26	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	29.6
8	01.31	34.6	57.5	34.6	.0	.0	.0	.0	57.5	.0	.0	.0	.0	598.2
9	01.32	11.6	18.8	11.6	.0	.0	.0	.0	18.8	.0	.0	.0	.0	767.7

TIME (HR) 3.300

APOLLO EMU IN A STANDING MODE IS LOCATED IN A DEEP SPACE ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = 48.00

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	100.00	.00	.00	180.0	1.0

SUMMARY OF THE THERMAL ENVIRONMENT.

				ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR					AD W
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	TEMP DEG R
	ITMG	688.8	2755.2	688.8	.0	.0	.0	.0	2755.2	.0	.0	.0	.0	
	VISOR	109.4	241.1	109.4	.0	.0	.0	.0	241.1	.0	.0	.0	.0	
	HELMT	31.1	124.4	31.1	.0	.0	.0	.0	124.4	.0	.0	.0	.0	
	PLSS	357.8	1182.7	357.8	.0	.0	.0	.0	1182.7	.0	.0	.0	.0	
	OPS	170.2	659.4	170.2	.0	.0	.0	.0	659.4	.0	.0	.0	.0	
	RCU	23.5	93.9	23.5	.0	.0	.0	.0	93.9	.0	.0	.0	.0	
	BOOTS	196.1	403.8	196.1	.0	.0	.0	.0	403.8	.0	.0	.0	.0	
	GLOVS	29.1	47.5	29.1	.0	.0	.0	.0	47.5	.0	.0	.0	.0	
	UMBIL	143.6	574.6	143.6	.0	.0	.0	.0	574.6	.0	.0	.0	.0	
	HARD	36.5	74.2	36.5	.0	.0	.0	.0	74.2	.0	.0	.0	.0	
	TOTAL	1786.0	6156.7	1786.0	.0	.0	.0	.0	6156.7	.0	.0	.0	.0	

				ABSORBED HEAT, BTU/HR					INCIDENT ENERGY, BTU/HR					AD W
NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	TEMP DEG R
1	01*11	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	01*21	23.3	38.8	23.3	.0	.0	.0	.0	38.8	.0	.0	.0	.0	582.8
3	01*22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4	01*23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5	01*24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6	01*25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7	01*26	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	29.6
8	01*31	34.6	57.5	34.6	.0	.0	.0	.0	57.5	.0	.0	.0	.0	598.2
9	01*32	11.6	18.8	11.6	.0	.0	.0	.0	18.8	.0	.0	.0	.0	767.7

TIME (HR) 3.400

APOLLO EMU IN A STANDING MODE IS LOCATED IN A DEEP SPACE ENVIRONMENT.

ENVIRONMENT SUN ANGLE (DEG) = -5.00

APOLLO EMU LOCATION	X (FT)	Y (FT)	Z (FT)	AZIMUTH (DEG)	CONTACT TEMP
	100.00	.00	.00	180.0	1.0

SUMMARY OF THE THERMAL ENVIRONMENT.

			ABSORBED HEAT, BTU/HR						INCIDENT ENERGY, BTU/HR				
NO. NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
ITMG	935.3	3741.2	935.3	.0	.0	.0	.0	3741.2	.0	.0	.0	.0	
VISOR	157.4	346.8	157.4	.0	.0	.0	.0	346.8	.0	.0	.0	.0	
HELMT	7.4	29.6	7.4	.0	.0	.0	.0	29.6	.0	.0	.0	.0	
PLSS	428.7	1342.1	428.7	.0	.0	.0	.0	1342.1	.0	.0	.0	.0	
OPS	147.0	556.2	147.0	.0	.0	.0	.0	556.2	.0	.0	.0	.0	
RCU	23.3	93.3	23.3	.0	.0	.0	.0	93.3	.0	.0	.0	.0	
BOOTS	136.2	271.6	136.2	.0	.0	.0	.0	271.6	.0	.0	.0	.0	
GLOVS	6.7	10.9	6.7	.0	.0	.0	.0	10.9	.0	.0	.0	.0	
UMBIL	101.7	406.7	101.7	.0	.0	.0	.0	406.7	.0	.0	.0	.0	
HARD	55.3	114.4	55.3	.0	.0	.0	.0	114.4	.0	.0	.0	.0	
TOTAL	1999.0	6912.9	1999.0	.0	.0	.0	.0	6912.9	.0	.0	.0	.0	

			ABSORBED HEAT, BTU/HR						INCIDENT ENERGY, BTU/HR				
NO. NODE NAME	TOTAL ABSOR	TOTAL INCID	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
1 01*11	13.8	22.9	13.8	.0	.0	.0	.0	22.9	.0	.0	.0	.0	350.1
2 01*21	34.7	57.8	34.7	.0	.0	.0	.0	57.8	.0	.0	.0	.0	693.7
3 01*22	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4 01*23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5 01*24	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6 01*25	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7 01*26	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	27.2
8 01*31	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
9 01*32	4.9	8.0	4.9	.0	.0	.0	.0	8.0	.0	.0	.0	.0	619.5

TIME (HR)															PAGE 121
3.400															

APOLLO EMU IN A STANDING MODE IS LOCATED IN A DEEP SPACE ENVIRONMENT.

NO.	NODE NAME	TOTAL ABSOR	TOTAL INCID	ABSORBED HEAT, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	INCIDENT ENERGY, BTU/HR DIRECT SOLAR	SOLAR ALBEDO	ENV I.R.	VEHIC ALBEDO	VEHIC I.R.	AD W TEMP DEG R
325	21.54	3.4	13.7	3.4	.0	.0	.0	.0	13.7	.0	.0	.0	.0	454.8
326	21.61	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
327	21.62	.5	2.0	.5	.0	.0	.0	.0	2.0	.0	.0	.0	.0	236.8
328	21.63	11.3	45.3	11.3	.0	.0	.0	.0	45.3	.0	.0	.0	.0	516.9
329	21.64	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
330	21.65	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	19.8
331	21.66	.5	2.1	.5	.0	.0	.0	.0	2.1	.0	.0	.0	.0	281.1
332	21.67	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
333	21.68	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
334	21.71	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
335	21.72	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
336	21.73	1.4	5.7	1.4	.0	.0	.0	.0	5.7	.0	.0	.0	.0	359.3
337	21.74	3.1	12.3	3.1	.0	.0	.0	.0	12.3	.0	.0	.0	.0	435.2
338	21.81	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
339	21.82	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
340	21.83	.7	2.6	.7	.0	.0	.0	.0	2.6	.0	.0	.0	.0	269.0
341	21.84	10.6	42.4	10.6	.0	.0	.0	.0	42.4	.0	.0	.0	.0	516.9
342	21.85	1.5	6.0	1.5	.0	.0	.0	.0	6.0	.0	.0	.0	.0	281.1
343	21.86	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
344	21.87	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
345	21.88	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
346	21.91	.1	.4	.1	.0	.0	.0	.0	.4	.0	.0	.0	.0	21.9
347	21.92	20.9	83.8	20.9	.0	.0	.0	.0	83.8	.0	.0	.0	.0	135.9
348	21.93	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	516.9
349	21.94	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

TAPE END OF FILE HAS BEEN GENERATED FOF THE DATA CALCULATED.

APPENDIX F

MRR SAMPLE PROBLEM

The results of a sample problem set up and run on the MRR to demonstrate the program capabilities are presented in this Appendix. The sample problem consists of the multiple reflection analyses of two timepoints of the EMU manned qualification test number 2. The EMU manned qualification test and the EHFR generated environments used as input to the MRR are reported in Appendix E as sample problem number 1.

The MRR sample problem analyzed EHFR timepoints at 16.6 and 16.683 hours using the MRR problem restart option. The EHFR environment calculations for these timepoints are shown on Appendix E pages E-19 through E-21. The resulting MRR analyses, presented on pages F-2 through F 8, tabulate updated adiabatic wall temperatures in °R and environmental energies in BTU /hr.

The EMU environmental absorbed heats calculated by the EHFR and modified for multiple reflections by the MRR are compared in Table F-1. This comparison shows that multiple reflections added approximately 2 1/2% additional absorbed energy to the EMU. Greater multiple reflections effects would have been demonstrated if the solar lamps had been on.

TABLE F-1 COMPARISON OF EMU ABSORBED HEATS CALCULATED BY EHFR AND MODIFIED BY MRR

Time	EMU Area	EHFR Results (E-19)*	MRR Results (F-3)
16.6	ITM	1944.7	2051.1
	Visor	127.2	128.3
	Helmet	89.1	96.3
	PLSS	805.6	820.9
	OPS	344.5	354.8
	RCU	36.0	39.6
	Boots	590.4	598.8
	Gloves	55.9	68.9
	Umbilicals	164.1	184.6
	Hard Points	24.3	24.7
	TOTAL	4231.9	4368.1

*Appendix E page number

TIME POINTS READ FOR RESTART

15.000
16.516

TIME(HR)
16.600

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

SUMMARY OF THERMAL ENVIRONMENT.

NODE	TOTAL ABSORBED	TOTAL SOLAR	TOTAL IR
ITMG	2051.05	60.92	1990.14
VISOR	128.33	4.57	123.75
HELMT	96.28	8.76	87.51
PLSS	820.91	36.53	784.39
OPS	354.86	23.74	331.11
RCU	39.63	1.79	37.85
BOOTS	598.79	26.93	571.86
GLOVS	68.90	4.81	64.09
UMBIL	184.56	11.04	173.52
HARD	24.76	1.22	23.54
TOTAL	4368.06	180.31	4187.75

ADIABATIC WALL TEMPERATURE

1	421.10	539.26	581.65	539.31	531.31	521.28	512.82	475.90	513.43	478.71	10
11	564.79	620.72	539.74	522.94	524.87	530.92	535.01	555.14	476.79	557.73	20
21	478.75	528.02	493.23	527.35	542.87	567.82	543.33	521.55	512.68	501.66	30
31	474.34	518.65	532.19	545.57	528.62	508.36	495.76	482.71	518.31	527.68	40
41	522.24	518.25	519.59	521.06	536.63	554.23	504.93	518.89	508.53	502.56	50
51	504.41	507.94	520.60	531.08	544.46	540.87	525.01	510.50	481.22	506.87	60
61	511.95	512.71	468.88	487.42	534.09	517.73	537.07	479.05	507.79	510.22	70
71	515.28	476.98	490.46	533.66	517.99	533.27	486.43	514.01	485.73	480.30	80
81	488.37	452.10	498.62	481.18	534.21	527.15	521.34	508.21	465.38	.00	90
91	481.00	509.35	528.03	520.19	525.01	490.17	.00	489.02	501.59	501.35	100
101	.00	477.40	476.60	469.22	433.98	430.83	471.26	516.15	509.20	514.94	110
111	473.30	469.15	489.06	470.05	498.34	532.51	531.83	450.44	459.23	536.29	120
121	534.50	498.59	458.91	441.96	430.78	440.41	469.84	491.10	530.50	528.14	130
131	497.82	451.20	449.06	481.33	565.92	536.31	533.62	497.90	459.46	439.95	140
141	427.23	431.23	467.22	521.10	531.28	527.57	497.31	450.48	442.30	461.45	150
151	538.00	511.24	495.84	477.33	477.18	486.67	517.04	537.40	547.82	522.96	160
161	501.10	483.57	484.51	503.04	532.48	566.91	573.35	510.92	496.70	476.81	170
171	473.41	483.51	517.76	557.43	546.07	522.50	500.16	483.60	482.78	498.95	180
181	528.67	570.42	570.96	494.74	480.06	622.20	554.03	487.48	475.21	621.45	190
191	556.43	482.37	536.35	557.19	557.39	535.45	479.18	477.81	469.44	779.90	200
201	778.42	460.32	475.05	501.66	501.78	489.75	463.70	544.11	535.96	459.05	210
211	488.60	482.87	459.28	440.77	442.49	450.74	480.62	477.37	434.98	417.85	220
221	425.61	435.30	474.05	482.12	458.59	449.72	450.43	459.49	482.33	507.80	230
231	535.83	549.53	548.14	534.15	504.43	509.63	524.17	534.94	533.41	521.86	240
241	508.25	502.73	510.94	516.88	515.73	509.73	500.85	493.90	487.34	488.13	250
251	489.01	488.07	494.10	564.27	498.30	467.10	436.70	502.77	482.22	535.81	260
261	532.53	521.93	513.95	574.68	560.20	629.21	494.84	448.34	495.49	428.20	270
271	534.44	613.12	520.59	522.44	463.99	495.29	515.42	497.73	444.83	.00	280
281	490.46	502.83	501.74	528.62	529.26	531.57	529.53	533.21	531.92	.00	290
291	463.28	.00	.00	.00	508.11	.00	.00	.00	484.26	.00	300
301	.00	.00	452.78	.00	.00	.00	493.19	.00	.00	.00	310
311	484.36	.00	.00	.00	449.96	.00	.00	.00	502.38	569.80	320
321	.00	.00	484.16	.00	.00	.00	566.19	520.86	475.93	507.81	330
331	569.22	.00	449.77	496.69	531.95	.00	562.28	455.35	449.41	.00	340
341	527.60	.00	.00	455.90	534.42	.00	535.92	.00	461.31		

TOTAL ABSORBED HEAT

1	136.28	17.10	43.03	12.89	13.21	13.26	40.08	9.12	1.94	9.59	10
11	2.16	135.95	17.16	43.33	13.63	13.17	12.49	40.86	9.73	2.05	20
21	9.59	2.17	19.96	23.83	21.55	20.92	24.35	24.92	24.25	21.52	30
31	25.13	36.05	29.35	23.21	28.55	33.18	31.26	28.15	17.97	23.88	40
41	25.08	24.51	25.58	24.82	23.18	18.65	23.56	36.18	33.28	33.07	50
51	33.50	33.07	27.03	19.37	13.49	8.74	8.74	11.49	1.93	2.34	60
61	4.32	6.25	8.29	8.04	4.75	2.38	3.01	1.94	2.31	4.27	70
71	6.12	7.89	8.25	4.75	2.39	3.64	4.76	27.52	4.72	7.15	80
81	7.98	16.03	6.48	7.47	42.59	117.38	44.60	31.64	32.23	.00	90
91	46.22	27.88	6.44	18.14	5.96	6.73	.07	6.12	10.48	10.68	100
101	2.63	3.51	3.50	1.50	2.11	3.07	1.70	2.27	4.67	2.25	110
111	.64	9.66	1.60	9.47	1.18	5.78	5.75	3.13	3.31	3.21	120
121	4.24	6.72	2.02	4.38	1.34	3.45	2.75	1.63	1.09	4.99	130
131	8.07	9.36	5.08	2.33	.44	3.19	4.20	6.69	2.03	4.30	140
141	1.30	3.10	2.82	3.68	1.08	4.96	8.04	9.30	4.78	2.91	150
151	1.00	14.05	21.97	18.47	21.53	18.89	15.55	8.77	8.31	10.36	160
161	9.63	9.10	9.81	10.62	9.28	8.65	9.82	13.60	21.72	18.39	170
171	20.85	18.41	16.47	6.87	5.74	10.59	8.98	9.11	9.67	10.28	180
181	9.19	10.21	10.47	10.85	4.09	15.13	4.47	10.22	3.93	15.66	190
191	4.55	2.17	1.68	.40	.39	1.63	2.09	2.34	1.09	.13	200
201	.13	1.02	2.31	7.11	7.12	2.21	2.80	1.14	1.15	2.73	210
211	2.21	2.23	3.47	3.78	3.84	3.23	2.20	2.19	2.82	3.06	220
221	3.29	2.83	2.13	2.48	3.36	3.83	3.85	3.39	2.48	2.77	230
231	5.46	7.41	7.19	5.23	2.66	2.95	6.37	8.94	8.82	6.20	240
241	2.89	2.91	5.94	7.96	7.89	5.88	2.85	2.73	4.91	6.32	250
251	6.37	4.94	2.73	153.58	151.60	121.47	73.42	152.19	7.02	143.46	260
261	11.12	.84	1.36	3.73	.47	.67	49.62	72.87	49.32	48.94	270
271	111.67	18.34	2.03	2.07	2.75	6.20	21.07	4.07	3.90	.00	280
281	1.65	1.57	2.14	3.80	4.21	3.99	3.30	2.63	3.11	.91	290
291	5.39	.64	.00	.00	7.05	.00	.00	.00	4.17	.00	300
301	.57	1.34	7.02	.52	.00	.89	6.13	.00	.00	.26	310
311	4.16	.00	.56	.59	4.40	.63	.00	.00	7.23	11.84	320
321	.00	.00	4.18	.20	.56	1.36	8.33	11.43	4.89	4.33	330
331	7.32	.00	3.50	5.01	6.89	.39	1.41	5.09	3.43	.00	340
341	11.24	.00	.00	4.89	12.73	.00	15.26	.16	7.67		

TOTAL SOLAR HEAT

1	4.28	.63	.44	.30	.52	.80	3.38	2.09	.60	.62	10
11	.32	4.28	.63	.23	.31	.52	.69	2.59	2.20	.47	20
21	.62	.41	.39	.66	.35	.16	.16	.17	.23	.27	30
31	.52	.95	.32	.12	.22	.27	.35	.44	.40	.65	40
41	.24	-.08	.12	.17	.21	.27	.51	.95	.21	-.22	50
51	-.19	.27	.31	.34	.30	.22	.13	.10	.06	.08	60
61	.11	.11	.17	.22	.06	.02	.05	.05	.07	.07	70
71	.15	.35	.35	.04	.02	.07	.26	.73	.20	.14	80
81	.33	1.26	.35	.33	1.23	3.10	.99	.66	2.20	.00	90
91	3.52	.86	.16	.61	.12	.36	.03	.48	.40	.39	100
101	.83	.25	.24	.17	.36	.47	.18	.07	.19	.05	110
111	.04	.83	.54	1.08	.06	.07	.04	.37	.62	.05	120
121	.10	.24	.14	.53	.19	.91	.35	.10	.03	.11	130
131	.24	.65	.80	.31	.05	.05	.07	.20	.15	.45	140
141	.14	.65	.24	.18	.02	.08	.19	.59	.47	.28	150
151	.08	.20	.77	.76	1.43	1.23	.44	.35	.28	.16	160
161	.28	.26	.35	.44	.34	.31	.30	.32	.76	.67	170
171	.78	.87	.38	.37	.26	.21	.18	.23	.22	.17	180
181	.20	.33	.30	1.92	.39	.37	.02	1.31	.24	.48	190
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.01	.03	.19	.22	.04	200

211	.12	.15	.60	.89	.95	.35	.11	.15	.22	.27	220
221	.50	.22	.09	.08	.17	.26	.29	.19	.09	.08	230
231	.12	.15	.14	.06	.02	.11	.18	.29	.18	.08	240
241	.08	.13	.26	.36	.29	.19	.09	.14	.29	.41	250
251	.46	.32	.14	.98	2.45	9.91	9.36	5.24	1.75	5.59	260
261	.90	.07	.12	.07	.01	.08	.85	9.41	1.29	4.20	270
271	6.48	1.26	.11	.14	.30	.16	.53	.17	.51	.00	280
281	.12	.05	.04	.21	.22	.21	.18	.15	.17	.27	290
291	.22	.26	.00	.00	.14	.00	.00	.00	.17	.00	300
301	.20	.42	.41	.10	.00	.17	.15	.00	.00	.08	310
311	.17	.00	.20	.10	.37	.26	.00	.00	.13	.20	320
321	.00	.00	.17	.06	.19	.33	.31	.27	.29	.10	330
331	.18	.00	.29	.22	.09	.14	.28	.40	.44	.00	340
341	.36	.00	.00	.63	.30	.00	.97	.07	.95		

TOTAL IR HEAT

1	132.01	16.47	42.58	12.59	12.70	12.46	36.70	7.04	1.33	8.97	10
11	1.83	131.67	16.53	43.11	13.31	12.66	11.79	38.27	7.54	1.59	20
21	8.97	1.76	19.58	23.17	21.20	20.75	24.19	24.75	24.03	21.25	30
31	24.61	35.11	29.03	23.09	28.33	32.91	30.91	27.71	17.57	23.23	40
41	24.84	24.59	25.47	24.66	22.97	18.37	23.04	35.23	33.07	33.29	50
51	33.31	32.80	26.72	19.03	13.19	8.52	8.61	11.39	1.87	2.26	60
61	4.21	6.13	8.12	7.82	4.69	2.36	2.96	1.90	2.24	4.21	70
71	5.98	7.54	7.90	4.71	2.37	3.57	4.50	26.79	4.52	7.02	80
81	7.65	14.77	6.12	7.14	41.36	114.28	43.61	30.98	30.03	.00	90
91	42.71	27.01	6.28	17.53	5.84	6.37	.05	5.64	10.08	10.29	100
101	1.80	3.26	3.25	1.33	1.75	2.60	1.52	2.20	4.48	2.20	110
111	.60	8.82	1.06	8.39	1.12	5.71	5.71	2.76	2.69	3.16	120
121	4.14	6.48	1.88	3.85	1.16	2.53	2.40	1.53	1.06	4.87	130
131	7.83	8.71	4.28	2.02	.39	3.13	4.14	6.48	1.88	3.85	140
141	1.15	2.45	2.57	3.50	1.05	4.88	7.84	8.71	4.31	2.61	150
151	.91	13.85	21.20	17.71	20.10	17.66	15.11	8.42	8.03	10.20	160
161	9.35	8.85	9.46	10.18	8.94	8.34	9.51	13.28	20.97	17.72	170
171	20.07	17.53	16.08	6.50	5.49	10.37	8.80	8.87	9.45	10.12	180
181	9.00	9.88	10.16	8.93	3.70	14.76	4.45	8.91	3.69	15.18	190
191	4.47	2.10	1.64	.38	.37	1.60	2.06	2.15	.87	.09	200
201	.09	.88	2.18	6.87	6.87	2.06	2.32	.80	.84	2.37	210
211	2.09	2.08	2.87	2.89	2.89	2.88	2.10	2.04	2.60	2.79	220
221	2.79	2.60	2.04	2.39	3.19	3.57	3.57	3.19	2.39	2.70	230
231	5.34	7.26	7.05	5.17	2.65	2.83	6.19	8.65	8.63	6.13	240
241	2.80	2.78	5.68	7.59	7.60	5.68	2.76	2.59	4.62	5.91	250
251	5.91	4.62	2.59	152.60	149.14	111.57	64.06	146.96	5.26	137.87	260
261	10.22	.77	1.23	3.67	.46	.59	48.78	63.46	48.03	49.74	270
271	105.19	17.07	1.92	1.93	2.45	6.04	20.54	3.90	3.90	.00	280
281	1.53	1.52	2.10	3.59	3.99	3.78	3.12	2.48	2.94	.63	290
291	5.17	.39	.00	.00	6.91	.00	.00	.00	4.00	.00	300
301	.37	.92	6.62	.42	.00	.72	5.98	.00	.00	.18	310
311	3.99	.00	.36	.49	4.03	.37	.00	.00	7.10	11.64	320
321	.00	.00	4.01	.14	.36	1.03	8.02	11.16	9.60	9.22	330
331	7.13	.00	3.22	4.79	6.80	.25	1.12	4.69	2.99	.00	340
341	10.88	.00	.00	4.26	12.44	.00	14.29	.09	6.72		

TIME(HR)
16.683

APOLLO EMU IN A BENDING MODE IS LOCATED IN A MSC CHAMBER ENVIRONMENT.

SUMMARY OF THERMAL ENVIRONMENT.

NODE	TOTAL ABSORBED	TOTAL SOLAR	TOTAL IR
ITMG	2051.05	60.92	1990.14
VISOR	128.33	4.57	123.75
HELMT	96.28	8.76	87.51
PLSS	820.91	36.53	784.39
OPS	354.86	23.74	331.11
RCU	39.63	1.79	37.85
BOOTS	598.79	26.93	571.86
GLOVS	68.90	4.81	64.09
UMBIL	184.56	11.04	173.52
HARD	24.76	1.22	23.54
TOTAL	4368.06	180.31	4187.75

ADIABATIC WALL TEMPERATURE

1	621.10	539.26	581.65	539.31	531.31	521.28	512.82	475.90	513.43	478.71	10
11	564.79	620.72	539.74	522.94	524.87	530.92	535.01	555.14	476.79	557.73	20
21	478.75	528.02	493.23	527.35	542.87	567.82	543.33	521.55	512.68	501.66	30
31	474.34	518.65	532.19	545.57	528.62	508.36	495.76	482.71	518.31	527.68	40
41	522.24	518.25	519.59	521.06	536.63	554.23	504.93	518.89	508.53	502.56	50
51	504.41	507.94	520.60	531.08	544.46	540.87	525.01	510.50	481.22	506.87	60
61	511.95	512.71	468.88	487.42	534.09	517.73	537.07	479.05	507.79	510.22	70
71	515.28	476.98	490.46	533.66	517.99	533.27	486.43	514.01	485.73	480.30	80
81	488.37	452.10	498.62	481.18	534.21	527.15	521.34	508.21	465.38	.00	90
91	481.00	509.35	528.03	520.19	525.01	490.17	.00	489.02	501.59	501.35	100
101	.00	477.40	476.60	469.22	433.98	430.83	471.26	516.15	509.20	514.94	110
111	473.30	469.15	489.06	470.05	498.34	532.51	531.83	450.44	459.23	536.29	120
121	534.50	498.59	458.91	441.96	430.78	440.41	469.84	491.10	530.50	528.14	130
131	497.82	451.20	449.06	481.33	565.92	536.31	533.62	497.90	459.46	439.95	140
141	427.23	431.23	467.22	521.10	531.28	527.57	497.31	450.48	442.30	461.45	150
151	538.00	511.24	495.84	477.33	477.18	486.67	517.04	537.40	547.82	522.96	160
161	501.10	483.57	484.51	503.04	532.48	566.91	573.35	510.92	496.70	476.81	170
171	473.41	483.51	517.76	557.43	546.07	522.50	500.16	483.60	482.78	498.95	180
181	528.67	570.42	570.96	494.74	480.06	622.20	554.03	487.48	475.21	621.45	190
191	556.43	482.37	536.35	557.19	557.39	535.45	479.18	477.81	469.44	779.90	200
201	778.42	460.32	475.05	501.66	501.78	489.75	463.70	544.11	535.96	459.05	210
211	488.60	482.87	459.28	440.77	442.49	450.74	480.62	477.37	434.98	417.85	220
221	425.61	435.30	474.05	482.12	458.59	449.72	450.43	459.49	482.33	507.80	230
231	535.83	549.53	548.14	534.15	504.43	509.63	524.17	534.94	533.41	521.86	240
241	508.25	502.73	510.94	516.88	515.73	509.73	500.85	493.90	487.34	488.13	250
251	489.01	488.07	494.10	564.27	498.30	467.10	436.70	502.77	482.22	535.81	260
261	532.53	521.93	513.95	574.68	560.20	629.21	494.84	448.34	495.49	428.20	270
271	534.64	613.12	520.59	522.44	463.99	495.29	515.42	497.73	444.83	.00	280
281	490.46	502.83	501.74	528.62	529.26	531.57	529.53	533.21	531.92	.00	290
291	463.28	.00	.00	.00	508.11	.00	.00	.00	484.26	.00	300
301	.00	.00	452.78	.00	.00	.00	493.19	.00	.00	.00	310
311	484.36	.00	.00	.00	449.96	.00	.00	.00	502.38	569.80	320
321	.00	.00	484.16	.00	.00	.00	566.19	520.86	475.93	507.81	330
331	569.22	.00	449.77	496.69	531.95	.00	562.28	455.35	449.41	.00	340
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	504.42	.00	535.92	.00	461.31		

1	136.28	17.10	43.03	12.89	13.21	13.26	40.08	9.12	1.94	9.59	10
11	2.16	135.95	17.16	43.33	13.63	13.17	12.49	40.86	9.73	2.05	20
21	9.59	2.17	19.96	23.83	21.55	20.92	24.35	24.92	24.25	21.52	30
31	25.13	36.05	29.35	23.21	28.55	33.18	31.26	28.15	17.97	23.88	40
41	25.08	24.51	25.58	24.82	23.18	18.65	23.56	36.18	33.28	33.07	50
51	33.50	33.07	27.03	19.37	13.49	8.74	8.74	11.49	1.93	2.34	60
61	4.32	6.25	8.29	8.04	4.75	2.38	3.01	1.94	2.31	4.27	70
71	6.12	7.89	8.25	4.75	2.39	3.64	4.76	27.52	4.72	7.15	80
81	7.98	16.03	6.48	7.47	42.59	117.38	44.60	31.64	32.23	.00	90
91	46.22	27.88	6.44	18.14	5.96	6.73	.07	6.12	10.48	10.68	100
101	2.63	3.51	3.50	1.50	2.11	3.07	1.70	2.27	4.67	2.25	110
111	.64	9.66	1.60	9.47	1.18	5.78	5.75	3.13	3.31	3.21	120
121	4.24	6.72	2.02	4.38	1.34	3.45	2.75	1.63	1.09	4.99	130
131	8.07	9.36	5.08	2.33	.44	3.19	4.20	6.69	2.03	4.30	140
141	1.30	3.10	2.82	3.68	1.08	4.96	8.09	9.30	4.78	2.91	150
151	1.00	14.05	21.97	18.47	21.53	18.89	15.55	8.77	8.31	10.36	160
161	9.63	9.10	9.81	10.62	9.28	8.65	9.82	13.60	21.72	18.39	170
171	20.85	18.41	16.47	6.87	5.74	10.59	8.98	9.11	9.67	10.28	180
181	9.19	10.21	10.47	10.85	4.09	15.13	4.47	10.22	3.93	15.66	190
191	4.55	2.17	1.68	.40	.39	1.63	2.09	2.34	1.09	.13	200
201	.13	1.02	2.31	7.11	7.12	2.21	2.80	1.14	1.15	2.73	210
211	2.21	2.23	3.47	3.78	3.84	3.23	2.20	2.19	2.82	3.06	220
221	3.29	2.83	2.13	2.48	3.36	3.83	3.85	3.39	2.48	2.77	230
231	5.46	7.41	7.19	5.23	2.66	2.95	6.37	8.94	8.82	6.20	240
241	2.89	2.91	5.94	7.96	7.89	5.88	2.85	2.73	4.91	6.32	250
251	6.37	4.94	2.73	153.58	151.60	121.47	73.42	152.19	7.02	143.46	260
261	11.12	.84	1.36	3.73	.47	.67	49.62	72.87	49.32	48.94	270
271	111.67	18.34	2.03	2.07	2.75	6.20	21.07	4.07	3.90	.00	280
281	1.65	1.57	2.14	3.80	4.21	3.99	3.30	2.63	3.11	.91	290
291	5.39	.64	.00	.00	7.05	.00	.00	.00	4.17	.00	300
301	.57	1.34	7.02	.52	.00	.89	6.13	.00	.00	.26	310
311	4.16	.00	.56	.59	4.40	.63	.00	.00	7.23	11.84	320
321	.00	.00	4.18	.20	.56	1.36	8.33	11.43	4.89	4.33	330
331	7.32	.00	3.50	5.01	6.89	.39	1.41	5.09	3.43	.00	340
341	11.24	.00	.00	4.89	12.73	.00	15.26	.16	7.67		

TOTAL SOLAR HEAT

1	4.28	.63	.44	.30	.52	.80	3.38	2.09	.60	.62	10
11	.32	4.28	.63	.23	.31	.52	.69	2.59	2.20	.47	20
21	.62	.41	.39	.66	.35	.16	.16	.17	.23	.27	30
31	.52	.95	.32	.12	.22	.27	.35	.44	.40	.65	40
41	.24	-.08	.12	.17	.21	.27	.51	.95	.21	-.22	50
51	.19	.27	.31	.34	.30	.22	.13	.10	.06	.08	60
61	.11	.11	.17	.22	.06	.02	.05	.05	.07	.07	70
71	.15	.35	.35	.04	.02	.07	.26	.73	.20	.19	80
81	.33	1.26	.35	.33	1.23	3.10	.99	.66	2.20	.00	90
91	3.52	.86	.16	.61	.12	.36	.03	.48	.40	.39	100
101	.83	.25	.24	.17	.36	.47	.18	.07	.19	.05	110
111	.04	.83	.54	1.08	.06	.07	.04	.37	.62	.05	120
121	.10	.24	.14	.53	.19	.91	.35	.10	.03	.11	130
131	.24	.65	.80	.31	.05	.05	.07	.20	.15	.45	140
141	.14	.65	.24	.18	.02	.08	.19	.59	.47	.28	150
151	.08	.20	.77	.76	1.43	1.23	.44	.35	.28	.16	160
161	.28	.26	.35	.44	.34	.31	.30	.32	.76	.67	170
171	.78	.87	.38	.37	.26	.21	.18	.23	.22	.17	180
181	.20	.33	.30	1.92	.39	.37	.02	1.31	.24	.48	190
191	.08	.07	.04	.02	.02	.03	.03	.19	.22	.04	200
201	.04	.14	.13	.24	.25	.15	.48	.34	.30	.35	210

211	.12	.15	.60	.89	.95	.35	.11	.15	.22	.27	220
221	.50	.22	.09	.08	.17	.26	.29	.19	.09	.08	230
231	.12	.15	.19	.06	.02	.11	.18	.29	.18	.08	240
241	.08	.13	.26	.36	.29	.19	.09	.14	.29	.41	250
251	.46	.32	.14	.98	2.45	9.91	9.36	5.24	1.75	5.59	260
261	.90	.07	.12	.07	.01	.08	.85	9.41	1.29	4.20	270
271	6.48	1.26	.11	.14	.30	.16	.53	.17	.51	.00	280
281	.12	.05	.04	.21	.22	.21	.18	.15	.17	.27	290
291	.22	.26	.00	.00	.14	.00	.00	.00	.17	.00	300
301	.20	.42	.41	.10	.00	.17	.15	.00	.00	.08	310
311	.17	.00	.20	.10	.37	.26	.00	.00	.13	.20	320
321	.00	.00	.17	.06	.19	.33	.31	.27	.29	.10	330
331	.18	.00	.29	.22	.09	.19	.28	.40	.44	.00	340
341	.36	.00	.00	.63	.30	.00	.97	.07	.95		

TOTAL IR HEAT

1	132.01	16.47	42.58	12.59	12.70	12.46	36.70	7.04	1.33	8.97	10
11	1.83	131.67	16.53	43.11	13.31	12.66	11.79	38.27	7.54	1.59	20
21	8.97	1.76	19.58	23.17	21.20	20.75	24.19	24.75	24.03	21.25	30
31	24.61	35.11	29.03	23.09	28.33	32.91	30.91	27.71	17.57	23.23	40
41	24.84	24.59	25.47	24.66	22.97	18.37	23.04	35.23	33.07	33.29	50
51	33.31	32.80	26.72	19.03	13.19	8.52	8.61	11.39	1.87	2.26	60
61	4.21	6.13	8.12	7.82	4.69	2.36	2.96	1.90	2.24	4.21	70
71	5.98	7.54	7.90	4.71	2.37	3.57	4.50	26.79	4.52	7.02	80
81	7.65	14.77	6.12	7.14	41.36	114.28	43.61	30.98	30.03	.00	90
91	42.71	27.01	6.28	17.53	5.84	6.37	.05	5.64	10.08	10.29	100
101	1.80	3.26	3.25	1.33	1.75	2.60	1.52	2.20	4.48	2.20	110
111	.60	8.82	1.06	8.39	1.12	5.71	5.71	2.76	2.69	3.16	120
121	4.14	6.48	1.88	3.85	1.16	2.53	2.40	1.53	1.06	4.87	130
131	7.83	8.71	4.28	2.02	.39	3.13	4.14	6.48	1.88	3.85	140
141	1.15	2.45	2.57	3.50	1.05	4.88	7.84	8.71	4.31	2.63	150
151	.91	13.85	21.20	17.71	20.10	17.66	15.11	8.42	8.03	10.20	160
161	9.35	8.85	9.46	10.18	8.94	8.34	9.51	13.28	20.97	17.72	170
171	20.07	17.53	16.08	6.50	5.49	10.37	8.80	8.87	9.45	10.12	180
181	9.00	9.88	10.16	8.93	3.70	14.76	4.45	8.91	3.69	15.18	190
191	4.47	2.10	1.64	.38	.37	1.60	2.06	2.15	.87	.09	200
201	.09	.88	2.18	6.87	6.87	2.06	2.32	.80	.84	2.37	210
211	2.09	2.08	2.87	2.89	2.89	2.88	2.10	2.04	2.60	2.79	220
221	2.79	2.60	2.04	2.39	3.19	3.57	3.57	3.19	2.39	2.70	230
231	5.34	7.26	7.05	5.17	2.65	2.83	6.19	8.65	8.63	6.13	240
241	2.80	2.78	5.68	7.59	7.60	5.68	2.76	2.59	4.62	5.91	250
251	5.91	4.62	2.59	152.60	149.14	111.57	64.06	146.96	5.26	137.87	260
261	10.22	.77	1.23	3.67	.46	.59	48.78	63.46	48.03	44.74	270
271	105.19	17.07	1.92	1.93	2.45	6.04	20.54	3.90	3.90	.00	280
281	1.53	1.52	2.10	3.59	3.99	3.78	3.12	2.48	2.94	.63	290
291	5.17	.39	.00	.00	6.91	.00	.00	.00	4.00	.00	300
301	.37	.92	6.62	.42	.00	.72	5.98	.00	.00	.18	310
311	3.99	.00	.36	.49	4.03	.37	.00	.00	7.10	11.64	320
321	.00	.00	4.01	.14	.36	1.03	8.02	11.16	4.60	4.22	330
331	7.13	.00	3.22	4.79	6.80	.25	1.12	4.69	2.99	.00	340
341	10.88	.00	.00	4.26	12.44	.00	14.29	.09	6.72		