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ABLATION AND THERMAL ANALYSIS OF THE APOLLO LUNAR RADIOISOTOPIC HEATER

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Sandia Laboratories, Albuquerque

July 1969

DISTRIB. SEP 22, 1969

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ABSTRACT

The ablation and thermal response of the Apollo Lunar Radioisotopic Heater (ALRH) is determined for orbital decay atmospheric reentry, lunar return prompt reentries, and multiple orbit reentries from near lunar apogees. The temperature response of the ALRH is also determined for operational and other steady state conditions.

The cutoff date for information in this report, with the exception of the "exact" trajectory multiple orbit reentry ablation analysis and the ALRH operational environment analysis, is March 15, 1969. The cutoff date for information on the above exceptions is May 15, 1969.

b

SUMMARY

In the Aerospace Nuclear Safety Program, Sandia Laboratories is responsible for performing analyses of space nuclear power systems to determine the behavior of the nuclear system during all phases of its mission, including any mission aborts which might occur.

As part of the Aerospace Nuclear Safety Program, the Reentry and Space Sciences Division of Sandia Laboratories' Aerospace Nuclear Safety Department conducted certain aerodynamic and thermodynamic analyses of the Apollo Lunar Radioisotopic Heater (ALRH). This report summarizes the analyses that were conducted to determine the ablation that would occur on the ALRH during orbital decay atmospheric reentry, prompt supercircular velocity reentries, and multiple orbit supercircular velocity reentries. It also includes the three-dimensional thermal analysis that was conducted to determine the temperature response of the ALRH during the above mentioned reentry trajectories. This report also contains the results of two steady state thermal analyses and an operational environment thermal analysis of the ALRH.

The results of the studies are shown as plots of ablation versus time, and of temperature distribution in the ALRH versus time for each of the atmospheric reentry trajectories considered. The results of the operational environment thermal analysis are shown as a plot of temperature versus time for the ALRH during the lunar day/night cycle. The temperature distribution through the ALRH is shown at lunar noon.

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ABLATION AND THERMAL ANALYSIS OF THE APOLLO LUNAR RADIOISOTOPIC HEATER

Introduction

As part of the NASA Apollo program, the Apollo Lunar Surface Experiment Package (ALSEP) will gather data on the characteristics and environment of the lunar surface and subsurface. References 1 and 2 describe the various experiments which are part of the original ALSEP array. This original ALSEP with the SNAP-27 radioisotope thermoelectric generator as a power source will be used on later Apollo missions. However, for the first manned lunar landing Apollo mission, a lighter weight ALSEP package, defined as the Early Apollo Scientific Experiment Package (EASEP) was developed. One part of the EASEP consists of an Early Apollo Scientific Experiment - Passive Seismic Experiment Package (EASE-PSEP). Figure 1 shows the EASE-PSEP in its deployed configuration.

The EASE-PSEP electronic package must be maintained within specified temperature limits (+140°F to -65°F)[3] during the lunar day/night cycle in order to remain operational. To prevent the temperature of the electronics from dropping below the lower temperature limit during the lunar night, 30 watts of thermal energy must be supplied to the central station electronics package. This thermal energy is supplied for the duration of the EASE-PSEP mission by two 15-watt Apollo Lunar Radioisotopic Heaters (ALRH's). These heaters use thermal energy from the radioactive decay of plutonium dioxide microspheres.

The development of the ALRH was under the direction of the Atomic Energy Commission's Space Electric Power Office (AEC/SEPO). Mound Laboratory was given design responsibility, and Sandia Laboratories provided the aerothermodynamic analyses and safety test programs to evaluate the design and to provide input data for the Safety Assessment Report which was written by AEC Headquarters personnel. As the Sandia analyses, test programs, and evaluation progressed, design changes were recommended to Mound Laboratory in order to improve the capabilities of the ALRH from a safety standpoint. The final ALRH design, incorporating the recommended changes, is shown in Figure 2. The ALRH consists of $^{238}PuO_2$ microspheres contained in two 20-mil tantalum-10 tungsten liners for high temperature protection. These liners are enclosed in a 10-mil platinum-10 rhodium cladding which prevents oxidation of the tantalum-10 tungsten liners. The heater is then encapsulated in a 0.25-inch titanium fragment and impact shield. The titanium is wrapped with 0.15-inch of fibrous graphite insulation to provide protection from the high heating rates experienced in a reentry environment. Ablation protection is then provided by enclosing all of the above in 0.6-inch of Poco (AXF-5Q) graphite. The heater is then enclosed in a 30-mil stainless steel can, which provides additional protection from fragments during a launch pad abort, and is fastened to an aluminum base plate. This is the basic ALRH which is then mounted on the EASE-PSEP mounting plate.

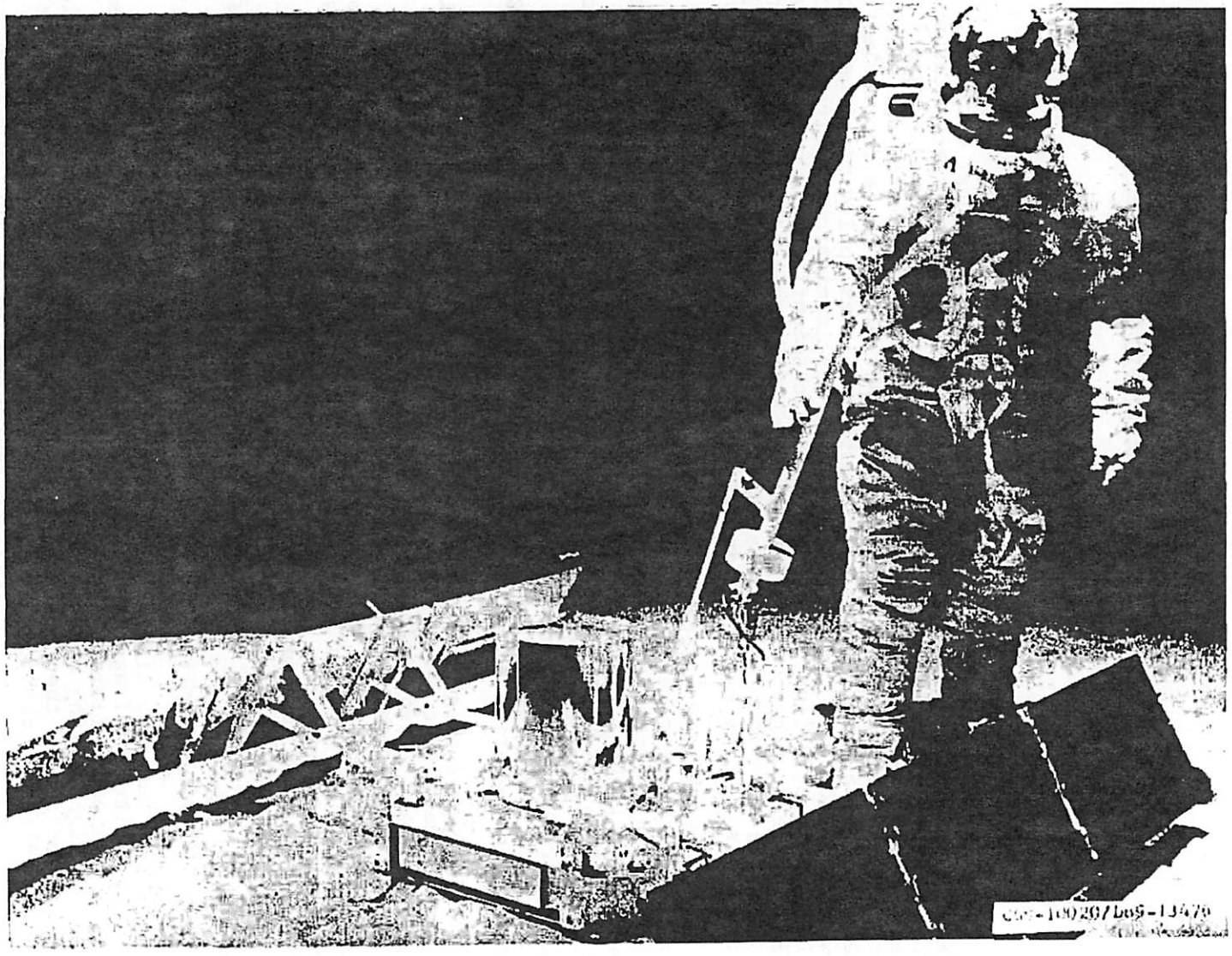

Figure 1. EASE-PSEP in deployed configuration

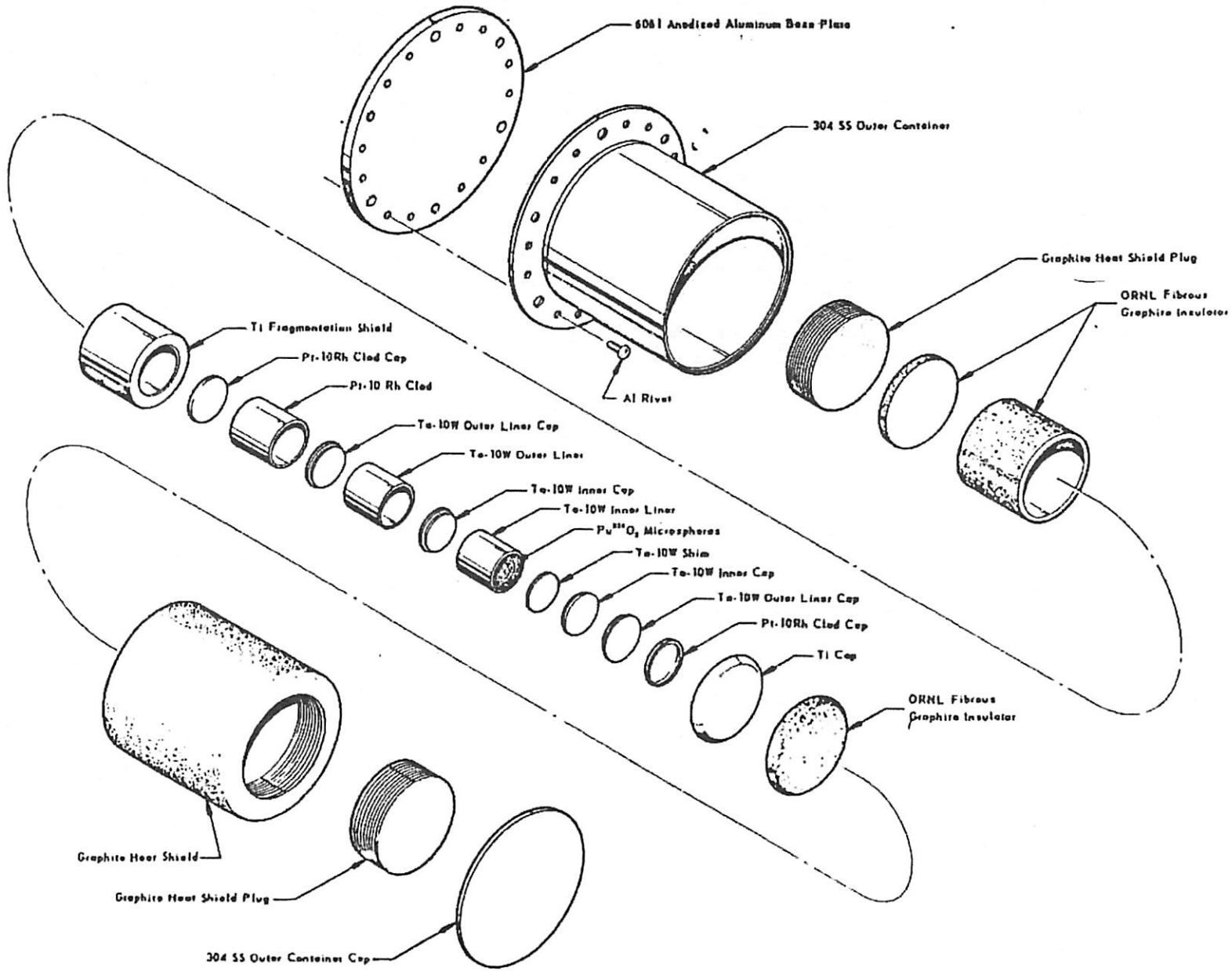

Figure 2. Apollo Lunar Radioisotopic Heater

An aerothermodynamic analysis of the ALRH was conducted by the Reentry and Space Sciences Division of Sandia Laboratories' Aerospace Nuclear Safety department between December 15, 1968, and March 1, 1969.[4] The analysis was used to determine the ability of the source to contain the radioactive fuel inventory during launch and reentry environments resulting from possible mission aborts. This report documents the ablation analysis and the two- and three-dimensional thermal studies which were performed as part of the entire aerothermodynamic analysis.

Ablation Model

The ablation model of the ALRH was constructed for use on the Charring Material Ablation (CMA) computer code.[5] This code is operational on Sandia's CDC 3600 and CDC 6600 computers. The CMA code uses an implicit, finite-difference computational procedure for computing the one-dimensional transient transport of thermal energy in a three-dimensional isotropic material which can ablate from the front surface and decompose (char) in depth. The finite-difference equations in the code are obtained from the laws of conservation of mass and energy. A mass and energy balance is maintained internally in the ablating material and also at the material surface. The output from the code prints such information as total ablation, current ablation rates, nodal temperatures and densities, and surface heat transfer rates (convective, radiative, and conductive).

The nodal construction used for the ALRH ablation model is shown in Figure 3. As shown, the ablation model consists of only the graphite portion of the ALRH because this is the ablating portion of the heater. The rear wall is assumed to be adiabatic. This closely approximates the actual boundary conditions due to the fibrous graphite insulation internal to the graphite. It will be noted in Figure 3 that the graphite thickness shown is 0.75 inch, while the final ALRH design has only 0.6 inch of this graphite. An earlier ALRH design had the thicker graphite wall, and the ablation model was so constructed. The thickness was changed sufficiently late in the time schedule to prohibit changing the ablation model and rerunning all the reentry trajectories. However, since the additional thickness is on the internal radius, it will have very little effect upon the ablation response of the ALRH. Therefore, the ablation results given in this report are valid for the 0.6-inch graphite wall.

In the CMA code, the aerodynamic heating experienced by the ALRH during reentry is input to the external node as a function of time. The code corrects this cold wall heating rate to account for the hot wall, mass injection into the boundary layer, and surface oxidation. Any surface recession causes the last (deepest) node of the ablating material to shrink. As the ablating surface recedes, it is the last ablation material node that is consumed. When the ablating surface recedes far enough, this node (deepest) is dropped from the rear surface of the ablating material, the remaining mass is added to the next node, and the number of nodes is reduced by one.

The material properties of the graphite are input as functions of temperature and are given in Appendix A. Other required input paramet and a typical CMA output are shown in Appendix B.

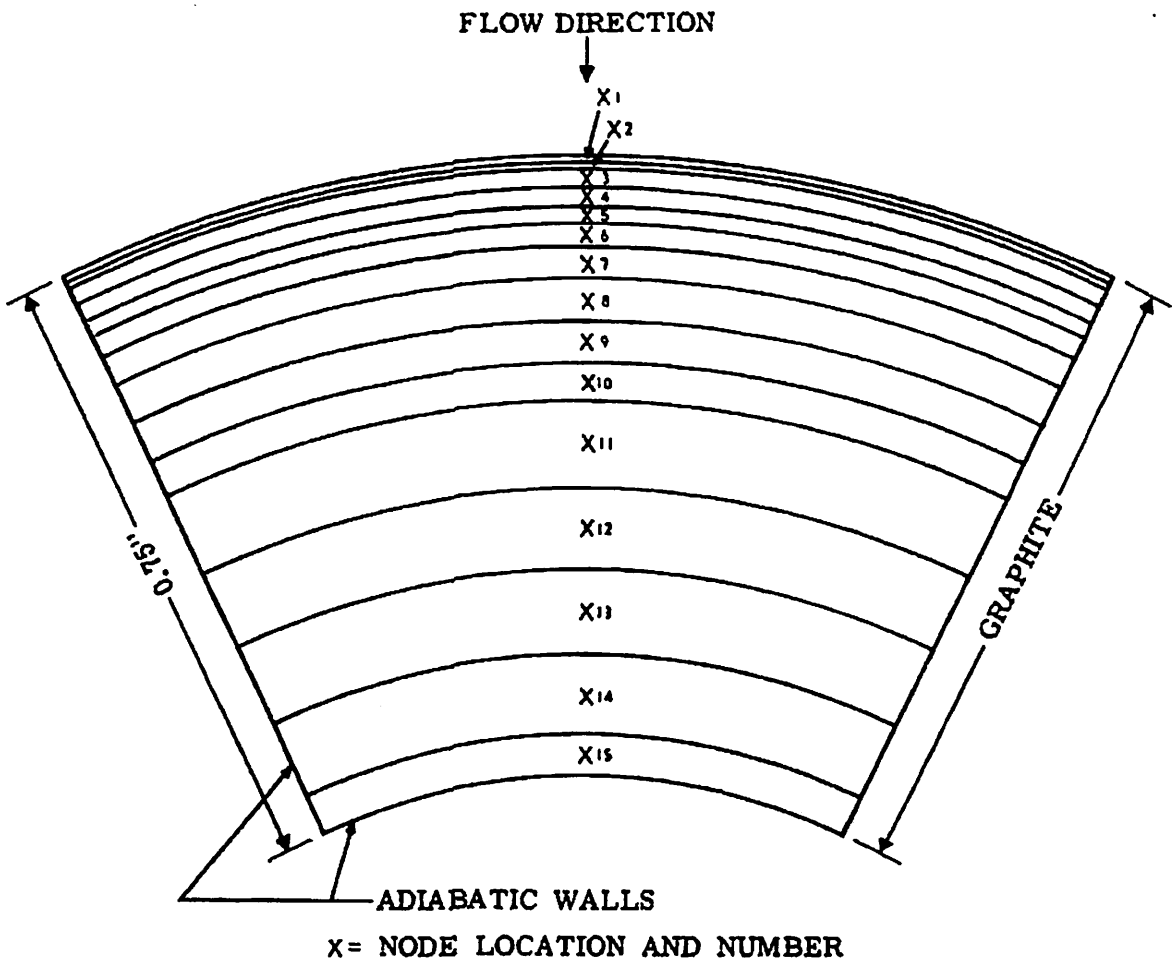

Figure 3. One-dimensional CMA ablation model

Thermal Models

The thermal models of the ALRH were constructed for use on the Chrysler Improved Numerical Differencing Analyzer for third Generation computers (CINDA-3G).[6] CINDA is a multi-options systems compiler computer code, which is operational on Sandia's Univac 1108 computer. It analyzes a mathematical model of any arbitrary one-, two-, or three-dimensional lumped parameter representation of a physical system governed by a set of diffusion equations. (A sample CINDA computer run is given in Appendix C.) To utilize the code, a thermal analog network representing the physical system must be constructed. Nonlinear material properties and boundary conditions may be input as functions of one or more independent variables.

The three-dimensional thermal model of the ALRH was constructed to determine the thermal response of the ALRH for side-on-stable reentry orientations. The nodal construction of the three-dimensional thermal model is shown in two planes in Figure 4. The model consists of 426 nodes, as indicated in Table I. The stainless steel container was not included in the thermal model since it will have little effect on the thermal response of the system during reentry.

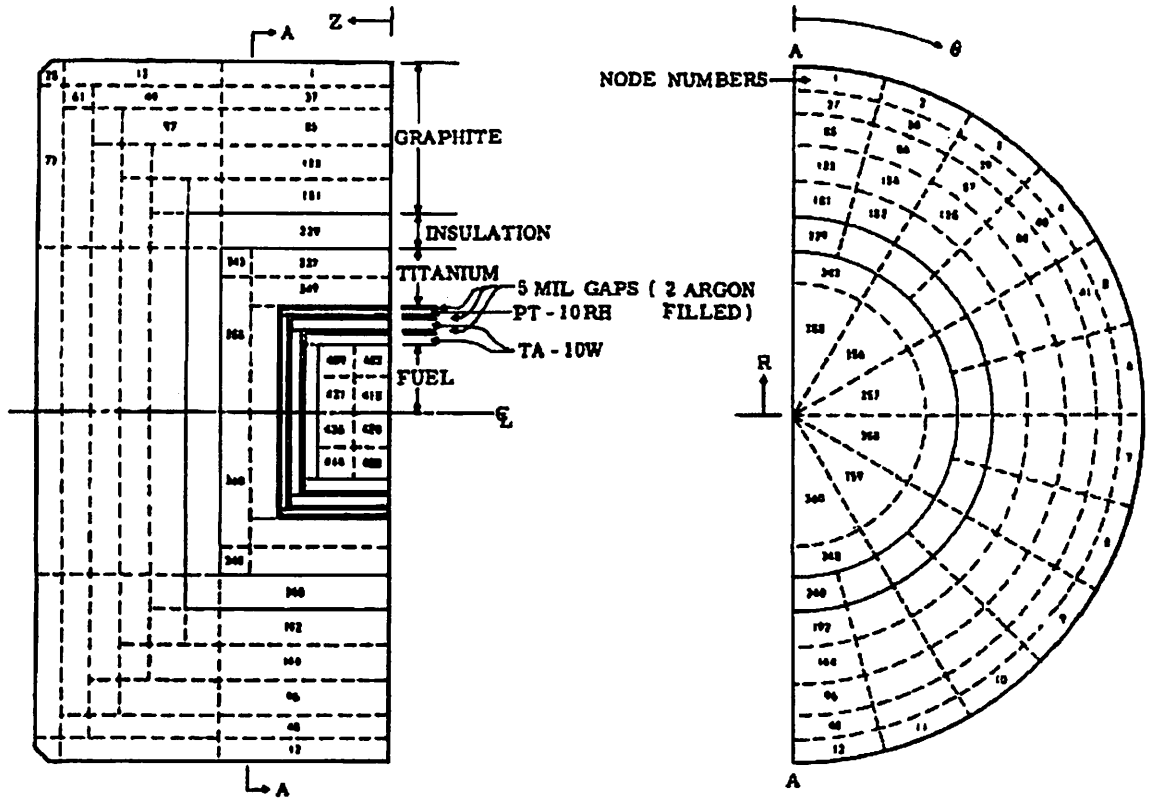

Figure 4. ALRH three-dimensional thermal model

TABLE I

ALRH Three-Dimensional Thermal Model Node Materials

Material	No. of Nodes
Poco graphite (AXF-5Q)	300
Fibrous carbon insulation	36
Titanium	30
Platinum-10% rhodium	12
Tantalum-10% tungsten	24
Fuel ($^{238}PuO_2$ microspheres)	24
Total	426

The model allows for heat transfer by both conduction and radiation between the appropriate nodes. All radiating surfaces are assumed to be grey with temperature varying emissivities. All other material properties are also allowed to vary with temperature. The internal energy generation in the ALRH is included in the fuel nodes. The reentry aerodynamic heating is accounted for by applying a time-varying heat generation to the nodes on the external surface. Each surface node can have a different aerodynamic heating rate applied to it in order to account for the heating distribution which occurs over the ALRH as it reenters the atmosphere in a side-on-stable orientation. Radiant cooling is accounted for by allowing each external node to radiate to space.

The two-dimensional thermal model was constructed to determine the thermal response of the ALRH under operational conditions on the lunar surface. The nodal construction of the two-dimensional thermal model is shown in Figure 5. The model consists of 99 nodes, as indicated in Table II.

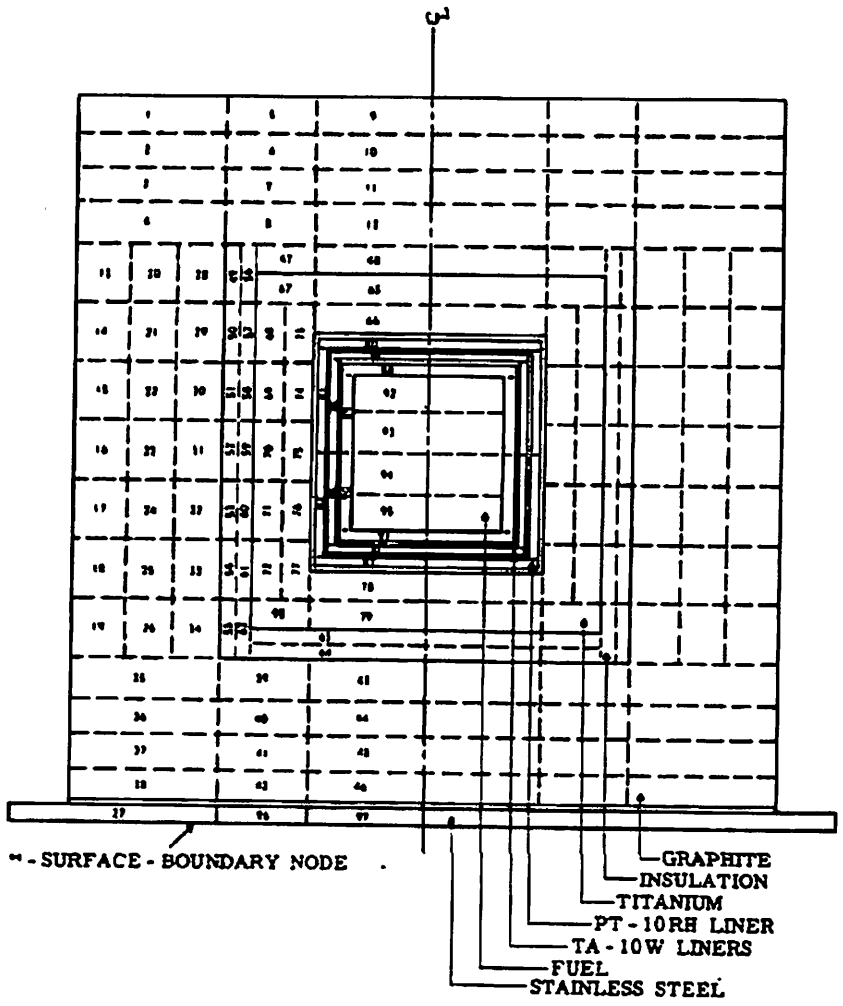

Figure 5. ALRH two-dimensional thermal model

TABLE II

ALRH Two-Dimensional Thermal Model Node Materials

Material	No. of Nodes
Poco graphite (AXF-5Q)	45
Fibrous carbon insulation	18
Titanium	16
Platinum-10% rhodium	4
Tantalum-10% tungsten	8
Fuel ($^{238}PuO_2$ microspheres)	4
Stainless steel	3
(Boundary node)	1
Total	99

The two-dimensional thermal model allows the material properties to vary as a function of temperature. The surface nodes are assumed to be insulated, since the ALRH has an insulation covering under operational conditions. The internal heat generation is included in the fuel nodes. The boundary node temperature is input as a function of time to account for the base plate temperature fluctuation during the lunar day/night cycle.

Aerodynamic Heating

During reentry into the atmosphere, the ALRH is subjected to high heating rates. The convective heating occurs in both the free-molecular and the continuum flow regimes. Radiant heating from the high temperature gas cap formed in front of the reentering ALRH must also be considered. This section of the report indicates how the aerodynamic heat input to the ALRH is determined.

The convective reference heat rate to the ALRH in the free-molecular flow regime is determined by

$$\dot{q}_{FM} = \frac{a\,\rho_\infty V_\infty^{\,3}}{50063} \qquad \text{(Reference 7)}$$

where

$\dot{q}_{FM}$ = free-molecular flow stagnation point heating rate (Btu/ft^2-sec)

a = thermal accommodation coefficient

ρ_∞ = free stream density (lbs/ft^3)

V_∞ = free stream velocity (ft/sec).

In the continuum flow regime, the convective reference heating rate to a one-foot radius sphere is determined by

$$\dot{q}_c = 17600 \left(\frac{\rho_\infty}{\rho_s}\right)^{0.5} \left(\frac{V_\infty}{V_c}\right)^{3.15} \quad \text{(Reference 8)}$$

where

$\dot{q}_c$ = continuum convective stagnation point heating rate (Btu/ft^2-sec)

ρ_∞ = local air density

ρ_s = sea level air density

V_∞ = free stream velocity

V_c = circular orbital velocity.

The convective heating which occurs in the transition flow regime is obtained by extending the free molecular and continuum heating curves to their intersection and using which ever heat rate is lower. An example is shown for one particular pass through the atmosphere in a multiple-orbit reentry in Figure 6 (The time in Figure 6 is referenced to perigee). This method gives results close to the various theories of transition flow heating as well as experimental results.[7]

The heating rates which are determined from the above equations are calculated during the multiple-orbit reentry trajectory by computer code HRS017-3.[9] For the orbital decay and supercircular velocity prompt reentries, Sandia's Theoretical Trajectory Program A (TTA)[10] is used to determine the trajectory and to calculate the heating. The TTA code calculates only the continuum convective heating. The heating rate to the ALRH for the prompt reentries is considered to be continuum for the entire trajectory since the ALRH is considered to be protected by the Lunar Module (LM) down to 300,000 feet altitude. At that altitude, when the ALRH is assumed to be free and unencumbered, the ALRH is already well into the transition flow regime. During the multiple-orbit reentry, both free molecular and continuum heating must be determined since the LM disassembles on the first pass through the atmosphere, and on each subsequent pass the ALRH is a free-body and thus encounters the high altitude free molecular heating as well as the lower altitude continuum heating.

The continuum heating rate determined by the previously mentioned equation is a reference value equivalent to the rate experienced by a one-foot radius sphere following the same trajectory. To obtain the actual rates, the reference heating rates determined for the sphere must be scaled for the size, configuration, and reentry orientation of the ALRH. The size effect is $1/\sqrt{R}$ where R is the ALRH radius. The heating ratio scale factors, Fq, for the ALRH configuration and orientation were based upon wind tunnel tests conducted on cylinders at Cornell Aeronautical Laboratory and Rhodes and Bloxsom by Sandia Laboratories.[11]

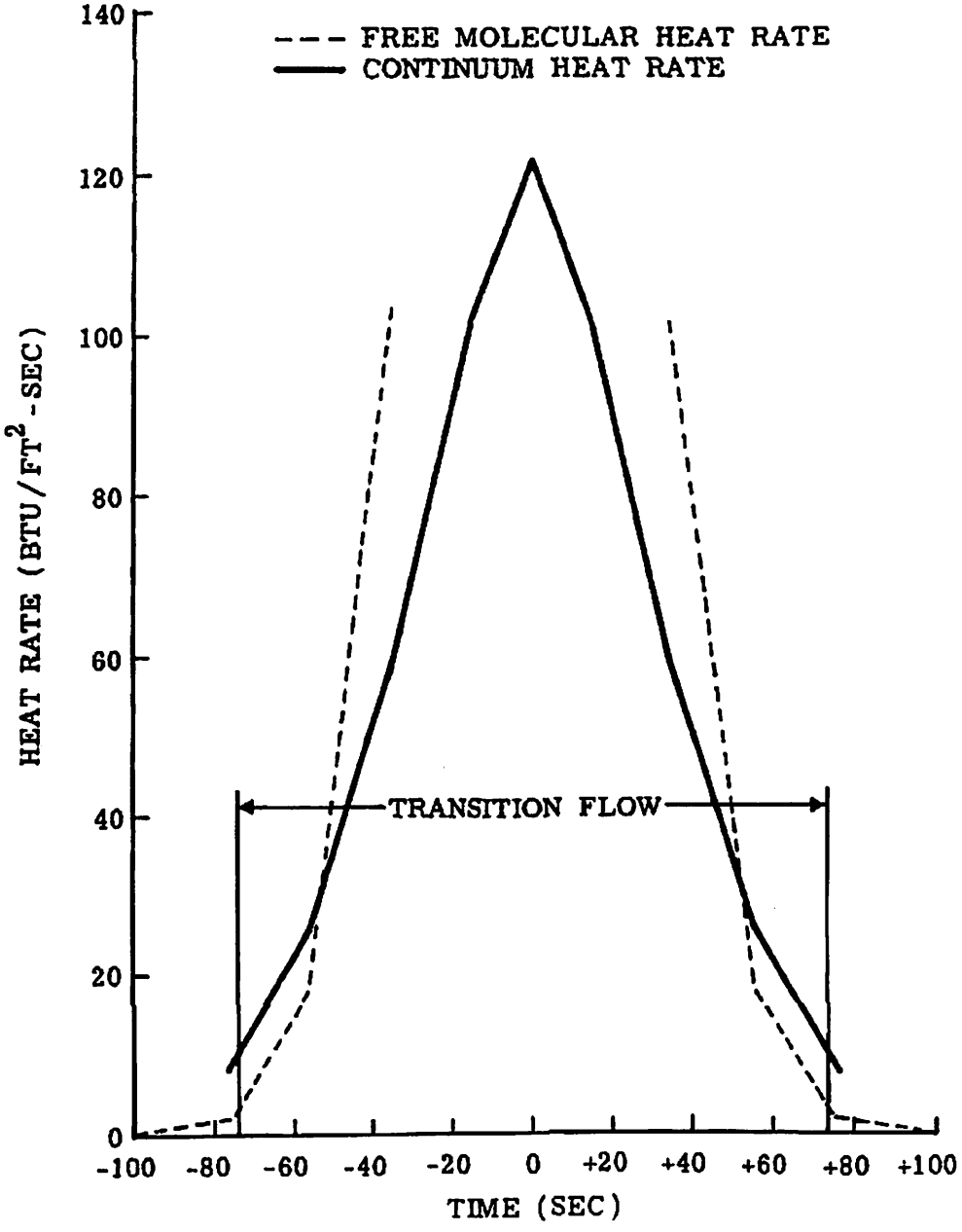

Figure 6. Transition flow heating

Figure 7 shows the heating ratio to a cylinder, referenced to a one-foot radius sphere, as a function of the circumferential angle at various axial locations along the cylinder. The heating ratio distribution in the axial direction at various circumferential angles is shown in Figure 8. The heating ratio distribution over the end of a cylinder in a side-on-stable orientation is shown in Figure 9. The heating ratio for a random-tumble and spin orientation was determined by properly averaging the heating ratios to the cylinder in various stable orientations. Using the techniques of Reference 7, the heating ratio for a random-tumble and spin orientation was determined to be 0.601.

The radiant heating to the ALRH during superorbital velocity reentry was determined by

$$\dot{q}_R = \left(3.748 \times 10^{-6}\right)\rho_\infty^{1.16}\, r_N^{0.5}\, U_\infty^{3} \left(U_\infty/10^4 - 3.25\right)^{1.337}$$

(Reference 21)

where

$\dot{q}_R$ = radiative stagnation point heating (Btu/ft^2-sec)

ρ_∞ = free-stream density (lbs/ft^2)

r_N = nose radius (ft)

U_∞ = free-stream velocity (ft/sec).

This equation correlates well with available experimental data.[12] A computer code (RADHTG) was written to evaluate the above radiant heating equation and the continuum convective heating equation. The code was written for use on the Sandia QUIKTRAN remote terminal computer in connection with an IBM 7040/44 computer in Los Angeles. Using RADHTG, the radiant heating to the ALRH was determined for the steep reentry angle lunar return trajectories. Due to the small size of the ALRH, the radiant heating rate was always less than 5 percent of the continuum convective heating. (See Appendix D for the output of RADHTG for -38° and -90° lunar return reentries.) Therefore, it was decided to ignore the radiant heating to the ALRH.

The aerodynamic heating rates discussed thus far in this section are cold wall heating rates. These cold wall rates are used as input to the CMA computer code. The CMA code calculates a corrected heating rate based upon the more realistic conditions of a hot wall, with mass injection into the boundary layer and oxidation of the graphite surface. The cold wall heating rates and the CMA corrected rates are compared in Figures 10 through 18. Figures 10 through 14 show a comparison of the heating rates for a random-tumble and spin reentry of the ALRH, and Figures 15 through 18 compare the heating rates along the ALRH stagnation line for a side-on stable reentry orientation.

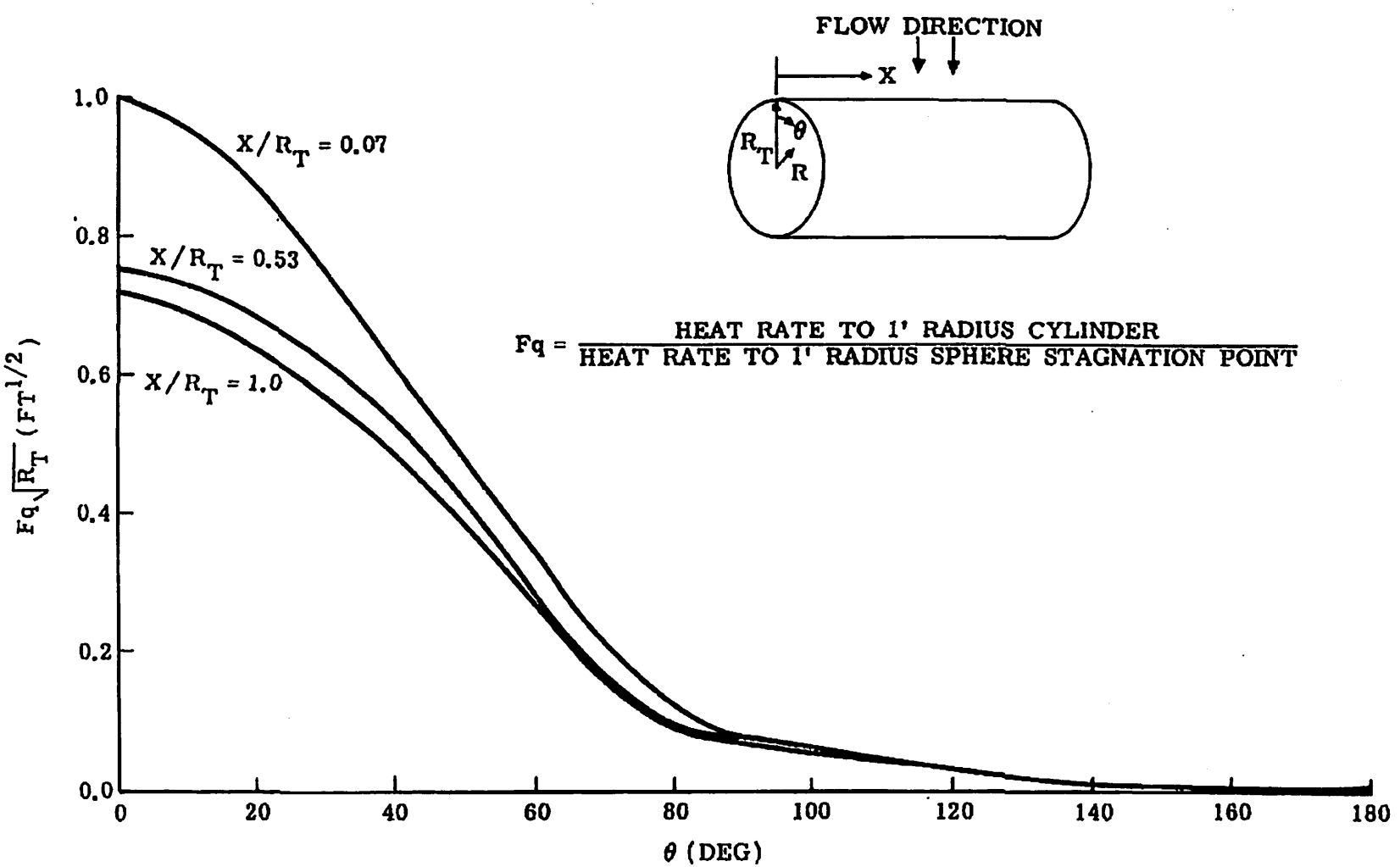

Figure 7. Heating ratios vs. θ for side-on cylinder

$$Fq = \frac{\text{HEAT RATE TO 1' RADIUS CYLINDER}}{\text{HEAT RATE TO 1' RADIUS SPHERE STAGNATION POINT}}$$

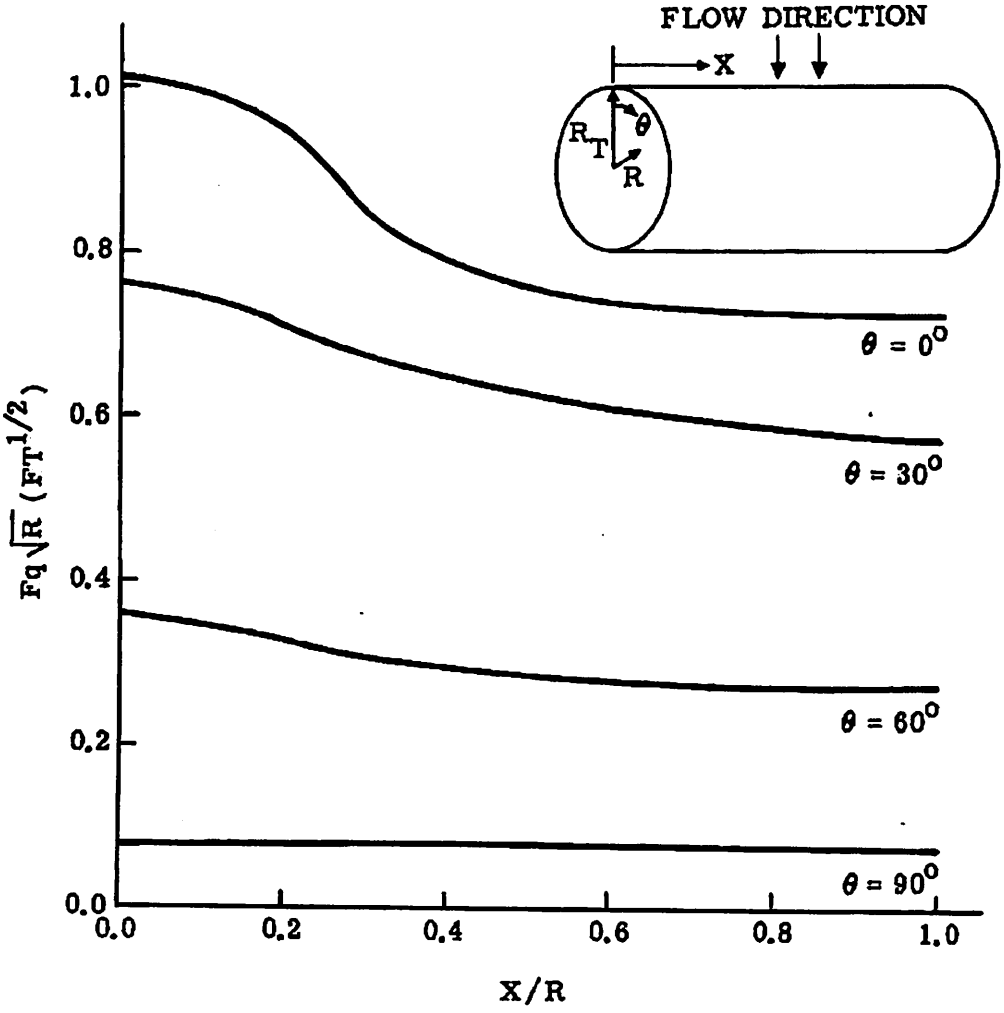

Figure 8. Heating ratios vs. X/R for side-on cylinder

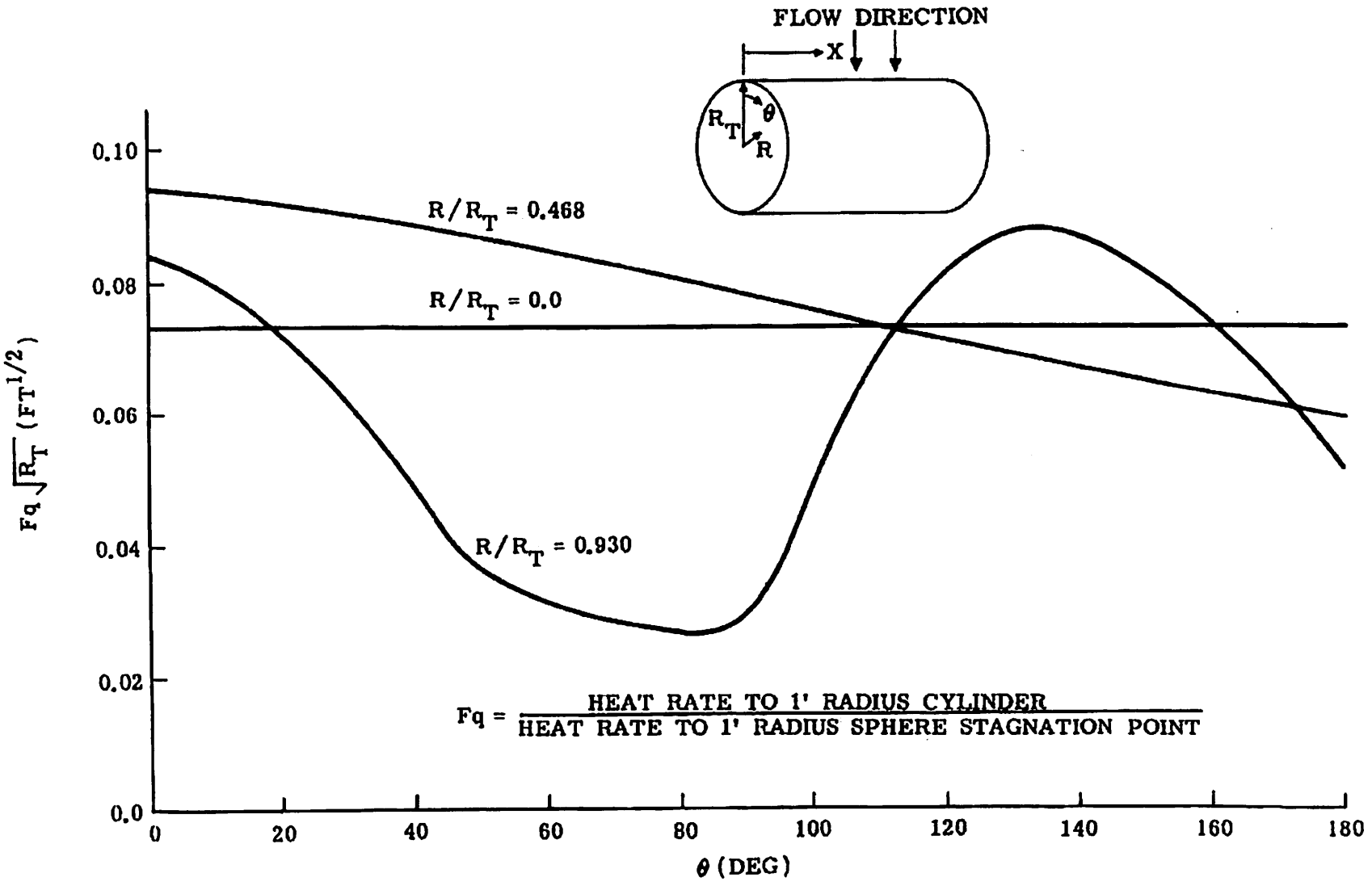

Figure 9. Heating ratios o· ·nds of side-on cylinder

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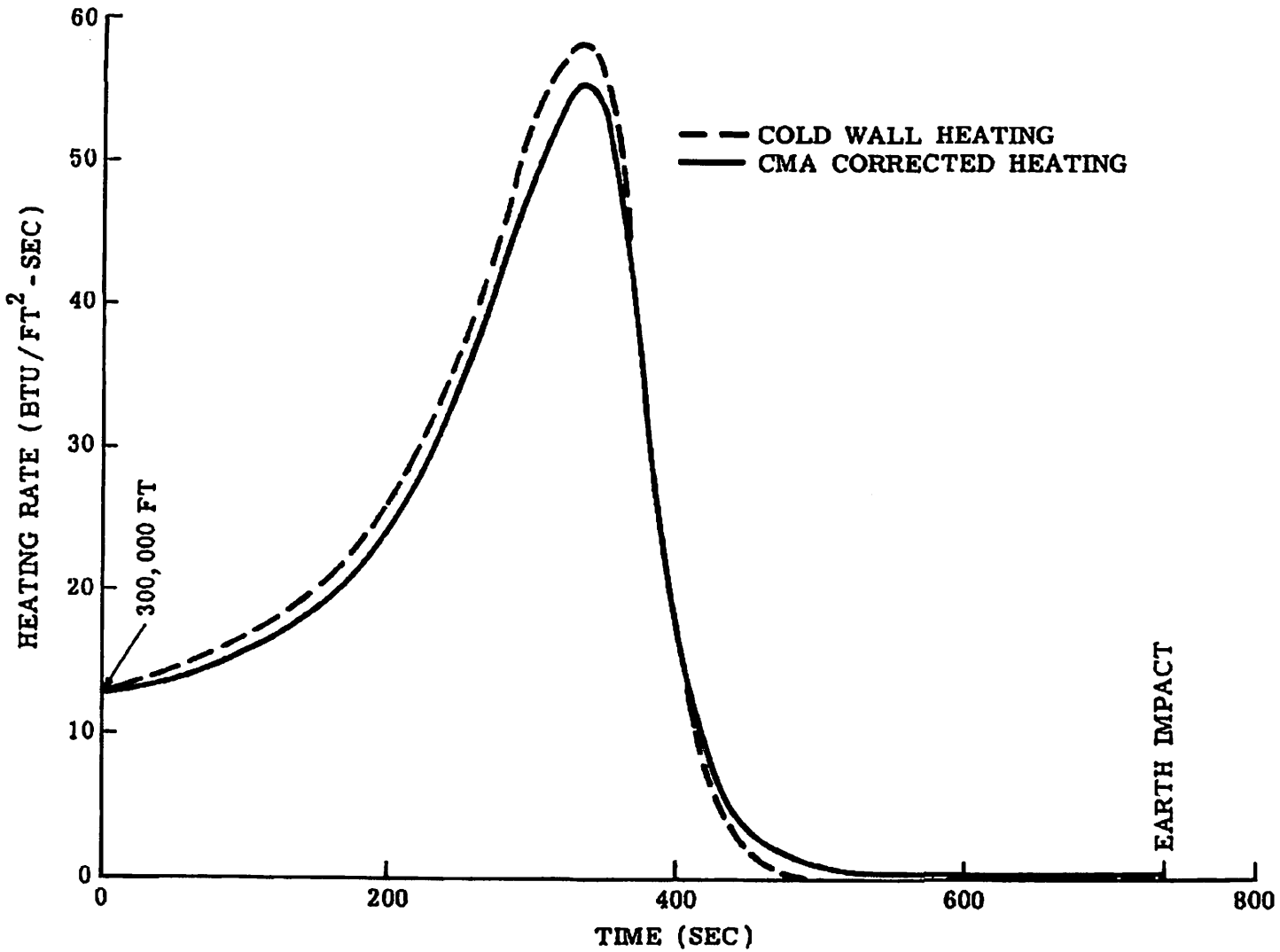


Figure 10. Heating rate to ALRH (random-tumble and spin) for orbital decay reentry

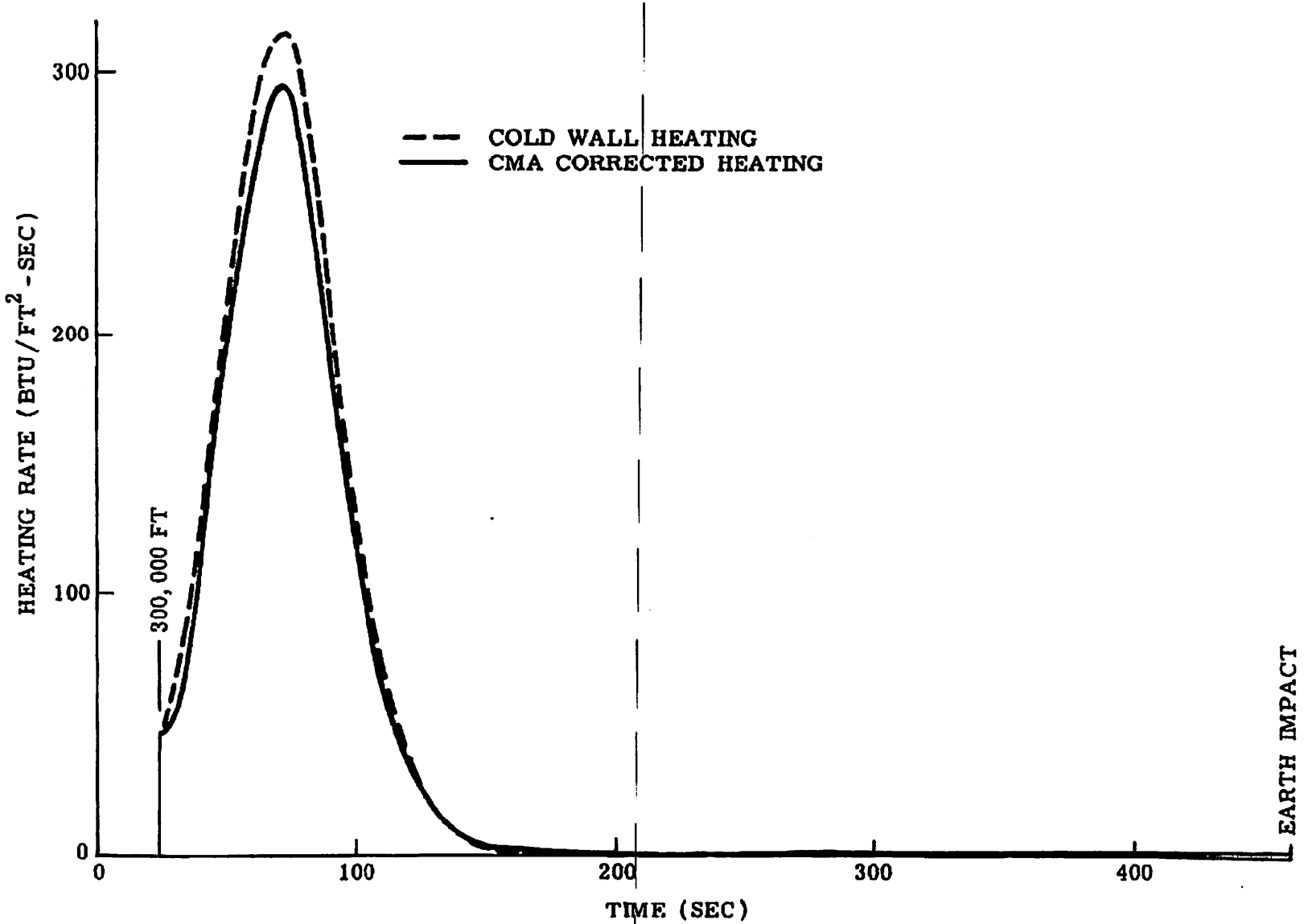


Figure 11. Heating rate to [illegible]H (random-tumble and spin) for -6.25° lunar return reentry

Figure 11. Heating rate to ΔH (random-tumble and spin) for -6.25° lunar return reentry

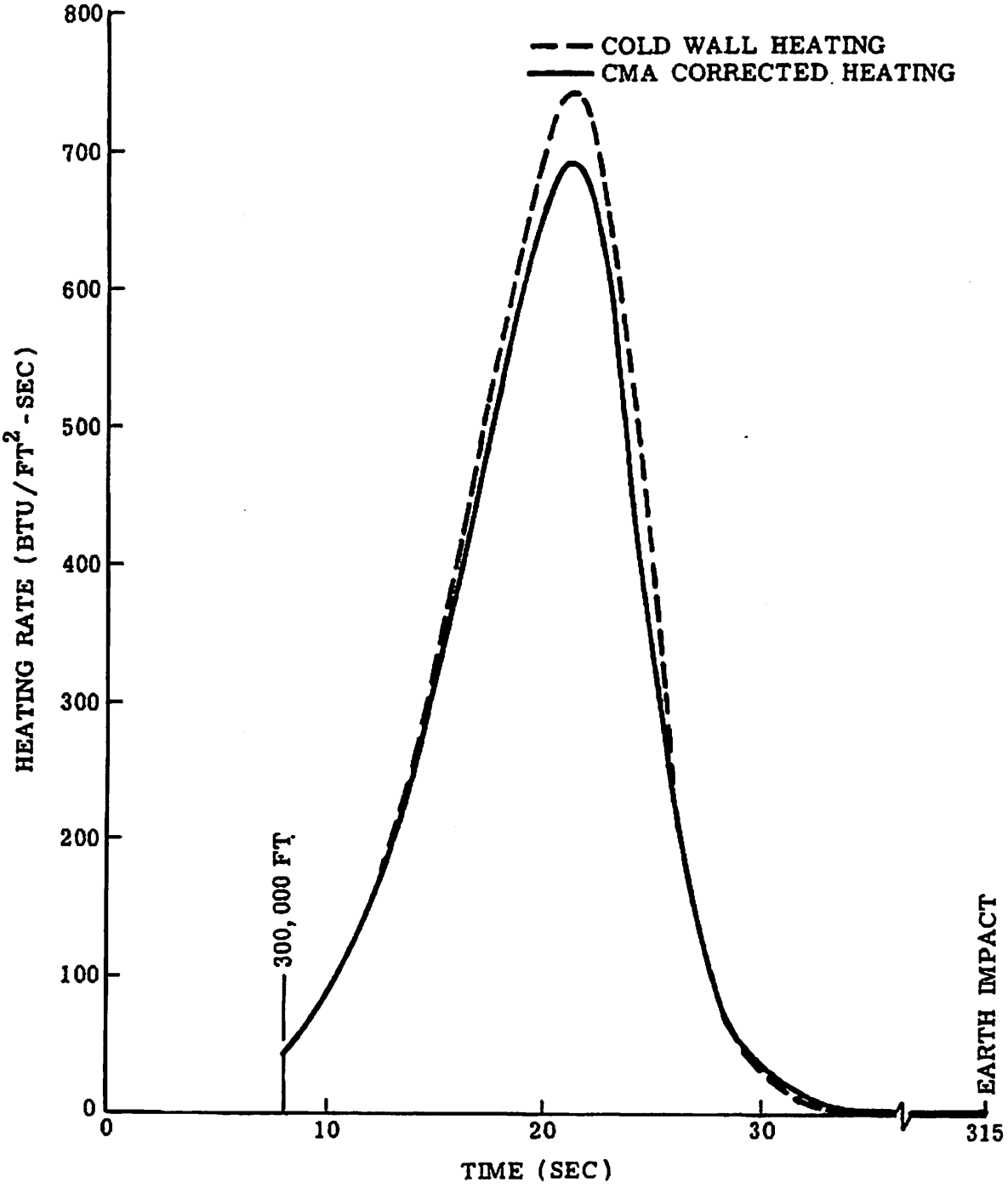


Figure 12. Heating rate to ALRH (random-tumble and spin) for -20° lunar return reentry

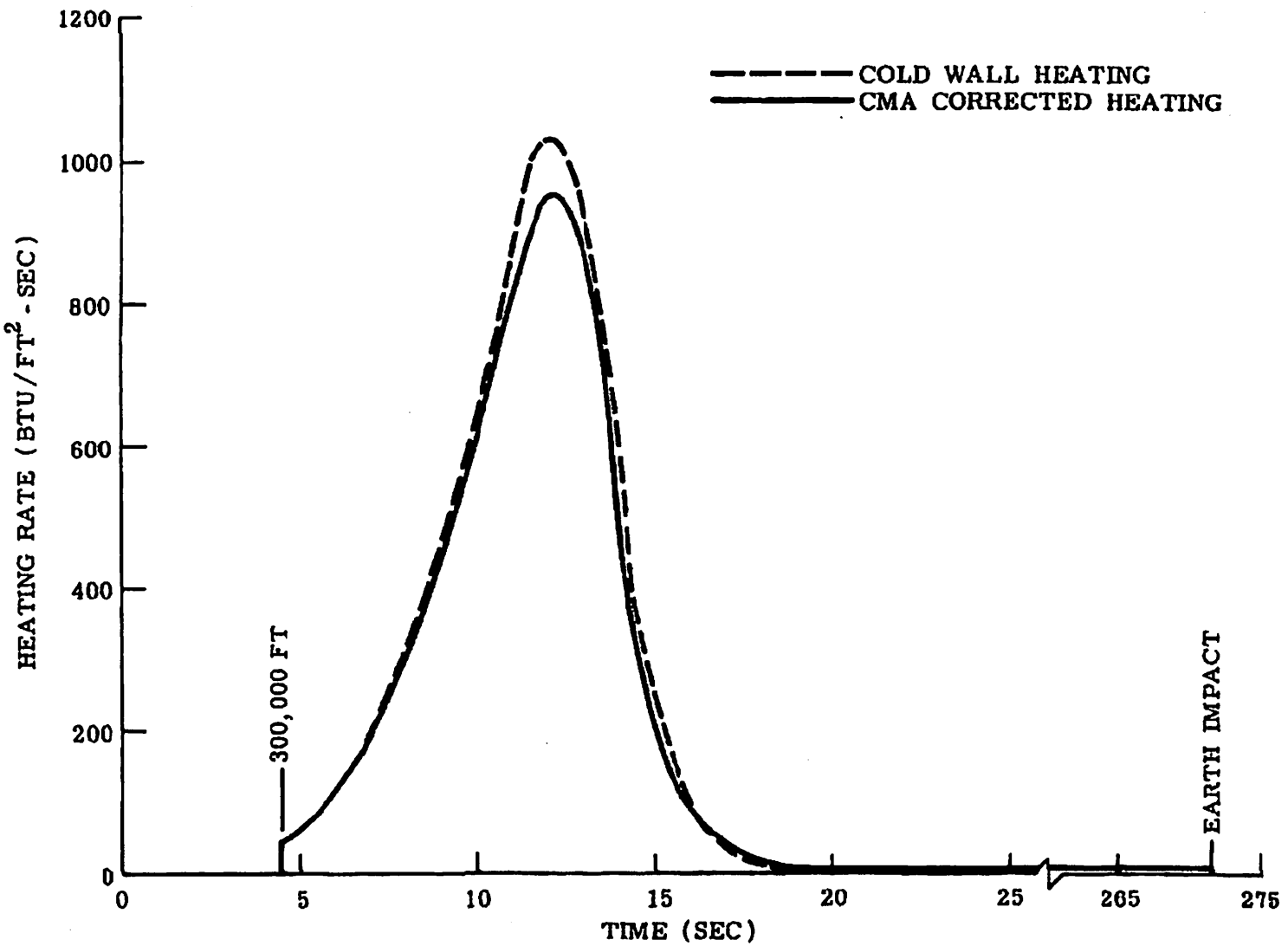


Figure 13. Heating rate to RH (random-tumble and spin) for -38° lunar return reentry

Figure 13. Heating rate to ALRH (random-tumble and spin) for -38° lunar return reentry

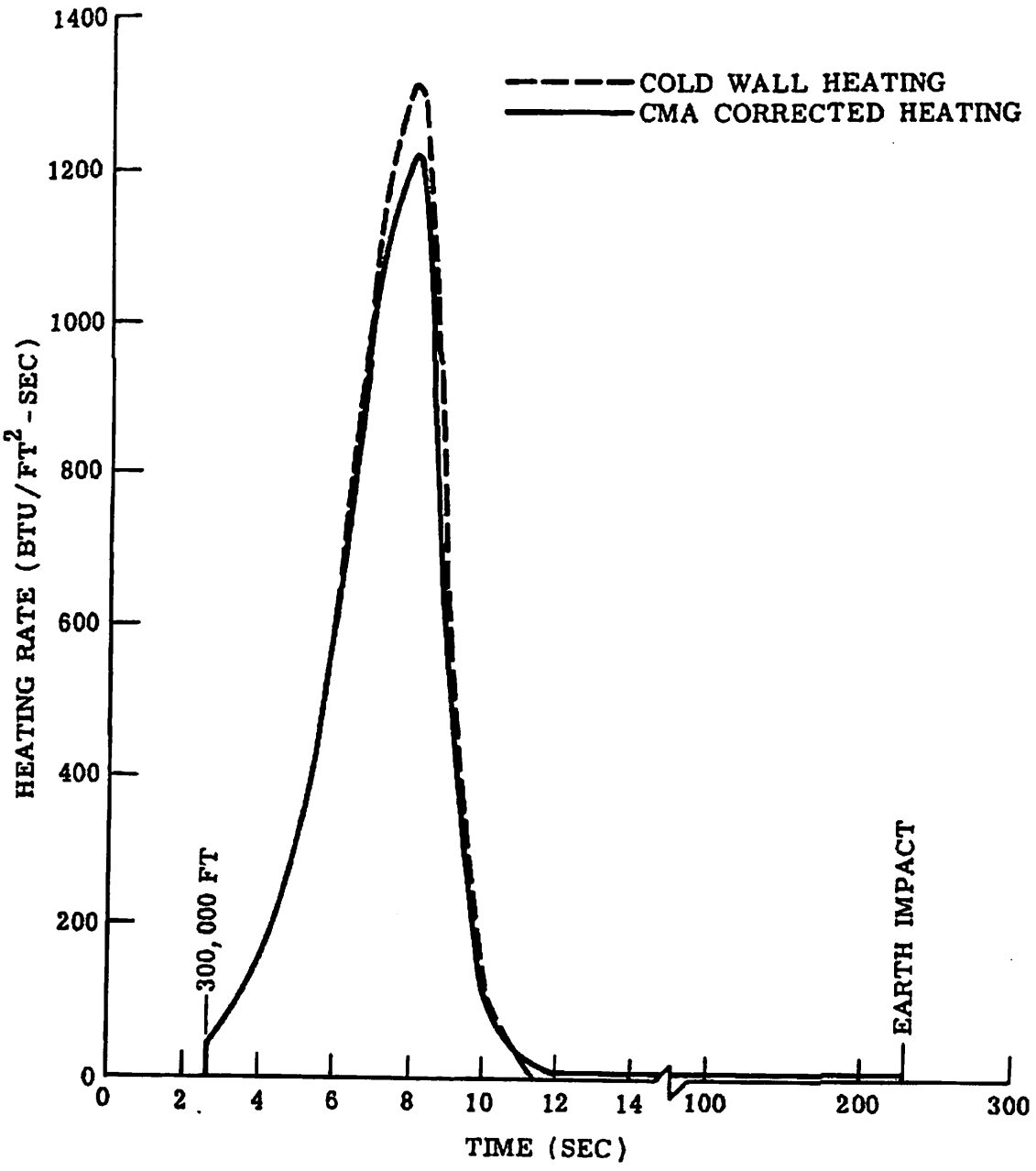


Figure 14. Heating rate to ALRH (random-tumble and spin) for -90° lunar return reentry

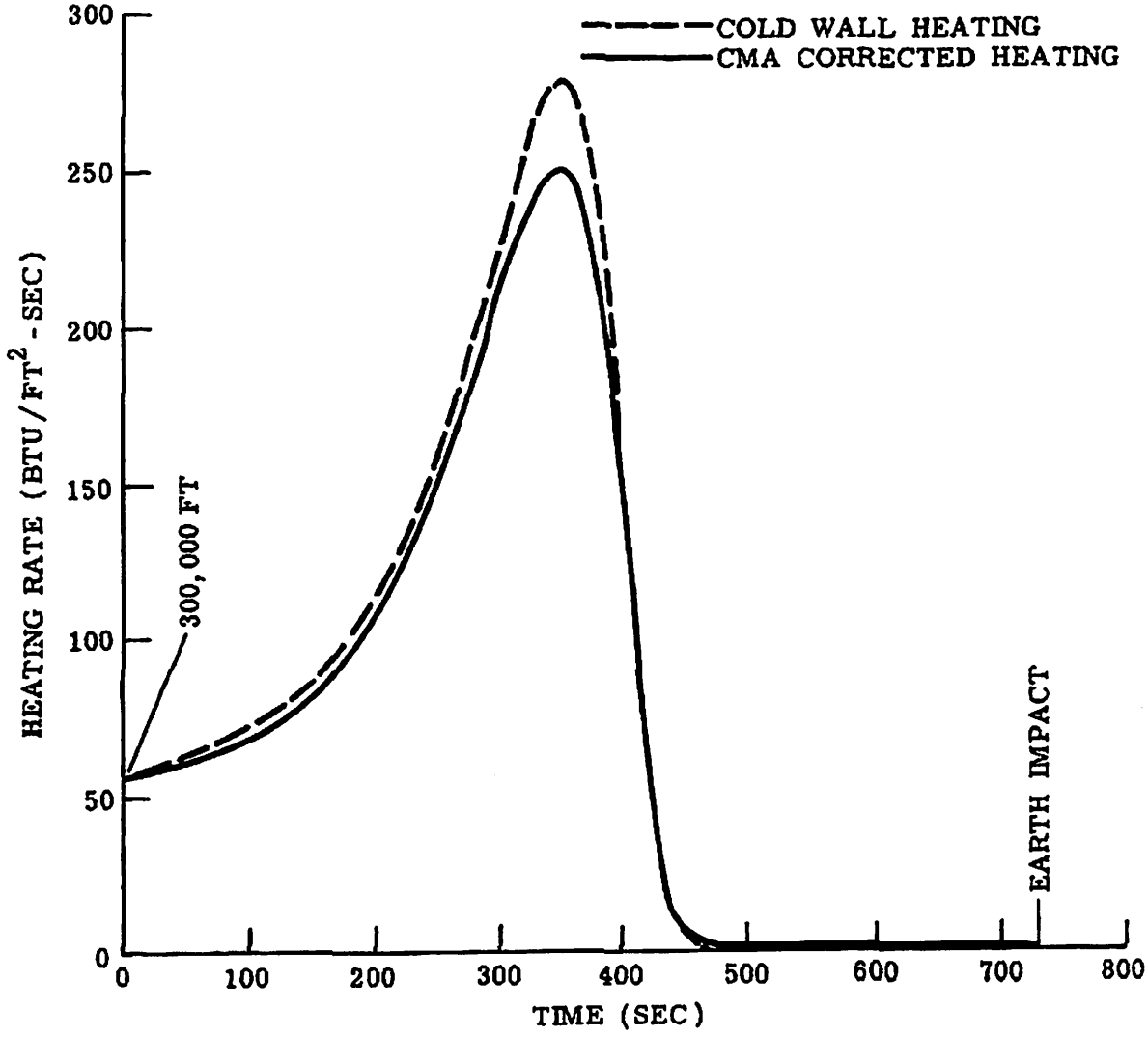


Figure 15. Heating rate to ALRH stagnation line (side-on-stable) for orbital decay

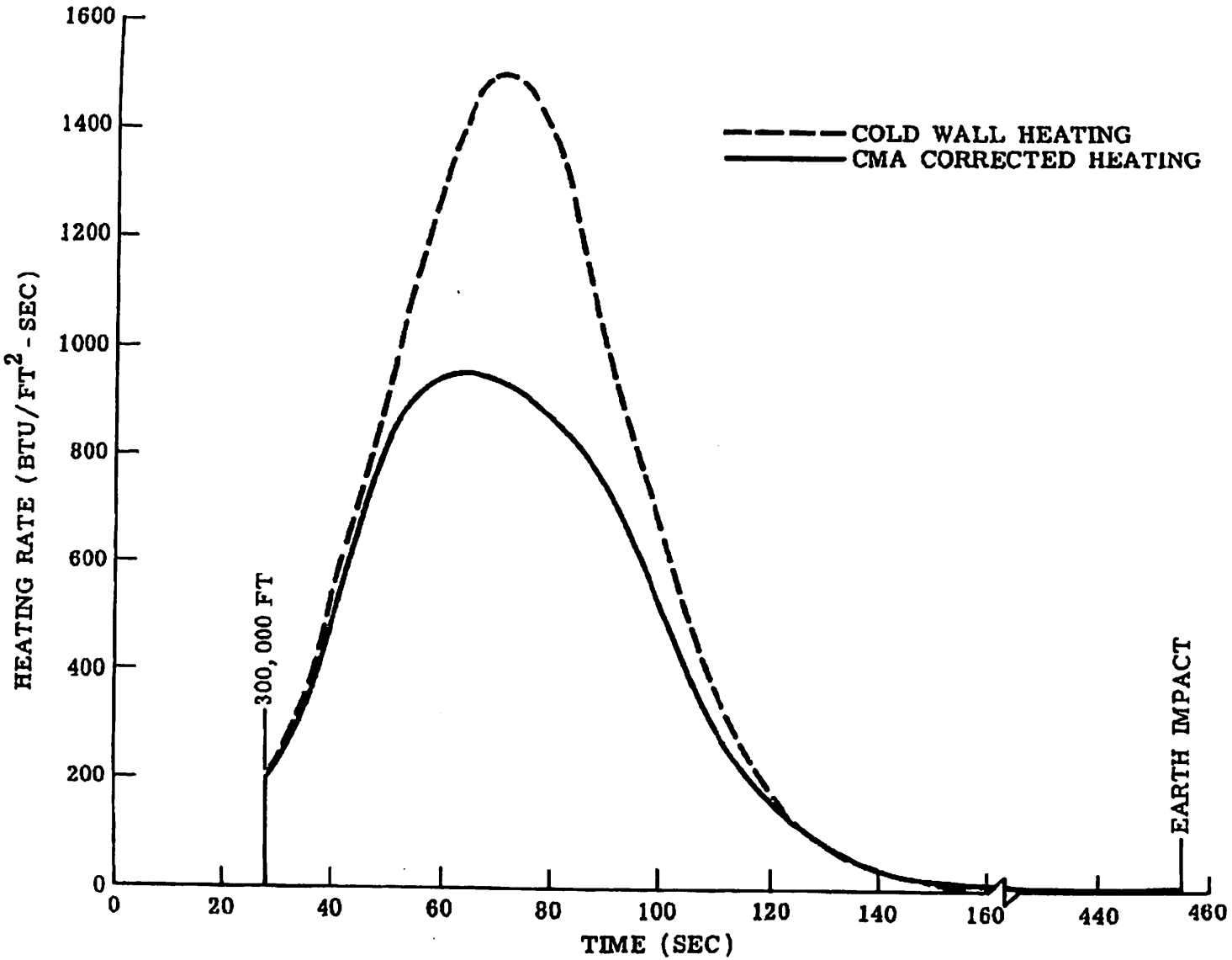


Figure 16. Heating rate to ALRH stagnation line (side-on-stable) for -6.25° lunar return reentry

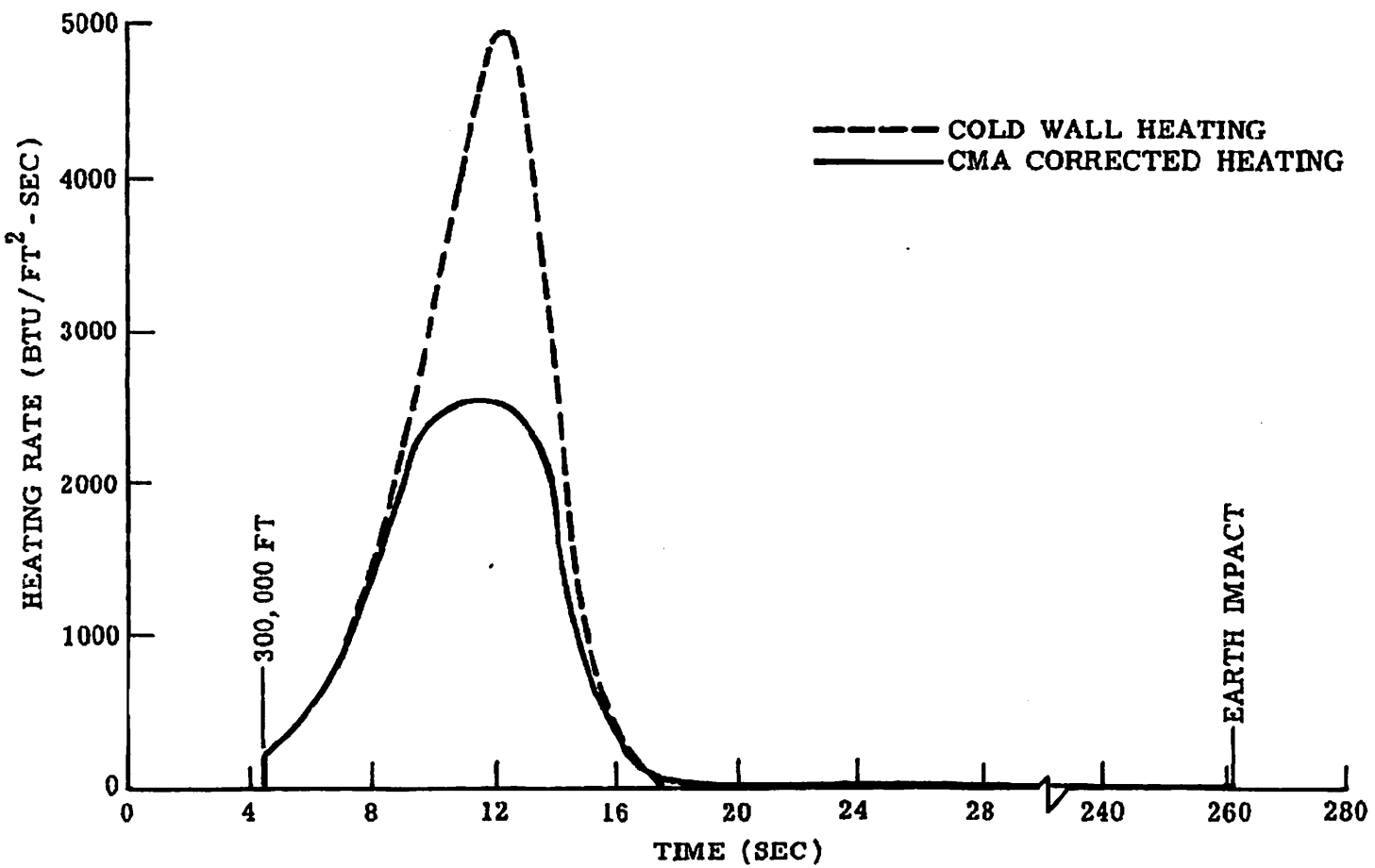


Figure 17. Heating rate to ALRH stagnation line (side-on-stable) for -38.05° lunar return reentry

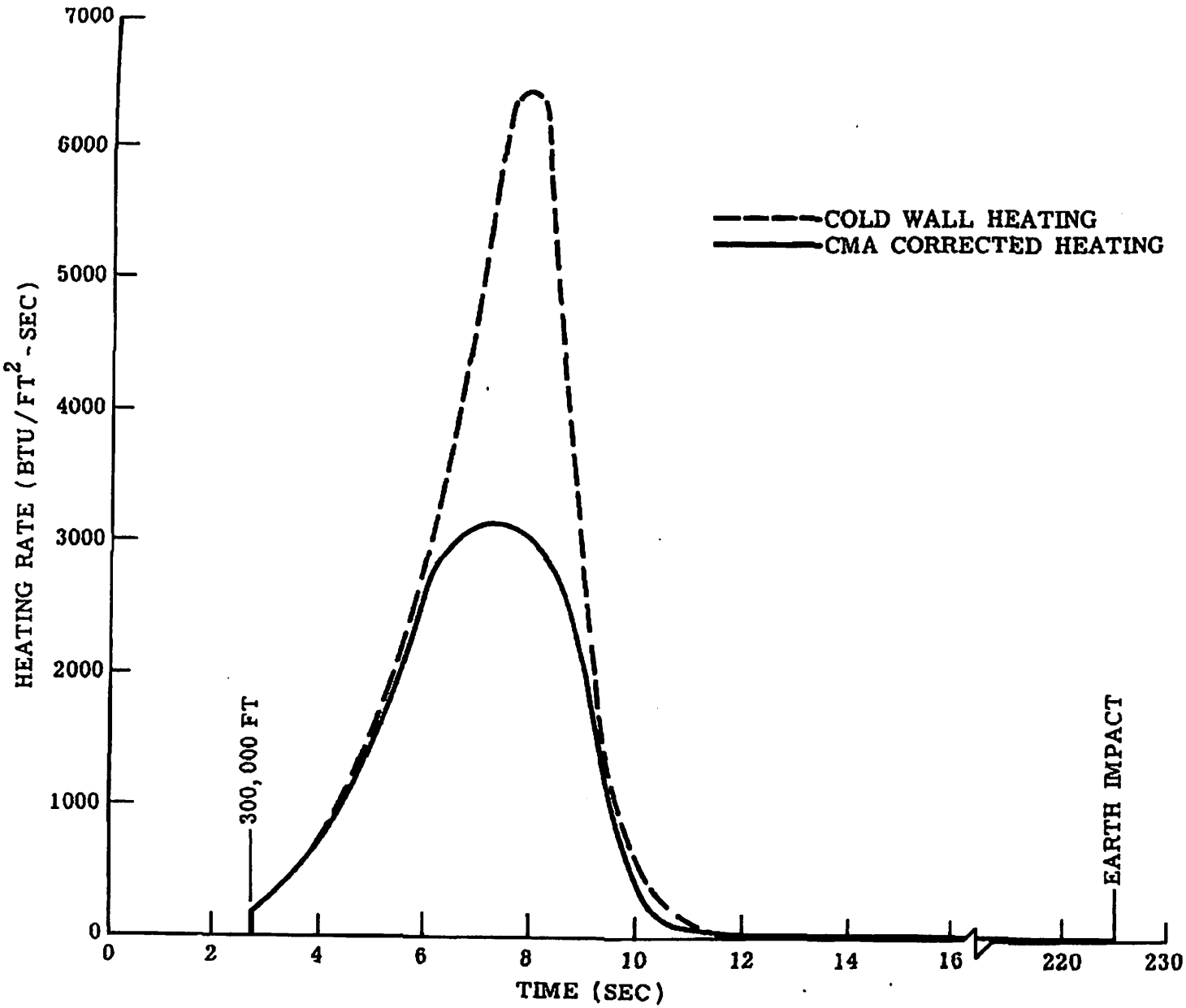


Figure 18. Heating rate to ALRH stagnation line (side-on-stable) for -90° lunar return reentry

Results

Ablation Analysis

The results of the ablation analysis are summarized in Figures 19 through 28. Figures 19 through 23 show the cumulative ablation of the ALRH during orbital decay and -6.25°, -20°, -38.05°, and -90° lunar return reentries for both a random-tumble and spin and a side-on-stable orientation. The cumulative ablation shown for the random-tumble reentry is the average ablation over the entire surface of the ALRH, while the material removal shown for the side-on-stable reentry is that which occurs along the stagnation line. (A side-on-stable -20° lunar return reentry is not shown since this reentry trajectory was never run.) The 300,000 feet altitude level is shown in each of the figures since this is where the ALRH is assumed to be first exposed to the flow. The time of earth impact is also shown. Figure 24 shows the total ALRH ablation for a random-tumble and spin reentry as a function of reentry angle. As shown, maximum ablation for this reentry orientation occurs during orbital decay. Figure 25 shows the same information for a side-on-stable orientation. In this case, maximum ablation occurs during the -6.25° lunar return reentry. It should be noted that, in Figures 24 and 25, extrapolation to reentry angles smaller than -6.25° is invalid since reentry angles of approximately -5° or less do not result in a prompt reentry situation.

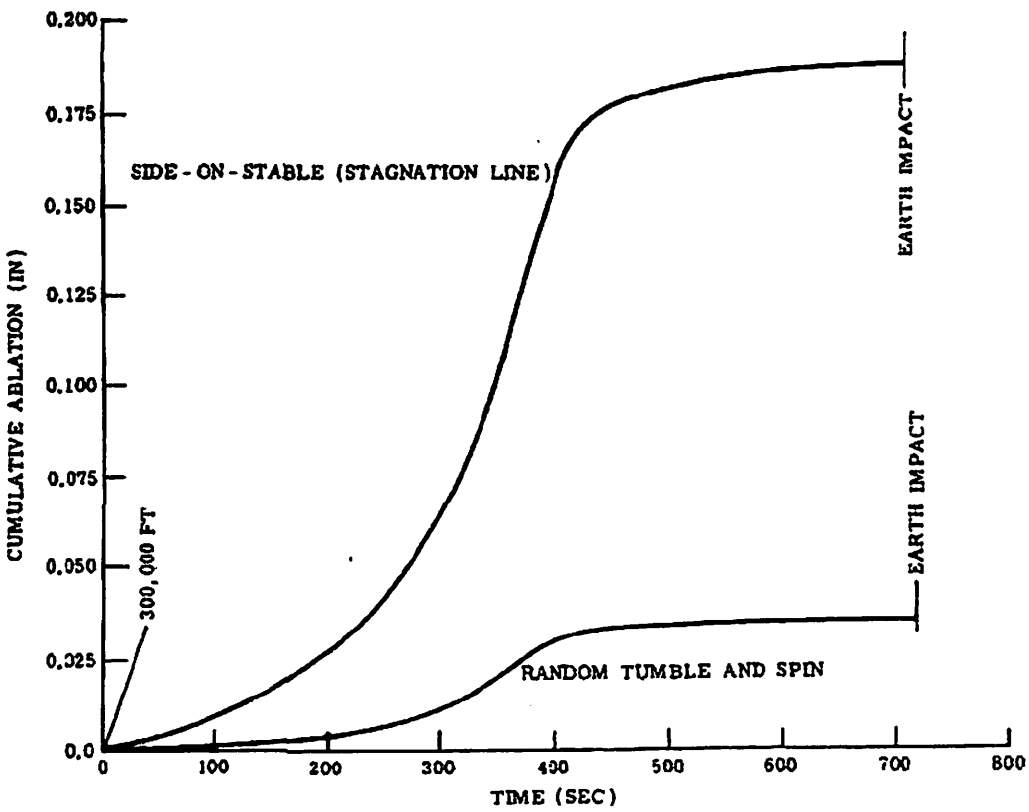


Figure 19. ALRH cumulative ablation for orbital decay reentry

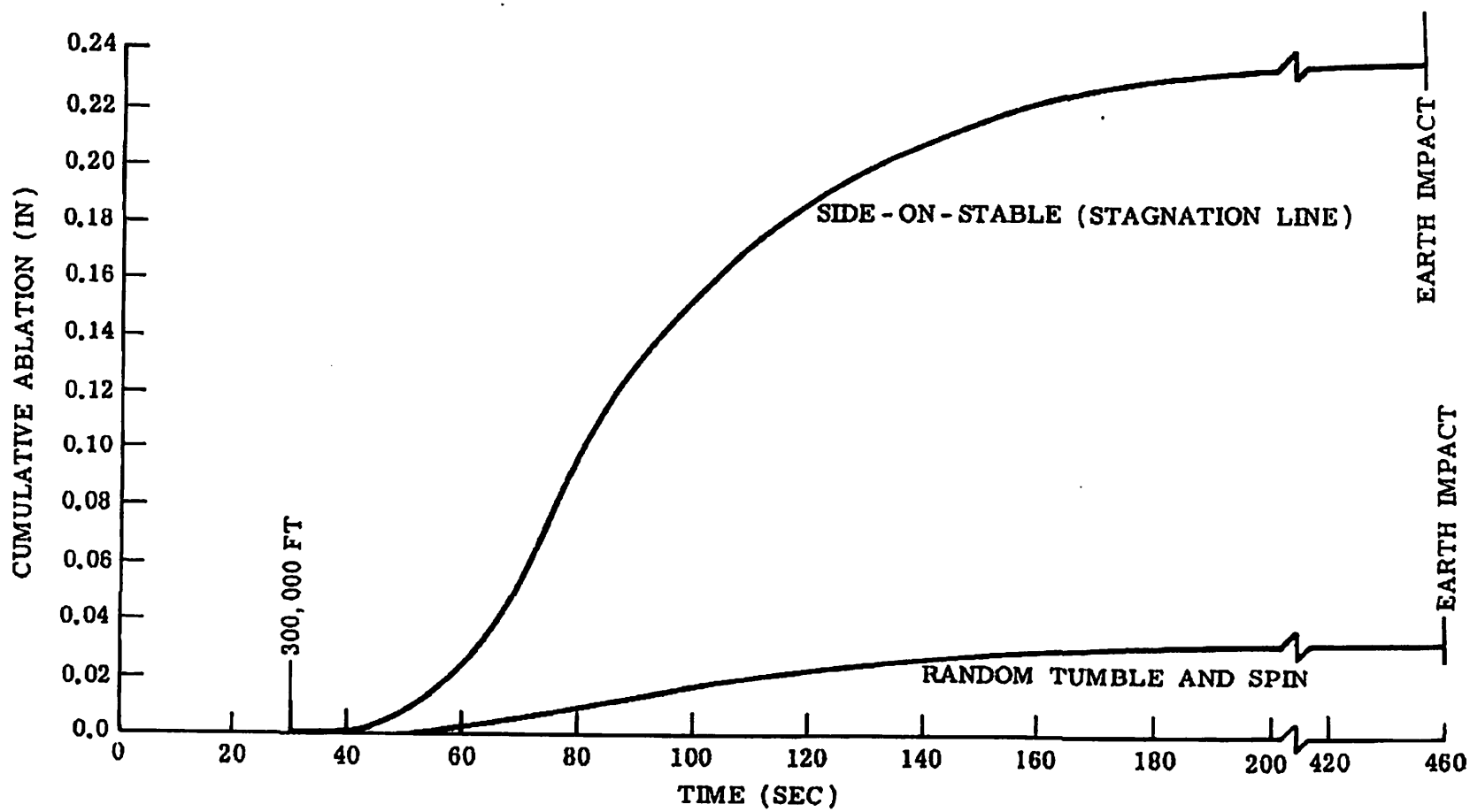


Figure 20. ALRH cumulative ablation for -6.25° lunar return reentry

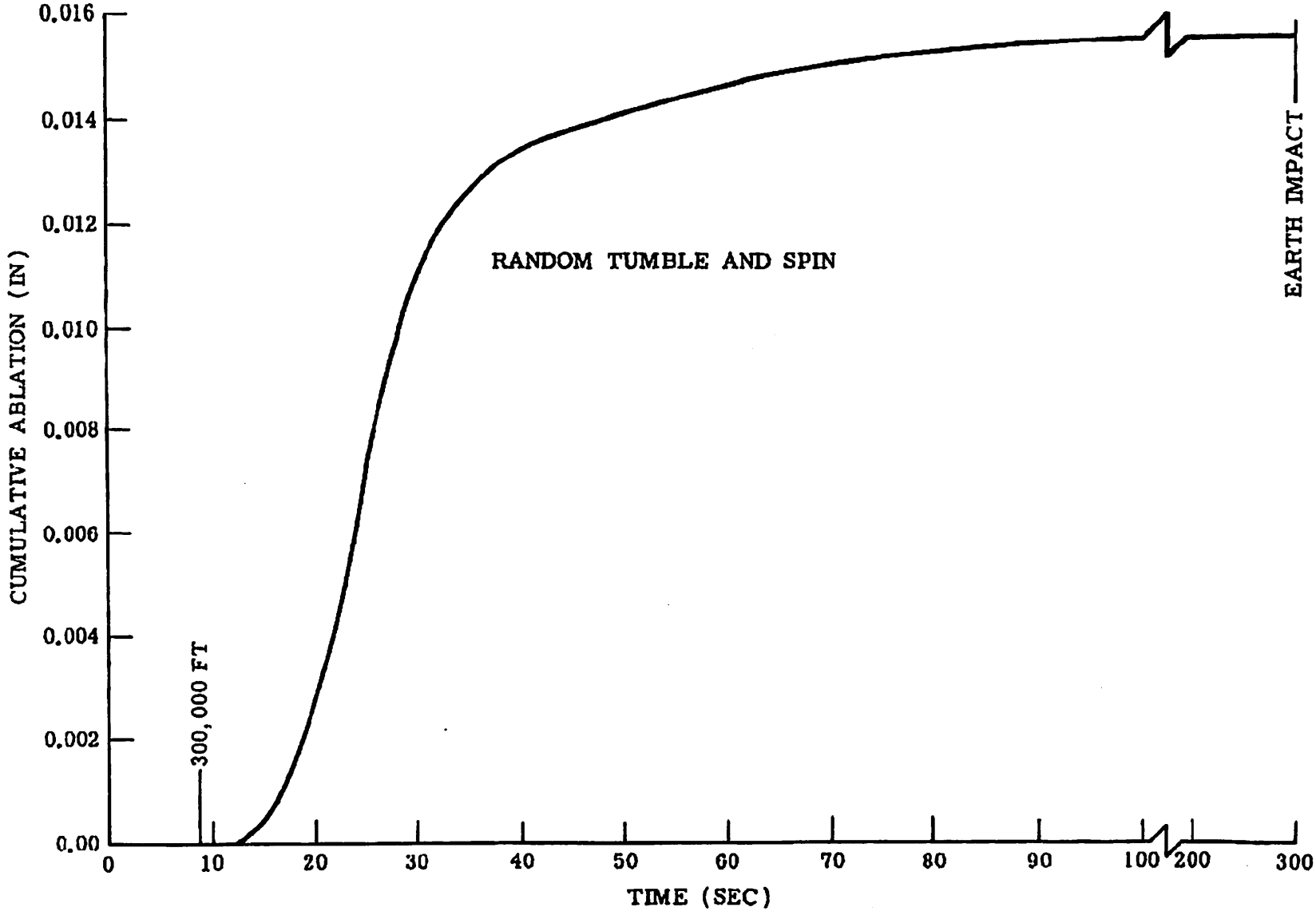


Figure 21. ALRH cumulative ablation for -20° lunar return reentry

Figure 21. ALRH cumulative abla ı for -20° lunar return reentry

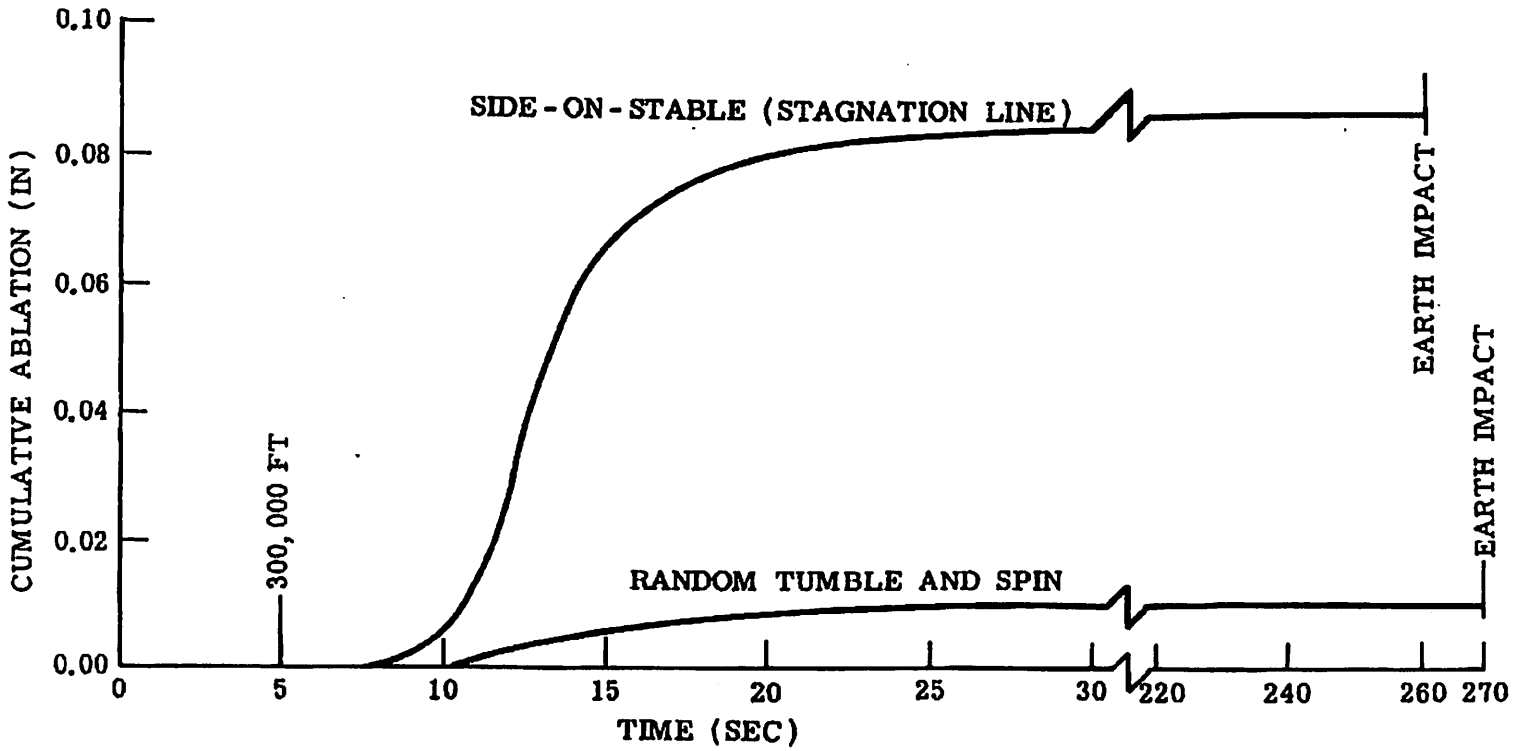


Figure 22. ALRH cumulative ablation for -38.05° lunar return reentry

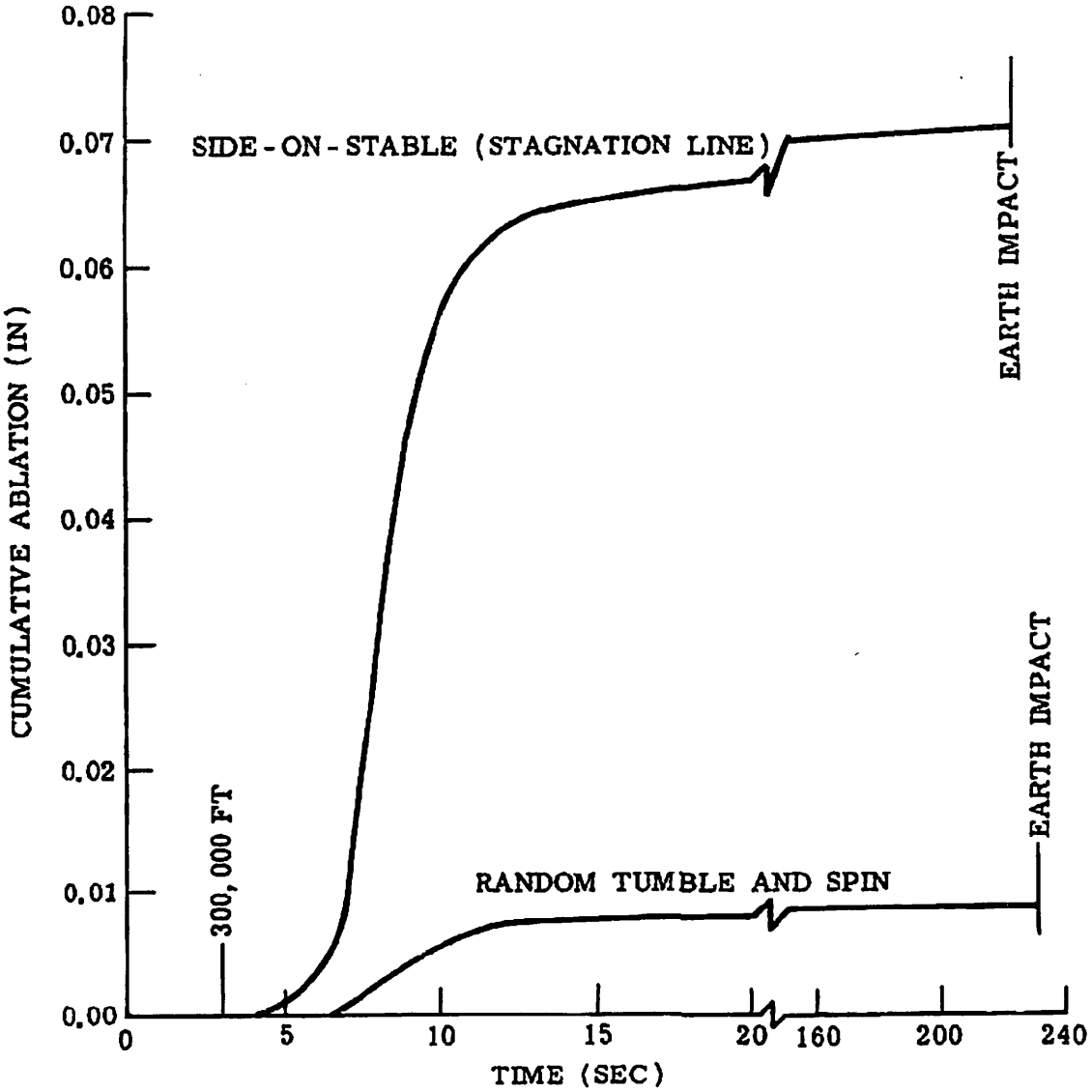


Figure 23. ALRH cumulative ablation for -90° lunar return reentry

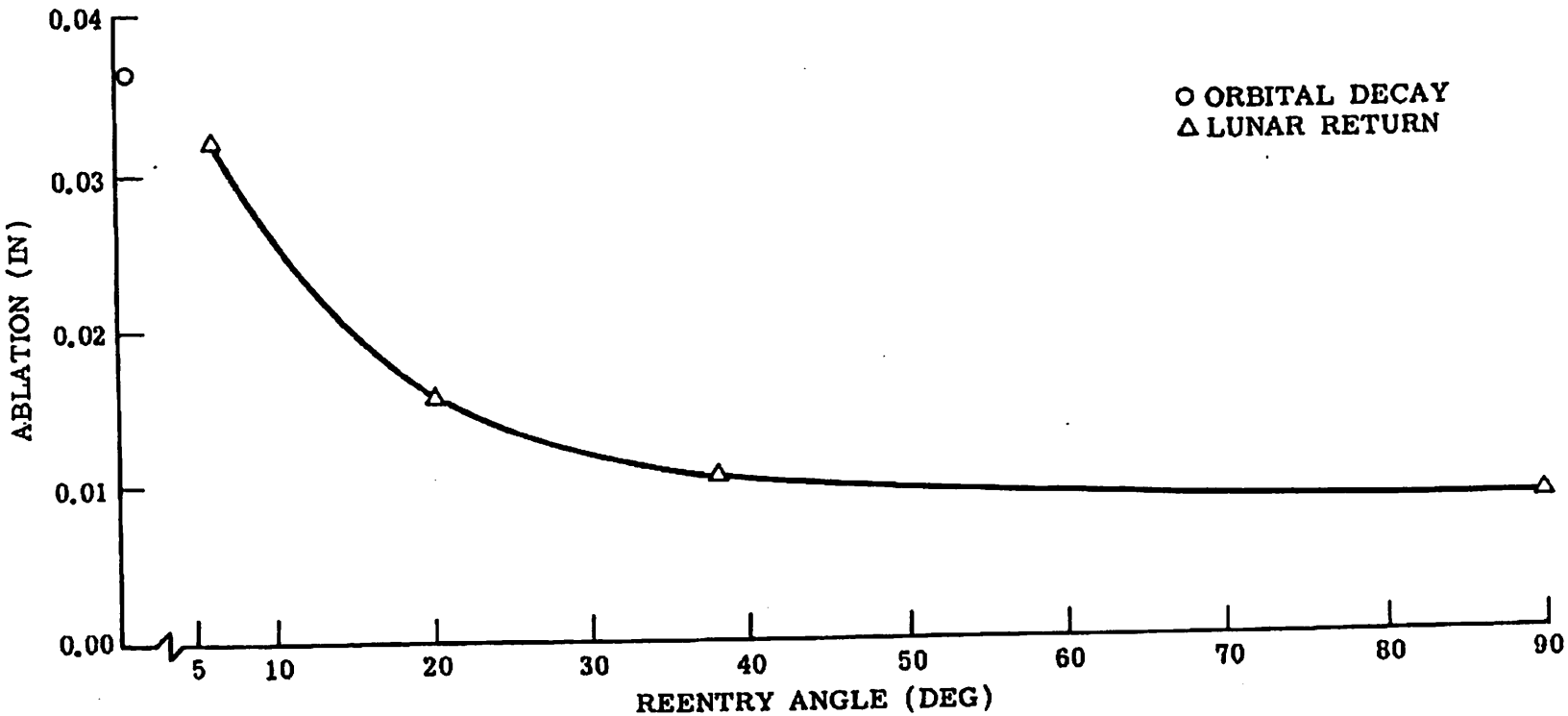


Figure 24. ALRH total ablation vs. reentry angle for random-tumble and spin reentry

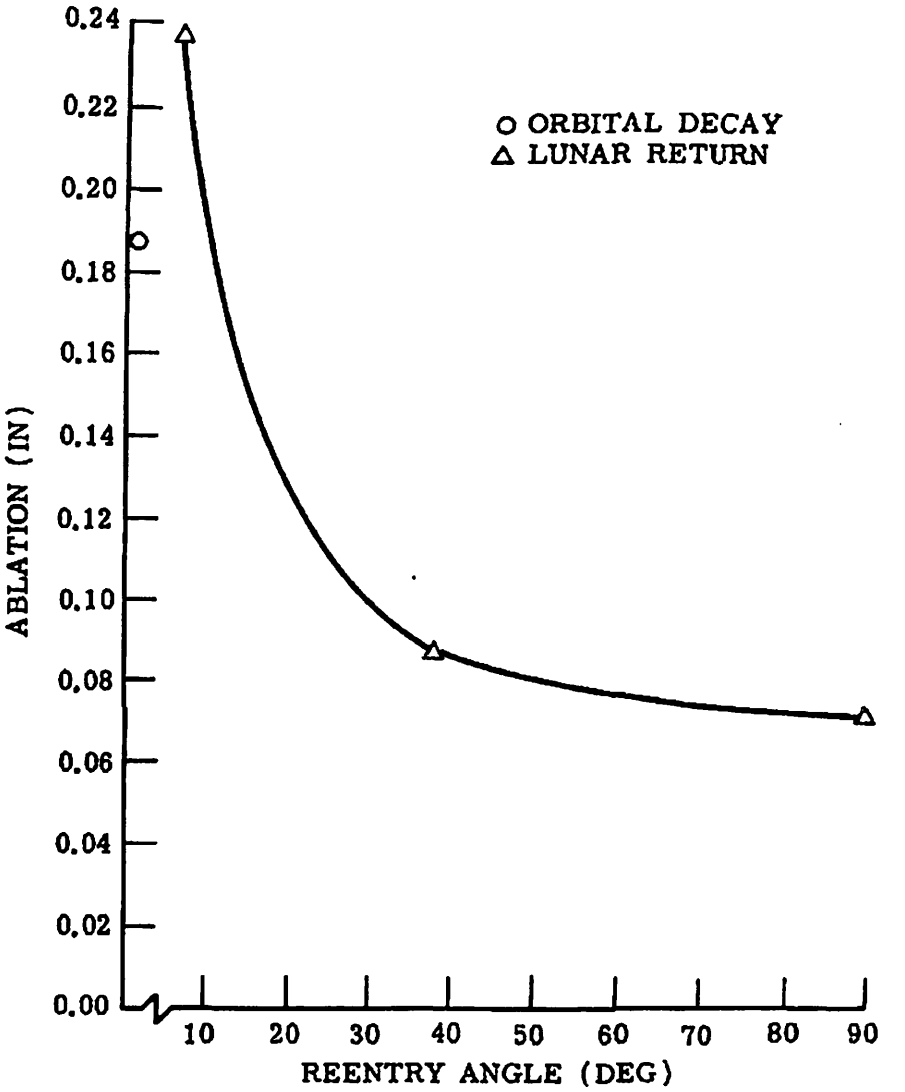


Figure 25. ALRH total ablation vs. reentry angle for side-on-stable reentry

Figure 26 indicates the ablation on the ALRH during a multiple orbit reentry. This occurs if there is a mission abort following translunar injection and the resulting atmosphere reentry angle is to shallow to cause a prompt reentry. The amount of graphite removed f the stagnation line of the ALRH for a side-on-stable orientation is shown as a function of the number of orbits prior to a final reentry. The dotted lines show the cumulative ablation that would occur for a reentry of a particular number of orbits. The solid line is the envelope of the curves, showing maximum expected stagnation line ablatic As shown, the maximum ablation would occur if the ALRH experienced approximately 25 orbits before final reentry. This corresponds to a initial perigee altitude of 280,000 feet.[9] Increasing the initial perigee beyond 280,000 feet results in more orbits but less total ab tion since the ablation per orbit drops off sharply at higher per e altitudes.

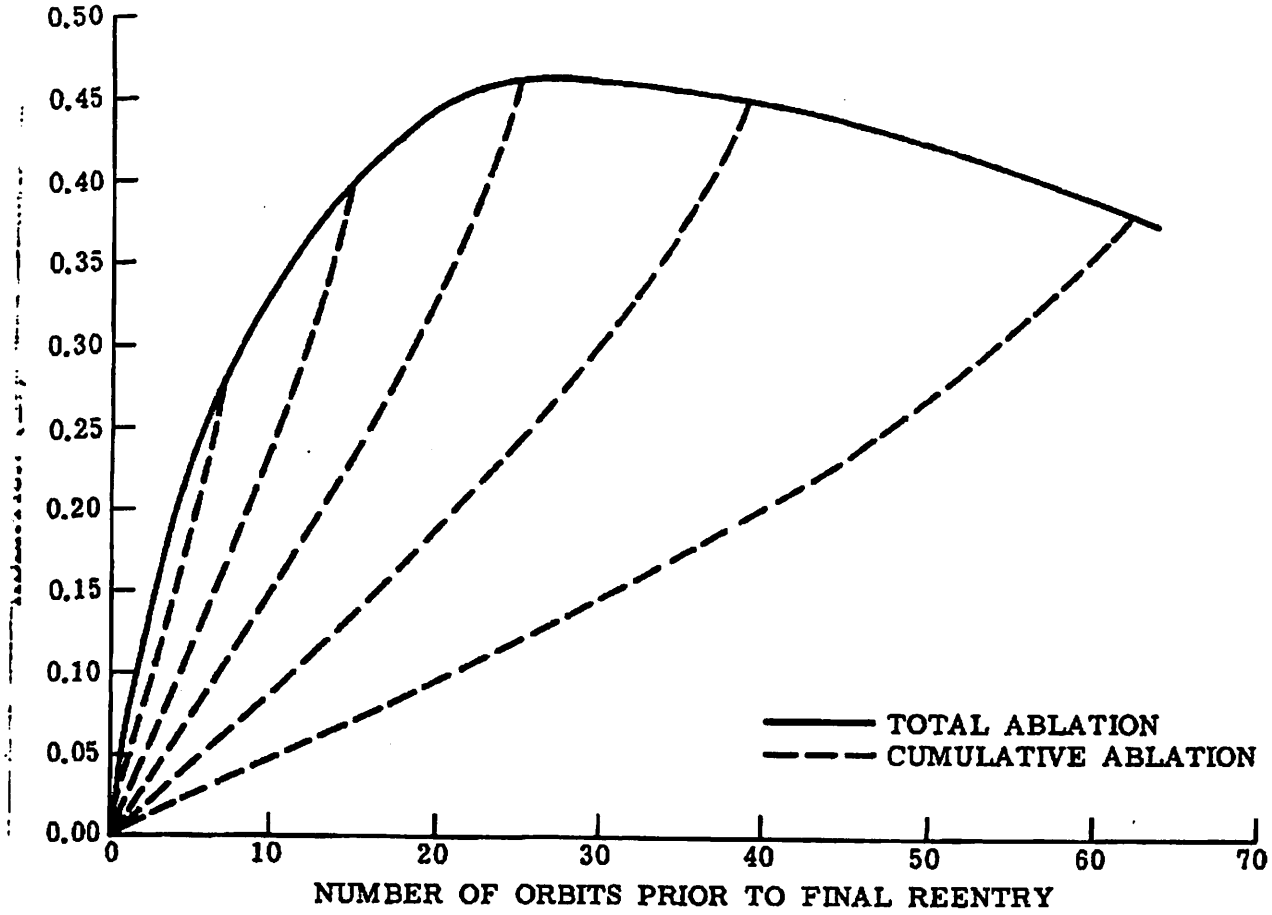


Figure 26. ALRH ablation for multiple orbit reentry (side-on-stable)

Two multiple orbit reentry trajectories (260,000 feet and 280,000 feet initial perigees) were run on the TTA computer code to determine how these trajectories compared to those calculated by the HRS017 computer code which uses an approximate method. The TTA code was not used for all multiple orbit trajectories since it integrates the differential equations of motion and therefore requires relatively large amounts of computer time for multiple orbit reentry trajectories. The TTA output also is not compatible with CMA input, as is the HRS017 code. The results of the comparison are shown in Figures 27 and 28. The difference in the number of orbits to earth impact, as well as the difference in total ablation to earth impact, is shown. The ablation occurring during the TTA computed trajectory was 13 to 35 percent lower than that occurring during the HRS017 computed trajectory.

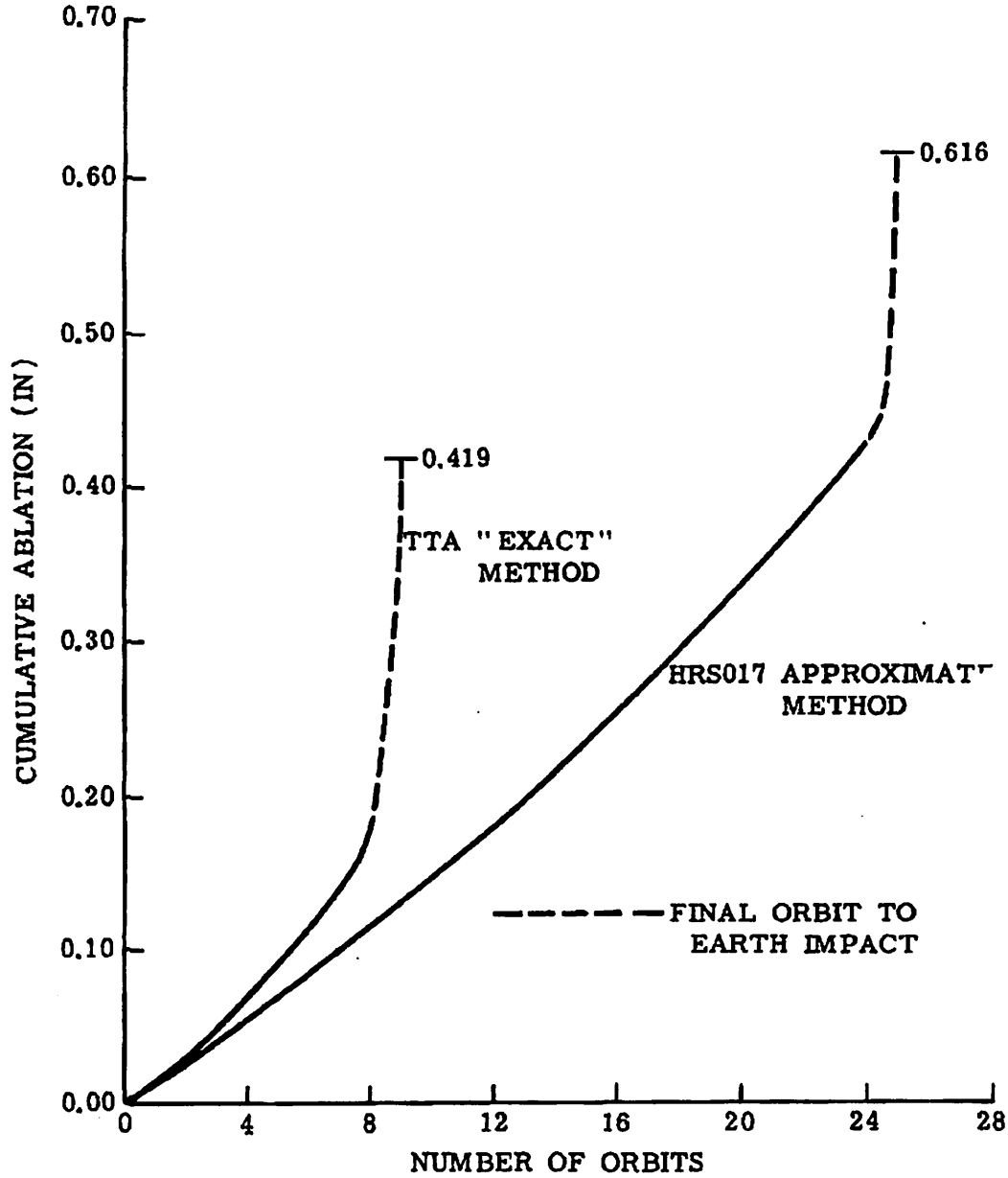


Figure 27. Comparison of ablation resulting from exact and approximate trajectory methods for 280,000 feet initial perigee, multiple orbit reentry

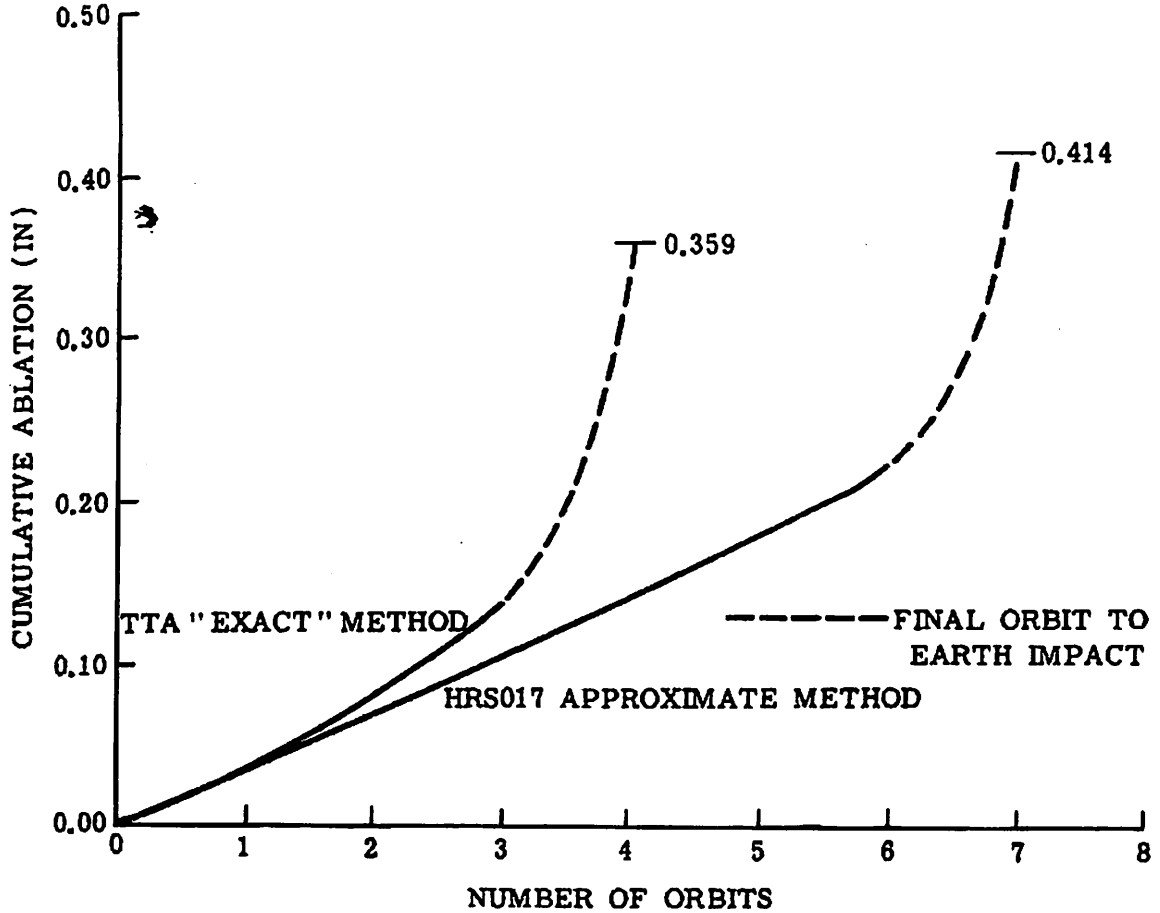


Figure 28. Comparison of ablation resulting from exact and approximate trajectory methods for 260,000 feet initial perigee, multiple orbit reentry

The ablation results indicate that the 0.6 inch of graphite on the ALRH provides sufficient ablation protection for all mission abort conditions examined, with the possible exception of a side-on-stable multiple orbit reentry (with the same side of the ALRH exposed to the stagnation line for each pass through the atmosphere) of 25 to 39 orbits (280,000 feet to 290,000 feet initial perigees, respectively) followed by a near orbital decay final reentry, again with the same side of the ALRH exposed to the stagnation line flow. This exception, based on the approximate trajectory code, leads to a total ablation on the ALRH stagnation line greater than the 0.6 inch of graphite thickness. It should be noted that the lack of three-dimensional heat transfer in the ablation model maximizes the ablation along the stagnation line for a side-on-stable reentry.

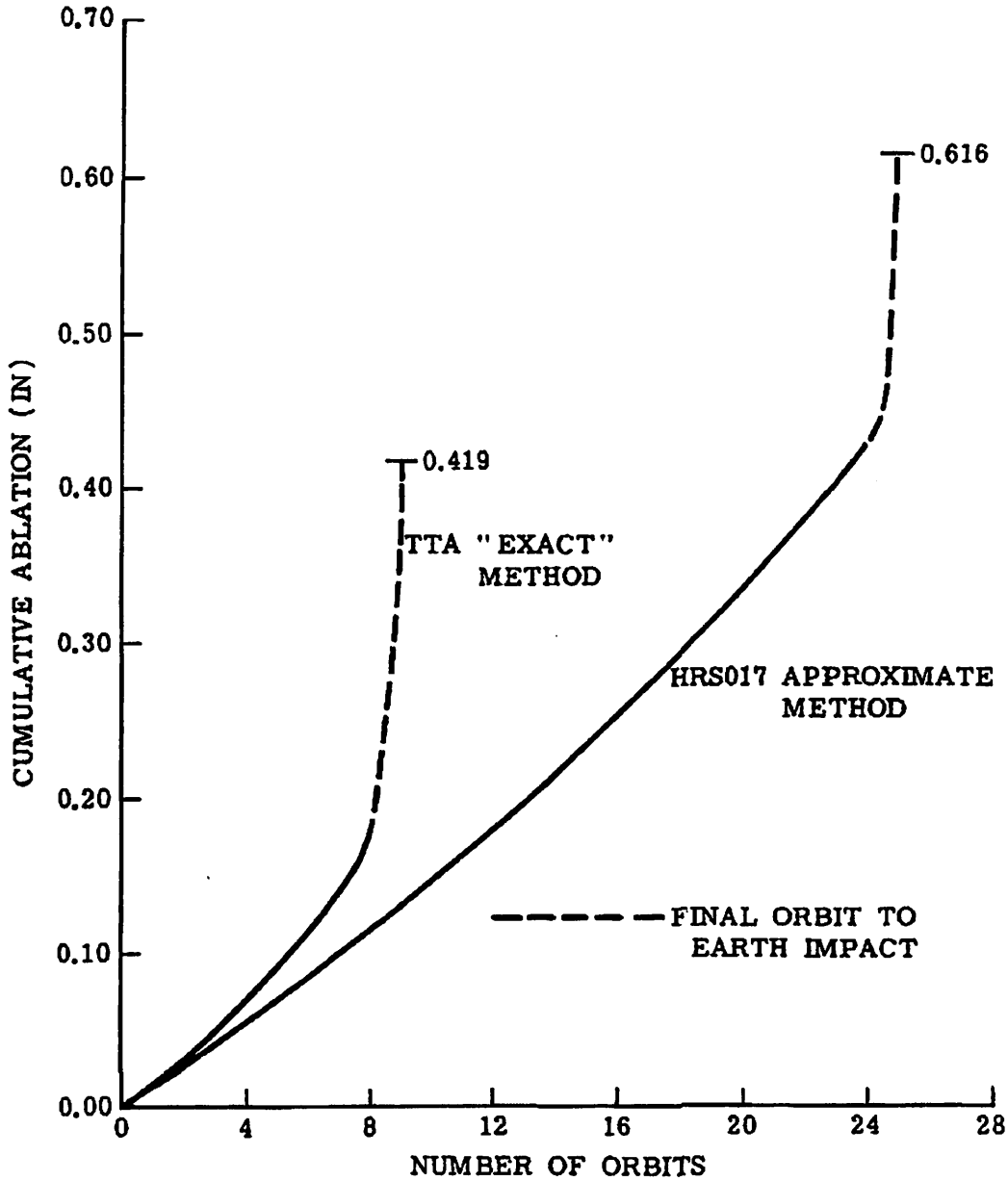


Figure 27. Comparison of ablation resulting from exact and approximate trajectory methods for 280,000 feet initial perigee, multiple orbit reentry

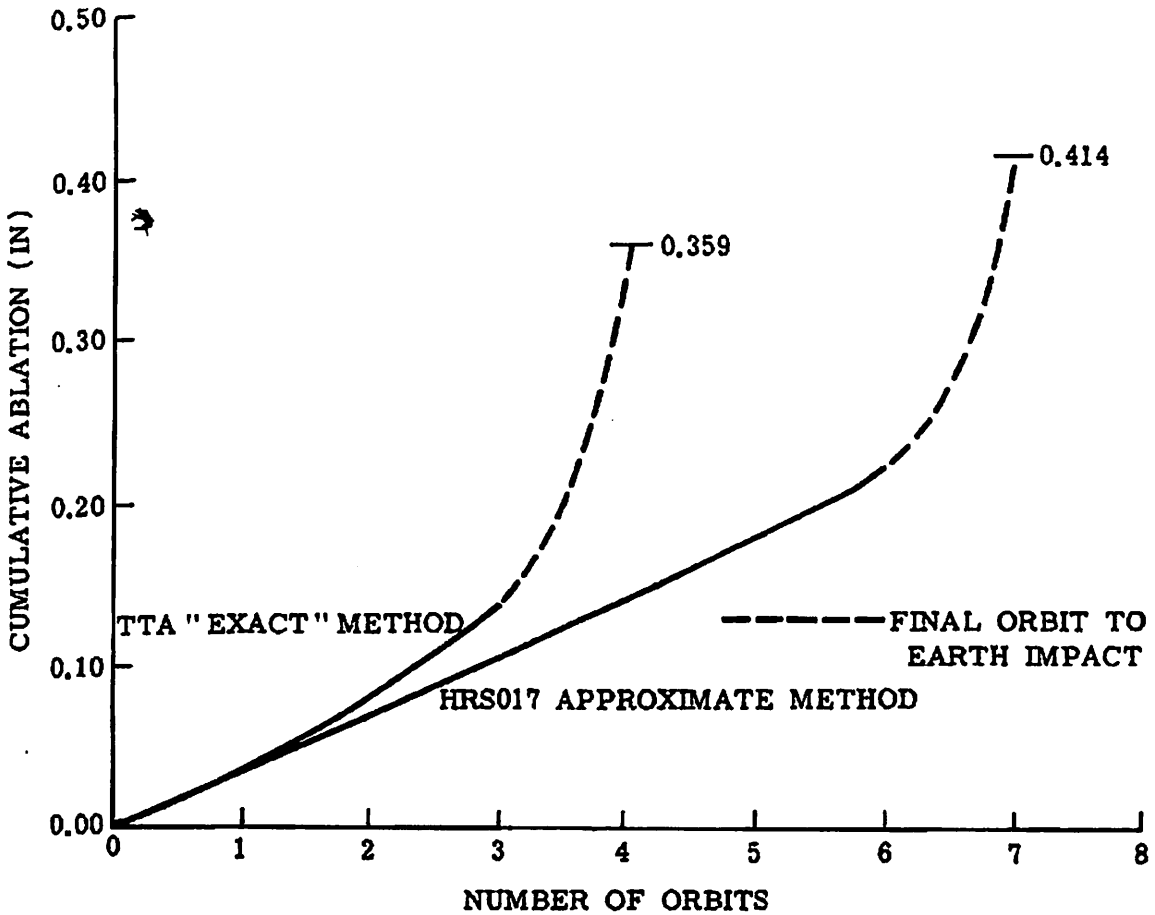


Figure 28. Comparison of ablation resulting from exact and approximate trajectory methods for 260,000 feet initial perigee, multiple orbit reentry

The ablation results indicate that the 0.6 inch of graphite on the ALRH provides sufficient ablation protection for all mission abort conditions examined, with the possible exception of a side-on-stable multiple orbit reentry (with the same side of the ALRH exposed to the stagnation line for each pass through the atmosphere) of 25 to 39 orbits (280,000 feet to 290,000 feet initial perigees, respectively) followed by a near orbital decay final reentry, again with the same side of the ALRH exposed to the stagnation line flow. This exception, based on the approximate trajectory code, leads to a total ablation on the ALRH stagnation line greater than the 0.6 inch of graphite thickness. It should be noted that the lack of three-dimensional heat transfer in the ablation model maximizes the ablation along the stagnation line for a side-on-stable reentry.

Reentry Thermal Analysis

The results of the three-dimensional thermal analysis are avai able for reference as computer output, where the temperature as a function of time is printed for each node for the following side-on-stable reentry trajectories:

1. Orbital decay reentry (cold wall heating rates),
2. -6.25° lunar return reentry (cold wall heating rates),
3. -38.05° lunar return reentry
   a. Cold wall heating rates
   b. CMA corrected heating rates,
4. -90° lunar return reentry
   a. Cold wall heating rates
   b. CMA corrected heating rates, and
5. Multiple orbit reentry - orbit 1 of 25 (cold wall heating rates).

As shown, the ablation effects (obtained from the CMA computer code) are considered for the three-dimensional thermal analysis for the s lunar return reentries. However, for orbital decay and -6.25° luna return, the ablation effects on the heating are not accounted for. During the orbital decay reentry and the -6.25° lunar return reentry the hot wall correction factor and the boundary layer blowing ef t reduce the heating to the ALRH by approximately the same amount t oxidation of the graphite wall increases it. However, during steepe lunar return reentries the hot wall effect and the blowing effect dominate, and therefore they must be accounted for in the thermal analysis of these steep reentries.

Due to the bulk of the computer printouts, they are not includ in this report; however, representative samples of the results are shown in Figures 29 through 40. Figures 29 and 30 show the tempera distribution in the radial and circumferential directions, respecti near the center plane of the ALRH, as a function of time for orbit decay. The node locations are as shown in Figure 4. The maximum s temperature, the maximum circumferential temperature gradient, and t maximum radial temperature gradient can be obtained from these figu Figures 31 through 36 show the same information for -6.25°, -38.05°, -90° lunar return reentries. The internal temperatures of the ALRH d not become significantly high for any of the above side-on-stable reentries during the portion of the trajectory that was analyzed. T verify that the internal components remained below their melt temper tures during the entire reentry, the three-dimensional thermal analy of the -6.25° lunar return reentry was carried out to earth impact. The instantaneous maximum titanium temperature and instantaneous max mum fuel temperature are shown as a function of time to earth impact in Figure 37. Earth impact temperatures of the internal components the other side-on-stable reentries will be lower than that shown fo the -6.25° lunar return. The time in Figures 29 through 37 is refe to 400,000 feet altitude.

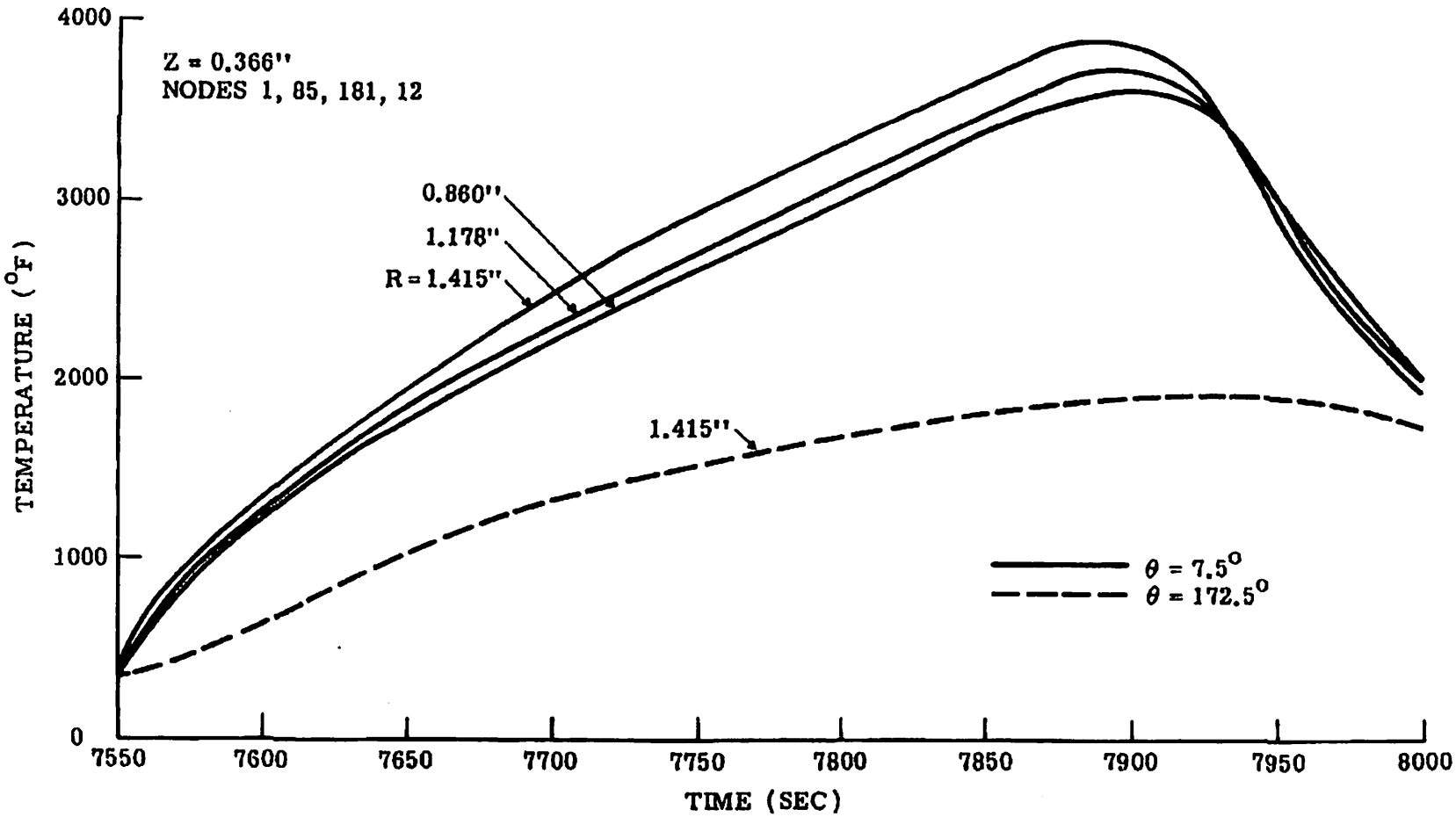


Figure 29. ALRH radial temperature distribution for side-on-stable orbital decay reentry

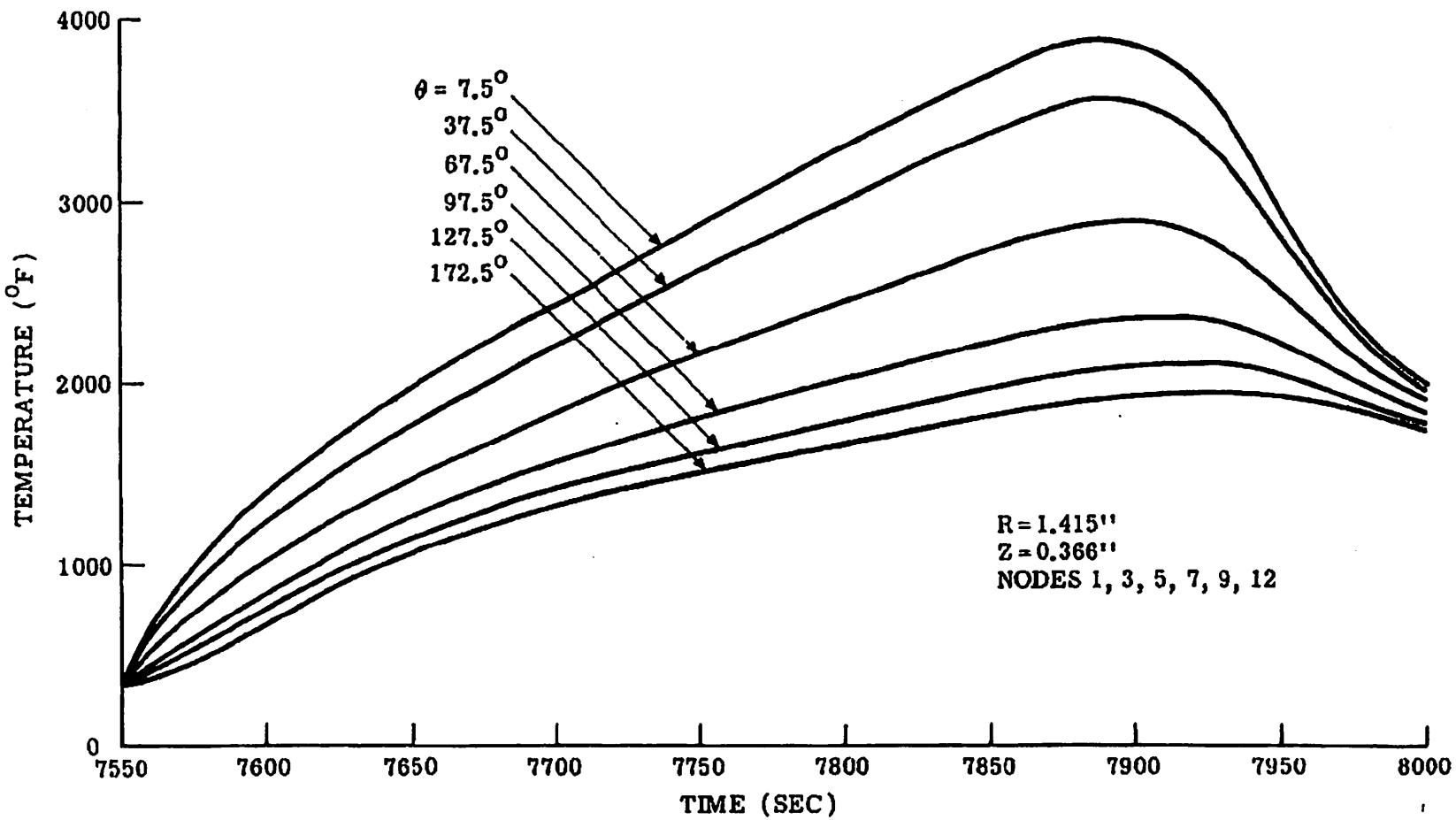


Figure 30. ALRH circumferential temperature distribution for side-on-stable c 'tal decay reentry

side-on-stable or ıl decay reentry

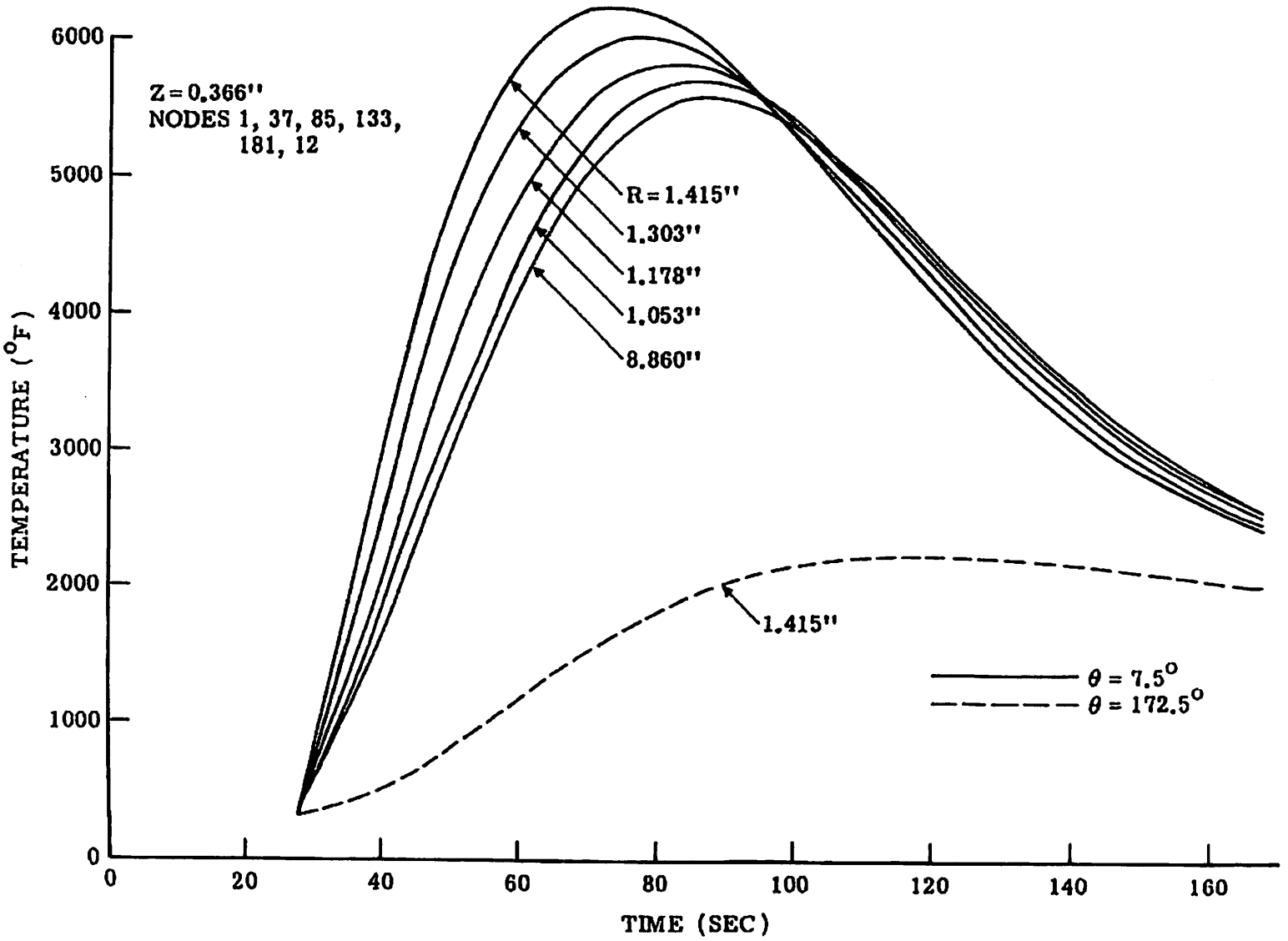
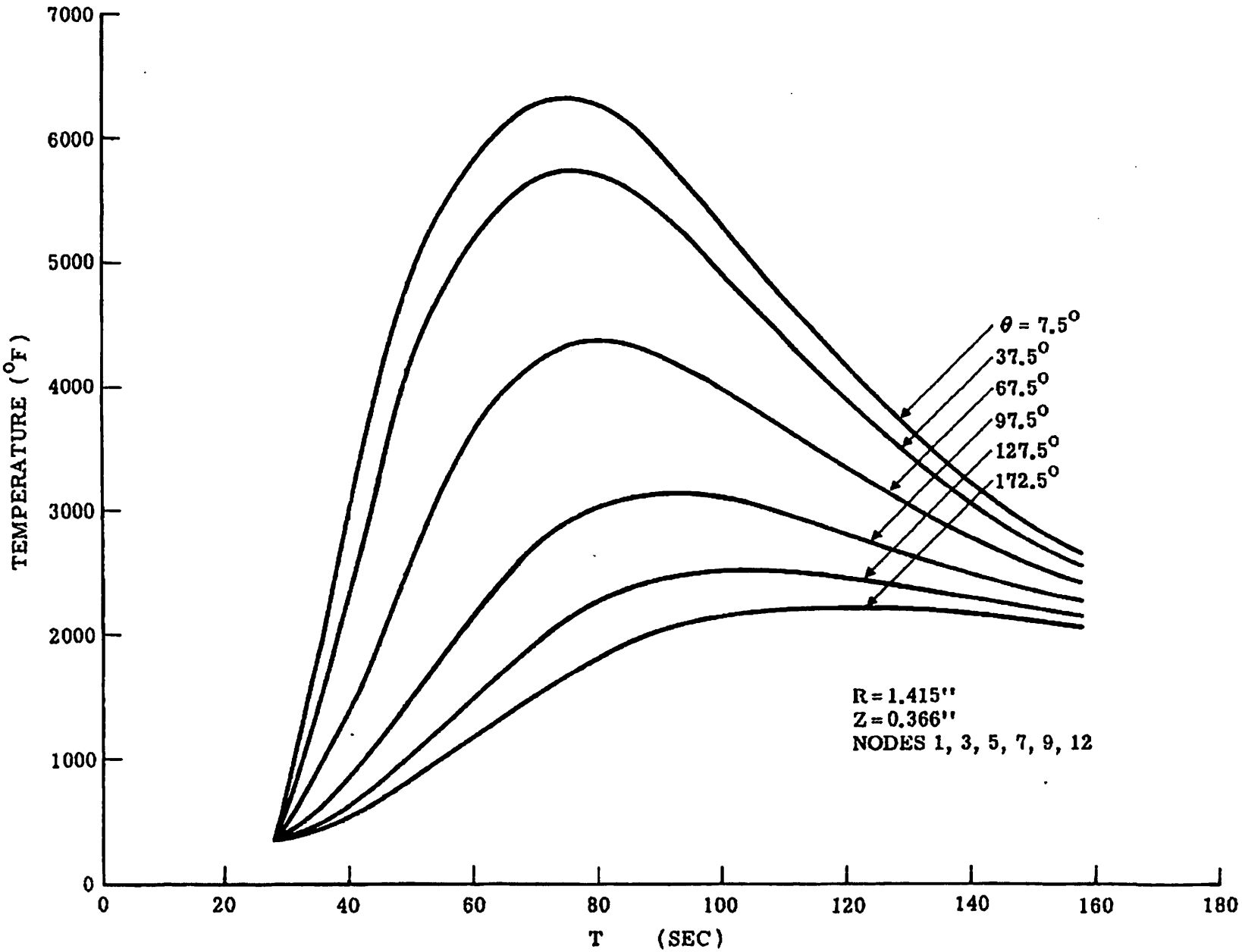


Figure 31. ALRH radial temperature distribution for side-on-stable -6.25° lunar return reentry


7000
6000
5000
4000
3000
2000
1000
0
TEMPERATURE (°F)
0
20
40
60
80
100
120
140
160
180
T (SEC)
θ = 7.5°
37.5°
67.5°
97.5°
127.5°
172.5°
R = 1.415"
Z = 0.366"
NODES 1, 3, 5, 7, 9, 12

T (SEC)

Figure 32. ALRH circumferential temperature distribution for side-on-stable -6.25° lunar return reentry

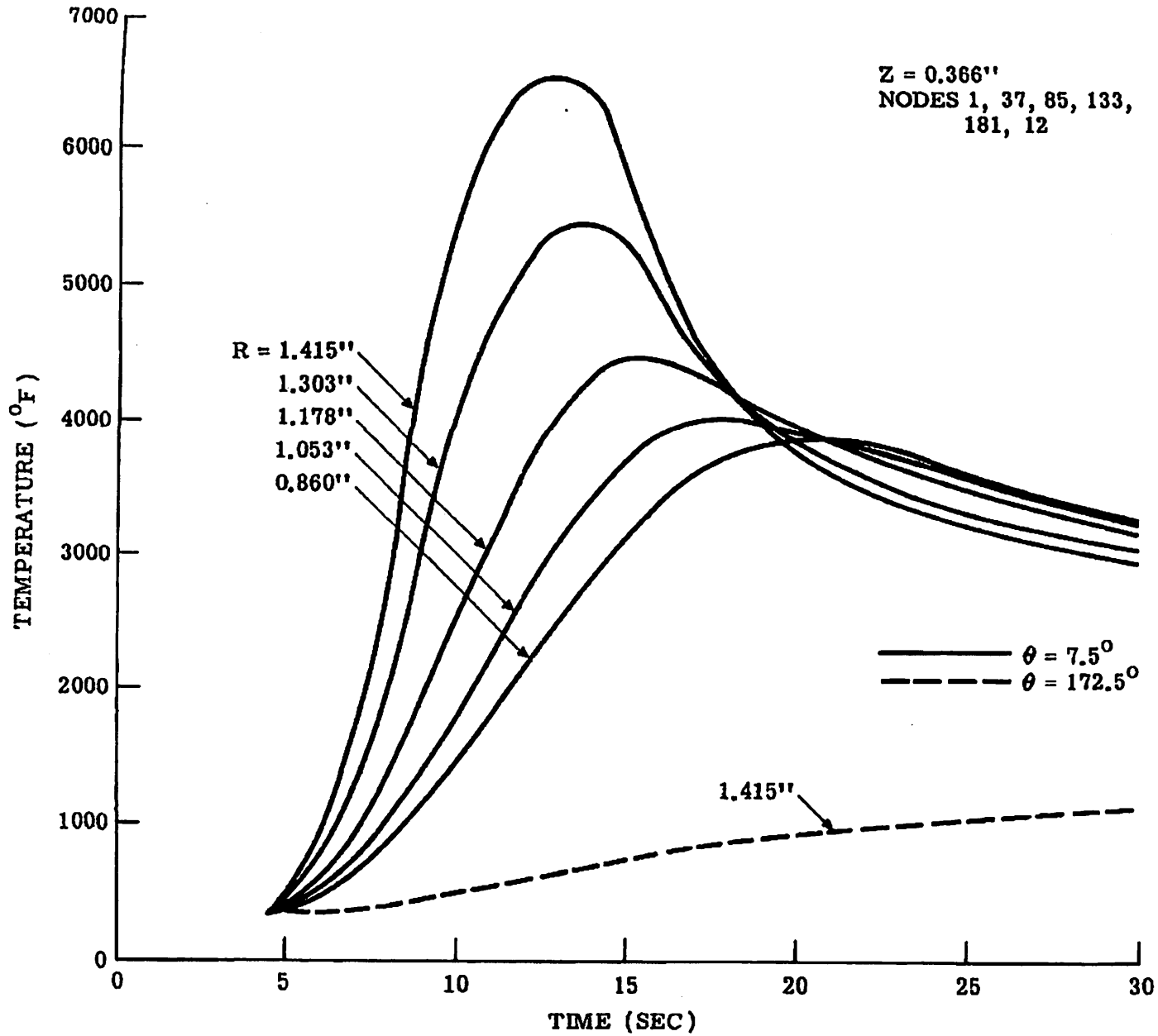


Figure 33. ALRH radial temperature distribution for side-on-stable -38.05° lunar return reentry

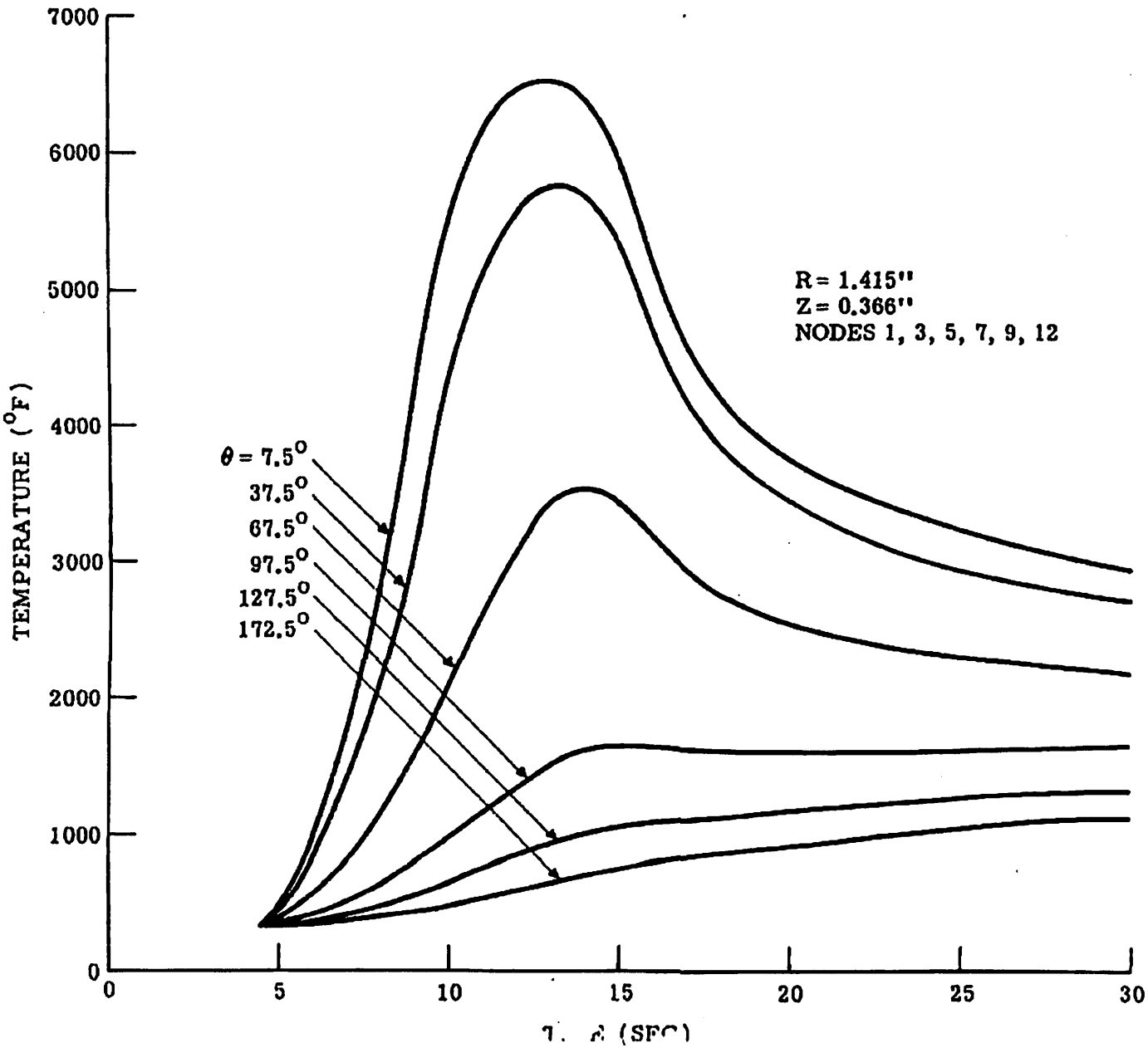

7000
6000
5000
4000
3000
2000
1000
0
TEMPERATURE (°F)
0
5
10
15
20
25
30
R = 1.415"
Z = 0.366"
NODES 1, 3, 5, 7, 9, 12
θ = 7.5°
37.5°
67.5°
97.5°
127.5°
172.5°

Figure 34. ALRH circumferential temperature distribution for side-on-stable -38.05° lunar return reentry

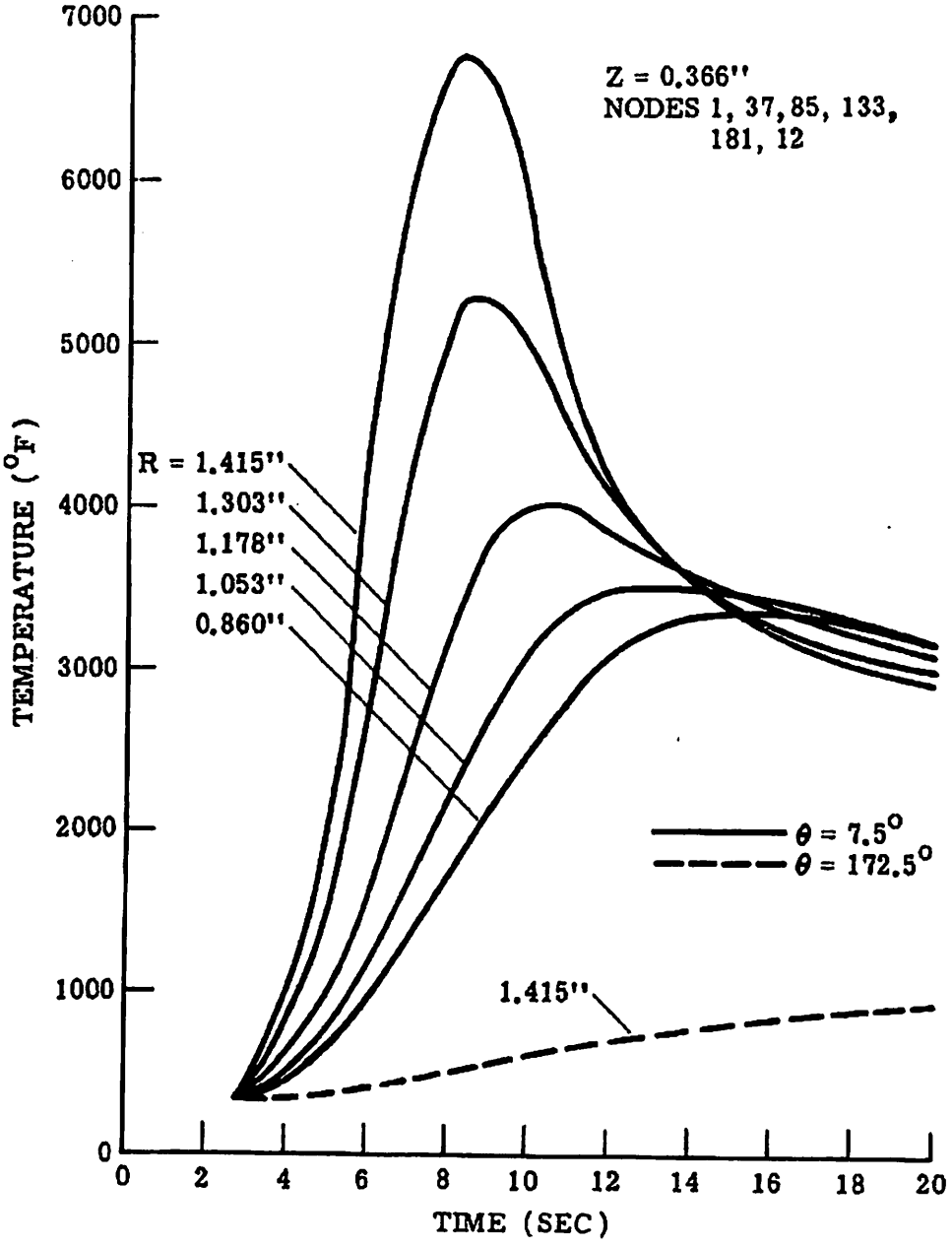


Figure 35. ALRH radial temperature distribution for side-on-stable -90° lunar return reentry

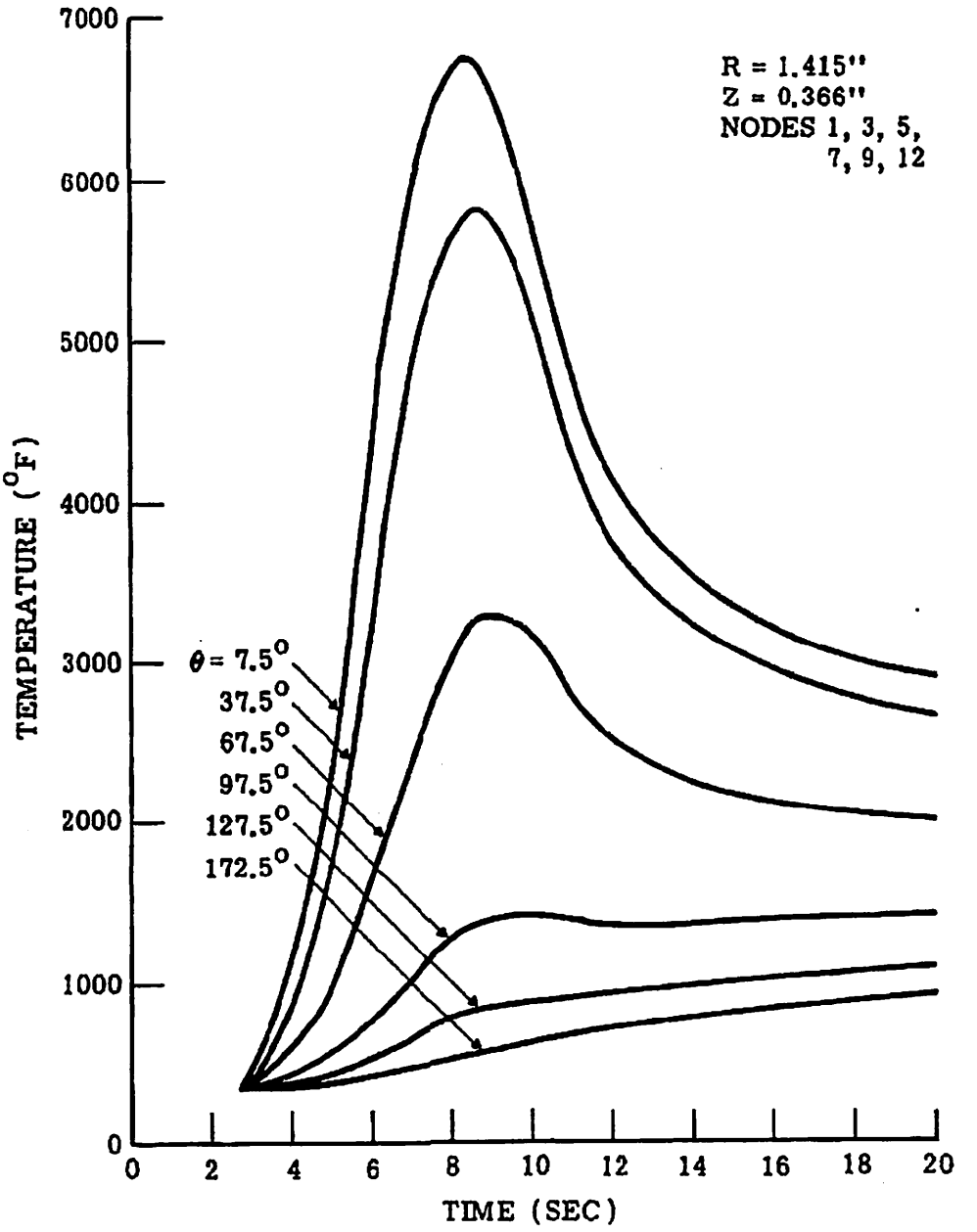


Figure 36. ALRH circumferential temperature distribution for side-on-stable -90° lunar return reentry

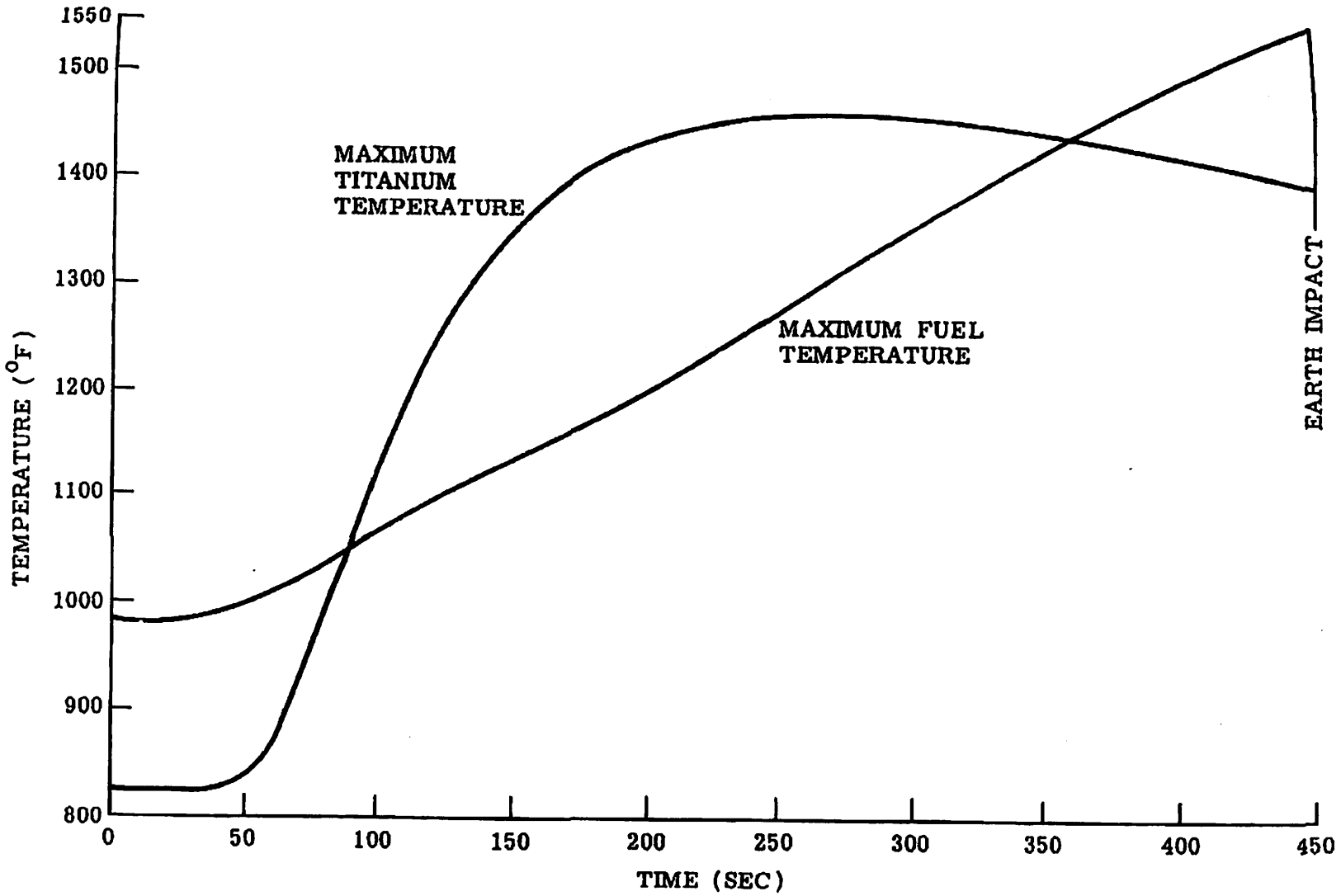


Figure 37. ALRH instantaneous maximum fuel and titanium temperature for side-on-stable -6.25° lunar return reentry

A thermal analysis was also conducted to determine the temperature response of the ALRH during a side-on-stable multiple orbit reentry. Figures 38 and 39 show the radial and circumferential temperature gradients, respectively, during the first atmospheric pass of a 25 orbit (280,000 feet initial perigee) reentry. Figure 40 shows the instantaneous maximum titanium and fuel temperatures. The time is referenced to perigee altitude. In Figure 40 the fuel temperature is shown to be still increasing at 300 seconds. The computer run was stopped at 300 seconds, and therefore the peak fuel temperature was not reached. However, by examining the temperature response of the titanium it can be seen that the titanium temperature has peaked and will begin to cool; therefore the fuel temperature will peak shortly and will thus still be well below any critical temperature.

Operational Thermal Analysis

The two-dimensional thermal model was used to predict the temperatures of the ALRH during the lunar day/night cycle. The ALRH mounting plate temperature was the externally prescribed boundary condition. Figure 41 shows the average temperature of the lunar surface and the ALRH mounting plate during the 28 day lunar cycle. Figure 42 shows the maximum graphite and fuel temperature during the lunar cycle. Figure 43 shows the temperature distribution through the ALRH at maximum operational temperatures.

Steady State Thermal Analyses

The results of two steady state thermal analyses are summarized briefly in this section of the report.

The first steady state analysis determined the steady state temperature of the titanium cladding of the ALRH following its construction and prior to its being placed in the ALRH graphite and stainless steel container. Based on free convection and radiative heat losses, the external surface temperature of the titanium was initially 370°F; it dropped slowly to 340°F as the titanium surface oxidized.

The second steady state analysis determined the long-term temperature change of the ALRH resulting from the radioisotope gradually losing its radioactivity when the ALRH was buried in soil (presumably following earth impact due to a mission abort). With soil conditions such that the initial titanium clad steady state temperature was 500°F, the clad temperature would change with time as shown in Figure 44.

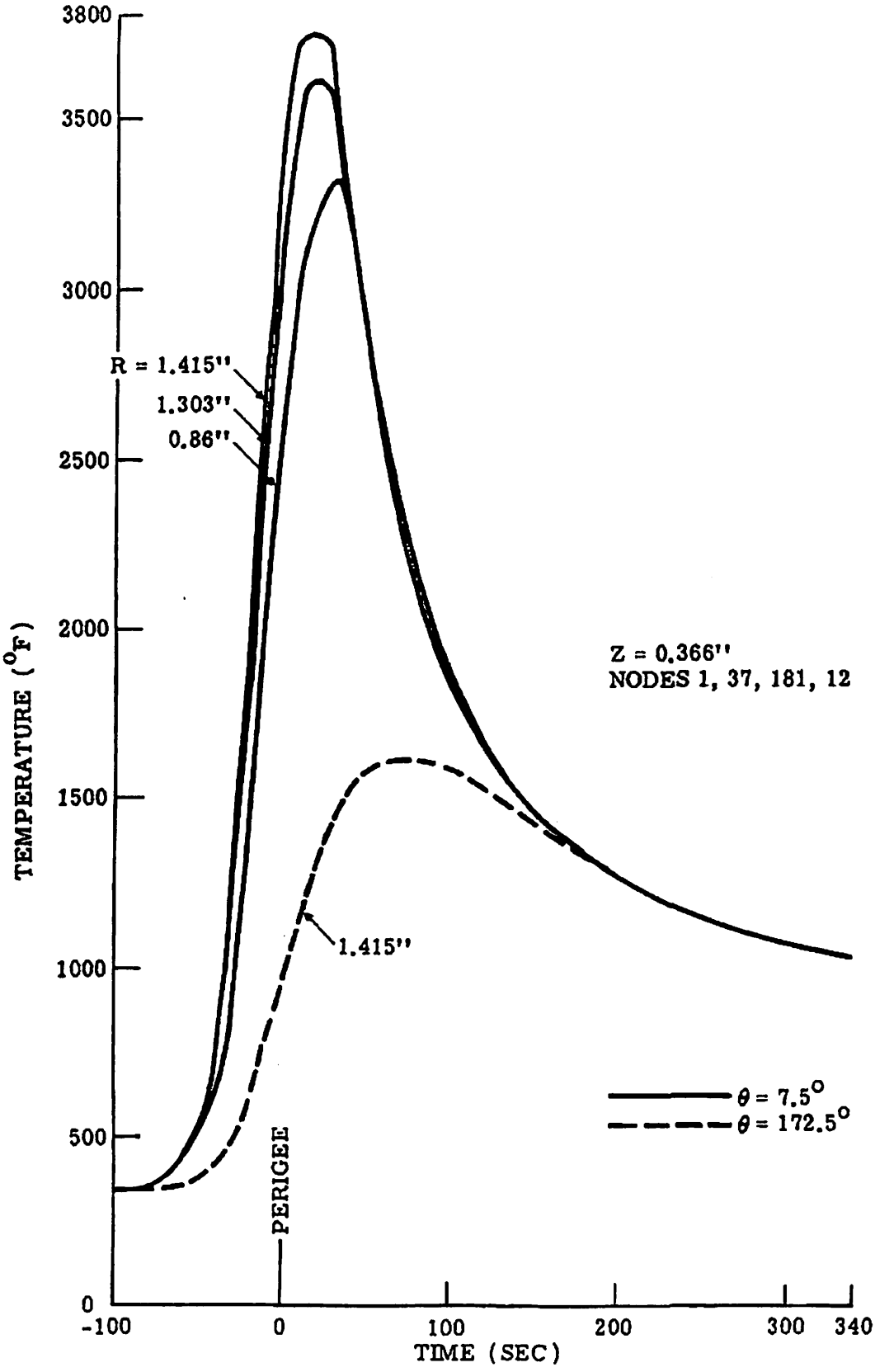


Figure 38. ALRH radial temperature distribution for one orbit of multiple orbit reentry

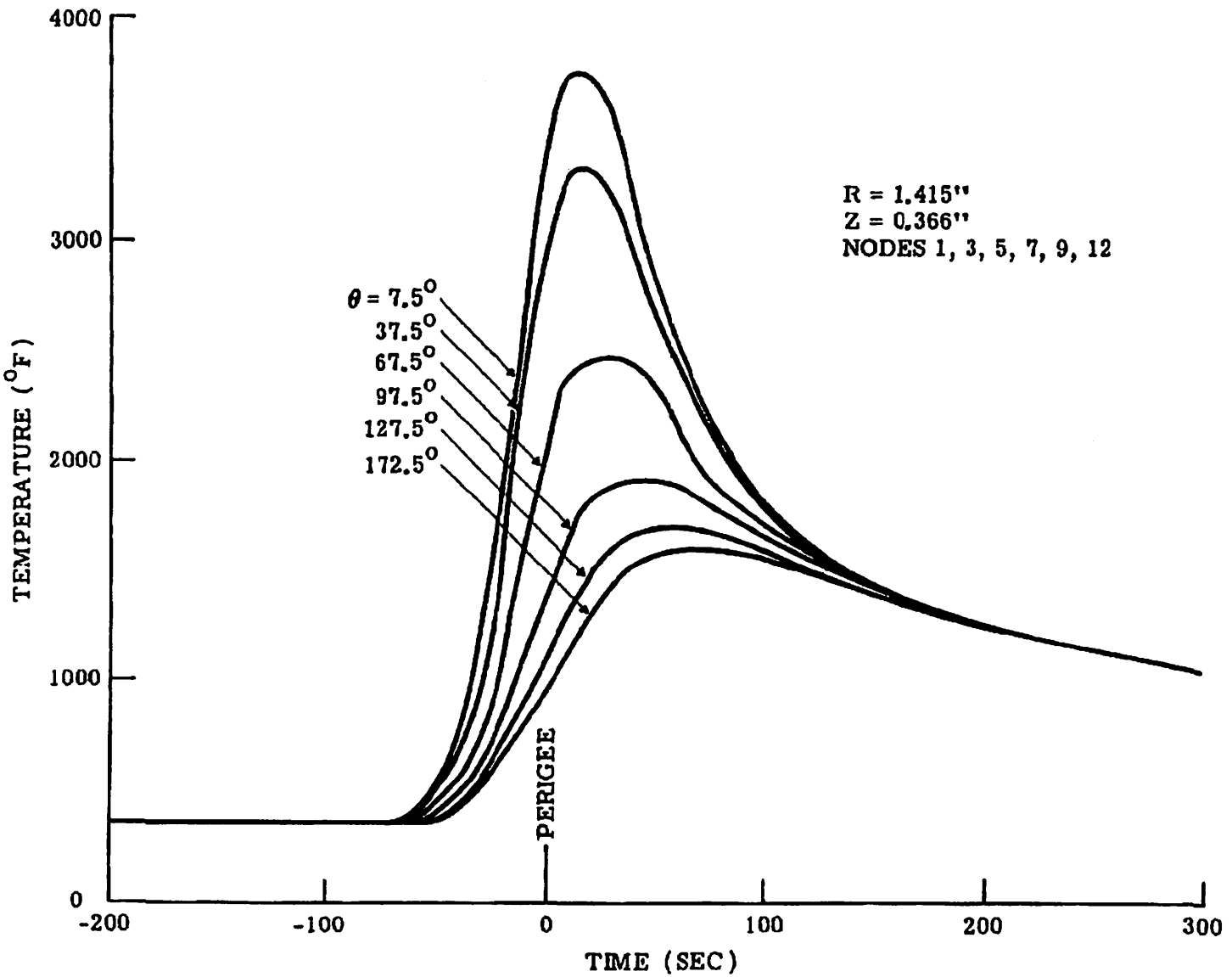


Figure 39. ALRH circumferentia' emperature distribution for one orbit of multiple o . reentry

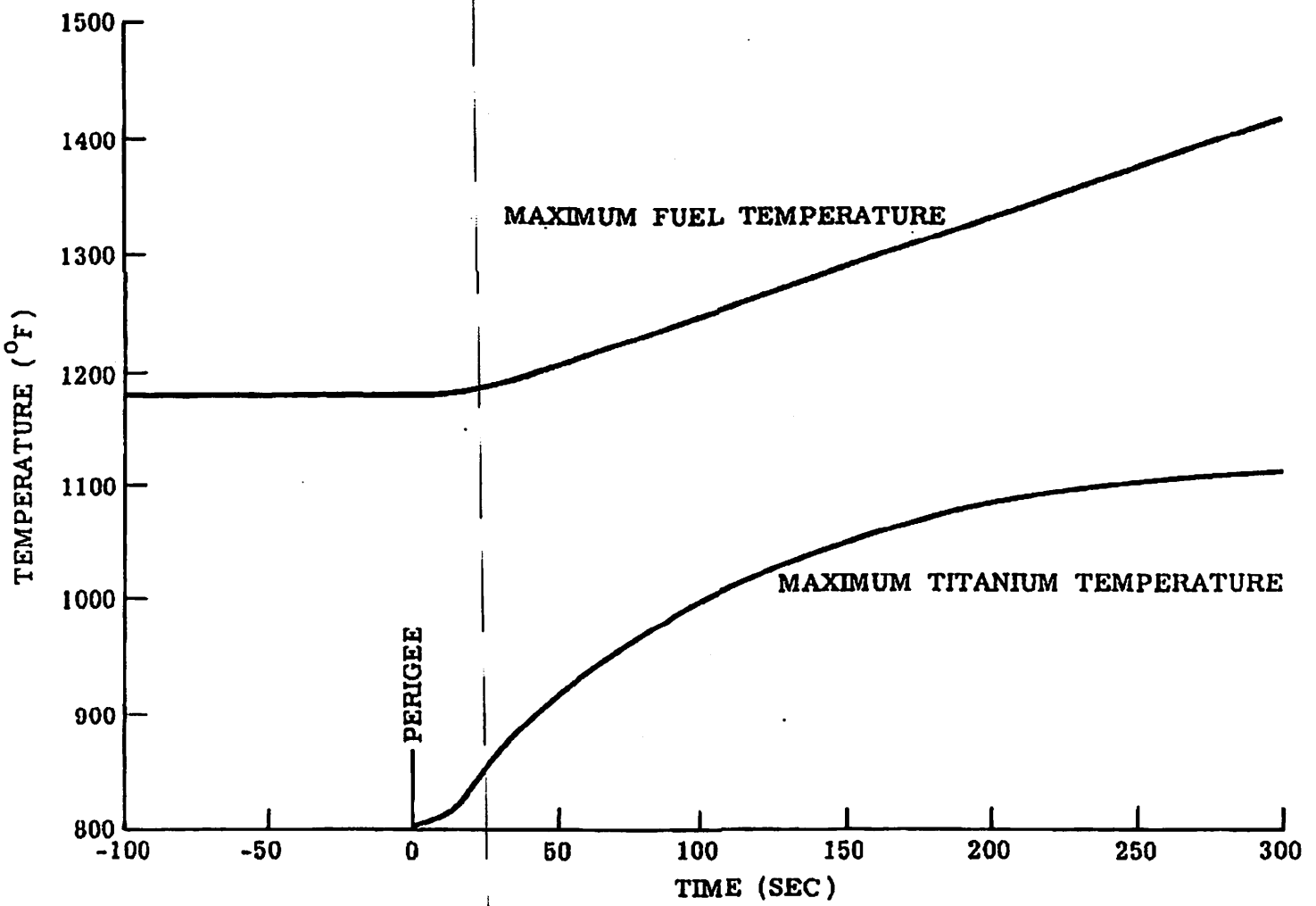


Figure 40. ALRH instantaneous maximum fuel and titanium temperature for one atmospheric pass of multiple orbit reentry

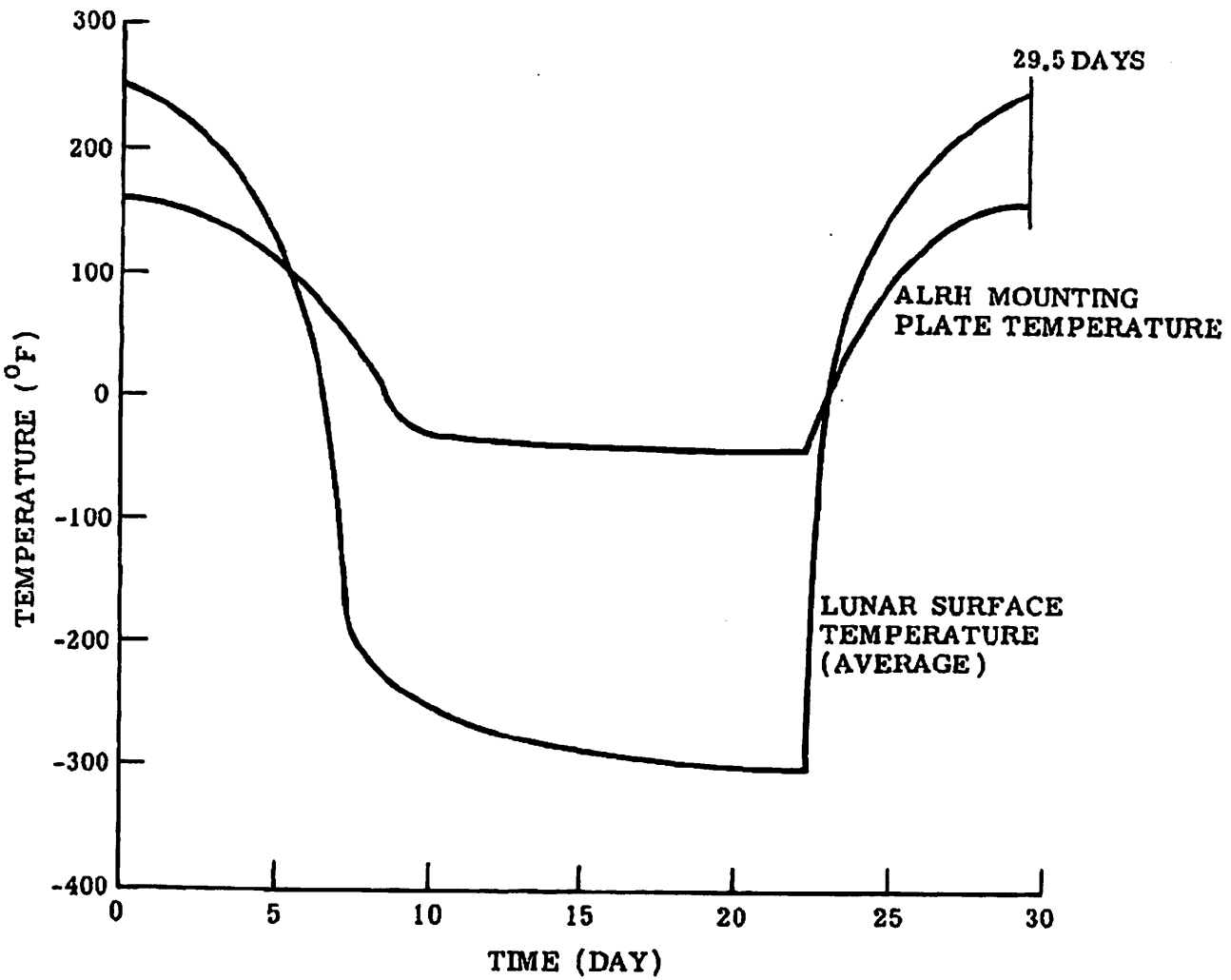


Figure 41. ALRH operational environment on lunar surface

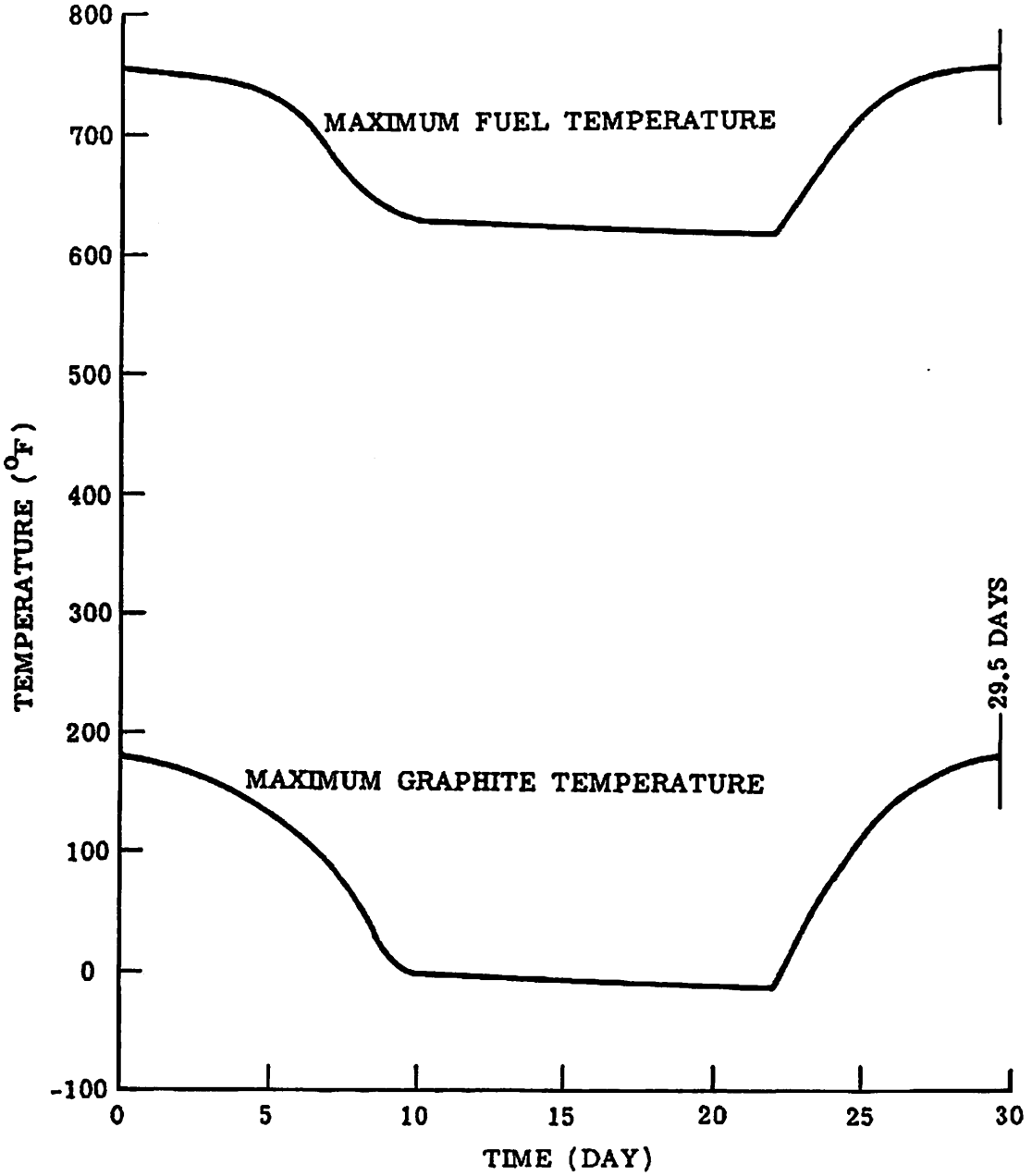


Figure 42. ALRH thermal response during lunar day/night cycle

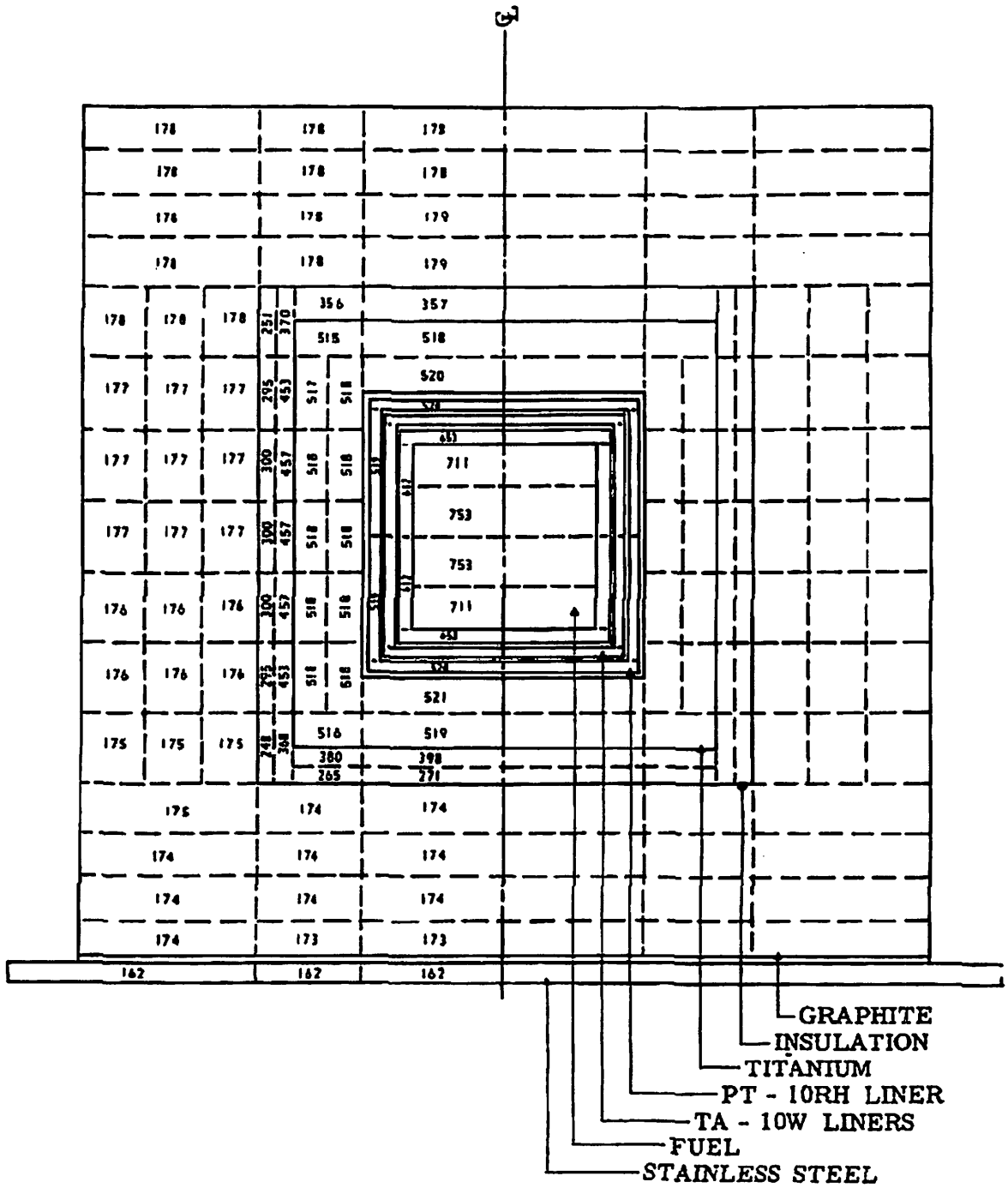


Figure 43. ALRH temperature distribution on lunar surface at lunar noon

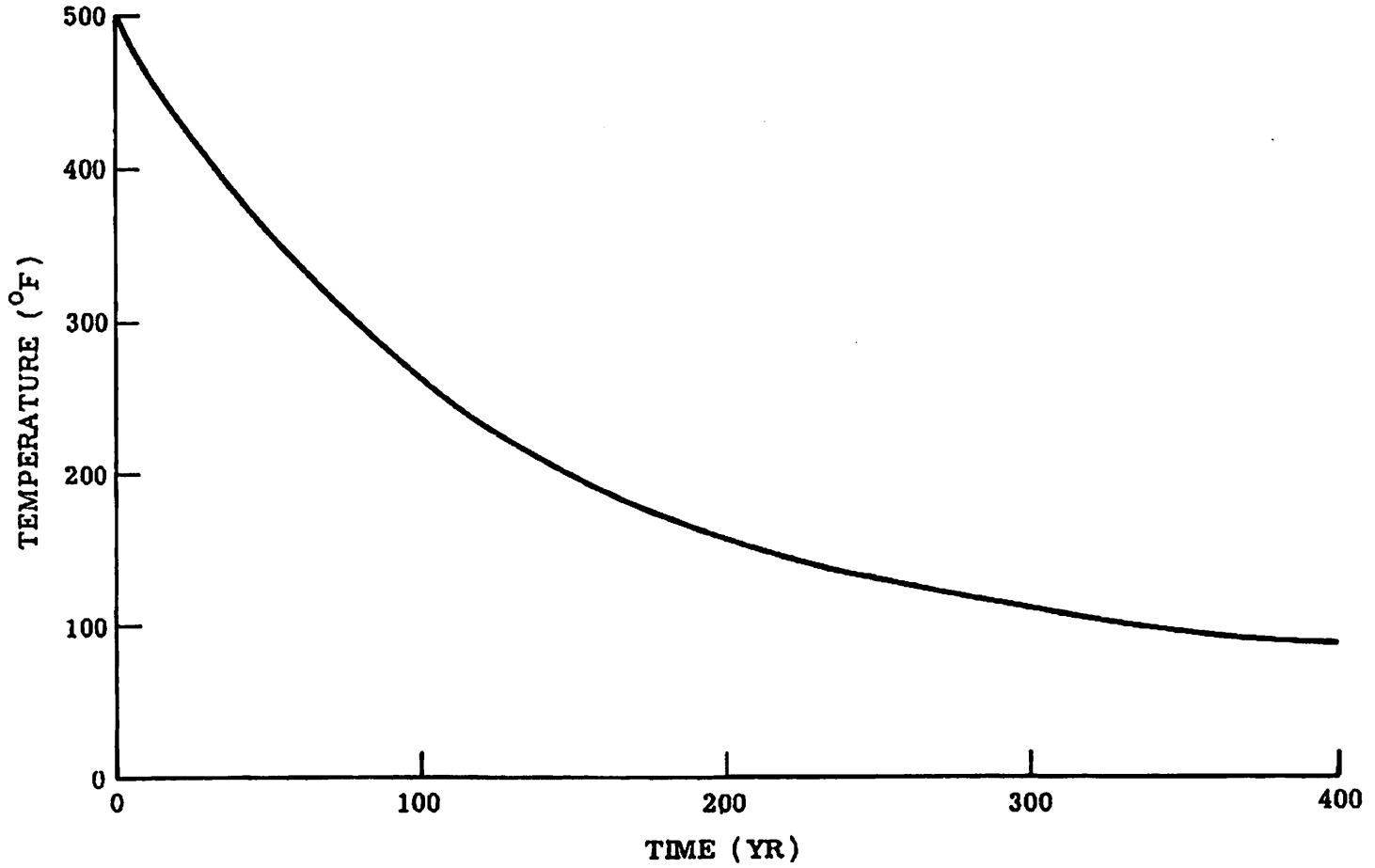


Figure 44. ALRH titanium temperature after earth burial

Conclusions

The basic conclusions which can be drawn from the analyses contained in this report are as follows:

1. The ALRH has adequate graphite thickness to prevent complete graphite removal by ablation for all prompt reentries considered.

2. The ALRH graphite may ablate through at the stagnation line if a mission abort results in a side-on-stable multiple orbit reentry of 25 to 39 orbits followed by a near orbital decay side-on-stable final reentry.

3. The temperatures reached by all components of the ALRH remain well below melt temperatures for all prompt and multiple-orbit reentries considered, as long as the graphite heat shield remains intact.

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APPENDIX A

Material Properties Used in the Thermal and Ablation Models

APPENDIX A

Material Properties Used in the Thermal and Ablation Models

Poco (AXF-5Q) Graphite

Density = 113.5 lb/ft^3

Emissivity, ϵ

Temperature (°F)	ϵ
0	0.70
400	0.73
800	0.78
1200	0.81
2000	0.86
3200	0.90
4000	0.93
8000	0.96

Specific Heat, C_p

Temperature (°F)	C_p (Btu/lb-°F)
0	0.15
500	0.29
1000	0.37
2000	0.45
3000	0.50
4000	0.55
5000	0.59

Thermal Conductivity, K

Temperature (°F)	K (Btu/hr-ft-°F)
0	72.0
500	51.0
1000	37.0
1500	27.0
2000	21.0
3000	17.0

Fibrous Carbon Insulation (Y-12)

Density = 7.0 lb/ft^3

Specific Heat, C_p

Temperature (°F)	C_p (Btu/lb-°F)
0	0.15
500	0.29
1000	0.37
2000	0.45
3000	0.50
4000	0.55
5000	0.59

Thermal Conductivity, K

Temperature (°F)	K (Btu/hr-ft-°F)
40	0.0280
540	0.0388
1040	0.0540
1540	0.0740
2040	0.1060
2540	0.1440
3040	0.2320

Titanium

Density = 287 lb/ft^3

Emissivity, ε

Temperature (°F)	ε (unoxidized)	ε (oxidized)
0	0.30	0.76
1500	0.34	0.60
2000	0.40	0.55
2500	0.40	0.50
3500	0.40	0.36

Specific Heat, C_p

Temperature (°F)	C_p (Btu/lb-°F)
0	0.120
400	0.138
800	0.148
1500	0.165
2000	0.150
2600	0.180
3600	0.270

Thermal Conductivity, K

Temperature (°F)	K (Btu/hr-ft-°F)
0	13.6
170	12.0
600	10.8
1000	10.0
1500	9.6

Platinum - 10% Rhodium

Density = 0.775 lb/in.^{3}

Emissivity, ε

Temperature (°F)	ε
40	0.02
1740	0.17
3334	0.23

Specific Heat, C_p

Temperature (°F)	C_p* (Btu/lb-°F)
0	0.0310
1500	0.0365
3000	0.0420

Thermal Conductivity, K

Temperature (°F)	K* (Btu/hr-ft-°F)
0	41.2
500	40.4
2000	38.4
3000	36.9

*These material property values are for platinum since data for platinum - 10% rhodium were unavailable.

Tantalum - 10% Tungsten

Density = 0.607 lb/in.^{3}

Emissivity, ϵ = 0.333 (at all temperatures)

Specific Heat, C_p

Temperature (°F)	C_p* (Btu/lb-°F)
0	0.035
3000	0.040
5000	0.050

Thermal Conductivity, K

Temperature (°F)	K (Btu/hr-ft-°F)
0	18.0
800	24.0
2400	32.0
4000	37.0
4800	39.0

Fuel ($^{238}PuO_2$ Microspheres)

Density = 0.383 lb/in.^{3}

Specific Heat, C_p = 0.063 Btu/lb-°F (at all temps.)

Thermal Conductivity, K

Temperature (°F)	K (Btu/hr-ft-°F)
0	0.46
1000	0.46
1200	0.52
1400	0.58
1600	0.68
1700	0.75

*These material property values are for tantalum since data for tantalum - 10% tungsten were not available.

Argon

Thermal Conductivity, K

Temperature (°F)	K (Btu/hr-ft-°F)
0	0.0088
530	0.0164
800	0.0194
1340	0.0246
3140	0.0400
6740	0.0680

APPENDIX B

Sample CMA Computer Run

(ALRH -20° lunar return reentry, random-tumble and spin orientation)

APPENDIX B

Sample CMA Computer Run

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                    SANDIA ABLATION PROGRAM (VERSION TWO)
6                                                                    PAGE  1
 ROUND EASEP HEATER  ABLATION STUDY
 D W LARSON, 9513, REENTRY AND SPACE SCIENCES DIVISION
 ALRM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

                    ---REACTION KINETIC EQUATION---

      DRHO/DTIME = GAMMA ( BA*EXP(-EA/T)RHOOA((RHOA-RHORA)/RHOOA)**PSIA )
                 + GAMMA ( BB*EXP(-EB/T)RHOOB((RHOB-RHORB)/RHOOB)**PSIB )
                 +(1-GAMMA)( BC*EXP(-EC/T)RHOOC((RHOC-RHORC)/RHOOC)**PSIC )
                    ---REACTION KINETIC CONSTANTS---

      REACTION  RHOO      RHOR        B         PSI        E        T REAC
                (LB/CU FT)        (1/SEC)                (DEG R)   (DEG R)
          A     108.00    108.00   0.000+000   0.00    0.000+000   90000
          B     108.00    108.00   0.000+000   0.00    0.000+000   90000
          C     108.00    108.00   0.000+000   0.00    0.000+000   90000
      RESIN VOLUME FRACTION, GAMMA = ****(MASS FRACTION = 0.000)

                    ---TIME INCREMENT INFORMATION---

 INITIAL TIME (SEC) 0.000                                FINAL TIME (SEC) 302.00

 OUTPUT INTERVAL = 1.000 SEC FROM INITIAL TIME UNTIL 26.000 SEC
 OUTPUT INTERVAL = 2.000 SEC FROM 26.000 SEC UNTIL 40.000 SEC
 OUTPUT INTERVAL =20.000 SEC FROM 40.000 SEC UNTIL FINAL TIME

 MAXIMUM TIME STEP =5.00 SECONDS
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SANDIA ABLATION PROGRAM (VERSION TWO)

ALRH HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

---NODAL DATA---

THE TITLE OF THIS FILE IS 0.75000 -0.00000 0.00000 0.00000

NODE NO.	MATL NO.	TEMPERATURE (DEG.RANKINE)	RELATIVE AREA	THICKNESS (INCHES)	NODAL DEPTH (INCHES)	CONT.RESISTANCE (SQFT-R-DEG/BTU)
1	1	730.00	1.5000+000	0.01000	0.000000*	0.0000+000
2	1	730.00	1.4850+000	0.01000	0.015000	0.0000+000
3	1	730.00	1.4700+000	0.02000	0.030000	0.0000+000
4	1	730.00	1.4500+000	0.02000	0.050000	0.0000+000
5	1	730.00	1.4300+000	0.02000	0.070000	0.0000+000
6	1	730.00	1.4050+000	0.03000	0.095000	0.0000+000
7	1	730.00	1.3700+000	0.04000	0.130000	0.0000+000
8	1	730.00	1.3250+000	0.05000	0.175000	0.0000+000
9	1	730.00	1.2750+000	0.05000	0.225000	0.0000+000
10	1	730.00	1.2250+000	0.05000	0.275000	0.0000+000
11	1	730.00	1.1500+000	0.10000	0.350000	0.0000+000
12	1	730.00	1.0500+000	0.10000	0.450000	0.0000+000
13	1	730.00	9.5000-001	0.10000	0.550000	0.0000+000
14	1	730.00	8.5000-001	0.10000	0.650000	0.0000+000
15	1	730.00	7.7500-001	0.05000	0.725000	0.0000+000

*INITIAL EXTERNAL RADIUS 1.500 AREA PROP.TO RADIUS**1.00

MINIMUM THICKNESS OF LAST ABLATOR NODE (INCHES) 0.0100

THERE ARE 10 NODELETS ASSIGNED TO EACH ABLATING NODE

BACK WALL CONVECTION COEF BTU/FTSQ-HR-DEG R	BACK WALL EMISSIVITY	RESERVOIR TEMPERATURE
-0.0000	-0.000	-0.00

---HEAT OF FORMATION OF MATERIAL CONSTITUENTS---

(BTU/LB)

PLASTIC	CHAR	GAS
-0.00	-0.00	-0.00

ENTHALPY DATUM TEMPERATURE = 536.000 DEG RANKINE

---MATERIAL THERMAL PROPERTY DATA---

MATERIAL NO. 1	MATERIAL NO. 2	MATERIAL NOS. 3 THROUGH20
VIRGIN PLASTIC	CHAR	BACK-UP

SANDIA ABLATION PROGRAM (VERSION TWO)

POCO GRAPHITE

MATERIAL NO. 1 DENSITY = 113.500 LB/CU FT

TEMPERATURE (DEG R)	SPECIFIC HEAT (BTU/LB-DEG)	CONDUCTIVITY (BTU/FT-SEC-DEG)	SENSIBLE ENTHALPY (BTU/LB)	EMMISIVITY
0.00	.1500	.0200000	-85.72	.7000
460.00	.1500	.0200000	-16.72	.7000
960.00	.2900	.0140000	93.28	.7400
1460.00	.3700	.0103000	258.28	.8000
1960.00	.4100	.0075000	453.28	.8200
2460.00	.4500	.0058000	668.28	.8600
2960.00	.4700	.0050000	898.28	.8800
3460.00	.5000	.0047000	1140.78	.9000
4460.00	.5500	.0043000	1665.78	.9300
5460.00	.5900	.0040000	2235.78	.9400
8000.00	.5900	.0040000	3734.38	.9600

MATERIAL NO. 2 DENSITY = 113.500 LB/CU FT

TEMPERATURE (DEG R)	SPECIFIC HEAT (BTU/LB-DEG)	CONDUCTIVITY (BTU/FT-SEC-DEG)	SENSIBLE ENTHALPY (BTU/LB)	EMMISIVITY
0.00	.1500	.0200000	-85.72	.7000
460.00	.1500	.0200000	-16.72	.7000
960.00	.2900	.0140000	93.28	.7400
1460.00	.3700	.0103000	258.28	.8000
1960.00	.4100	.0075000	453.28	.8200
2460.00	.4500	.0058000	668.28	.8600
2960.00	.4700	.0050000	898.28	.8800
3460.00	.5000	.0047000	1140.78	.9000
4460.00	.5500	.0043000	1665.78	.9300
5460.00	.5900	.0040000	2235.78	.9400
8000.00	.5900	.0040000	3734.38	.9600

---RESIN DECOMPOSITION GAS SENSIBLE ENTHALPY---

TEMPERATURE (DEG R)	500.00	1000.00
ENTHALPY (BTU/LB)	0.00	100.00

SANDIA ABLATION PROGRAM (VERSION TWO)

ALHH HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

---TIME DEPENDENT BOUNDARY CONDITIONS---

THE TITLE OF THIS FILE IS 0000000000000000000000

TIME (SEC)	RECOVERY ENTHALPY (BTU/LB)	RADIATION HEAT RATE (BTU/SQ FT-SEC)	HEAT COEFF (LB/SQ FT-SEC)	PRESSURE (ATMS)
8.11	23729.36	0.00	0.0019	0.00047
9.00	23729.36	0.00	0.0026	0.00090
10.00	23731.96	0.00	0.0036	0.00192
11.00	23720.29	0.00	0.0051	0.00357
12.00	23685.32	0.00	0.0068	0.00644
13.00	23616.79	0.00	0.0089	0.01092
14.00	23491.50	0.00	0.0114	0.01811
16.00	22949.25	0.00	0.0178	0.04439
18.00	21699.10	0.00	0.0263	0.09798
19.00	20625.86	0.00	0.0313	0.13992
20.00	19150.81	0.00	0.0368	0.19653
21.00	17197.58	0.00	0.0427	0.26919
22.00	14750.17	0.00	0.0480	0.34975
23.00	11966.43	0.00	0.0514	0.41655
24.00	9142.74	0.00	0.0526	0.45658
26.00	4610.01	0.00	0.0465	0.40652
28.00	2169.19	0.00	0.0353	0.28301
30.00	1086.40	0.00	0.0251	0.18125
34.00	393.59	0.00	0.0118	0.08648
40.00	155.73	0.00	0.0036	0.04854
152.00	112.78	0.00	0.0000	0.12914
362.00	154.72	0.00	0.0000	0.93546

CM/CHO = PHI/(EXP(PHI)-1.) WHERE PHI = 2.*BRP*M DOT/CHO. BRP IS 0.4 FOR STAGNATION AND TURBULENT FLOW, AND 0.3 FOR LAMINAR FLOW.

RATIO OF MASS TO HEAT TRANSFER COEFFICIENTS = 0.930

UNEQUAL DIFFUSION EXPONENT = 0.333

NOMINAL SURFACE VIEW FACTOR = 1.000 (OPTION 1)

SANDIA ABLATION PROGRAM (VERSION TWO)

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ALRH HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

---OUTPUT---

9.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
1	0	1	1.5000	0.00	23729.36	0.0026	0.00000	0.00090	Co

---ABLATION RATES---

B PRIME	B PRIME G	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/DRIO SQ FT)	M GAS
0.00000	0.00000	0.000000	0.000000	0.000000	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN) / (IN/SEC)	CHAR (0.02)	PYROLYSIS (0.98)
0.0000000/0.0000000	0.0000000/0.0000000	0.0000000/0.0000000

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/DRIO SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	0.000+000	0.000+000	0.000+000	0.000+000	0.000+000
TOTAL	0.000+000	0.000+000	0.000+000	0.000+000	0.000+000

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/DRIO SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	0.000+000	0.000+000	0.000+000
TOTAL	0.000+000	0.000+000	0.000+000	0.000+000	0.000+000

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	1	730.00	108.000	94.09	9	1	730.00	108.000	94.09
2	1	730.00	108.000	94.09	10	1	730.00	108.000	94.09
3	1	730.00	108.000	94.09	11	1	730.00	108.000	94.09
4	1	730.00	108.000	94.09	12	1	730.00	108.000	94.09
5	1	730.00	108.000	94.09	13	1	730.00	108.000	94.09
6	1	730.00	108.000	94.09	14	1	730.00	108.000	94.09
7	1	730.00	108.000	94.09	15	1	730.00	108.000	94.09
8	1	730.00	108.000	94.09					

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ALRH HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

10.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
9	3	1	1.5000	10196.27	23731.96	0.0036	1.00000	0.00182	C+

---ABLATION RATES---

B PRIME	B PRIME O	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS (LB/SQ FT-SEC)	M CHAR (LB/ORIG SQ FT)	M GAS (LB/ORIG SQ FT)
0.00000	0.00000	0.000000	0.000000	0.000000	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN) / (IN/SEC)	CHAR (0.02) (IN) / (IN/SEC)	PYROLYSIS (0.98) (IN) / (IN/SEC)
0.0000000/0.0000000	0.0000000/0.0000000	0.0000000/0.0000000

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	4.913+001	0.000+000	1.887+001	4.113+001	8.007+001
TOTAL	4.186+001	0.000+000	1.549+001	3.772+001	7.943+001

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	0.000+000	9.007+001	2.842+005
TOTAL	0.000+000	0.000+000	0.000+000	7.943+001	2.431+005

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	856.25	108.000	155.32	9	2	779.13	108.000	117.92
2	2	849.17	108.000	151.89	10	2	769.44	108.000	113.22
3	2	842.31	108.000	148.56	11	2	757.61	108.000	107.48
4	2	833.70	108.000	144.39	12	2	747.84	108.000	102.74
5	2	825.65	108.000	140.48	13	2	742.12	108.000	99.97
6	2	816.22	108.000	135.91	14	2	739.18	108.000	98.54
7	2	804.32	108.000	130.14	15	2	738.53	108.000	98.23
8	2	791.12	108.000	123.73					

SANDIA ABLATION PROGRAM (VERSION TWO)

ALAM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

11.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CM/CHO	PRESSURE (ATM)	SURFACE
12	3	1	1.5000	9014.58	23720.29	0.0031	1.00000	0.00357	C0

---ABLATION RATES---

B PRIME	B PRIME G	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.00000	0.00000	0.000000	0.000000	0.000000	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN) / (IN/SEC)	CHAR (0.02)	PYROLYSIS (0.98)
0.0000000/0.0000000	0.0000000/0.0000000	0.0000000/0.0000000

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	7.471+001	0.000+000	3.445-001	5.137+001	1.257+005
TOTAL	1.078+002	0.000+000	4.384-001	8.595-001	1.933+002

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	0.000+000	1.257+002	2.948-005
TOTAL	0.000+000	0.000+000	0.000+000	1.933+002	3.732-005

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	989.77	108.000	191.53	9	2	867.96	108.000	159.25
2	2	979.35	108.000	188.77	10	2	849.62	108.000	152.11
3	2	969.20	108.000	186.09	11	2	825.73	108.000	140.53
4	2	956.37	108.000	182.68	12	2	803.51	108.000	129.74
5	2	944.22	108.000	179.46	13	2	789.19	108.000	122.79
6	2	929.78	108.000	175.63	14	2	781.30	108.000	118.97
7	2	911.02	108.000	170.66	15	2	779.52	108.000	118.11
8	2	889.20	108.000	164.88					

SANDIA ABLATION PROGRAM (VERSION TWO)

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ALRM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

12.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
16	3	1	1.3000	7994.42	23685.32	0.0036	1.00000	0.00644	Co

---ABLATION RATES---

B PRIME	B PRIME G	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS (LB/SQ FT-SEC)	M CHAR (LB/ORIG SQ FT)	M GAS (LB/ORIG SQ FT)
0.00000	0.00000	0.000000	0.000000	0.000000	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN) / (IN/SEC)	CHAR (0.02) (IN) / (IN/SEC)	PYROLYSIS (0.98) (IN) / (IN/SEC)
0.0000000/0.0000000	0.0000000/0.0000000	0.0000000/0.0000000

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	1.070+002	0.000+000	6.754-001	6.136+001	1.477+002
TOTAL	2.026+002	0.000+000	9.721-001	1.437+002	3.455+002

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	0.000+000	1.677+002	3.272-002
TOTAL	0.000+000	0.000+000	0.000+000	3.455+002	8.863-002

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	1163.27	108.000	237.51	9	2	993.60	108.000	192.54
2	2	1148.13	108.000	233.49	10	2	969.19	108.000	186.08
3	2	1133.49	108.000	229.62	11	2	937.34	108.000	177.43
4	2	1115.14	108.000	224.79	12	2	906.71	108.000	169.52
5	2	1097.92	108.000	220.10	13	2	886.09	108.000	164.09
6	2	1077.66	108.000	214.02	14	2	874.15	108.000	160.89
7	2	1051.69	108.000	207.94	15	2	871.41	108.000	160.16
8	2	1022.01	108.000	200.07					

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ALRH HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

13.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
21	2	1	1.4999	7121.38	23616.75	0.0089	0.95730	0.01092	C.

---ABLATION RATES---

B PRIME	B PRIME G	H DOT CHAR (LB/SQ FT-SEC)	H DOT GAS (LB/SQ FT-SEC)	M CHAR (LB/ORIG SQ FT)	M GAS (LB/ORIG SQ FT)
0.13947	0.00000	0.001070	0.000000	0.000492	0.000000

---RECESSIONS/RECESSION RATES---
(IN) / (IN/SEC)

SURFACE	CHAR (0.02)	PYROLYSIS (0.98)
0.0000546/0.0001189	0.0000546/0.0001068	0.0000546/0.0001068

---SURFACE ENERGY FLUX TERMS---
CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	1.401+002	0.000+000	1.321+000	6.772+001	2.065+002
TOTAL	3.299+002	0.000+000	2.008+000	2.097+002	5.375+002

---INTERIOR ENERGY TERMS---
CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	8.413-002	2.064+002	3.755-009
TOTAL	0.000+000	0.000+000	4.026-002	5.375+002	1.242-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG-R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	1366.28	108.000	299.28	9	2	1141.34	108.000	231.70
2	2	1345.63	108.000	292.26	10	2	1110.43	108.000	223.50
3	2	1325.74	108.000	285.49	11	2	1070.70	108.000	212.97
4	2	1300.93	108.000	277.06	12	2	1033.51	108.000	203.12
5	2	1277.78	108.000	269.19	13	2	1009.26	108.000	196.69
6	2	1250.77	108.000	260.69	14	2	995.79	108.000	193.12
7	2	1216.52	108.000	251.62	15	2	992.74	108.000	192.32
8	2	1177.84	108.000	241.37					

SANDIA ABLATION PROGRAM (VERSION TWO)

ALGH HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

14.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CW/CWO	PRESSURE (ATM)	SURFACE
26	2	1	1.4998	6433.61	23491.50	0.0108	0.94224	0.01811	C.

---ABLATION RATES---

B PRIME	B PRIME 0	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.17990	0.00000	0.001800	0.000000	0.001860	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN)	CHAR (0.02) (IN/SEC)	PYROLYSIS (0.98) (IN/SEC)
0.0002066/0.0002000	0.0002066/0.0001869	0.0002066/0.0001869

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	1.835+002	0.000+000	2.580+000	7.571+001	2.567+005
TOTAL	4.960+002	0.000+000	4.018+000	2.825+002	7.745+002

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	2.157+001	2.565+002	4.225-005
TOTAL	0.000+000	0.000+000	1.951+001	7.743+002	1.446-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	1606.16	108.000	380.84	9	2	1304.33	108.000	278.21
2	2	1577.62	108.000	371.13	10	2	1264.32	108.000	264.41
3	2	1550.35	108.000	361.86	11	2	1213.66	108.000	250.86
4	2	1516.58	108.000	350.38	12	2	1166.99	108.000	238.49
5	2	1485.29	108.000	339.74	13	2	1136.91	108.000	230.52
6	2	1448.99	108.000	327.40	14	2	1120.31	108.000	226.12
7	2	1403.27	108.000	311.85	15	2	1116.57	108.000	225.13
8	2	1352.11	108.000	294.46					

SANDIA ABLATION PROGRAM (VERSION TWO)

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ALRM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

15.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
33	2	1	1.4996	5848.48	23220.38	0.0137	0.93785	0.02835	0.

---ABLATION RATES---

B PRIME	B PRIME G	M DOT CHAR. (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.15539	0.00000	0.002364	0.000000	0.003911	0.000000

---RECESSIONS/RECESSION RATES---

(IN) / (IN/SEC)

SURFACE	CHAR (0.02)	PYROLYSIS (0.98)
0.0004347/0.0002627	0.0004347/0.0002579	0.0004347/0.0002578

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	2.382+002	0.000+000	5.152+000	8.757+001	3.206+003
TOTAL	7.108+002	0.000+000	7.931+000	3.652+002	1.068+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	4.453-001	3.201+002	4.779-005
TOTAL	0.000+000	0.000+000	5.378-001	1.068+003	2.099-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	1900.42	108.000	492.90	9	2	1486.23	108.000	340.06
2	2	1859.67	108.000	477.01	10	2	1434.24	108.000	322.35
3	2	1820.98	108.000	461.92	11	2	1368.89	108.000	300.16
4	2	1773.48	108.000	443.40	12	2	1309.21	108.000	279.87
5	2	1729.84	108.000	425.38	13	2	1271.07	108.000	266.00
6	2	1679.63	108.000	406.80	14	2	1250.22	108.000	260.55
7	2	1617.37	108.000	384.64	15	2	1245.55	108.000	259.31
8	2	1549.02	108.000	361.41					

SANDIA ABLATION PROGRAM (VERSION TWO)

ALRM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

16.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
40	2	1	1.4993	5275.86	22949.23	0.0147	0.93826	0.04437	C*

---ABLATION RATES---

B PRIME	B PRIME O	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.10543	0.00008	0.002883	0.000000	0.004478	0.000000

---RECESSIONS/RECESSION RATES---

(IN) / (IN/SEC)

SURFACE	CHAR (0.02)	PYROLYSIS (0.98)
0.0007222/0.0003204	0.0007222/0.0003122	0.0007222/0.0003122

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	2.955+002	0.000+000	1.015+001	9.638+001	3.818+000
TOTAL	9.816+002	0.000+000	1.567+001	4.582+002	1.424+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	7.768+001	3.810+002	5.290+000
TOTAL	0.000+000	0.000+000	1.163+000	1.423+003	2.603-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	2236.82	108.000	630.29	9	2	1589.74	108.000	410.74
2	2	2102.12	108.000	607.04	10	2	1622.53	108.000	386.40
3	2	2130.27	108.000	583.00	11	2	1539.34	108.000	359.12
4	2	2066.62	108.000	558.04	12	2	1464.21	108.000	332.57
5	2	2008.93	108.000	535.22	13	2	1416.53	108.000	316.36
6	2	1942.87	108.000	509.46	14	2	1390.48	108.000	307.50
7	2	1861.20	108.000	477.61	15	2	1384.69	108.000	305.53
8	2	1771.60	108.000	442.70					

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ALRH HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

18.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CW/CWO	PRESSURE (ATM)	SURFACE
57	2	1	1.4985	4325.51	21695.10	0.0246	0.93466	0.09795	C.

---ABLATION RATES---

9 PRIME	8 PRIME G	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.19567	0.00000	0.004475	0.000000	0.013798	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN) / (IN/SEC)	CHAR (0.02)	PYROLYSIS (0.98)
0.0015328/0.0004972	0.0015328/0.0004884	0.0015328/0.0004884

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	4.271+002	0.000+000	3.557+001	1.136+002	3.054+003
TOTAL	1.712+003	0.000+000	5.863+001	6.714+002	2.325+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR-FACE
RATE	0.000+000	0.000+000	2.200+000	9.031+002	9.475+005
TOTAL	0.000+000	0.000+000	4.675+000	2.321+003	3.784-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	3030.75	108.000	986.25	9	2	2155.42	108.000	509.69
2	2	2945.28	108.000	945.65	10	2	2050.55	108.000	551.44
3	2	2863.10	108.000	906.61	11	2	1922.60	108.000	501.55
4	2	2761.93	108.000	860.96	12	2	1808.76	108.000	457.16
5	2	2668.59	108.000	819.00	13	2	1737.40	108.000	429.33
6	2	2561.12	108.000	770.64	14	2	1598.78	108.000	414.27
7	2	2428.26	108.000	711.65	15	2	1590.35	108.000	410.98
8	2	2284.67	108.000	550.62					

SANDIA ABLATION PROGRAM (VERSION TWO).

ALRM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

19.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
66	2	1	1.4979	4216.88	20825.86	0.0292	0.03465	0.13992	C*

---ABLATION RATES---

B PRIME	B PRIME O	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.19569	0.00000	0.005322	0.000000	0.019634	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN) / (IN/SEC)	CHAR (0.02)	PYROLYSIS (0.98)
0.0020719/0.0005914	0.0020719/0.0005809	0.0020719/0.0005809

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	4.799+002	0.000+000	5.959+001	1.287+002	5.492-009
TOTAL	2.169+003	0.000+000	1.068+002	7.933+002	2.856+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	3.209+000	5.439+002	7.117-009
TOTAL	0.000+000	0.000+000	6.816+000	2.849+003	4.466-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	3433.42	108.000	1177.91	9	2	2415.80	108.000	706.35
2	2	3338.30	108.000	1132.33	10	2	2288.87	108.000	652.41
3	2	3246.43	108.000	1088.70	11	2	2134.26	108.000	586.70
4	2	3132.02	108.000	1034.35	12	2	1997.64	108.000	530.82
5	2	3025.36	108.000	983.69	13	2	1912.90	108.000	497.77
6	2	2900.85	108.000	924.54	14	2	1867.36	108.000	480.01
7	2	2744.83	108.000	853.31	15	2	1857.59	108.000	476.15
8	2	2572.64	108.000	775.83					

SANDIA ABLATION PROGRAM (VERSION TWO)

ALPH HEATER +20 DEGREE REENTRY RANDOMTUMBLE SPIN

20.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
74	2	1	1.4973	4127.26	19150.81	0.0344	0.93466	0.19683	C.

---ABLATION RATES---

B PRIME	B PRIME G	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.19594	0.00000	0.006275	0.000000	0.024363	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN) / (IN/SEC)	CHAR (0.02)	PYROLYSIS (0.98)
0.0027095/0.0006972	0.0027095/0.0006838	0.0027095/0.0006838

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	5.173+002	0.000+000	9.149+001	1.447+002	5.708+002
TOTAL	2.671+003	0.000+000	1.836+002	9.310+002	3.419+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	4.366+000	5.664+002	7.783-005
TOTAL	0.000+000	0.000+000	1.065+001	3.408+003	5.213-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	3807.05	108.000	1357.93	9	2	2590.05	108.000	828.66
2	2	3706.19	108.000	1308.81	10	2	2541.45	108.000	761.79
3	2	3608.19	108.000	1260.53	11	2	2358.87	108.000	682.16
4	2	3485.42	108.000	1202.21	12	2	2197.82	108.000	613.71
5	2	3370.34	108.000	1147.55	13	2	2097.95	108.000	571.27
6	2	3235.30	108.000	1083.41	14	2	2044.52	108.000	549.10
7	2	3063.43	108.000	1001.77	15	2	2033.21	108.000	544.69
8	2	2369.70	108.000	909.79					

SANDIA ABLATION PROGRAM (VERSION TWO)

ALAH HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

21.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
B1	3	1	1.4965	4033.15	17197.58	0.0398	0.93381	0.26919	Co

---ABLATION RATES---

B PRIME	B PRIME G	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.19923	0.00000	0.007383	0.000000	0.031052	0.000000

---RECESSIONS/RECESSION RATES---

(IN) / (IN/SEC)

SURFACE	CHAR (0.02)	PYROLYSIS (0.99)
0.0034582/0.0008203	0.0034582/0.0008027	0.0034582/0.0008027

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	5.245+002	0.000+000	1.264+002	1.589+002	5.575+002
TOTAL	3.193+003	0.000+000	2.948+002	1.084+003	3.982+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	5.602+000	5.518+002	8.477-005
TOTAL	0.000+000	0.000+000	1.570+001	3.966+003	6.829-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	4114.03	108.000	1509.88	9	2	2961.62	108.000	953.41
2	2	4015.00	108.000	1460.87	10	2	2798.03	108.000	877.25
3	2	3917.94	108.000	1412.82	11	2	2591.84	108.000	784.47
4	2	3794.60	108.000	1351.76	12	2	2496.65	108.000	702.47
5	2	3677.34	108.000	1293.72	13	2	2291.68	108.000	653.60
6	2	3538.41	108.000	1227.38	14	2	2230.29	108.000	627.51
7	2	3359.76	108.000	1142.52	15	2	2217.48	108.000	622.07
8	2	3155.58	108.000	1045.54					

SANDIA ABLATION PROGRAM (VERSION TWO)

ALRM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

21.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
R1	3	1	1.4969	4033.15	17197.58	0.0398	0.93381	0.26917	C.

---ABLATION RATES---

B PRIME	B PRIME G	M.DOT CHAR (LB/SQ FT-SEC)	M.DOT GAS	M.CHAR (LB/ORIG SQ FT)	M.GAS
0.19923	0.00000	0.007383	0.000000	0.031087	0.000000

---RECESSIONS/RECESSION RATES---

(IN) / (IN/SEC)

SURFACE	CHAR (0.02)	PYROLYSIS (0.99)
0.0034582/0.0008203	0.0034582/0.0008027	0.0034582/0.0008027

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	5.249+002	0.000+000	1.264+002	1.589+002	5.575+009
TOTAL	3.193+003	0.000+000	2.948+002	1.084+003	3.982+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	5.602+000	5.518+002	8.477-009
TOTAL	0.000+000	0.000+000	1.570+001	3.966+003	6.020-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	4114.03	108.000	1509.88	9	2	2961.62	108.000	953.41
2	2	4015.00	108.000	1460.87	10	2	2798.03	108.000	877.25
3	2	3917.94	108.000	1412.82	11	2	2591.84	108.000	784.47
4	2	3794.60	108.000	1351.76	12	2	2406.65	108.000	702.47
5	2	3677.34	108.000	1293.72	13	2	2291.05	108.000	653.60
6	2	3538.41	108.000	1227.39	14	2	2230.29	108.000	627.51
7	2	3359.76	108.000	1142.52	15	2	2217.48	108.000	622.07
8	2	3155.58	108.000	1045.94					

SANDIA ABLATION PROGRAM (VERSION TWO)

ALRM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

22.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
87	2	1	1.4957	3937.48	14750.17	0.0448	0.93368	0.34973	C.

---ABLATION RATES---

B PRIME	B PRIME.0	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.19934	0.00000	0.008301	0.000000	0.038833	0.000000

---RECESSIONS/RECESSION RATES---

(IN) / (IN/SEC)

SURFACE	CHAR (0.02)	PYROLYSIS (0.98)
0.0043211/0.0009223	0.0043211/0.0009053	0.0043211/0.0009053

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	4.841+002	0.000+000	1.546+002	1.718+002	5.016+002
TOTAL	3.694+003	0.000+000	4.381+002	1.250+003	4.507+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	4.472+000	4.951+002	9.197-009
TOTAL	0.000+000	0.000+000	2.187+001	4.485+003	4.915-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	4317.78	108.000	1910.74	9	2	3200.76	108.000	1071.27
2	2	4228.00	108.000	1566.30	10	2	3040.69	108.000	990.97
3	2	4139.39	108.000	1522.44	11	2	2922.16	108.000	888.11
4	2	4025.26	108.000	1465.94	12	2	2520.06	108.000	797.17
5	2	3915.30	108.000	1411.52	13	2	2491.44	108.000	739.29
6	2	3782.80	108.000	1343.93	14	2	2422.40	108.000	709.16
7	2	3608.79	108.000	1260.82	15	2	2408.25	108.000	703.16
8	2	3406.03	108.000	1164.80					

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ALAH HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

23.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
90	2	1	1.4947	3852.12	11966.43	0.0480	0.93400	0.41655	0.

---ABLATION RATES---

B PRIME	B PRIME G	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS (LB/SQ FT-SEC)	M CHAR (LB/ORIG SQ FT)	M GAS (LB/ORIG SQ FT)
0.19935	0.00000	0.008906	0.000000	0.047304	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN)/(IN/SEC)	CHAR (0.02) (IN)/(IN/SEC)	PYROLYSIS (0.98) (IN)/(IN/SEC)
0.0052654/0.0009895	0.0052654/0.0009845	0.0052654/0.0009845

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	3.898+002	0.000+000	1.650+002	1.793+002	4.043+002
TOTAL	4.115+003	0.000+000	6.003+002	1.426+003	4.942+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	6.645+000	3.979+002	9.794-005
TOTAL	0.000+000	0.000+000	2.843+001	4.913+003	7.869-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	4385.69	108.000	1544.36	9	2	3409.92	108.000	1160.35
2	2	4312.53	108.000	1508.14	10	2	3247.27	108.000	1089.09
3	2	4239.58	108.000	1572.03	11	2	3031.87	108.000	986.78
4	2	4143.02	108.000	1524.63	12	2	2925.89	108.000	849.79
5	2	4049.95	108.000	1478.16	13	2	2591.84	108.000	829.47
6	2	3934.99	108.000	1421.26	14	2	2518.57	108.000	796.59
7	2	3780.27	108.000	1344.67	15	2	2603.74	108.000	789.82
8	2	3594.63	108.000	1254.09					

SANDIA ABLATION PROGRAM (VERSION TWO)

ALRM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

24.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
91	2	1	1.4937	3723.68	9142.74	0.0491	0.93376	0.45653	C.

---ABLATION RATES---

B PRIME	B PRIME G	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.19935	0.00000	0.009099	0.000000	0.056172	0.000000

---RECESSIONS/RECESSION RATES---

SURFACE (IN)	CHAR (0.02) (IN/SEC)	PYROLYSIS (0.98)
0.0062550/0.0010110	0.0062550/0.0009895	0.0062550/0.0009895

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	2.635+002	0.000+000	1.541+002	1.804+002	2.898+002
TOTAL	4.377+003	0.000+000	7.538+002	1.606+003	5.231+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	6.987+000	2.842+002	1.008-004
TOTAL	0.000+000	0.000+000	3.499+001	5.197+003	8.874-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	4314.19	108.000	1508.97	9	2	3333.41	108.000	1295.01
2	2	4260.97	108.000	1382.67	10	2	3389.87	108.000	1156.83
3	2	4207.19	108.000	1556.00	11	2	3195.72	108.000	1064.61
4	2	4134.26	108.000	1520.20	12	2	3003.42	108.000	973.76
5	2	4062.41	108.000	1484.33	13	2	2975.34	108.000	912.43
6	2	3971.96	108.000	1439.56	14	2	2904.73	108.000	880.29
7	2	3847.03	108.000	1377.72	15	2	2790.67	108.000	873.94
8	2	3692.35	108.000	1301.15					

SANDIA ABLATION PROGRAM (VERSION TWO)

ALRM HEATER -20 DEGREE REENTRY RANDOMTUMBLE SPIN

25.0000 SECONDS

TIME STEP	SURF ITER	PROB OPTN	SURFACE RAD (IN)	H WALL (BTU/LB)	H EDGE (BTU/LB)	HEAT COEFF (LB/SQ FT-SEC)	CH/CHO	PRESSURE (ATM)	SURFACE
94	2	1	1.4928	3769.32	6876.37	0.0461	0.93150	0.43082	C*

---ABLATION RATES---

B PRIME	B PRIME Q	M DOT CHAR (LB/SQ FT-SEC)	M DOT GAS	M CHAR (LB/ORIG SQ FT)	M GAS
0.19934	0.00000	0.008352	0.000000	0.063053	0.000000

---RECESSIONS/RECESSION RATES---

(IN) / (IN/SEC)

SURFACE	CHAR (0.02)	PYROLYSIS (0.99)
0.0072462/0.0009503	0.0072462/0.0009649	0.0072462/0.0009649

---SURFACE ENERGY FLUX TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	CONVECTED IN	RADIATED IN	RADIATED OUT	CHEMICAL GENERATION	CONDUCTION AWAY
RATE	1.433+002	0.000+000	1.300+002	1.709+002	1.784+002
TOTAL	4.556+003	0.000+000	8.952+002	1.779+003	5.441+003

---INTERIOR ENERGY TERMS---

CURRENT RATES (BTU/SQ FT SURFACE-SEC)
AND INTEGRATED VALUES (BTU/ORIG SQ FT)

	PYROL GAS PICK UP	DECOMP ABSORPTION	CONVECTION WITH SOLIDS	STORAGE IN SOLID	LOSS AT REAR FACE
RATE	0.000+000	0.000+000	4.640+000	1.740+002	1.130-004
TOTAL	0.000+000	0.000+000	4.024+001	5.402+003	7.970-004

NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)	NODE	MAT	TEMP (DEG R)	DENSITY (LB/CUFT)	ENTHALPY (BTU/LB)
1	2	4187.34	108.000	1546.17	9	2	3616.57	108.000	1264.51
2	2	4153.78	108.000	1529.56	10	2	3496.71	108.000	1207.58
3	2	4119.13	108.000	1512.41	11	2	3330.12	108.000	1128.44
4	2	4070.71	108.000	1488.44	12	2	3158.65	108.000	1047.00
5	2	4020.59	108.000	1463.63	13	2	3040.84	108.000	991.04
6	2	3956.19	108.000	1431.75	14	2	2974.57	108.000	959.56
7	2	3863.90	108.000	1386.07	15	2	2961.63	108.000	953.41
8	2	3744.69	108.000	1327.06					

APPENDIX C

Sample CINDA Computer Run

1. Sample CINDA Input
2. Sample CINDA Output

APPENDIX C-1
Sample CINDA Input

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BCD $THERMAL LPCS
BCD 9MOUND ALSEP HEATER 3-D THERMAL MODEL  P.CO
BCD 9 -6.25 DEGREE REENTRY  CROSSWISE STABLE
END
BCD $NODE DATA
REM GRAPHITE NODES ARE  NO. 1-228,253-264,AND 277-336
REM INSULATION NODES ARE NO. 229-252,AND 265-276
REM TITANIUM NODES ARE NOS. 337-366
REM PT-10RH NODES ARE  NOS. 367-378
REM TA-10W  NODES ARE  NOS. 379-402
REM FUEL    NODES ARE  NOS. 403-426
GEN 1,336,1,.350,,1.0,1.0,1.0,1.0 $GENERATE GRAPHITE AND INSULATION NODES
GEN 337,30,1,.350,,1.0,1.0,1.0,1.0 $GENERATE TITANIUM NODES
GEN 367,12,1,.350,,1.0,1.0,1.0,1.0 $GENERATE PT-10RH NODES
GEN 379,24,1,.350,,1.0,1.0,1.0,1.0 $GENERATE TA-10W NODES
GEN 403,24,1,.350,,1.0,1.0,1.0,1.0 $GENERATE FUEL NODES
    -500,-60,,0,        $ SPACE BOUNDARY NODE
END
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RELATIVE NODE NUMBERS			ACTUAL NODE NUMBERS									
1	THRU	10	1	2	3	4	5	6	7	8	9	10
11	THRU	20	11	12	13	14	15	16	17	18	19	20
21	THRU	30	21	22	23	24	25	26	27	28	29	30
31	THRU	40	31	32	33	34	35	36	37	38	39	40
41	THRU	50	41	42	43	44	45	46	47	48	49	50
51	THRU	60	51	52	53	54	55	56	57	58	59	60
61	THRU	70	61	62	63	64	65	66	67	68	69	70
71	THRU	80	71	72	73	74	75	76	77	78	79	80
81	THRU	90	81	82	83	84	85	86	87	88	89	90
91	THRU	100	91	92	93	94	95	96	97	98	99	100
101	THRU	110	101	102	103	104	105	106	107	108	109	110
111	THRU	120	111	112	113	114	115	116	117	118	119	120
121	THRU	130	121	122	123	124	125	126	127	128	129	130
131	THRU	140	131	132	133	134	135	136	137	138	139	140
141	THRU	150	141	142	143	144	145	146	147	148	149	150
151	THRU	160	151	152	153	154	155	156	157	158	159	160
161	THRU	170	161	162	163	164	165	166	167	168	169	170
171	THRU	180	171	172	173	174	175	176	177	178	179	180
181	THRU	190	181	182	183	184	185	186	187	188	189	190
191	THRU	200	191	192	193	194	195	196	197	198	199	200
201	THRU	210	201	202	203	204	205	206	207	208	209	210
211	THRU	220	211	212	213	214	215	216	217	218	219	220
221	THRU	230	221	222	223	224	225	226	227	228	229	230
231	THRU	240	231	232	233	234	235	236	237	238	239	240
241	THRU	250	241	242	243	244	245	246	247	248	249	250
251	THRU	260	251	252	253	254	255	256	257	258	259	260
261	THRU	270	261	262	263	264	265	266	267	268	269	270
271	THRU	280	271	272	273	274	275	276	277	278	279	280
281	THRU	290	281	282	283	284	285	286	287	288	289	290
291	THRU	300	291	292	293	294	295	296	297	298	299	300
301	THRU	310	301	302	303	304	305	306	307	308	309	310
311	THRU	320	311	312	313	314	315	316	317	318	319	320
321	THRU	330	321	322	323	324	325	326	327	328	329	330
331	THRU	340	331	332	333	334	335	336	337	338	339	340
341	THRU	350	341	342	343	344	345	346	347	348	349	350

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351 THRU 360          351 352 353 354 355 356 357 358 359 360
361 THRU 370          361 362 363 364 365 366 367 368 369 370
371 THRU 380          371 372 373 374 375 376 377 378 379 380
381 THRU 390          381 382 383 384 385 386 387 388 389 390
391 THRU 400          391 392 393 394 395 396 397 398 399 400
401 THRU 410          401 402 403 404 405 406 407 408 409 410
411 THRU 420          411 412 413 414 415 416 417 418 419 420
421 THRU 427          421 422 423 424 425 426 500
RCD )CONDUCTOR DATA
REM GRAPHITE CONDUCTOR ARE NOS. 1-513,526-544,561-642,725-759
REM AND 783-885
GEN 1,11,1,1,1,2,1,0,1,0,1,0,1,0      $THETA
GEN 12,12,1,1,1,37,1,1,0,1,0,1,0,1,0  $R
GEN 24,12,1,1,1,13,1,1,0,1,0,1,0,1,0  $Z
GEN 36,11,1,13,1,19,1,1,0,1,0,1,0,1,0 $THETA
GEN 47,12,1,13,1,49,1,1,0,1,0,1,0,1,0 $R
GEN 59,12,1,13,1,25,1,1,0,1,0,1,0,1,0 $Z
GEN 71,11,1,25,1,26,1,1,0,1,0,1,0,1,0 $THETA
GEN 82,12,1,25,1,73,1,1,0,1,0,1,0,1,0 $R
GEN 94,11,1,37,1,38,1,1,0,1,0,1,0,1,0 $THETA
GEN 105,12,1,37,1,85,1,1,0,1,0,1,0,1,0 $R
GEN 117,12,1,37,1,49,1,1,0,1,0,1,0,1,0 $Z
GEN 129,11,1,49,1,50,1,1,0,1,0,1,0,1,0      $THETA
GEN 140,12,1,49,1,97,1,1,0,1,0,1,0,1,0      $R
GEN 152,12,1,49,1,109,1,1,0,1,0,1,0,1,0     $Z
GEN 164,12,1,49,1,61,1,1,0,1,0,1,0,1,0      $Z
GEN 176,11,1,61,1,62,1,1,0,1,0,1,0,1,0      $THETA
GEN 187,12,1,61,1,121,1,1,0,1,0,1,0,1,0     $Z
GEN 199,12,1,61,1,73,1,1,0,1,0,1,0,1,0      $Z
GEN 211,11,1,73,1,74,1,1,0,1,0,1,0,1,0      $THETA
GEN 222,12,1,73,1,325,1,1,0,1,0,1,0,1,0     $R
GEN 234,11,1,85,1,86,1,1,0,1,0,1,0,1,0      $THETA
GEN 245,12,1,85,1,133,1,1,0,1,0,1,0,1,0     $Z
GEN 257,12,1,85,1,97,1,1,0,1,0,1,0,1,0      $Z
GEN 269,11,1,97,1,98,1,1,0,1,0,1,0,1,0      $THETA
GEN 280,12,1,97,1,145,1,1,0,1,0,1,0,1,0     $R
GEN 292,12,1,97,1,157,1,1,0,1,0,1,0,1,0     $R
GEN 304,12,1,97,1,109,1,1,0,1,0,1,0,1,0     $Z
GEN 316,11,1,121,1,122,1,1,0,1,0,1,0,1,0    $THETA
GEN 327,12,1,121,1,313,1,1,0,1,0,1,0,1,0    $R
GEN 339,12,1,121,1,73,1,1,0,1,0,1,0,1,0     $Z
GEN 351,11,1,133,1,134,1,1,0,1,0,1,0,1,0    $THETA
GEN 362,12,1,133,1,181,1,1,0,1,0,1,0,1,0    $R
GEN 374,12,1,133,1,145,1,1,0,1,0,1,0,1,0    $Z
GEN 386,11,1,145,1,146,1,1,0,1,0,1,0,1,0    $THETA
GEN 397,12,1,145,1,193,1,1,0,1,0,1,0,1,0    $R
GEN 409,12,1,145,1,205,1,1,0,1,0,1,0,1,0    $R
GEN 421,12,1,145,1,157,1,1,0,1,0,1,0,1,0    $Z
GEN 433,11,1,157,1,158,1,1,0,1,0,1,0,1,0    $THETA
GEN 444,12,1,157,1,217,1,1,0,1,0,1,0,1,0    $R
GEN 456,12,1,157,1,169,1,1,0,1,0,1,0,1,0    $Z
GEN 468,11,1,169,1,170,1,1,0,1,0,1,0,1,0    $THETA
GEN 479,12,1,169,1,301,1,1,0,1,0,1,0,1,0    $R
GEN 491,12,1,169,1,121,1,1,0,1,0,1,0,1,0    $Z
GEN 503,11,1,181,1,182,1,1,0,1,0,1,0,1,0    $THETA
REM INSULATION CONDUCTOR ARE NOS.514-525,545-560,643-724,760-782
REM AND 914-925,948-957
GEN 514,12,1,101,1,229,1,1,0,1,0,1,0,1,0    $Z
GEN 526,12,1,101,1,193,1,1,0,1,0,1,0,1,0    $Z
GEN 538,11,1,193,1,194,1,1,0,1,0,1,0,1,0    $THETA
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GEN 561,12,1,193,1,205,1,1.0,1.0,1.0,1.0      $W
GEN 573,11,1,205,1,206,1,1.0,1.0,1.0,1.0      $Z
GEN 584,12,1,205,1,253,1,1.0,1.0,1.0,1.0      $THETA
GEN 596,12,1,205,1,217,1,1.0,1.0,1.0,1.0      $W
GEN 608,11,1,217,1,218,1,1.0,1.0,1.0,1.0      $Z
GEN 619,12,1,217,1,289,1,1.0,1.0,1.0,1.0      $THETA
GEN 631,12,1,217,1,169,1,1.0,1.0,1.0,1.0      $W
GEN 643,11,1,229,1,230,1,1.0,1.0,1.0,1.0      $Z
GEN 654,6,1,229,2,337,1,1.0,1.0,1.0,1.0       $THETA
GEN 660,6,1,230,2,337,1,1.0,1.0,1.0,1.0       $W
GEN 666,6,1,229,2,343,1,1.0,1.0,1.0,1.0       $W
GEN 672,6,1,230,2,343,1,1.0,1.0,1.0,1.0       $W
GEN 678,12,1,229,1,241,1,1.0,1.0,1.0,1.0      $Z
GEN 690,11,1,241,1,242,1,1.0,1.0,1.0,1.0      $THETA
GEN 701,12,1,241,1,265,1,1.0,1.0,1.0,1.0      $W
GEN 713,12,1,241,1,253,1,1.0,1.0,1.0,1.0      $Z
GEN 725,11,1,253,1,254,1,1.0,1.0,1.0,1.0      $THETA
GEN 736,12,1,253,1,277,1,1.0,1.0,1.0,1.0      $W
GEN 748,12,1,253,1,217,1,1.0,1.0,1.0,1.0      $Z
GEN 760,11,1,265,1,266,1,1.0,1.0,1.0,1.0      $THETA
GEN 771,12,1,265,1,277,1,1.0,1.0,1.0,1.0      $Z
GEN 783,12,1,277,1,289,1,1.0,1.0,1.0,1.0      $Z
GEN 795,36,1,289,1,301,1,1.0,1.0,1.0,1.0      $Z
GEN 831,11,1,277,1,278,1,1.0,1.0,1.0,1.0      $THETA
GEN 842,11,1,289,1,290,1,1.0,1.0,1.0,1.0      $THETA
GEN 853,11,1,301,1,302,1,1.0,1.0,1.0,1.0      $THETA
GEN 864,11,1,313,1,314,1,1.0,1.0,1.0,1.0      $THETA
GEN 875,11,1,325,1,326,1,1.0,1.0,1.0,1.0      $THETA
REM TITANIUM CONDUCTORS ARE NOS. 886-913,924-947,AND 960- 970
GEN 886,5,1,337,1,338,1,1.0,1.0,1.0,1.0       $THETA
GEN 891,6,1,337,1,349,1,1.0,1.0,1.0,1.0       $W
GEN 897,6,1,337,1,343,1,1.0,1.0,1.0,1.0       $Z
GEN 903,5,1,343,1,344,1,1.0,1.0,1.0,1.0       $THETA
GEN 909,6,1,343,1,355,1,1.0,1.0,1.0,1.0       $Z
GEN 914,6,1,343,1,265,2,1.0,1.0,1.0,1.0       $Z
GEN 920,6,1,343,1,266,2,1.0,1.0,1.0,1.0       $Z
GEN 926,5,1,349,1,350,1,1.0,1.0,1.0,1.0       $THETA
GEN 931,6,1,349,1,361,1,1.0,1.0,1.0,1.0       $W
GEN 937,6,1,349,1,355,1,1.0,1.0,1.0,1.0       $Z
GEN 943,5,1,355,1,356,1,1.0,1.0,1.0,1.0       $THETA
GEN 948,6,1,355,1,265,2,1.0,1.0,1.0,1.0       $Z
GEN 954,6,1,355,1,266,2,1.0,1.0,1.0,1.0       $Z
GEN 960,5,1,361,1,362,1,1.0,1.0,1.0,1.0       $THETA
GEN 965,6,1,361,1,355,1,1.0,1.0,1.0,1.0       $Z
REM PT-IRIDIUM CONDUCTORS  NOS. 971-975, AND 1047-1071
GEN 971,5,1,367,1,368,1,1.0,1.0,1.0,1.0       $THETA
REM ARGON CONDUCTORS ARE NOS. 976-981,987-992,1050-1055,1061-1066
GEN 976,6,1,367,1,379,1,1.0,1.0,1.0,1.0       $W
GEN 982,5,1,379,1,380,1,1.0,1.0,1.0,1.0       $THETA
GEN 987,6,1,379,1,391,1,1.0,1.0,1.0,1.0       $W
GEN 993,5,1,391,1,392,1,1.0,1.0,1.0,1.0       $THETA
GEN 998,6,1,391,1,403,1,1.0,1.0,1.0,1.0       $W
GEN 1004,6,1,391,1,404,1,1.0,1.0,1.0,1.0      $W
GEN 1010,5,1,403,1,404,1,1.0,1.0,1.0,1.0      $THETA
GEN 1015,6,1,403,1,415,1,1.0,1.0,1.0,1.0      $Z
GEN 1021,6,1,403,1,409,1,1.0,1.0,1.0,1.0      $Z
GEN 1027,5,1,409,1,410,1,1.0,1.0,1.0,1.0      $THETA
GEN 1032,6,1,409,1,421,1,1.0,1.0,1.0,1.0      $W
GEN 1038,6,1,409,1,397,1,1.0,1.0,1.0,1.0      $Z
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GEN 1044,5,1,397,1,398,1,1,0,1,0,1,0,1,0   $THETA
GEN 1049,6,1,397,1,385,1,1,0,1,0,1,0,1,0   $Z
GEN 1055,5,1,385,1,386,1,1,0,1,0,1,0,1,0   $THETA
REM TA-10W CONDUCTORS ARE NOS.982-986,993-997,1044-1048,1055-1059
REM FULL CONDUCTORS ARE NOS. 990-1043,AND 1071-1092
GEN 1060,6,1,385,1,373,1,1,0,1,0,1,0,1,0   $Z
GEN 1066,5,1,373,1,374,1,1,0,1,0,1,0,1,0   $THETA
GEN 1071,5,1,415,1,416,1,1,0,1,0,1,0,1,0   $THETA
GEN 1076,6,1,415,1,421,1,1,0,1,0,1,0,1,0   $Z
GEN 1082,5,1,421,1,422,1,1,0,1,0,1,0,1,0   $THETA
GEN 1087,6,1,421,1,397,1,1,0,1,0,1,0,1,0   $Z
REM ADDITIONAL GRAPHITE CONDUCTORS 1093-1139
GEN 1093,11,1,109,1,119,1,1,0,1,0,1,0,1,0  $THETA
GEN 1104,12,1,109,1,169,1,1,0,1,0,1,0,1,0  $R
GEN 1116,12,1,109,1,121,1,1,0,1,0,1,0,1,0  $Z
GEN 1128,12,1,13,1,61,1,1,0,1,0,1,0,1,0$R
REM RADIATION CONDUCTORS ARE NOS 1140-1235
REM RADIATORS TO SPACE ARE 1190-1199
GEN -1140,36,1,1,1,500,0,1,0,1,0,1,0,1,0   $R-RADIATOR TO SPACE
GEN -1176,12,1,73,1,508,0,1,0,1,0,1,0,1,0  $Z-RADIATORS TO SPACE
GEN -1188,12,1,325,1,509,0,1,0,1,0,1,0,1,0 $Z-RADIATORS TO SPACE
REM INTERNAL RADIATION CONDUCTORS ARE NOS 1200-1235
GEN -1200,6,1,399,1,367,1,1,0,1,0,1,0,1,0  $R
GEN -1206,6,1,373,1,361,1,1,0,1,0,1,0,1,0  $Z
GEN -1212,6,1,367,1,379,1,1,0,1,0,1,0,1,0  $R
GEN -1218,6,1,385,1,373,1,1,0,1,0,1,0,1,0  $Z
GEN -1224,6,1,379,1,391,1,1,0,1,0,1,0,1,0  $R
GEN -1230,6,1,397,1,385,1,1,0,1,0,1,0,1,0  $Z
END
```

RELATIVE CONDUCTOR NUMBERS			ACTUAL CONDUCTOR NUMBERS									
1	THRU	10	1	2	3	4	5	6	7	8	9	10
11	THRU	20	11	12	13	14	15	16	17	18	19	20
21	THRU	30	21	22	23	24	25	26	27	28	29	30
31	THRU	40	31	32	33	34	35	36	37	38	39	40
41	THRU	50	41	42	43	44	45	46	47	48	49	50
51	THRU	60	51	52	53	54	55	56	57	58	59	60
61	THRU	70	61	62	63	64	65	66	67	68	69	70
71	THRU	80	71	72	73	74	75	76	77	78	79	80
81	THRU	90	81	82	83	84	85	86	87	88	89	90
91	THRU	100	91	92	93	94	95	96	97	98	99	100
101	THRU	110	101	102	103	104	105	106	107	108	109	110
111	THRU	120	111	112	113	114	115	116	117	118	119	120
121	THRU	130	121	122	123	124	125	126	127	128	129	130
131	THRU	140	131	132	133	134	135	136	137	138	139	140
141	THRU	150	141	142	143	144	145	146	147	148	149	150
151	THRU	160	151	152	153	154	155	156	157	158	159	160
161	THRU	170	161	162	163	164	165	166	167	168	169	170
171	THRU	180	171	172	173	174	175	176	177	178	179	180
181	THRU	190	181	182	183	184	185	186	187	188	189	190
191	THRU	200	191	192	193	194	195	196	197	198	199	200
201	THRU	210	201	202	203	204	205	206	207	208	209	210
211	THRU	220	211	212	213	214	215	216	217	218	219	220
221	THRU	230	221	222	223	224	225	226	227	228	229	230
231	THRU	240	231	232	233	234	235	236	237	238	239	240
241	THRU	250	241	242	243	244	245	246	247	248	249	250
251	THRU	260	251	252	253	254	255	256	257	258	259	260
261	THRU	270	261	262	263	264	265	266	267	268	269	270
271	THRU	280	271	272	273	274	275	276	277	278	279	280

281 THRU 290 281 282 [illegible]

281	THRU	290	281	282	283	284	285	286	287	288	289	290
291	THRU	300	291	292	293	294	295	296	297	298	299	300
301	THRU	310	301	302	303	304	305	306	307	308	309	310
311	THRU	320	311	312	313	314	315	316	317	318	319	320
321	THRU	330	321	322	323	324	325	326	327	328	329	330
331	THRU	340	331	332	333	334	335	336	337	338	339	340
341	THRU	350	341	342	343	344	345	346	347	348	349	350
351	THRU	360	351	352	353	354	355	356	357	358	359	360
361	THRU	370	361	362	363	364	365	366	367	368	369	370
371	THRU	380	371	372	373	374	375	376	377	378	379	380
381	THRU	390	381	382	383	384	385	386	387	388	389	390
391	THRU	400	391	392	393	394	395	396	397	398	399	400
401	THRU	410	401	402	403	404	405	406	407	408	409	410
411	THRU	420	411	412	413	414	415	416	417	418	419	420
421	THRU	430	421	422	423	424	425	426	427	428	429	430
431	THRU	440	431	432	433	434	435	436	437	438	439	440
441	THRU	450	441	442	443	444	445	446	447	448	449	450
451	THRU	460	451	452	453	454	455	456	457	458	459	460
461	THRU	470	461	462	463	464	465	466	467	468	469	470
471	THRU	480	471	472	473	474	475	476	477	478	479	480
481	THRU	490	481	482	483	484	485	486	487	488	489	490
491	THRU	500	491	492	493	494	495	496	497	498	499	500
501	THRU	510	501	502	503	504	505	506	507	508	509	510
511	THRU	520	511	512	513	514	515	516	517	518	519	520
521	THRU	530	521	522	523	524	525	526	527	528	529	530
531	THRU	540	531	532	533	534	535	536	537	538	539	540
541	THRU	550	541	542	543	544	545	546	547	548	549	550
551	THRU	560	551	552	553	554	555	556	557	558	559	560
561	THRU	570	561	562	563	564	565	566	567	568	569	570
571	THRU	580	571	572	573	574	575	576	577	578	579	580
581	THRU	590	581	582	583	584	585	586	587	588	589	590
591	THRU	600	591	592	593	594	595	596	597	598	599	600
601	THRU	610	601	602	603	604	605	606	607	608	609	610
611	THRU	620	611	612	613	614	615	616	617	618	619	620
621	THRU	630	621	622	623	624	625	626	627	628	629	630
631	THRU	640	631	632	633	634	635	636	637	638	639	640
641	THRU	650	641	642	643	644	645	646	647	648	649	650
651	THRU	660	651	652	653	654	655	656	657	658	659	660
661	THRU	670	661	662	663	664	665	666	667	668	669	670
671	THRU	680	671	672	673	674	675	676	677	678	679	680
681	THRU	690	681	682	683	684	685	686	687	688	689	690
691	THRU	700	691	692	693	694	695	696	697	698	699	700
701	THRU	710	701	702	703	704	705	706	707	708	709	710
711	THRU	720	711	712	713	714	715	716	717	718	719	720
721	THRU	730	721	722	723	724	725	726	727	728	729	730
731	THRU	740	731	732	733	734	735	736	737	738	739	740
741	THRU	750	741	742	743	744	745	746	747	748	749	750
751	THRU	760	751	752	753	754	755	756	757	758	759	760
761	THRU	770	761	762	763	764	765	766	767	768	769	770
771	THRU	780	771	772	773	774	775	776	777	778	779	780
781	THRU	790	781	782	783	784	785	786	787	788	789	790
791	THRU	800	791	792	793	794	795	796	797	798	799	800
801	THRU	810	801	802	803	804	805	806	807	808	809	810
811	THRU	820	811	812	813	814	815	816	817	818	819	820
821	THRU	830	821	822	823	824	825	826	827	828	829	830
831	THRU	840	831	832	833	834	835	836	837	838	839	840
841	THRU	850	841	842	843	844	845	846	847	848	849	850
851	THRU	860	851	852	853	854	855	856	857	858	859	860
861	THRU	870	861	862	863	864	865	866	867	868	869	870
871	THRU	880	871	872	873	874	875	876	877	878	879	880

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881  THRU  890        881  882  883  884  885  886  887  888  889  890
891  THRU  900        891  892  893  894  895  896  897  898  899  900
901  THRU  910        901  902  903  904  905  906  907  908  909  910
911  THRU  920        911  912  913  914  915  916  917  918  919  920
921  THRU  930        921  922  923  924  925  926  927  928  929  930
931  THRU  940        931  932  933  934  935  936  937  938  939  940
941  THRU  950        941  942  943  944  945  946  947  948  949  950
951  THRU  960        951  952  953  954  955  956  957  958  959  960
961  THRU  970        961  962  963  964  965  966  967  968  969  970
971  THRU  980        971  972  973  974  975  976  977  978  979  980
981  THRU  990        981  982  983  984  985  986  987  988  989  990
991  THRU  1000       991  992  993  994  995  996  997  998  999  1000
1001 THRU  1010       1001 1002 1003 1004 1005 1006 1007 1008 1009 1010
1011 THRU  1020       1011 1012 1013 1014 1015 1016 1017 1018 1019 1020
1021 THRU  1030       1021 1022 1023 1024 1025 1026 1027 1028 1029 1030
1031 THRU  1040       1031 1032 1033 1034 1035 1036 1037 1038 1039 1040
1041 THRU  1050       1041 1042 1043 1044 1045 1046 1047 1048 1049 1050
1051 THRU  1060       1051 1052 1053 1054 1055 1056 1057 1058 1059 1060
1061 THRU  1070       1061 1062 1063 1064 1065 1066 1067 1068 1069 1070
1071 THRU  1080       1071 1072 1073 1074 1075 1076 1077 1078 1079 1080
1081 THRU  1090       1081 1082 1083 1084 1085 1086 1087 1088 1089 1090
1091 THRU  1100       1091 1092 1093 1094 1095 1096 1097 1098 1099 1100
1101 THRU  1110       1101 1102 1103 1104 1105 1106 1107 1108 1109 1110
1111 THRU  1120       1111 1112 1113 1114 1115 1116 1117 1118 1119 1120
1121 THRU  1130       1121 1122 1123 1124 1125 1126 1127 1128 1129 1130
1131 THRU  1140       1131 1132 1133 1134 1135 1136 1137 1138 1139 1140
1141 THRU  1150       1141 1142 1143 1144 1145 1146 1147 1148 1149 1150
1151 THRU  1160       1151 1152 1153 1154 1155 1156 1157 1158 1159 1160
1161 THRU  1170       1161 1162 1163 1164 1165 1166 1167 1168 1169 1170
1171 THRU  1180       1171 1172 1173 1174 1175 1176 1177 1178 1179 1180
1181 THRU  1190       1181 1182 1183 1184 1185 1186 1187 1188 1189 1190
1191 THRU  1200       1191 1192 1193 1194 1195 1196 1197 1198 1199 1200
1201 THRU  1210       1201 1202 1203 1204 1205 1206 1207 1208 1209 1210
1211 THRU  1220       1211 1212 1213 1214 1215 1216 1217 1218 1219 1220
1221 THRU  1230       1221 1222 1223 1224 1225 1226 1227 1228 1229 1230
1231 THRU  1235       1231 1232 1233 1234 1235
DEC )CONSTANTS DATA
    :TIMEND,200.0:JMELL,0.1,OUTPUT,5.0
    :TIMED,20.0
    ARLRCA,1.0,VLOOP,500.,ARLRCA,5.0,DTIMEH,1.
    1,0.0,  2,0.0,  3,0.0,  4,0.0,  5,0.0,  6,0.0
    7,0.0,  8,0.0,  9,0.0,  10,0.0,  11,0.0,  12,0.0
    13,0.0,  14,0.0,  15,0.0,  16,0.0,  17,0.0,  18,0.0
    19,0.0,  20,0.0,  21,0.0,  22,0.0,  23,0.0,  24,0.0
    25,0.0,  26,0.0,  27,0.0,  28,0.0,  29,0.0,  30,0.0
    31,0.0,  32,0.0,  33,0.0,  34,0.0,  35,0.0,  36,0.0
    40,CAPCTY,51,CONDCT,52,HEATS LABELING CONSTANTS
    73,0.0,  74,0.0,  75,0.0,  76,0.0,  77,0.0,  78,0.0
    79,0.0,  80,0.0,  81,0.0,  82,0.0,  83,0.0,  84,0.0
    325,0.0,  326,0.0,  327,0.0,  328,0.0,  329,0.0,  330,0.0
    331,0.0,  332,0.0,  333,0.0,  334,0.0,  335,0.0,  336,0.0
END
DEC )ARRAY DATA
HLM POCO  CP VS T BTU/LB-F
    1
    0.,0.15,500.,0.29,1000.,0.37,2000.,0.45,3000.,0.53
    4000.,0.55,5000.,0.59,END $POCO CP
HLM POCO K VS T  BTU/HR-FT-F   ALL DIRECTIONS
    2
    0.,77.,500.,51.,1000.,37.,1500.,27.,2000.,21.,2500.,18.
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REM POCO K VS T   BTU/HR-FT-F    ALL DIRECTIONS
    3
    0.,72.,500.,51.,1000.,37.,1500.,27.,2000.,21.,2500.,18.
    3000.,17.,ENDSPOCO K
REM TITANIUM CP VS T   BTU/LB-F
    4
    0.,0.12,900.,0.138,800.,0.148,1500.,0.165,2000.,0.15
    2600.,0.18,3600.,0.27,END
REM TITANIUM K VS T   BTU/HR-FT-F
    5
    0.,13.6,170.,12.0,600.,10.8,1000.,10.0,1500.,9.6,END
REM USE ATJ CP FOR INSULATION CP
REM INSULATION K VS T   BTU/HR-FT-F
    6
    80.,0.014,590.,0.0194,1040.,0.027,1590.,0.037,2040.,0.053
    2590.,0.077,3040.,0.116,END
REM PT-10RH CP VS T   (USE PURE PT)   BTU/LB-F
    7
    0.,0.031,1500.,0.0365,3000.,0.042,END
REM PT-10RH K VS T    (USE PURE PT) BTU/HR-FT-F
    8
    0.,41.2,500.,40.4,2000.,38.4,3000.,36.9,END
REM TA-10W K VS T (USE PURE TA)   BTU/HR-FT-F
    9
    0.,18.0,800.,24.0,2400.,32.0,4000.,37.,4800.,39.,END
REM TA-10W CP VS T   (PURE TA) BTU/LB-F
    10
    0.,0.035,3000.,0.04,5000.,0.05,END
REM FUEL CP VS T   BTU/LB-F
    11
    0.0,0.063,5000.,0.063,END
REM FUEL K VS T    BTU/HR-FT-F
    12
    0.,0.46,1000.,0.46,1200.,0.52,1400.,0.58,1600.,0.68
    1700.,0.75,END
REM GRAPHITE (ATJ) EMISSIVITY VS TEMP
    13
    0.,0.7,400.,0.73,800.,0.79,1200.,0.81,2000.,0.86
    3200.,0.90,4000.,0.93,6000.,0.96,END
REM TITANIUM EMISSIVITY VS TEMP (UNOXIDIZED)
    14
    0.,0.3, 1500.,0.34, 2000.,0.4,END
REM PT-10RH EMISSIVITY VS T
    15
    40.,0.02,1740.,0.17,3334.,0.23,END
REM TA-10W EMISSIVITY VS T
    16
    0.,0.333,5000.,0.333,END
REM TTA CONVECTIVE COLD WALL INPUT
REM CHA CORRECTED INPUT MUST BE SCALED TO 1 FT RADIUS IN EXECUTION
REM -6.25 DEGREE REENTRY TTA HEATING
    17
    28.0,0.0,0.28,4.,73.1,30.,85.8,35.,127.5,40.,189.4,45.,259.3
    50.,331.6,55.,404.3,60.,468.4,65.,512.5,70.,531.4,75.,524.3
    80.,467.9,85.,430.0,90.,362.6,95.,293.3,100.,229.0
    110.,128.2,120.,65.5,130.,30.7,140.,13.5,150.,5.0,160.,2.2
    170.,0.9,200.,0.1,ENDS -6.25 REENTRY
REM VELOCITY VS TIME   N MUST GO IN EXECUTION.
    18
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     25000.,25000.,ENDSVELOCITY SINGLET ARRAY;SAMPLE NEED TIMEALSO
REM ,ALL ENTHALPY VS TEMP  BTU/LB
     19
     -460.,0.0,0.0,100.,1000.,360.,2000.,650.,5000.,1320.,
     6000.,1800.,7000.,3510.,END
REM DTIME1 ARRAY
     20
     0.0,0.2,150.,0.2,150.01,0.5,ENDSDTIME1 FOR 6,25
REM OUTPUT ARRAY
     21
     0.0,5.0,100.,5.0,100.01,10.0,ENDSOUTPUT FOR 6-25
REM GRAPHITE NODE WEIGHTS  NODE 1-336 SCALED BY E-4
     22
     17.,15.,2.3,2.0,19.,3.3,11.,18.,9.7,3.0,11.,16.,5.9,2.7,7.6
     15.,3.,2.5,4.9,0.9,0.2,0.4,2.4,5.2,5.1,5.1,5.1,4.1,END
REM TITANIUM NODE WEIGHTS  NODES337-366 SCALED BY E-4
     23
     42.,8.8,34.,19.,11.,END
REM 1A-1UN NODE WEIGHTS   NODES 379-402 SCALED BY E-4
     24
     12.,5.5,11.,9.7,END
REM FUEL NODE WEIGHTS    NODES 403,426 SCALED BY E-4
     25
     21.,21.,7.2,7.2,END
REM ARGON K VS T  BTU/HR-FT-F
     26
     0.,0.0088,530.,0.0169,800.,0.0199, 1390.,0.0296,3190.,0.09
     4390.,0.068,END
REM HEATING MULTIPLIERS FOR EXTERNAL NODES
REM  HEATING RATIOS FU (INCLUDING RADIUS EFFECT)
     27  SNODES 1-12    PUT MULTIPLIER FU ONLY,AREA SCALED IN EXECUTION
     2.06,1.86,1.52,1.06,0.601,0.286,0.172,0.119,0.072,0.043
     0.029,0.020,ENDSNODES 1-12
     28  SNODES 13-24
     2.35,2.17,1.72,1.20,0.658,0.315,0.20,0.143,0.086,0.043
     0.029,0.020,ENDSNODES13-24
     29  SNODES 25-36
     1.52,1.32,1.03,0.715,0.43,0.172,0.157,0.166,0.165,0.143
     0.123,0.097,ENDSNODES 25-36
     30  SNODES 73-84
     0.252,0.232,0.203,0.183,0.172,0.192,0.194,0.20,0.215,0.212
     0.174,0.160,ENDSNODES 73-84
     31  SNODES 325-336
     0.240,0.237,0.232,0.229,0.226,0.223,0.215,0.209,0.203
     0.197,0.192,0.186,ENDSNODES 325-336
REM A LABEL ARRAY
     32
     LOOPCT,END
END
NCO 3LEXECUTION
DIMENSION X(2000)                                                    F
NDIM = 2000                                                          F
NIM  = 0                                                             F
     SCLDEP(A2,2.31E-5) $SCALE K TO BTU/SEC-IN-F
     SCLDEP(A3,2.31E-5)
     SCLDEP(A5,2.31E-5)
     SCLDEP(A6,2.31E-5)
     SCLDEP(A8,2.31E-5)
     SCLDEP(A9,2.31E-5)
     SCLDEP(A12,2.31E-5)
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      ARYDIV(2,A18+1,50063.,A18+1) $A18 IS NOW STAG ENTHALPY
      ARYADD(2,A18+1,1(0.,A18+1)   $A18 IS NOW  STAG + LOCAL ENTHAL
      ARYMPY(28,A22+1,0.0001,A22+1)$SCALE GRAPHITE NODE HEIGHTS
      ARYMPY(5,A23+1,0.0001,A23+1) $SCALE TITANIUM NODE HEIGHTS
      ARYMPY(9,A24+1,0.0001,A24+1) $SCALE TA-10W NODE HEIGHTS
      ARYMPY(9,A25+1,0.0001,A25+1) $SCALE FUEL NODES
      SCLDEP(A26,2,3)E-5)          $SCALE ARGON K
      ARYMPY(12,A27+1,0.00193,A27+1)$SCALE FQ BY NODE AREA SQ FT ND
      ARYMPY(12,A28+1,0.00174,A28+1)$NODES 13-24
      ARYMPY(12,A29+1,0.00052,A29+1)$NODES 25-36
      ARYMPY(12,A30+1,0.00124,A30+1)$NODES 73-84
      ARYMPY(12,A31+1,0.00096,A31+1)$NODES 325-336
REM   IF CMA HEATING OUTPUT IS USED AS INPUT, THEN A17 NEEDS TO BE
REM   SCALED BACK TO A 1 FT. RADIUS SINCE FQ SCALES IT DOWN TO THE
REM   PROPER RADIUS.  FOR ITA REFERENCE HEAT INPUT THIS SCALE FACTO
REM   IS NOT REQUIRED
      ENDBOK
END
BCD   DVARIABLES 1
      DIDEG1(TIMEN,A20,DTIME1)
      DIDEG1(TIMEN,A21,OUTPUT)
REM   THE FOLLOWING CARDS EVALUATE THERMAL CAPACITANCE
      DAVID1(336,12,T1,A1,A22+1,C1)$NODES 1-336,INSULATION CP IS SA
      DAVID1(30,6,T337,A4,A23+1,C337)$NODES 337-336     TITANIUM
      DIDI(MT6,T367,A7,0.00089,C367) $NODES 367-372     PT-10RH
      DIDI(MT6,T373,A7,0.00039,C373) $NODES 373-378     PT-10RH
      DAVID1(24,6,T379,A10,A24+1,C379)  $NODES 379-402 TA-10W
      DAVID1(24,6,T403,A11,A25+1,C403)  $NODES 403-426 FUEL
REM   THE FOLLOWING CARDS EVALUATE LINEAR CONDUCTORS
REM   THETA CONDUCTORS   (HIGH K IS A3)
      DAVID2(1,T1,T2,A3,0.195,G1)       $CONDUCTORS 1-11
      DAVID2(1,T13,T14,A3,0.176,G36)    $CONDUCTORS 36-46
      DAVID2(1,T25,T26,A3,0.027,G71)    $CONDUCTORS 71-81
      DAVID2(1,T37,T38,A3,0.265,G94)    $CONDUCTORS 94-104
      DAVID2(1,T49,T50,A3,0.193,G129)   $CONDUCTORS 129-139
      DAVID2(1,T61,T62,A3,0.0458,G176)  $CONDUCTORS 176-186
      DAVID2(1,T73,T74,A3,0.235,G211)   $CONDUCTORS 211-221
      DAVID2(1,T85,T86,A3,0.294,G234)   $CONDUCTORS 234-244
      DAVID2(1,T97,T98,A3,0.163,G269)   $CONDUCTORS 269-279
      DAVID2(1,T121,T122,A3,0.262,G316)$CONDUCTORS 316-326
      DAVID2(1,T133,T134,A3,0.328,G351)$CONDUCTORS 351-361
      DAVID2(1,T145,T146,A3,0.125,G386)$CONDUCTORS 386-396
      DAVID2(1,T157,T158,A3,0.057,G433)$CONDUCTORS 433-443
      DAVID2(1,T169,T170,A3,0.214,G468)$CONDUCTORS 468-478
      DAVID2(1,T181,T182,A3,0.395,G503)$CONDUCTORS 503-513
      DAVID2(1,T193,T194,A3,0.082,G538)$CONDUCTORS 538-548
      DAVID2(1,T205,T206,A3,0.069,G573)$CONDUCTORS 573-583
      DAVID2(1,T217,T218,A3,0.159,G608)$CONDUCTORS 608-618
      DAVID2(1,T229,T230,A6,0.530,G643)$CONDUCTORS 643-653 INSULAT
      DAVID2(1,T241,T242,A6,0.110,G690)$CONDUCTORS 690-700 INSULAT
      DAVID2(1,T253,T254,A3,0.092,G725)$CONDUCTORS 725-735
      DAVID2(1,T265,T266,A6,1.15,G760) $CONDUCTORS 760-770  INSULA
      DAVID2(1,T277,T278,A3,0.764,G831)$CONDUCTORS 831-841
      DAVID2(1,T289,T290,A3,0.764,G842)$CONDUCTORS 842-852
      DAVID2(1,T301,T302,A3,0.764,G853)$CONDUCTORS 853-863
      DAVID2(1,T313,T314,A3,0.764,G864)$CONDUCTORS 864-874
      DAVID2(1,T325,T326,A3,0.611,G875)$CONDUCTORS 875-885
      DAVID2(5,T337,T338,A5,0.213,G886) $CONDUCTORS 886-890    TITAN
      DAVID2(5,T343,T344,A5,0.044,G903) $CONDUCTORS 903-907    TITAN
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DAVID2(5,T349,T350,A5,0.276,G926) $CONDUCTORS 926-930    TITAN
DAVID2(5,T355,T356,A5,0.460,G943) $CONDUCTORS 943-947    TITAN
DAVID2(5,T361,T362,A5,0.497,G960) $CONDUCTORS 960-964    TITAN
DAVID2(5,T367,T368,A8,0.020,G971) $CONDUCTORS 971-975    PT-R
DAVID2(5,T379,T380,A9,0.042,G982) $CONDUCTORS 982-986    TA-R
DAVID2(5,T391,T392,A9,0.040,G993) $CONDUCTORS 993-997    TA-R
DAVID2(5,T403,T404,A12,0.357,G1010)$CONDUCTORS 1010-1014  FU
DAVID2(5,T409,T410,A12,0.357,G1027)$CONDUCTORS 1027-1031  FU
DAVID2(5,T397,T398,A9,0.1530,G1044)$CONDUCTORS 1044-1048  TA
DAVID2(5,T385,T386,A9,0.080,G1055) $CONDUCTORS 1055-1059  TA
DAVID2(5,T373,T374,A8,0.090,G1066) $CONDUCTORS 1066-1070  PT
DAVID2(5,T415,T416,A12,0.71,G1071)$CONDUCTORS 1071-1075
DAVID2(5,T421,T422,A12,0.71,G1082) $CONDUCTORS 1082-1086  FU
DAVID2(11,T109,T110,A3,0.05,G1093) $CONDUCTORS 1093-1103
REM 4 CONDUCTORS  (HIGH K)
DAVID2(12,T1,T37,A3,2.29,G12)      $CONDUCTORS 12-23
DAVID2(12,T13,T49,A3,1.98,G47)     $CONDUCTORS 47-50
DAVID2(12,T25,T73,A3,0.075,G82)    $CONDUCTORS 82-93
DAVID2(12,T37,T85,A3,1.80,G105)    $CONDUCTORS 105-116
DAVID2(12,T49,T97,A3,0.91,G140)    $CONDUCTORS 140-151
DAVID2(12,T49,T109,A3,0.176,G152)  $CONDUCTORS 152-163
DAVID2(12,T61,T121,A3,0.111,G187)  $CONDUCTORS 187-198
DAVID2(12,T73,T325,A3,0.025,G222)  $CONDUCTORS 222-233
DAVID2(12,T85,T133,A3,1.690,G245)  $CONDUCTORS 245-256
DAVID2(12,T97,T145,A3,0.577,G280)  $CONDUCTORS 280-291
DAVID2(12,T97,T157,A3,0.192,G297)  $CONDUCTORS 292-303
DAVID2(12,T121,T313,A3,0.033,G327)$CONDUCTORS 327-338
DAVID2(12,T133,T181,A3,1.136,G362)$CONDUCTORS 362-373
DAVID2(12,T145,T193,A3,0.204,G397)$CONDUCTORS 397-404
DAVID2(12,T145,T205,A3,0.219,G409)$CONDUCTORS 409-420
DAVID2(12,T157,T217,A3,0.152,G444)$CONDUCTORS 444-455
DAVID2(12,T169,T301,A3,0.035,G479)$CONDUCTORS 479-490
DAVID2(12,T181,T229,A6,2.07, G514)$CONDUCTORS 514-525 INSULAT
DAVID2(12,T193,T241,A6,0.304,G549)$CONDUCTORS 549-560 INSULAT
DAVID2(12,T205,T253,A3,0.199,G584)$CONDUCTORS 584-595
DAVID2(12,T217,T289,A3,0.037,G619)$CONDUCTORS 619-630
DIDIIM16,T337,A6,1.56,G654)        $CONDUCTORS 654-659  INSULA
DIDIIM16,T337,A6,1.56,G660)        $CONDUCTORS 660-665  INSULA
DIDIIM16,T343,A6,0.067,G666)       $CONDUCTORS 666-671  INSULA
DIDIIM16,T343,A6,0.067,G672)       $CONDUCTORS 672-677  INSULA
DAVID2(12,T241,T265,A6,0.050,G701)$CONDUCTORS 701-712  INSULA
DAVID2(12,T253,T277,A3,0.042,G736)$CONDUCTORS 736-747
DAVID2(6,T337,T349,A5,1.204,G891)$CONDUCTORS 891-896  TITANI
DAVID2(6,T343,T355,A5,0.080,G900)$CONDUCTORS 908-913  TITANI
DAVID2(6,T349,T361,A5,0.056,G931) $CONDUCTORS 931-936  TITANI
DAVID2(6,T367,T379,A26,20.5,G976) $CONDUCTORS 976-981  ARGON
DAVID2(6,T379,T391,A26,18.2,G987) $CONDUCTORS 987-992  ARGON
DAVID2(6,T391,T403,A12,0.312,G998)$CONDUCTORS 998-1003 FUEL
DAVID2(6,T391,T409,A12,0.312,G1004)$CONDUCTORS 1004-1009  FU
DAVID2(6,T403,T415,A12,0.090,G1015)$CONDUCTORS 1015-1020  FU
DAVID2(6,T409,T421,A12,0.161,G1032)$CONDUCTORS 1032-1037  FU
DAVID2(12,T109,T169,A3,0.169,G1104)$CONDUCTORS 1104-1115
REM 2 CONDUCTORS  (LOW K)  ARRAY 2
DAVID2(12,T1,T13,A2,0.054,G24)     $CONDUCTORS 24-35
DAVID2(12,T13,T25,A2,0.099,G59)    $CONDUCTORS 59-70
DAVID2(12,T37,T49,A2,0.068,G117)   $CONDUCTORS 117-128
DAVID2(12,T49,T61,A2,0.139,G164)   $CONDUCTORS 164-175
DAVID2(12,T61,T73,A2,0.132,G199)$CONDUCTORS 199-210
DAVID2(12,T85,T97,A2,0.069,G257)   $CONDUCTORS 257-268
DAVID2(12,T97,T109,A2,0.146,G304)  $CONDUCTORS 304-315
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DAVID2(12,T121,T73,A2,1.165,G339)   $CONDUCTORS   339-350
DAVID2(12,T133,T145,A2,0.070,G374)$CONDUCTORS   374-385
DAVID2(12,T145,T157,A2,0.168,G421)$CONDUCTORS   421-432
DAVID2(12,T157,T169,A2,0.185,G456)$CONDUCTORS   456-467
DAVID2(12,T169,T121,A2,0.367,G491)$CONDUCTORS   491-502
DAVID2(12,T181,T193,A2,0.074,G526)$CONDUCTORS   526-537
DAVID2(12,T193,T205,A2,0.233,G561)$CONDUCTORS   561-572
DAVID2(12,T205,T217,A2,0.197,G596)$CONDUCTORS   576-607
DAVID2(12,T217,T169,A2,0.465,G631)$CONDUCTORS   631-642
DAVID2(12,T229,T241,A6,0.071,G678)$CONDUCTORS   678-689 INSUL
DIDIIM(12,T241,A6,0.37,G713)        $CONDUCTORS   713-724 INSUL
DAVID2(12,T253,T217,A2,0.088,G748)$CONDUCTORS   748-759
DIDIIM(12,T265,A6,0.874,G771)       $CONDUCTORS   771-782 INSUL
DAVID2(12,T277,T209,A2,0.406,G783)$CONDUCTORS   783-794
DAVID2(34,T289,T301,A2,0.525,G795)$CONDUCTORS   795-830
DAVID2(6,T337,T343,A5,0.113,G897)  $CONDUCTORS   897-902 TITAN
DAVID4(11,2,T265,A6,0.067,G914)     $CONDUCTORS   914-919 INSUL
DAVID4(12,2,T266,A6,0.067,G920)     $CONDUCTORS   920-925 INSUL
DAVID2(6,T349,T355,A5,0.076,G937)  $CONDUCTORS   937-942 TITAN
DAVID4(11,2,T265,A6,0.592,G948)     $CONDUCTORS   948-953 INSUL
DAVID4(12,2,T266,A6,0.592,G954)     $CONDUCTORS   954-959 INSUL
DAVID2(6,T361,T355,A5,0.327,G965)  $CONDUCTORS   965-970 TITAN
DAVID2(6,T403,T409,A12,0.161,G1021)$CONDUCTORS 1021-1026 FUEL
DAVID2(6,T409,T397,A12,0.269,G1038)$CONDUCTORS 1038-1043 FUEL
DAVID2(6,T397,T385,A26,0.91,G1049) $CONDUCTORS 1049-1054 ARGO
DAVID2(6,T385,T373,A26,0.91,G1060) $CONDUCTORS 1060-1065 ARGO
DAVID2(6,T415,T421,A12,0.054,G1071)$CONDUCTORS 1076-1081 FUEL
DAVID2(6,T421,T397,A12,0.195,G1087)$CONDUCTORS 1087-1092 FUEL
DAVID2(12,T109,T121,A2,0.159,G1116)$CONDUCTORS 1116-1127
DAVID2(12,T13,T61,A3,0.103,G1128)$CONDUCTORS 1128-1139
REM THE FOLLOWING CARDS EVALUATE RADIATION CONDUCTORS
REM RADIATION TO SPACE
DIDIIM(12,T1,A13,9.18E-16,G1140)    $CONDUCTORS 1140-1151
DIDIIM(12,T13,A13,8.25E-16,G1152)   $CONDUCTORS 1152-1163
DIDIIM(12,T25,A13,2.49E-16,G1164)   $CONDUCTORS 1164-1175
DIDIIM(12,T73,A13,5.89E-16,G1176)   $CONDUCTORS 1176-1187
DIDIIM(12,T325,A13,2.17E-16,G1188)$CONDUCTORS 1188-1199
REM INTERNAL RADIATION CONDUCTORS
DAVID5(6,T367,A15,0.110,1.0,T349,A14,0.112,3.305E-15,G1200)
DAVID5(6,T361,A14,0.052,1.0,T373,A15,0.052,3.305E-15,G1206)
DAVID5(6,T367,A15,0.102,1.0,T379,A16,0.102,3.305E-15,G1212)
DAVID5(6,T385,A16,0.050,1.0,T373,A15,0.050,3.305E-15,G1218)
DAVID5(6,T391,A16,0.070,1.0,T379,A16,0.068,3.305E-15,G1224)
DAVID5(6,T397,A16,0.070,1.0,T385,A16,0.070,3.305E-15,G1230)
REM THE FOLLOWING CARD APPLYS INTERNAL GENERATION  BTU/SEC
STFS05(0.00015,24,9403)
REM THE FOLLOWING CARDS INPUT THE AEROHEATING
REM THESE CARDS ARE FOR CHA HEATING, IF NO HOT WALL CORRECTION RE
DAVID6(12,TIMEN,A17,A27+1,9113)$HEATING TO NODES 1-12
DAVID6(12,TIMEN,A17,A28+1,9133)    $NODES 13-24
DAVID6(12,TIMEN,A17,A29+1,9253)    $NODES 25-36
DAVID6(12,TIMEN,A17,A30+1,9273)    $NODES 73-84
DAVID6(12,TIMEN,A17,A31+1,9325)    $NODES 325-336
END
BCD 3VARIABLES 2
END
BCD 3OUTPUT CALLS
PRINTC(A32+1,LOOPCT)
PRNT.UP
END
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APPENDIX C-2

Sample CINDA Output

Loopct is the number of iterations required to relax the nodal network for the previous timestep.

Time is the time in seconds.

Nodal numbers are the two columns of numbers on the left of the page.

Nodal temperatures, in degrees Fahrenheit, are the columns of numbers immediately following the nodal numbers.

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - CODOMS (FORTRAN V VERSION)

MOUNO ALSEP HEATER 3-D THERMAL MODEL POCO =6.25 DEGREE REENTRY CROSSWISE STABLE

LOUPCT 1.00000+00

TIME	2.00000+01	DTIMEU	0.00000	CSGMINI	01	0.00000	DIMPCCI	01	0.00000	ARLXCCI	01	0.00000
1	THRU	5	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
6	THRU	10	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
11	THRU	15	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
16	THRU	20	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
21	THRU	25	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
26	THRU	30	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
31	THRU	35	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
36	THRU	40	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
41	THRU	45	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
46	THRU	50	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
51	THRU	55	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
56	THRU	60	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
61	THRU	65	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
66	THRU	70	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
71	THRU	75	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
76	THRU	80	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
81	THRU	85	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
86	THRU	90	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
91	THRU	95	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
96	THRU	100	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
101	THRU	105	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
106	THRU	110	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
111	THRU	115	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
116	THRU	120	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
121	THRU	125	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
126	THRU	130	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
131	THRU	135	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
136	THRU	140	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
141	THRU	145	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
146	THRU	150	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
151	THRU	155	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
156	THRU	160	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
161	THRU	165	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
166	THRU	170	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
171	THRU	175	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
176	THRU	180	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
181	THRU	185	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
186	THRU	190	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
191	THRU	195	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
196	THRU	200	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
201	THRU	205	3.500000+02	3.500000+02			3.500000+02			3.500000+02		
206	THRU	210	3.500000+02	3.500000+02			3.500000+02			3.500000+02		

137P

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - CODUNS (FORTRAN V VERSION)

ROUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

211	THRU	215	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
216	THRU	220	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
221	THRU	225	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
226	THRU	230	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
231	THRU	235	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
236	THRU	240	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
241	THRU	245	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
246	THRU	250	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
251	THRU	255	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
256	THRU	260	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
261	THRU	265	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
266	THRU	270	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
271	THRU	275	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
276	THRU	280	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
281	THRU	285	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
286	THRU	290	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
291	THRU	295	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
296	THRU	300	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
301	THRU	305	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
306	THRU	310	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
311	THRU	315	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
316	THRU	320	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
321	THRU	325	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
326	THRU	330	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
331	THRU	335	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
336	THRU	340	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
341	THRU	345	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
346	THRU	350	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
351	THRU	355	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
356	THRU	360	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
361	THRU	365	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
366	THRU	370	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
371	THRU	375	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
376	THRU	380	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
381	THRU	385	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
386	THRU	390	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
391	THRU	395	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
396	THRU	400	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
401	THRU	405	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
406	THRU	410	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
411	THRU	415	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
416	THRU	420	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
421	THRU	425	3.500000+02	3.500000+02	3.500000+02	3.500000+02	3.500000+02
426	THRU	427	3.500000+02	-6.000000+01			

LONPCT 4.00000+00

TIME 3.30000+01 DTIMEU 1.00000-01 CSGRINI 471 1.66634-02 DTMPCCI 251 2.31052-01 ANLXCCI 371 3.68805-01

1 THRU 5 1.376748+03 1.282766+03 1.119734+03 9.208021+02 7.336905+02

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - CODD45 (FORTRAN V VERSION)

HOUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

6	THRU	10	5.940821+02	5.104657+02	4.590585+02	4.262593+02	4.035924+02
11	THRU	15	3.905284+02	3.841252+02	1.437109+03	1.340675+03	1.153755+03
16	THRU	20	9.304330+02	7.377610+02	5.961626+02	5.194840+02	4.746948+02
21	THRU	25	4.437766+02	4.219188+02	4.092336+02	4.024965+02	1.663465+03
26	THRU	30	1.513003+03	1.273791+03	1.015024+03	7.887902+02	6.209510+02
31	THRU	35	5.515497+02	5.164379+02	4.914184+02	4.687474+02	4.518441+02
36	THRU	40	4.392698+02	1.200467+03	1.129572+03	1.002831+03	8.467801+02
41	THRU	45	6.954638+02	5.774166+02	5.015656+02	4.536821+02	4.231023+02
46	THRU	50	4.018183+02	3.894753+02	3.835346+02	1.163982+03	1.099499+03
51	THRU	55	9.744995+02	8.251231+02	6.791906+02	5.691112+02	5.032958+02
56	THRU	60	4.635426+02	4.364084+02	4.175966+02	4.062188+02	4.003193+02
61	THRU	65	9.958410+02	9.485269+02	8.593571+02	7.505250+02	6.420125+02
66	THRU	70	5.575657+02	5.041591+02	4.710580+02	4.486800+02	4.325223+02
71	THRU	75	4.215713+02	4.151315+02	8.514408+02	8.177565+02	7.575069+02
76	THRU	80	6.844353+02	6.118634+02	5.538295+02	5.135823+02	4.876020+02
81	THRU	85	4.705693+02	4.548845+02	4.455692+02	4.372799+02	1.026166+03
86	THRU	90	9.751411+02	8.831565+02	7.669651+02	6.498132+02	5.539371+02
91	THRU	95	4.881821+02	4.452235+02	4.168776+02	3.981465+02	3.869816+02
96	THRU	100	3.816435+02	9.723643+02	9.275256+02	8.928371+02	7.370132+02
101	THRU	105	6.301880+02	5.448613+02	4.890180+02	4.536128+02	4.296252+02
106	THRU	110	4.132137+02	4.030553+02	3.979061+02	9.004758+02	8.628619+02
111	THRU	115	7.918450+02	7.028248+02	6.125757+02	5.396093+02	4.907241+02
116	THRU	120	4.592937+02	4.379447+02	4.229652+02	4.131267+02	4.077736+02
121	THRU	125	8.149923+02	7.050619+02	7.306937+02	6.633031+02	5.954218+02
126	THRU	130	5.365861+02	5.000334+02	4.739325+02	4.563722+02	4.431573+02
131	THRU	135	4.331061+02	4.264355+02	9.197784+02	8.602350+02	8.077676+02
136	THRU	140	7.147861+02	6.189979+02	5.377962+02	4.792409+02	4.397520+02
141	THRU	145	4.133057+02	3.959586+02	3.855249+02	3.805633+02	8.572813+02
146	THRU	150	8.236472+02	7.404328+02	6.798396+02	5.969682+02	5.277524+02
151	THRU	155	4.791181+02	4.467892+02	4.247981+02	4.098699+02	4.005915+02
156	THRU	160	3.959666+02	8.280980+02	7.898415+02	7.331368+02	6.608376+02
161	THRU	165	5.863835+02	5.238182+02	4.793699+02	4.495681+02	4.271926+02
166	THRU	170	4.152020+02	4.062491+02	4.016656+02	7.656846+02	7.402756+02
171	THRU	175	6.933310+02	6.337143+02	5.723381+02	5.199703+02	4.815239+02
176	THRU	180	4.551701+02	4.370400+02	4.242634+02	4.156112+02	4.108853+02
181	THRU	185	8.502024+02	8.174652+02	7.570553+02	6.790006+02	5.974938+02
186	THRU	190	5.264643+02	4.731712+02	4.361682+02	4.110851+02	3.996130+02
191	THRU	195	3.846640+02	3.799506+02	7.899612+02	7.624246+02	7.111091+02
196	THRU	200	6.450854+02	5.763368+02	5.168515+02	4.727013+02	4.421200+02
201	THRU	205	4.211421+02	4.070096+02	3.982042+02	3.938949+02	7.663082+02
206	THRU	210	7.408861+02	6.935355+02	6.326731+02	5.692704+02	5.192806+02
211	THRU	215	4.732791+02	4.447139+02	4.249917+02	4.115745+02	4.031045+02
216	THRU	220	3.986942+02	7.403167+02	7.171251+02	6.741710+02	6.191671+02
221	THRU	225	5.619899+02	5.122765+02	4.749295+02	4.487596+02	4.306044+02
226	THRU	230	4.180408+02	4.098446+02	4.056162+02	3.908408+02	3.877809+02
231	THRU	235	3.872503+02	3.753162+02	3.682988+02	3.624507+02	3.582991+02
236	THRU	240	3.555609+02	3.537890+02	3.526644+02	3.520062+02	3.516880+02
241	THRU	245	3.946624+02	3.917146+02	3.862809+02	3.793824+02	3.723185+02
246	THRU	250	3.663454+02	3.620201+02	3.591017+02	3.571466+02	3.558452+02

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - CODD45 (FORTRAN V VERSION)

MOUNT ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

241	THRU	255	3.550268+02	3.546192+02	7.158275+02	6.999828+02	6.569040+02
256	THRU	260	6.047401+02	5.546225+02	5.063079+02	4.723724+02	4.469884+02
261	THRU	265	4.282998+02	4.158299+02	4.079008+02	4.039698+02	3.518030+02
266	THRU	270	3.517468+02	3.516424+02	3.515047+02	3.513522+02	3.512029+02
271	THRU	275	3.510495+02	3.509582+02	3.508709+02	3.508059+02	3.507628+02
276	THRU	280	3.507913+02	5.139611+02	5.093202+02	5.006113+02	4.490197+02
281	THRU	285	4.759428+02	4.628773+02	4.508499+02	4.405229+02	4.321867+02
286	THRU	290	4.259303+02	4.217370+02	4.196420+02	5.186521+02	5.139262+02
291	THRU	295	5.051052+02	4.933703+02	4.802037+02	4.670449+02	4.649931+02
296	THRU	300	4.446617+02	4.363149+02	4.300401+02	4.258162+02	4.236974+02
301	THRU	305	5.263804+02	5.215357+02	5.125064+02	5.005153+02	4.871072+02
306	THRU	310	4.737727+02	4.615755+02	4.511746+02	4.427523+02	4.363904+02
311	THRU	315	4.320990+02	4.299324+02	5.385235+02	5.334835+02	5.291278+02
316	THRU	320	5.117632+02	4.979798+02	4.843378+02	4.719147+02	4.612946+02
321	THRU	325	4.526849+02	4.441334+02	4.416352+02	4.393140+02	5.647715+02
326	THRU	330	5.495018+02	5.397675+02	5.269775+02	5.128123+02	4.987699+02
331	THRU	335	4.858934+02	4.798770+02	4.650987+02	4.589546+02	4.541572+02
336	THRU	340	4.515926+02	3.500049+02	3.500041+02	3.500045+02	3.500153+02
341	THRU	345	3.500046+02	3.500034+02	3.500359+02	3.500260+02	3.500144+02
346	THRU	350	3.500045+02	3.500028+02	3.500015+02	3.500340+02	3.500290+02
351	THRU	355	3.500159+02	3.500071+02	3.500030+02	3.500014+02	3.500071+02
356	THRU	360	3.500057+02	3.500038+02	3.500023+02	3.500015+02	3.500011+02
361	THRU	365	3.500042+02	3.500033+02	3.500021+02	3.500011+02	3.500006+02
366	THRU	370	3.500003+02	3.500757+02	3.500756+02	3.500756+02	3.500756+02
371	THRU	375	3.500757+02	3.500757+02	3.501220+02	3.501220+02	3.501220+02
376	THRU	380	3.501220+02	3.501220+02	3.501220+02	3.502849+02	3.502849+02
381	THRU	385	3.502849+02	3.502849+02	3.502849+02	3.502849+02	3.504810+02
386	THRU	390	3.504810+02	3.504810+02	3.504811+02	3.504810+02	3.504810+02
391	THRU	395	3.515168+02	3.515168+02	3.515168+02	3.515168+02	3.515168+02
396	THRU	400	3.515168+02	3.524256+02	3.524256+02	3.524256+02	3.524256+02
401	THRU	405	3.524264+02	3.524255+02	3.555744+02	3.555763+02	3.555763+02
406	THRU	410	3.555743+02	3.555743+02	3.555744+02	3.554936+02	3.554935+02
411	THRU	415	3.554935+02	3.554935+02	3.554935+02	3.554936+02	3.659390+02
416	THRU	420	3.659389+02	3.659389+02	3.659389+02	3.659390+02	3.659390+02
421	THRU	425	3.641944+02	3.641944+02	3.641944+02	3.641944+02	3.641944+02
426	THRU	427	3.641945+02	-6.000000+01			

LVOPCT 4.00000+00

TIME 3.80000+01 DTIMEU 1.00000-01 CSGMIN(47) 1.09875-02 DTMPCCI 25) 2.56997+01 ARLXCCI 40) 2.33566-01

1	THRU	5	2.475890+03	2.283409+03	1.944520+03	1.533857+03	1.162073+03
6	THRU	10	8.952760+02	7.355046+02	6.338073+02	5.620137+02	5.166781+02
11	THRU	15	4.855575+02	4.106739+02	2.577792+03	2.387071+03	2.000164+03
16	THRU	20	1.561858+03	1.165516+03	8.970806+02	7.497634+02	6.579624+02
21	THRU	25	5.919915+02	5.441732+02	5.158355+02	5.011303+02	2.941962+03
26	THRU	30	2.676177+03	2.210947+03	1.703356+03	1.256735+03	9.380082+02

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - COODAS (FORTRAN V VERSION)

HOUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.75 DEGREE REENTRY CROSSWISE STABLE

31	THRU	35	8.025680+02	7.262036+02	6.694196+02	6.204754+02	5.852186+02
36	THRU	40	5.610713+02	2.100126+03	1.952992+03	1.698429+03	1.384025+03
41	THRU	45	1.090670+03	8.662870+02	7.208231+02	6.235845+02	5.572518+02
46	THRU	50	5.116463+02	4.846749+02	4.701956+02	1.993791+03	1.866645+03
51	THRU	55	1.626047+03	1.334202+03	1.056891+03	8.503775+02	7.229509+02
56	THRU	60	6.396264+02	5.798964+02	5.376605+02	5.114777+02	4.981359+02
61	THRU	65	1.657032+03	1.567628+03	1.398891+03	1.193846+03	9.899375+02
66	THRU	70	8.303475+02	7.243794+02	6.525653+02	6.008980+02	5.631383+02
71	THRU	75	5.377928+02	5.236134+02	1.383922+03	1.321801+03	1.210569+03
76	THRU	80	1.073678+03	9.362636+02	8.237209+02	7.401665+02	6.807728+02
81	THRU	85	6.383681+02	6.049202+02	5.790926+02	5.618981+02	1.741450+03
86	THRU	90	1.641086+03	1.459129+03	1.233068+03	1.008652+03	8.270715+02
91	THRU	95	6.990833+02	6.099693+02	5.479175+02	5.062582+02	4.795799+02
96	THRU	100	4.666947+02	1.618149+03	1.531720+03	1.370149+03	1.170690+03
101	THRU	105	9.695548+02	8.045876+02	6.996642+02	6.239615+02	5.697020+02
106	THRU	110	5.314800+02	5.073514+02	4.952482+02	1.478526+03	1.406806+03
111	THRU	115	1.274198+03	1.107736+03	9.380476+02	8.002247+02	7.024032+02
116	THRU	120	6.337602+02	5.842081+02	5.485730+02	5.251292+02	5.127533+02
121	THRU	125	1.319957+03	1.264040+03	1.162827+03	1.036111+03	9.077251+02
126	THRU	130	7.995816+02	7.177153+02	6.584312+02	6.154412+02	5.829231+02
131	THRU	135	5.592616+02	5.450981+02	1.538864+03	1.458534+03	1.317769+03
136	THRU	140	1.138630+03	9.550897+02	8.005052+02	6.847050+02	6.013033+02
141	THRU	145	5.423292+02	5.020775+02	4.770141+02	4.648172+02	1.403137+03
146	THRU	150	1.339553+03	1.220599+03	1.068700+03	9.124495+02	7.811893+02
151	THRU	155	6.836808+02	6.135049+02	5.628451+02	5.272302+02	5.045601+02
156	THRU	160	4.933541+02	1.332629+03	1.275830+03	1.169597+03	1.033571+03
161	THRU	165	8.933996+02	7.740489+02	6.839583+02	6.184922+02	5.708787+02
166	THRU	170	5.370480+02	5.151368+02	5.040485+02	1.233266+03	1.165465+03
171	THRU	175	1.097172+03	9.044074+02	8.684310+02	7.669135+02	6.879703+02
176	THRU	180	6.203327+02	5.849127+02	5.534259+02	5.322142+02	5.207815+02
181	THRU	185	1.407622+03	1.333576+03	1.226258+03	1.075234+03	9.184675+02
186	THRU	190	7.818982+02	6.749168+02	5.956772+02	5.388874+02	4.998350+02
191	THRU	195	4.766121+02	4.639079+02	1.204278+03	1.231753+03	1.134106+03
196	THRU	200	1.008173+03	8.778254+02	7.633112+02	6.734040+02	6.069241+02
201	THRU	205	5.576941+02	5.233996+02	5.015884+02	4.908913+02	1.237080+03
206	THRU	210	1.188931+03	1.099356+03	9.837903+02	8.639644+02	7.579644+02
211	THRU	215	6.741698+02	6.113212+02	5.652323+02	5.326150+02	5.116299+02
216	THRU	220	5.012077+02	1.188505+03	1.144584+03	1.063279+03	9.589197+02
221	THRU	225	8.506690+02	7.540267+02	6.767706+02	6.183504+02	5.752220+02
226	THRU	230	5.442760+02	5.239452+02	5.135729+02	5.280928+02	5.151845+02
231	THRU	235	4.920704+02	4.634149+02	4.349592+02	4.111782+02	3.936642+02
236	THRU	240	3.819918+02	3.730873+02	3.675716+02	3.642193+02	3.626248+02
241	THRU	245	5.405300+02	5.289919+02	5.079234+02	4.619045+02	4.591760+02
246	THRU	250	4.304607+02	4.122159+02	3.989902+02	3.896051+02	3.831406+02
251	THRU	255	3.790473+02	3.770291+02	1.140816+03	1.101369+03	1.028334+03
256	THRU	260	9.342025+02	8.356870+02	7.459589+02	6.729501+02	6.157469+02
261	THRU	265	5.735016+02	5.433510+02	5.237927+02	5.140631+02	3.602515+02
266	THRU	270	3.599816+02	3.594742+02	3.580001+02	3.580348+02	3.572628+02
271	THRU	275	3.565475+02	3.559285+02	3.554243+02	3.550425+02	3.547865+02

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - CODD45 (FORTRAN V VERSION)

HOUND ALSEP HEATER 3-D THERMAL MODEL POCO +6.25 DEGREE REENTRY CROSSWISE STABLE

276	THRU	280	3.546547+02	7.727910+02	7.633319+02	7.455057+02	7.213296+02
281	THRU	285	6.936221+02	6.699941+02	6.378131+02	6.136951+02	5.936387+02
286	THRU	290	5.782179+02	5.677394+02	5.629379+02	7.802882+02	7.707569+02
291	THRU	295	7.527991+02	7.285031+02	7.005928+02	6.718825+02	6.446310+02
296	THRU	300	6.204944+02	6.004091+02	5.849931+02	5.744025+02	5.690658+02
301	THRU	305	7.926899+02	7.829891+02	7.647460+02	7.401081+02	7.118666+02
306	THRU	310	6.828739+02	6.554692+02	6.312041+02	6.109440+02	5.952923+02
311	THRU	315	5.846179+02	5.791474+02	8.125697+02	8.025402+02	7.837662+02
316	THRU	320	7.585550+02	7.297570+02	7.003052+02	6.726852+02	6.479970+02
321	THRU	325	6.273400+02	6.112320+02	6.001535+02	5.994667+02	8.400774+02
326	THRU	330	8.295974+02	8.100690+02	7.841052+02	7.545581+02	7.299519+02
331	THRU	335	6.959341+02	6.706538+02	6.492312+02	6.323781+02	6.206722+02
336	THRU	340	6.145324+02	3.506868+02	3.505295+02	3.503191+02	3.501446+02
341	THRU	345	3.500865+02	3.500548+02	3.503579+02	3.502767+02	3.501701+02
346	THRU	350	3.500923+02	3.500506+02	3.500335+02	3.509292+02	3.503327+02
351	THRU	355	3.507097+02	3.501094+02	3.500576+02	3.500362+02	3.501182+02
356	THRU	360	3.500996+02	3.500726+02	3.500492+02	3.500337+02	3.500265+02
361	THRU	365	3.500918+02	3.500782+02	3.500500+02	3.500367+02	3.500271+02
366	THRU	370	3.500210+02	3.506419+02	3.506417+02	3.506415+02	3.506413+02
371	THRU	375	3.506413+02	3.506413+02	3.510488+02	3.510488+02	3.510489+02
376	THRU	380	3.510490+02	3.510488+02	3.510487+02	3.514054+02	3.514053+02
381	THRU	385	3.514053+02	3.514053+02	3.514052+02	3.514053+02	3.523677+02
386	THRU	390	3.523678+02	3.523679+02	3.523681+02	3.523679+02	3.523678+02
391	THRU	395	3.544310+02	3.544309+02	3.544309+02	3.544309+02	3.544309+02
396	THRU	400	3.544310+02	3.570592+02	3.570593+02	3.570595+02	3.570597+02
401	THRU	405	3.570594+02	3.570592+02	3.610995+02	3.610993+02	3.610993+02
406	THRU	410	3.610993+02	3.610993+02	3.610995+02	3.608855+02	3.608854+02
411	THRU	415	3.608854+02	3.608854+02	3.608854+02	3.608855+02	3.806645+02
416	THRU	420	3.806644+02	3.806644+02	3.806644+02	3.806645+02	3.806646+02
421	THRU	425	3.752529+02	3.752529+02	3.752527+02	3.752528+02	3.752526+02
426	THRU	427	3.752529+02	6.000000+01			

LDMPC1 4.00000+00

TIME	4.30000+01	DTIMEV	1.00000-01	CSGMINI	47)	2.37132-02	DTMPCCI	14)	2.12694+01	ARLXCCI	47)	2.32559-01
1	THRU	5	3.668031+03	3.431530+03	2.967401+03	2.320988+03	1.695470+03					
6	THRU	10	1.258860+03	1.068250+03	8.539360+02	7.472919+02	6.709068+02					
11	THRU	15	6.300902+02	4.153007+02	3.786508+03	3.563509+03	3.053386+03					
16	THRU	20	2.372403+03	1.705862+03	1.264922+03	1.032983+03	8.912491+02					
21	THRU	25	7.884012+02	7.148700+02	6.711613+02	6.495773+02	4.082977+03					
26	THRU	30	3.753292+03	3.247202+03	2.576870+03	1.859496+03	1.330639+03					
31	THRU	35	1.119946+03	1.000705+03	9.111921+02	8.330247+02	7.770329+02					
36	THRU	40	7.396543+02	3.143847+03	2.940048+03	2.555552+03	2.050480+03					
41	THRU	45	1.567041+03	1.209073+03	9.035412+02	8.361881+02	7.350415+02					
46	THRU	50	6.672945+02	6.275129+02	6.207411+02	2.983157+03	2.799906+03					
51	THRU	55	2.429950+03	1.959086+03	1.511051+03	1.166049+03	9.887530+02					

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - C00045 (FORTRAN V VERSION)

HOUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

56	THRU	60	8.620249+02	7.705011+02	7.050705+02	6.647554+02	6.451611+02
61	THRU	65	2.432751+03	2.297978+03	2.034906+03	1.716244+03	1.398755+03
66	THRU	70	1.153828+03	9.911922+02	8.821506+02	8.029156+02	7.440311+02
71	THRU	75	7.043835+02	6.827801+02	1.973236+03	1.082325+03	1.719064+03
76	THRU	80	1.517033+03	1.313057+03	1.144054+03	1.017325+03	9.270793+02
81	THRU	85	8.617514+02	8.090307+02	7.680035+02	7.410032+02	2.577172+03
86	THRU	90	2.421919+03	2.140279+03	1.780298+03	1.425429+03	1.144298+03
91	THRU	95	9.486162+02	8.150498+02	7.213960+02	6.580118+02	6.214423+02
96	THRU	100	6.073605+02	2.349212+03	2.237965+03	1.986439+03	1.675826+03
101	THRU	105	1.364116+03	1.118650+03	9.510334+02	8.372774+02	7.547772+02
106	THRU	110	6.950868+02	6.588250+02	6.410314+02	2.138414+03	2.030177+03
111	THRU	115	1.829493+03	1.572214+03	1.314013+03	1.104226+03	9.556543+02
116	THRU	120	8.525287+02	7.770424+02	7.218654+02	6.854154+02	6.666395+02
121	THRU	125	1.872699+03	1.791436+03	1.643166+03	1.455942+03	1.266197+03
126	THRU	130	1.104083+03	9.809335+02	8.911651+02	8.254510+02	7.746707+02
131	THRU	135	7.373742+02	7.152489+02	2.234064+03	2.114706+03	1.895311+03
136	THRU	140	1.619294+03	1.336709+03	1.100826+03	9.255883+02	8.014931+02
141	THRU	145	7.119205+02	6.525037+02	6.173010+02	6.034764+02	2.013972+03
146	THRU	150	1.916454+03	1.738416+03	1.506126+03	1.270920+03	1.072256+03
151	THRU	155	9.253597+02	8.207372+02	7.441927+02	6.896206+02	6.549679+02
156	THRU	160	6.384256+02	1.898786+03	1.813152+03	1.654804+03	1.450351+03
161	THRU	165	1.241320+03	1.061452+03	9.261658+02	8.285148+02	7.565043+02
166	THRU	170	7.044841+02	6.706219+02	6.538465+02	1.739065+03	1.669207+03
171	THRU	175	1.539232+03	1.373831+03	1.202562+03	1.050695+03	9.318392+02
176	THRU	180	8.437193+02	7.780241+02	7.294670+02	6.969195+02	6.790271+02
181	THRU	185	2.017215+03	1.920038+03	1.743023+03	1.513579+03	1.277055+03
186	THRU	190	1.070455+03	9.098891+02	7.925614+02	7.076552+02	6.493229+02
191	THRU	195	6.146628+02	6.003236+02	1.819975+03	1.741638+03	1.596536+03
196	THRU	200	1.408823+03	1.214999+03	1.043002+03	9.087695+02	8.094291+02
201	THRU	205	7.341188+02	6.839495+02	6.507914+02	6.350563+02	1.745671+03
206	THRU	210	1.674636+03	1.541979+03	1.371370+03	1.193914+03	1.035141+03
211	THRU	215	9.102204+02	8.169880+02	7.476900+02	6.978882+02	6.657091+02
216	THRU	220	6.500254+02	1.669382+03	1.605246+03	1.485700+03	1.333722+03
221	THRU	225	1.174045+03	1.029735+03	9.147535+02	8.280344+02	7.630740+02
226	THRU	230	7.156561+02	6.841428+02	6.681744+02	7.697378+02	7.337416+02
231	THRU	235	6.788354+02	6.127467+02	5.492896+02	4.969587+02	4.584447+02
236	THRU	240	4.313470+02	4.125069+02	3.999890+02	3.922269+02	3.886089+02
241	THRU	245	7.783811+02	7.527039+02	7.061787+02	6.485658+02	5.902849+02
246	THRU	250	5.399791+02	5.013678+02	4.729128+02	4.522153+02	4.376493+02
251	THRU	255	4.283089+02	4.236887+02	1.595516+03	1.537742+03	1.430764+03
256	THRU	260	1.294486+03	1.149713+03	1.016287+03	9.072097+02	8.233069+02
261	THRU	265	7.600918+02	7.143296+02	6.844397+02	6.696665+02	3.762213+02
266	THRU	270	3.756066+02	3.744539+02	3.729097+02	3.711522+02	3.693664+02
271	THRU	275	3.676929+02	3.662273+02	3.650177+02	3.640940+02	3.634762+02
276	THRU	280	3.631498+02	1.052766+03	1.039144+03	1.013412+03	9.785341+02
281	THRU	285	9.304146+02	8.492645+02	8.574876+02	8.223038+02	7.928837+02
286	THRU	290	7.701369+02	7.546250+02	7.467695+02	1.064811+03	1.051095+03
291	THRU	295	1.025170+03	9.899533+02	9.494934+02	9.077007+02	8.681386+02
296	THRU	300	8.328502+02	8.033353+02	7.804791+02	7.648510+02	7.569130+02

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - CODU45 (FORTRAN V VERSION)

ROUND ALSEP HEATER 3-D THERMAL MODEL - POC2 -6.25 DEGREE REENTRY CROSSWISE STABLE

301	THRU	305	1.084665+03	1.070739+03	1.044396+03	1.008615+03	9.674613+02
306	THRU	310	9.251710+02	8.850856+02	8.494509+02	8.196306+02	7.964760+02
311	THRU	315	7.805921+02	7.724525+02	1.116630+03	1.102291+03	1.075247+03
316	THRU	320	1.038571+03	9.963169+02	9.529635+02	9.119630+02	8.755637+02
321	THRU	325	8.450612+02	8.212542+02	8.047698+02	7.962469+02	1.162100+03
326	THRU	330	1.146969+03	1.118739+03	1.080790+03	1.037176+03	9.921912+02
331	THRU	335	9.499068+02	9.119801+02	8.796259+02	8.545693+02	8.370859+02
336	THRU	340	8.278278+02	3.521801+02	3.516948+02	3.510739+02	3.506199+02
341	THRU	345	3.503591+02	3.502490+02	3.512475+02	3.510040+02	3.506570+02
346	THRU	350	3.503915+02	3.502386+02	3.501720+02	3.515356+02	3.512179+02
351	THRU	355	3.507946+02	3.504653+02	3.502741+02	3.501905+02	3.505241+02
356	THRU	360	3.509522+02	3.503941+02	3.502485+02	3.501809+02	3.501475+02
361	THRU	365	3.504399+02	3.503847+02	3.503012+02	3.502212+02	3.501635+02
366	THRU	370	3.501342+02	3.519140+02	3.519154+02	3.519147+02	3.519140+02
371	THRU	375	3.519135+02	3.519133+02	3.531101+02	3.531101+02	3.531102+02
376	THRU	380	3.531103+02	3.531100+02	3.531098+02	3.532748+02	3.532746+02
381	THRU	385	3.532744+02	3.532743+02	3.532741+02	3.532741+02	3.554034+02
386	THRU	390	3.554035+02	3.554037+02	3.554038+02	3.554036+02	3.554036+02
391	THRU	395	3.579180+02	3.579179+02	3.579179+02	3.579179+02	3.579179+02
396	THRU	400	3.579180+02	3.623100+02	3.623101+02	3.623104+02	3.623106+02
401	THRU	405	3.623104+02	3.623102+02	3.666347+02	3.666365+02	3.666365+02
406	THRU	410	3.666345+02	3.666345+02	3.666367+02	3.662774+02	3.662772+02
411	THRU	415	3.662771+02	3.662772+02	3.662772+02	3.662775+02	3.942263+02
416	THRU	420	3.942262+02	3.942262+02	3.942262+02	3.942262+02	3.942264+02
421	THRU	425	3.845207+02	3.845207+02	3.845207+02	3.845208+02	3.845209+02
426	THRU	427	3.845210+02	-6.000000+01			

LUNPCT 4.00000+00

TIME 4.00000+01 DTIMEU 1.00000-01 CSGMIN(47) 2.83105-02 UTMPCC(16) 1.58579+01 ARLXCC(45) 1.58554+01

1	THRU	5	4.573546+03	4.342289+03	3.880683+03	3.160228+03	2.313901+03
6	THRU	10	1.675666+03	1.317760+03	1.098201+03	9.517229+02	8.510449+02
11	THRU	15	7.875917+02	7.601113+02	4.700234+03	4.486310+03	3.974958+03
16	THRU	20	3.224496+03	2.335082+03	1.690639+03	1.359277+03	1.161254+03
21	THRU	25	1.017463+03	9.158843+02	8.556377+02	8.241213+02	4.677771+03
26	THRU	30	4.447923+03	4.011775+03	3.364070+03	2.526786+03	1.782643+03
31	THRU	35	1.409209+03	1.376541+03	1.202067+03	1.091563+03	1.011193+03
36	THRU	40	9.541810+02	4.023266+03	3.816400+03	3.405317+03	2.790238+03
41	THRU	45	2.113766+03	1.596901+03	1.279793+03	1.076903+03	9.386543+02
46	THRU	50	8.452204+02	7.466250+02	7.589838+02	3.866924+03	3.677375+03
51	THRU	55	3.259604+03	2.667802+03	2.032892+03	1.566859+03	1.292124+03
56	THRU	60	1.117119+03	9.907160+02	9.015922+02	8.463899+02	8.179452+02
61	THRU	65	3.218403+03	3.060956+03	2.735225+03	2.309067+03	1.860137+03
66	THRU	70	1.510313+03	1.296904+03	1.197289+03	1.038456+03	9.577595+02
71	THRU	75	9.034630+02	8.728335+02	2.583763+03	2.469620+03	2.260760+03
76	THRU	80	1.998638+03	1.730577+03	1.505015+03	1.336096+03	1.214816+03

MOUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.75 DEGREE REENTRY CROSSWISE STABLE

81	THRU	85	1.126398+03	1.054017+03	9.967569+02	9.583247+02	3.410618+03
86	THRU	90	3.232016+03	2.881486+03	2.396553+03	1.894050+03	1.996819+03
91	THRU	95	1.228158+03	1.045623+03	9.190907+02	8.329189+02	7.788533+02
96	THRU	100	7.524884+02	3.162322+03	3.001706+03	2.676728+03	2.246081+03
101	THRU	105	1.806895+03	1.462790+03	1.235162+03	1.079725+03	9.672626+02
106	THRU	110	8.880407+02	8.376457+02	8.120178+02	2.852461+03	2.713569+03
111	THRU	115	2.449987+03	2.090629+03	1.732607+03	1.492404+03	1.242566+03
116	THRU	120	1.102343+03	9.995362+02	9.250414+02	8.756589+02	8.493089+02
121	THRU	125	2.462375+03	2.356348+03	2.161210+03	1.913551+03	1.661297+03
126	THRU	130	1.443615+03	1.280084+03	1.160157+03	1.071249+03	1.001997+03
131	THRU	135	9.506750+02	9.200652+02	2.986008+03	2.832429+03	2.540426+03
136	THRU	140	2.155250+03	1.760387+03	1.431088+03	1.194052+03	1.025466+03
141	THRU	145	9.068771+02	8.255300+02	7.742333+02	7.491295+02	2.691971+03
146	THRU	150	2.561539+03	2.312122+03	1.992111+03	1.666054+03	1.393248+03
151	THRU	155	1.196377+03	1.054581+03	9.513318+02	8.785679+02	8.317253+02
156	THRU	160	8.081492+02	2.526908+03	2.410779+03	2.192663+03	1.910621+03
161	THRU	165	1.623924+03	1.378490+03	1.198023+03	1.066049+03	9.688619+02
166	THRU	170	8.994850+02	8.540226+02	8.307163+02	2.289874+03	2.195935+03
171	THRU	175	2.020735+03	1.798556+03	1.567348+03	1.363866+03	1.206726+03
176	THRU	180	1.088397+03	9.998711+02	9.348907+02	8.906243+02	8.669243+02
181	THRU	185	2.692174+03	2.559986+03	2.314787+03	1.996242+03	1.670670+03
186	THRU	190	1.385808+03	1.170590+03	1.012062+03	8.990891+02	8.210808+02
191	THRU	195	7.716960+02	7.474952+02	2.412199+03	2.305478+03	2.105432+03
196	THRU	200	1.847939+03	1.582986+03	1.399910+03	1.171058+03	1.037241+03
201	THRU	205	9.391593+02	8.699961+02	8.253180+02	8.030230+02	2.307904+03
206	THRU	210	2.210926+03	2.028918+03	1.795531+03	1.553358+03	1.339490+03
211	THRU	215	1.173497+03	1.048169+03	9.552839+02	8.892421+02	8.461995+02
216	THRU	220	8.245333+02	2.195475+03	2.108419+03	1.946508+03	1.791681+03
221	THRU	225	1.525270+03	1.332967+03	1.100853+03	1.064590+03	9.773914+02
226	THRU	230	9.144017+02	8.724434+02	8.508071+02	1.129230+03	1.066078+03
231	THRU	235	9.502084+02	8.341249+02	7.155433+02	6.210934+02	5.531482+02
236	THRU	240	5.060043+02	4.737026+02	4.519618+02	4.386344+02	4.323457+02
241	THRU	245	1.117896+03	1.070259+03	9.867423+02	8.849900+02	7.825487+02
246	THRU	250	6.956088+02	6.289778+02	5.800452+02	5.448399+02	5.202286+02
251	THRU	255	5.044907+02	4.967215+02	2.097133+03	2.018073+03	1.872615+03
256	THRU	260	1.687443+03	1.489999+03	1.312355+03	1.168285+03	1.056245+03
261	THRU	265	9.716262+02	9.102964+02	8.711029+02	8.511082+02	3.999743+02
266	THRU	270	3.908847+02	3.948406+02	3.941175+02	3.910160+02	3.878687+02
271	THRU	275	3.849135+02	3.823214+02	3.801754+02	3.785349+02	3.774243+02
276	THRU	280	3.368543+02	1.351916+03	1.334229+03	1.300943+03	1.255957+03
281	THRU	285	1.204068+03	1.150142+03	1.098513+03	1.052323+03	1.013636+03
286	THRU	290	9.837799+02	9.635904+02	9.533122+02	1.369695+03	1.351674+03
291	THRU	295	1.318297+03	1.272879+03	1.220618+03	1.166376+03	1.119507+03
296	THRU	300	1.068117+03	1.029219+03	9.990758+02	9.785516+02	9.681499+02
301	THRU	305	1.399057+03	1.380923+03	1.346749+03	1.300530+03	1.247418+03
306	THRU	310	1.192441+03	1.139949+03	1.093012+03	1.053508+03	1.022911+03
311	THRU	315	1.001841+03	9.910646+02	1.446883+03	1.428128+03	1.392853+03
316	THRU	320	1.345235+03	1.290591+03	1.239242+03	1.180452+03	1.132397+03
321	THRU	325	1.091829+03	1.060078+03	1.036036+03	1.026607+03	1.517091+03

HOUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.75 DEGREE REENTRY CROSSWISE STABLE

106	THRU	110	1.096916+03	1.030960+03	9.975691+02	3.497031+03	3.351362+03	
111	THRU	115	3.049768+03	2.633302+03	2.179430+03	1.805773+03	1.550988+03	
116	THRU	120	1.373250+03	1.243704+03	1.147968+03	1.083425+03	1.048845+03	
121	THRU	125	3.099201+03	2.910530+03	2.685460+03	2.388644+03	2.075647+03	
126	THRU	130	1.807569+03	1.604586+03	1.454210+03	1.343173+03	1.255049+03	
131	THRU	135	1.188224+03	1.147119+03	3.683553+03	3.515830+03	3.187028+03	
136	THRU	140	2.722769+03	2.215136+03	1.785792+03	1.478659+03	1.264999+03	
141	THRU	145	1.119430+03	1.011262+03	9.445557+02	9.124372+02	3.349206+03	
146	THRU	150	3.203290+03	2.910520+03	2.513279+03	2.090857+03	1.738148+03	
151	THRU	155	1.484997+03	1.306597+03	1.176582+03	1.083098+03	1.022251+03	
156	THRU	160	9.917571+02	3.159140+03	3.019757+03	2.756790+03	2.403616+03	
161	THRU	165	2.031927+03	1.718701+03	1.487855+03	1.322422+03	1.200623+03	
166	THRU	170	1.111745+03	1.052743+03	1.022467+03	2.859089+03	2.745896+03	
171	THRU	175	2.530431+03	2.249747+03	1.953668+03	1.699198+03	1.500500+03	
176	THRU	180	1.352981+03	1.242895+03	1.160346+03	1.103019+03	1.072025+03	
181	THRU	185	3.349675+03	3.216160+03	2.919500+03	2.517822+03	2.091402+03	
186	THRU	190	1.729194+03	1.445060+03	1.296442+03	1.103394+03	1.003907+03	
191	THRU	195	9.406610+02	9.100591+02	3.032162+03	2.901603+03	2.652417+03	
196	THRU	200	2.321942+03	1.975436+03	1.670552+03	1.449219+03	1.282051+03	
201	THRU	205	1.158973+03	1.070546+03	1.012896+03	9.842590+02	2.901511+03	
206	THRU	210	2.701631+03	2.552555+03	2.252430+03	1.936773+03	1.665391+03	
211	THRU	215	1.453122+03	1.296776+03	1.180688+03	1.096458+03	1.040962+03	
216	THRU	220	1.013024+03	2.753834+03	2.645932+03	2.441313+03	2.177777+03	
221	THRU	225	1.899139+03	1.657235+03	1.464039+03	1.319516+03	1.211196+03	
226	THRU	230	1.131113+03	1.077011+03	1.048953+03	1.699654+03	1.575779+03	
231	THRU	235	1.371548+03	1.142622+03	9.404096+02	7.869591+02	6.766469+02	
236	THRU	240	6.058848+02	5.556225+02	5.223108+02	5.019047+02	4.922290+02	
241	THRU	245	1.605592+03	1.520491+03	1.372044+03	1.196363+03	1.031396+03	
246	THRU	250	8.971054+02	7.951925+02	7.213499+02	6.679242+02	6.303842+02	
251	THRU	255	6.063530+02	5.944919+02	2.639387+03	2.539277+03	2.351695+03	
256	THRU	260	2.109986+03	1.854615+03	1.629640+03	1.445749+03	1.306101+03	
261	THRU	265	1.200967+03	1.124162+03	1.073223+03	1.047527+03	4.318465+02	
266	THRU	270	4.301040+02	4.268715+02	4.225965+02	4.177801+02	4.129323+02	
271	THRU	275	4.083928+02	4.044149+02	4.011157+02	3.985086+02	3.968726+02	
276	THRU	280	3.959950+02	1.669226+03	1.647176+03	1.605742+03	1.549718+03	
281	THRU	285	1.484726+03	1.418077+03	1.355007+03	1.298903+03	1.251939+03	
286	THRU	290	1.215535+03	1.190658+03	1.178028+03	1.693564+03	1.671377+03	
291	THRU	295	1.629605+03	1.573230+03	1.507928+03	1.440647+03	1.377133+03	
296	THRU	300	1.320700+03	1.273433+03	1.236713+03	1.211540+03	1.196711+03	
301	THRU	305	1.733745+03	1.711261+03	1.668905+03	1.611695+03	1.545682+03	
306	THRU	310	1.477170+03	1.412550+03	1.355224+03	1.307170+03	1.269707+03	
311	THRU	315	1.243890+03	1.230627+03	1.799352+03	1.776270+03	1.732833+03	
316	THRU	320	1.679168+03	1.606775+03	1.536051+03	1.469807+03	1.410471+03	
321	THRU	325	1.360668+03	1.321505+03	1.294354+03	1.280171+03	1.696603+03	
326	THRU	330	1.872174+03	1.826496+03	1.765441+03	1.695419+03	1.622778+03	
331	THRU	335	1.552371+03	1.488895+03	1.435937+03	1.393183+03	1.363431+03	
336	THRU	340	1.347465+03	3.596709+02	3.575779+02	3.550047+02	3.531313+02	
341	THRU	345	3.520598+02	3.515864+02	3.562478+02	3.550317+02	3.539824+02	
346	THRU	350	3.522909+02	3.515762+02	3.512512+02	3.574731+02	3.560092+02	

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - C00045 (FORTRAN V VERSION)

MOUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

351	THRU	355	3.541198+02	3.526480+02	3.517636+02	3.513640+02	3.531717+02
356	THRU	360	3.578008+02	3.522526+02	3.517345+02	3.513641+02	3.511777+02
361	THRU	365	3.528233+02	3.525305+02	3.520841+02	3.518466+02	3.513213+02
366	THRU	370	3.511521+02	3.564188+02	3.564141+02	3.564120+02	3.564080+02
371	THRU	375	3.564051+02	3.564036+02	3.599861+02	3.599861+02	3.599860+02
376	THRU	380	3.599858+02	3.599851+02	3.599846+02	3.587544+02	3.587536+02
381	THRU	385	3.587525+02	3.587513+02	3.587504+02	3.587499+02	3.636163+02
386	THRU	390	3.636149+02	3.636147+02	3.636149+02	3.636166+02	3.436163+02
391	THRU	395	3.659074+02	3.659072+02	3.659068+02	3.659066+02	3.659064+02
396	THRU	400	3.659063+02	3.732500+02	3.732501+02	3.732505+02	3.732508+02
401	THRU	405	3.732505+02	3.732503+02	3.777863+02	3.777859+02	3.777859+02
406	THRU	410	3.777859+02	3.777859+02	3.777863+02	3.770688+02	3.770686+02
411	THRU	415	3.770686+02	3.770687+02	3.770687+02	3.770689+02	4.182784+02
416	THRU	420	4.182783+02	4.182782+02	4.182782+02	4.182784+02	4.182786+02
421	THRU	425	4.001432+02	4.001432+02	4.001433+02	4.001435+02	4.001436+02
426	THRU	427	4.001437+02	-6.000000+01			

LCMPCT 4.00000+00

TIME 5.80000+01 DTIMEU 1.00000-01 CSGMINI 471 4.06490-02 DTMPCCI 2301 1.66773+01 ARLXCCI 471 1.25702-01

1	THRU	5	5.692754+03	5.482602+03	5.057835+03	4.367869+03	3.460868+03
6	THRU	10	2.568362+03	1.998721+03	1.649663+03	1.407762+03	1.262407+03
11	THRU	15	1.154655+03	1.103274+03	5.830558+03	5.641004+03	5.166375+03
16	THRU	20	4.452036+03	3.099964+03	2.600780+03	2.082375+03	1.766313+03
21	THRU	25	1.532774+03	1.366880+03	1.260723+03	1.217161+03	5.503007+03
26	THRU	30	5.284140+03	4.803113+03	4.306297+03	3.549002+03	2.669725+03
31	THRU	35	2.284514+03	2.062757+03	1.874631+03	1.693337+03	1.555075+03
36	THRU	40	1.456048+03	5.212082+03	5.012975+03	4.610900+03	3.986542+03
41	THRU	45	3.196522+03	2.434438+03	1.927946+03	1.609737+03	1.366035+03
46	THRU	50	1.248733+03	1.149045+03	1.101348+03	5.078210+03	4.097260+03
51	THRU	55	4.485523+03	3.674034+03	3.098205+03	2.392429+03	1.958595+03
56	THRU	60	1.684920+03	1.483916+03	1.341727+03	1.252862+03	1.206801+03
61	THRU	65	4.341567+03	4.210538+03	3.881246+03	3.406879+03	2.624114+03
66	THRU	70	2.308634+03	1.967535+03	1.791151+03	1.572776+03	1.443945+03
71	THRU	75	1.355823+03	1.305717+03	3.569585+03	3.454294+03	3.231751+03
76	THRU	80	2.928022+03	2.584679+03	2.279858+03	2.041381+03	1.867425+03
81	THRU	85	1.738566+03	1.625456+03	1.530048+03	1.462539+03	4.673650+03
86	THRU	90	4.987712+03	4.116699+03	3.563248+03	2.889220+03	2.266902+03
91	THRU	95	1.835411+03	1.548797+03	1.351889+03	1.223462+03	1.134086+03
96	THRU	100	1.090594+03	4.402735+03	4.236054+03	3.684050+03	3.373649+03
101	THRU	105	2.758085+03	2.216386+03	1.855406+03	1.616050+03	1.440597+03
106	THRU	110	1.316781+03	1.236872+03	1.196007+03	4.024019+03	3.882118+03
111	THRU	115	3.577463+03	3.141624+03	2.629270+03	2.180406+03	1.869859+03
116	THRU	120	1.657579+03	1.499272+03	1.382073+03	1.309177+03	1.261727+03
121	THRU	125	3.509124+03	3.308452+03	3.159136+03	2.842944+03	2.490162+03
126	THRU	130	2.179277+03	1.938380+03	1.764002+03	1.632997+03	1.524876+03

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - COUDAS (FORTRAN V VERSION)

MOUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

131	THRU	135	1.441601+03	1.389911+03	4.275084+03	4.101482+03	3.758661+03
136	THRU	140	3.262301+03	2.679695+03	2.154582+03	1.775050+03	1.512557+03
141	THRU	145	1.329799+03	1.207276+03	1.125009+03	1.084723+03	3.918311+03
146	THRU	150	3.767074+03	3.461029+03	3.025937+03	2.529016+03	2.095710+03
151	THRU	155	1.705941+03	1.569264+03	1.410467+03	1.298341+03	1.225104+03
156	THRU	160	1.188017+03	3.707331+03	3.567940+03	3.288730+03	2.895760+03
161	THRU	165	2.459943+03	2.070550+03	1.790056+03	1.590335+03	1.441717+03
166	THRU	170	1.339929+03	1.263940+03	1.227205+03	3.383743+03	3.262664+03
171	THRU	175	3.026320+03	2.706296+03	2.354800+03	2.094671+03	1.806338+03
176	THRU	180	1.630525+03	1.497246+03	1.397519+03	1.328278+03	1.290568+03
181	THRU	185	3.971163+03	3.808342+03	3.491032+03	3.041155+03	2.531213+03
186	THRU	190	2.075449+03	1.733504+03	1.488123+03	1.315174+03	1.196780+03
191	THRU	195	1.119577+03	1.081624+03	3.604453+03	3.469448+03	3.189558+03
196	THRU	200	2.808851+03	2.388502+03	2.018703+03	1.740180+03	1.536391+03
201	THRU	205	1.387000+03	1.281420+03	1.212346+03	1.177696+03	3.458230+03
206	THRU	210	3.327908+03	3.072490+03	2.723585+03	2.340559+03	2.002513+03
211	THRU	215	1.745699+03	1.555885+03	1.414723+03	1.314000+03	1.247574+03
216	THRU	220	1.213890+03	3.287611+03	3.168501+03	2.937345+03	2.627028+03
221	THRU	225	2.291634+03	1.991879+03	1.760089+03	1.586139+03	1.454497+03
226	THRU	230	1.350579+03	1.293749+03	1.259718+03	2.483792+03	2.306397+03
231	THRU	235	1.966339+03	1.580630+03	1.240217+03	9.959440+02	8.365615+02
236	THRU	240	7.293820+02	6.581460+02	6.108544+02	5.815690+02	5.676092+02
241	THRU	245	2.279905+03	2.135940+03	1.895085+03	1.611902+03	1.350024+03
246	THRU	250	1.133164+03	9.977567+02	8.937549+02	8.191561+02	7.670040+02
251	THRU	255	7.334596+02	7.168127+02	3.168083+03	3.055725+03	2.838817+03
256	THRU	260	2.550676+03	2.239909+03	1.958324+03	1.736486+03	1.567385+03
261	THRU	265	1.439279+03	1.347262+03	1.286382+03	1.255556+03	4.723770+02
266	THRU	270	4.697047+02	4.648011+02	4.584738+02	4.514764+02	4.445405+02
271	THRU	275	4.300944+02	4.324803+02	4.278265+02	4.242719+02	4.218550+02
276	THRU	280	4.206241+02	1.999095+03	1.972434+03	1.922657+03	1.855408+03
281	THRU	285	1.778169+03	1.698811+03	1.623302+03	1.555919+03	1.499416+03
286	THRU	290	1.455951+03	1.426508+03	1.411618+03	2.029530+03	2.002659+03
291	THRU	295	1.952432+03	1.884960+03	1.807511+03	1.728003+03	1.652403+03
296	THRU	300	1.584895+03	1.528169+03	1.484038+03	1.454040+03	1.438809+03
301	THRU	305	2.079702+03	2.052734+03	2.001719+03	1.933342+03	1.854708+03
306	THRU	310	1.774956+03	1.698805+03	1.630684+03	1.573232+03	1.528232+03
311	THRU	315	1.497111+03	1.481150+03	2.161702+03	2.134349+03	2.082790+03
316	THRU	320	2.012407+03	1.920992+03	1.850597+03	1.773420+03	1.703717+03
321	THRU	325	1.649548+03	1.597731+03	1.565079+03	1.547707+03	2.282868+03
326	THRU	330	2.254618+03	2.201710+03	2.130768+03	2.048396+03	1.963369+03
331	THRU	335	1.881099+03	1.807297+03	1.744905+03	1.699038+03	1.658199+03
336	THRU	340	1.638748+03	3.671019+02	3.633432+02	3.587905+02	3.556091+02
341	THRU	345	3.538040+02	3.530037+02	3.613499+02	3.591393+02	3.563630+02
346	THRU	350	3.542848+02	3.530443+02	3.524777+02	3.634955+02	3.608330+02
351	THRU	355	3.574506+02	3.548861+02	3.533579+02	3.526659+02	3.560510+02
356	THRU	360	3.553668+02	3.543625+02	3.534242+02	3.527514+02	3.524087+02
361	THRU	365	3.554606+02	3.549186+02	3.540940+02	3.532941+02	3.526981+02
366	THRU	370	3.523877+02	3.594730+02	3.594677+02	3.594600+02	3.594526+02
371	THRU	375	3.594472+02	3.594449+02	3.643509+02	3.643506+02	3.643501+02

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - CODONS (FORTRAN V VERSION)

MOUNU ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

376	THRU	380	3.643496+02	3.643484+02	3.643476+02	3.621737+02	3.621763+02
381	THRU	385	3.621740+02	3.621716+02	3.621700+02	3.621690+02	3.683779+02
386	THRU	390	3.683780+02	3.683782+02	3.683784+02	3.683780+02	3.683777+02
391	THRU	395	3.702732+02	3.702720+02	3.702722+02	3.702716+02	3.702711+02
396	THRU	400	3.702709+02	3.787819+02	3.787820+02	3.787824+02	3.787827+02
401	THRU	405	3.787829+02	3.787822+02	3.833917+02	3.833914+02	3.833913+02
406	THRU	410	3.833912+02	3.833912+02	3.833916+02	3.824646+02	3.824643+02
411	THRU	415	3.824643+02	3.824644+02	3.824643+02	3.824646+02	4.289998+02
416	THRU	420	4.289997+02	4.289997+02	4.289996+02	4.289998+02	4.290001+02
421	THRU	425	4.071221+02	4.071220+02	4.071222+02	4.071224+02	4.071224+02
426	THRU	427	4.071226+02	-8.000000+01			

COMPCT 4.00000+00

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TIME 6.30000+01 DTIMEU 1.00000-01 CSGMIN(47) 4.73783-02 DTMPCC(243) 1.37724+01 ARLXCC(25) 1.60400-01

1	THRU	5	6.016449+03	5.813217+03	5.405159+03	4.739205+03	3.852463+03
6	THRU	10	2.965095+03	2.329914+03	1.917333+03	1.638488+03	1.469977+03
11	THRU	15	1.339206+03	1.282479+03	6.155731+03	5.973263+03	5.519114+03
16	THRU	20	4.824503+03	3.887601+03	2.991055+03	2.427407+03	2.066696+03
21	THRU	25	1.793942+03	1.597682+03	1.481796+03	1.420949+03	5.737256+03
26	THRU	30	5.520161+03	5.127812+03	4.571269+03	3.844661+03	2.998102+03
31	THRU	35	2.623545+03	2.399423+03	2.201294+03	1.990715+03	1.832494+03
36	THRU	40	1.716424+03	5.593704+03	5.398440+03	5.005276+03	4.391803+03
41	THRU	45	3.606721+03	2.820972+03	2.250379+03	1.670204+03	1.613624+03
46	THRU	50	1.446483+03	1.333755+03	1.260714+03	5.972770+03	5.295400+03
51	THRU	55	4.891124+03	4.270144+03	3.517224+03	2.780359+03	2.290258+03
56	THRU	60	1.970122+03	1.736954+03	1.568424+03	1.403524+03	1.409510+03
61	THRU	65	4.738762+03	4.591031+03	4.272100+03	3.008073+03	3.229542+03
66	THRU	70	2.683713+03	2.301508+03	2.040478+03	1.845839+03	1.497008+03
71	THRU	75	1.593669+03	1.532477+03	3.890921+03	3.782476+03	3.573376+03
76	THRU	80	3.286459+03	2.946351+03	2.637073+03	2.381915+03	2.172676+03
81	THRU	85	2.049973+03	1.920124+03	1.809494+03	1.728359+03	5.120662+03
86	THRU	90	4.734943+03	4.563771+03	4.006984+03	3.319616+03	2.643711+03
91	THRU	95	2.144540+03	1.805409+03	1.573279+03	1.416601+03	1.317125+03
96	THRU	100	1.268894+03	4.846935+03	4.001265+03	4.329489+03	3.815610+03
101	THRU	105	3.184364+03	2.580768+03	2.171516+03	1.888407+03	1.685555+03
106	THRU	110	1.538584+03	1.444496+03	1.396784+03	4.453862+03	4.308490+03
111	THRU	115	4.004755+03	3.560110+03	3.038738+03	2.549535+03	2.168633+03
116	THRU	120	1.939262+03	1.757360+03	1.621330+03	1.528689+03	1.477868+03
121	THRU	125	3.822978+03	3.748090+03	3.543560+03	3.232142+03	2.869449+03
126	THRU	130	2.533512+03	2.267480+03	2.049683+03	1.919399+03	1.796911+03
131	THRU	135	1.700773+03	1.638403+03	4.762122+03	4.585326+03	4.235219+03
136	THRU	140	3.725061+03	3.112743+03	2.520083+03	2.073532+03	1.763449+03
141	THRU	145	1.547605+03	1.400018+03	1.307699+03	1.262524+03	4.391040+03
146	THRU	150	4.237363+03	3.925436+03	3.478098+03	2.947465+03	2.452542+03
151	THRU	155	2.089064+03	1.833052+03	1.649081+03	1.516072+03	1.430110+03

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - CDD045 (FORTRAN V VERSION)

MOUND ALSEP HEATER 3-D THERMAL MODEL POCO =6.25 DEGREE REENTRY CROSSWISE STABLE

156	THRU	160	1.386998+03	4.168383+03	4.027048+03	3.742620+03	3.338619+03
161	THRU	165	2.862749+03	2.422247+03	2.094134+03	1.858682+03	1.687613+03
166	THRU	170	1.561917+03	1.477958+03	1.434749+03	3.822849+03	3.700739+03
171	THRU	175	3.460886+03	3.126741+03	2.744439+03	2.389420+03	2.113564+03
176	THRU	180	1.907349+03	1.755168+03	1.639804+03	1.558280+03	1.513131+03
181	THRU	185	4.483049+03	4.314803+03	3.983558+03	3.513314+03	2.959432+03
186	THRU	190	2.431146+03	2.023665+03	1.734779+03	1.530600+03	1.390195+03
191	THRU	195	1.302179+03	1.259123+03	4.094572+03	3.949613+03	3.663029+03
196	THRU	200	3.262688+03	2.797668+03	2.365302+03	2.033694+03	1.793956+03
201	THRU	205	1.620167+03	1.495112+03	1.419359+03	1.374183+03	3.934407+03
206	THRU	210	3.800193+03	3.536109+03	3.166214+03	2.740771+03	2.345800+03
211	THRU	215	2.040851+03	1.817434+03	1.654132+03	1.535363+03	1.457021+03
216	THRU	220	1.417653+03	3.748668+03	3.624577+03	3.386099+03	3.054812+03
221	THRU	225	2.679996+03	2.331636+03	2.058360+03	1.853976+03	1.703005+03
226	THRU	230	1.590926+03	1.514309+03	1.474153+03	3.154695+03	3.003948+03
231	THRU	235	2.687302+03	2.162057+03	1.638570+03	1.261513+03	1.024851+03
236	THRU	240	8.700880+02	7.798486+02	7.161140+02	6.770797+02	6.583505+02
241	THRU	245	3.010930+03	2.861063+03	2.558087+03	2.140246+03	1.750239+03
246	THRU	250	1.448046+03	1.237335+03	1.094695+03	9.953990+02	9.264249+02
251	THRU	255	8.821478+02	8.602121+02	3.628610+03	3.512112+03	3.266594+03
256	THRU	260	2.974617+03	2.623102+03	2.293664+03	2.030375+03	1.830795+03
261	THRU	265	1.683106+03	1.575257+03	1.503370+03	1.466977+03	5.224592+02
266	THRU	270	5.184100+02	5.110703+02	5.018699+02	4.920087+02	4.825202+02
271	THRU	275	4.738337+02	4.663407+02	4.601347+02	4.554019+02	4.521782+02
276	THRU	280	4.505428+02	2.336567+03	2.305527+03	2.294451+03	2.167512+03
281	THRU	285	2.076232+03	1.981833+03	1.893566+03	1.816059+03	1.751650+03
286	THRU	290	1.701885+03	1.667925+03	1.650687+03	2.370595+03	2.337690+03
291	THRU	295	2.281503+03	2.202539+03	2.111599+03	2.017569+03	1.928864+03
296	THRU	300	1.851100+03	1.786426+03	1.736307+03	1.701958+03	1.684441+03
301	THRU	305	2.425634+03	2.394865+03	2.337051+03	2.258688+03	2.168227+03
306	THRU	310	2.074637+03	1.985268+03	1.906475+03	1.840884+03	1.769821+03
311	THRU	315	1.764568+03	1.736434+03	2.514484+03	2.483813+03	2.426295+03
316	THRU	320	2.348704+03	2.259122+03	2.166034+03	2.076435+03	1.995607+03
321	THRU	325	1.927607+03	1.874276+03	1.836766+03	1.817429+03	2.844884+03
326	THRU	330	2.614461+03	2.557210+03	2.479922+03	2.390489+03	2.296899+03
331	THRU	335	2.205087+03	2.121698+03	2.049967+03	1.991939+03	1.950671+03
336	THRU	340	1.928241+03	3.771717+02	3.717432+02	3.643893+02	3.592449+02
341	THRU	345	3.543886+02	3.551311+02	3.686559+02	3.652754+02	3.607135+02
346	THRU	350	3.573057+02	3.552983+02	3.543847+02	3.720934+02	3.679930+02
351	THRU	355	3.624324+02	3.582356+02	3.557700+02	3.546602+02	3.604795+02
356	THRU	360	3.593493+02	3.576599+02	3.560814+02	3.549528+02	3.543786+02
361	THRU	365	3.595569+02	3.586538+02	3.572655+02	3.559098+02	3.549036+02
366	THRU	370	3.543800+02	3.627574+02	3.629484+02	3.629349+02	3.629222+02
371	THRU	375	3.629128+02	3.629081+02	3.691052+02	3.691045+02	3.691034+02
376	THRU	380	3.691021+02	3.691004+02	3.690993+02	3.659612+02	3.659587+02
381	THRU	385	3.659547+02	3.659506+02	3.659474+02	3.659457+02	3.734056+02
386	THRU	390	3.734057+02	3.734056+02	3.734059+02	3.734054+02	3.734050+02
391	THRU	395	3.748310+02	3.748302+02	3.748292+02	3.748280+02	3.748271+02
396	THRU	400	3.740267+02	3.843316+02	3.843318+02	3.843321+02	3.843324+02

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - C00095 (FORTRAN V VERSION)

ROUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

401	THRU	405	3.843321+02	3.843319+02	3.890102+02	3.890102+02	3.890100+02
406	THRU	410	3.890099+02	3.890099+02	3.890102+02	3.878636+02	3.878637+02
411	THRU	415	3.878635+02	3.878634+02	3.878634+02	3.878637+02	4.389973+02
416	THRU	420	4.389972+02	4.389972+02	4.389973+02	4.389975+02	4.389977+02
421	THRU	425	4.137713+02	4.137713+02	4.137715+02	4.137717+02	4.137718+02
426	THRU	427	4.137719+02	-6.000000+01			

LOMPCT 4.00000+00

TIME 6.80000+01	DTIMCU	1.00000-01	CSGMINI (7)	5.53874-02	DTMPCCI (244)	1.16005+01	ARLXCCI (26) 1.99958-01
1	THRU	5	6.212567+03	6.019880+03	5.620387+03	4.970267+03	4.121702+03
6	THRU	10	3.252785+03	2.617249+03	2.170653+03	1.854759+03	1.692851+03
11	THRU	15	1.515068+03	1.451858+03	6.348987+03	6.171695+03	5.725766+03
16	THRU	20	5.060410+03	4.154493+03	3.286579+03	2.720504+03	2.335715+03
21	THRU	25	2.033379+03	1.812029+03	1.684427+03	1.615951+03	5.867392+03
26	THRU	30	5.652213+03	5.267150+03	4.727019+03	4.028676+03	3.224238+03
31	THRU	35	2.874900+03	2.665946+03	2.465991+03	2.250220+03	2.075930+03
36	THRU	40	1.944800+03	5.854796+03	5.662916+03	5.278054+03	4.678671+03
41	THRU	45	3.909339+03	3.133799+03	2.539545+03	2.121488+03	1.828260+03
46	THRU	50	1.631469+03	1.510587+03	1.451438+03	5.743153+03	5.569872+03
51	THRU	55	5.179176+03	4.587075+03	3.829068+03	3.079478+03	2.567638+03
56	THRU	60	2.237784+03	1.973505+03	1.783742+03	1.664704+03	1.605471+03
61	THRU	65	5.001438+03	4.857766+03	4.550367+03	4.101615+03	3.538303+03
66	THRU	70	2.967286+03	2.620115+03	2.317488+03	2.102269+03	1.933637+03
71	THRU	75	1.816535+03	1.740350+03	4.112337+03	4.010043+03	3.819648+03
76	THRU	80	3.547675+03	3.229916+03	2.929342+03	2.675406+03	2.479503+03
81	THRU	85	2.329576+03	2.189950+03	2.065847+03	1.973285+03	5.456505+03
86	THRU	90	5.271287+03	4.901861+03	4.348166+03	3.661862+03	2.973629+03
91	THRU	95	2.432696+03	2.051709+03	1.706195+03	1.604421+03	1.494151+03
96	THRU	100	1.439753+03	5.180632+03	5.016396+03	4.667859+03	4.158216+03
101	THRU	105	3.528035+03	2.918015+03	2.466022+03	2.151026+03	1.917440+03
106	THRU	110	1.752673+03	1.646990+03	1.592603+03	4.772428+03	4.629301+03
111	THRU	115	4.331168+03	3.900825+03	3.375699+03	2.868605+03	2.483928+03
116	THRU	120	2.209197+03	2.002233+03	1.848109+03	1.748199+03	1.687367+03
121	THRU	125	4.157283+03	4.047010+03	3.832084+03	3.533107+03	3.160504+03
126	THRU	130	2.842081+03	2.563761+03	2.351147+03	2.188813+03	2.051713+03
131	THRU	135	1.941573+03	1.871972+03	5.146129+03	4.967730+03	4.615003+03
136	THRU	140	4.049960+03	3.478142+03	2.857355+03	2.360895+03	2.005685+03
141	THRU	145	1.759186+03	1.590894+03	1.484635+03	1.433672+03	4.765097+03
146	THRU	150	4.611127+03	4.298104+03	3.848331+03	3.309560+03	2.786287+03
151	THRU	155	2.380035+03	2.090226+03	1.878143+03	1.729543+03	1.631460+03
156	THRU	160	1.582154+03	4.533355+03	4.392362+03	4.107969+03	3.702216+03
161	THRU	165	3.219150+03	2.752141+03	2.365589+03	2.120494+03	1.923206+03
166	THRU	170	1.781529+03	1.687430+03	1.630451+03	4.169871+03	4.049014+03
171	THRU	175	3.811344+03	3.478053+03	3.087513+03	2.712074+03	2.405364+03
176	THRU	180	2.176217+03	2.002247+03	1.871267+03	1.779675+03	1.729225+03

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - COODAS (FORTRAN V VERSION)

MOUND ALSEP HEATER 3-D THERMAL MODEL PDCO -6.25 DEGREE REENTRY CROSSWISE STABLE

181	THRU	185	4.900358+03	4.728523+03	4.391081+03	3.908248+03	3.337391+03
186	THRU	190	2.770208+03	2.308189+03	1.974075+03	1.740897+03	1.560782+03
191	THRU	195	1.479329+03	1.430490+03	4.495582+03	4.348822+03	4.058466+03
196	THRU	200	3.647766+03	3.166074+03	2.698335+03	2.321607+03	2.046132+03
201	THRU	205	1.845931+03	1.705129+03	1.613482+03	1.567453+03	4.323398+03
206	THRU	210	4.108021+03	3.920746+03	3.543880+03	3.102332+03	2.675290+03
211	THRU	215	2.329449+03	2.074101+03	1.885392+03	1.751455+03	1.663309+03
216	THRU	220	1.618505+03	4.118718+03	3.996583+03	3.757383+03	3.422252+03
221	THRU	225	3.031606+03	2.656305+03	2.347808+03	2.116644+03	1.942252+03
226	THRU	230	1.815545+03	1.729685+03	1.684604+03	3.670793+03	3.524888+03
231	THRU	235	3.234296+03	2.785754+03	2.130709+03	1.590946+03	1.252061+03
236	THRU	240	1.047491+03	9.199189+02	8.365486+02	7.856477+02	7.615832+02
241	THRU	245	3.569374+03	3.438142+03	3.170775+03	2.748707+03	2.227046+03
246	THRU	250	1.808028+03	1.519799+03	1.326413+03	1.194773+03	1.105321+03
251	THRU	255	1.048671+03	1.020857+03	4.009256+03	3.892007+03	3.663670+03
256	THRU	260	3.344852+03	2.974858+03	2.617207+03	2.317844+03	2.090482+03
261	THRU	265	1.919064+03	1.796829+03	1.716096+03	1.675152+03	5.832366+02
266	THRU	270	5.774942+02	5.669109+02	5.535384+02	5.396506+02	5.267005+02
271	THRU	275	5.153122+02	5.056022+02	4.976311+02	4.915909+02	4.874754+02
276	THRU	280	4.853970+02	2.665542+03	2.630673+03	2.564633+03	2.474553+03
281	THRU	285	2.371279+03	2.269783+03	2.164065+03	2.074279+03	1.999229+03
286	THRU	290	1.941799+03	1.903085+03	1.883546+03	2.699281+03	2.665019+03
291	THRU	295	2.600049+03	2.511238+03	2.408814+03	2.303467+03	2.203472+03
296	THRU	300	2.114353+03	2.039592+03	1.981510+03	1.942164+03	1.922209+03
301	THRU	305	2.751811+03	2.718487+03	2.655266+03	2.568773+03	2.467934+03
306	THRU	310	2.363899+03	2.264901+03	2.176516+03	2.101851+03	2.043278+03
311	THRU	315	2.002673+03	1.981837+03	2.833506+03	2.801586+03	2.741125+03
316	THRU	320	2.658484+03	2.561779+03	2.459723+03	2.361909+03	2.273869+03
321	THRU	325	2.198867+03	2.139141+03	2.096959+03	2.074820+03	2.951107+03
326	THRU	330	2.920453+03	2.862737+03	2.784687+03	2.692985+03	2.595196+03
331	THRU	335	2.497146+03	2.407633+03	2.330549+03	2.268057+03	2.222991+03
336	THRU	340	2.198190+03	3.888152+02	3.822723+02	3.720701+02	3.643283+02
341	THRU	345	3.600315+02	3.581482+02	3.776844+02	3.733981+02	3.668418+02
346	THRU	350	3.416378+02	3.585641+02	3.571686+02	3.825200+02	3.772617+02
351	THRU	355	3.693445+02	3.629807+02	3.592216+02	3.575346+02	3.665851+02
356	THRU	360	3.649574+02	3.624182+02	3.599803+02	3.582197+02	3.573211+02
361	THRU	365	3.652696+02	3.639500+02	3.618546+02	3.597609+02	3.581904+02
366	THRU	370	3.573695+02	3.680428+02	3.667933+02	3.667723+02	3.667520+02
371	THRU	375	3.647371+02	3.667294+02	3.741338+02	3.741324+02	3.741299+02
376	THRU	380	3.741274+02	3.741250+02	3.741238+02	3.700491+02	3.700450+02
381	THRU	385	3.700385+02	3.700316+02	3.700263+02	3.700234+02	3.786196+02
386	THRU	390	3.786194+02	3.786189+02	3.786185+02	3.786181+02	3.786178+02
391	THRU	395	3.795507+02	3.795496+02	3.795477+02	3.795457+02	3.795442+02
396	THRU	400	3.795433+02	3.898934+02	3.898934+02	3.898933+02	3.898933+02
401	THRU	405	3.898932+02	3.898931+02	3.946388+02	3.946383+02	3.946379+02
406	THRU	410	3.946377+02	3.946375+02	3.946378+02	3.932713+02	3.932709+02
411	THRU	415	3.932707+02	3.932705+02	3.932703+02	3.932705+02	4.483686+02
416	THRU	420	4.483684+02	4.483684+02	4.483684+02	4.483685+02	4.483667+02
421	THRU	425	4.201848+02	4.201847+02	4.201848+02	4.201849+02	4.201870+02

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - COOD45 (FORTRAN V VERSION)

HOUND ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

426 THRU 427 4.201870+02 -6.000000+01

LOAPCT 4.00000+00

TIME 7.10000+01 DTIMEU 1.00000-01 CSGMIN(47) 6.18935-02 DTMPCC(245) 9.71738+00 ARLXCC(251) 2.09091-01

1	THRU	5	6.298871+03	6.106683+03	5.725097+03	5.107675+03	4.288164+03
6	THRU	10	3.458072+03	2.841301+03	2.383474+03	2.048319+03	1.817899+03
11	THRU	15	1.600322+03	1.611691+03	6.426901+03	6.255168+03	5.822694+03
16	THRU	20	5.182046+03	4.314461+03	3.486206+03	2.991289+03	2.555974+03
21	THRU	25	2.239954+03	2.003337+03	1.864629+03	1.791233+03	5.905449+03
26	THRU	30	5.493527+03	5.316509+03	4.792586+03	4.123876+03	3.360682+03
31	THRU	35	3.040636+03	2.846736+03	2.658639+03	2.491920+03	2.269571+03
36	THRU	40	2.133766+03	6.007622+03	5.819786+03	5.499194+03	4.862061+03
41	THRU	45	4.117322+03	3.366138+03	2.776968+03	2.339426+03	2.029225+03
46	THRU	50	1.808563+03	1.677750+03	1.613254+03	5.902302+03	5.733131+03
51	THRU	55	5.397499+03	4.777506+03	4.093749+03	3.337615+03	2.830039+03
56	THRU	60	2.468832+03	2.186218+03	1.978083+03	1.850525+03	1.789372+03
61	THRU	65	5.169669+03	5.026339+03	4.728235+03	4.296610+03	3.755336+03
66	THRU	70	3.239962+03	2.841342+03	2.551801+03	2.323990+03	2.149422+03
71	THRU	75	2.016980+03	1.941364+03	4.253354+03	4.156370+03	3.971726+03
76	THRU	80	3.722327+03	3.426131+03	3.195175+03	2.900182+03	2.700076+03
81	THRU	85	2.556905+03	2.412011+03	2.282224+03	2.184212+03	5.686482+03
86	THRU	90	5.503260+03	5.138313+03	4.593095+03	3.917613+03	3.238489+03
91	THRU	95	2.685071+03	2.275381+03	1.989943+03	1.784831+03	1.662578+03
96	THRU	100	1.602441+03	5.408957+03	5.296285+03	4.905262+03	4.405131+03
101	THRU	105	3.787256+03	3.166305+03	2.723318+03	2.385270+03	2.133403+03
106	THRU	110	1.948975+03	1.833040+03	1.773048+03	4.993519+03	4.853391+03
111	THRU	115	4.661907+03	4.192094+03	3.629479+03	3.130909+03	2.739125+03
116	THRU	120	2.446707+03	2.224757+03	2.056090+03	1.990620+03	1.874059+03
121	THRU	125	4.396341+03	4.240246+03	4.033678+03	3.798456+03	3.411532+03
126	THRU	130	3.084506+03	2.806988+03	2.589946+03	2.410362+03	2.273778+03
131	THRU	135	2.156797+03	2.079940+03	5.426997+03	5.250674+03	4.898506+03
136	THRU	140	4.305619+03	3.769965+03	3.190928+03	2.619752+03	2.232561+03
141	THRU	145	1.956520+03	1.770193+03	1.654120+03	1.597382+03	5.091714+03
146	THRU	150	4.884825+03	4.573241+03	4.132046+03	3.590118+03	3.069228+03
151	THRU	155	2.644169+03	2.327070+03	2.094027+03	1.925591+03	1.818529+03
156	THRU	160	1.769625+03	4.804839+03	4.665265+03	4.383872+03	3.902524+03
161	THRU	165	3.503330+03	3.032127+03	2.649404+03	2.359757+03	2.149553+03
166	THRU	170	1.985459+03	1.880725+03	1.827083+03	4.933318+03	4.311339+03
171	THRU	175	4.077516+03	3.749856+03	3.364775+03	2.987775+03	2.666676+03
176	THRU	180	2.418061+03	2.227970+03	2.085940+03	1.983514+03	1.927220+03
181	THRU	185	5.219953+03	5.046549+03	4.707348+03	4.221803+03	3.673500+03
186	THRU	190	3.063270+03	2.571255+03	2.202956+03	1.938534+03	1.740601+03
191	THRU	195	1.649152+03	1.594769+03	4.804130+03	4.657373+03	4.367169+03
196	THRU	200	3.955790+03	3.470279+03	2.989012+03	2.588103+03	2.263738+03
201	THRU	205	2.060532+03	1.901363+03	1.799981+03	1.799963+03	4.623713+03

CHRYSLER IMPROVED NUMERICAL DIFFERENCING ANALYZER - C00045 (FORTRAN V VERSION)

MOUNT ALSEP HEATER 3-D THERMAL MODEL POCO -6.25 DEGREE REENTRY CROSSWISE STABLE

206	THRU	210	4.488658+03	4.222003+03	3.845619+03	3.402445+03	2.962744+03
211	THRU	215	2.595812+03	2.314007+03	2.105377+03	1.953771+03	1.855673+03
216	THRU	220	1.806318+03	4.405999+03	4.284715+03	4.047155+03	3.714432+03
221	THRU	225	3.324901+03	2.938321+03	2.613015+03	2.358795+03	2.168140+03
226	THRU	230	2.025973+03	1.929525+03	1.879480+03	4.080418+03	3.935156+03
231	THRU	235	3.640440+03	3.230347+03	2.663706+03	1.977000+03	1.517675+03
236	THRU	240	1.241699+03	1.073080+03	9.691176+02	4.057826+02	8.757176+02
241	THRU	245	3.969022+03	3.846117+03	3.600508+03	3.237402+03	2.740837+03
246	THRU	250	2.210554+03	1.835301+03	1.585071+03	1.416403+03	1.302458+03
251	THRU	255	1.231377+03	1.196526+03	4.309385+03	4.192264+03	3.964167+03
256	THRU	260	3.645524+03	3.273606+03	2.901710+03	2.583850+03	2.332494+03
261	THRU	265	2.144130+03	2.006104+03	1.915222+03	1.869631+03	6.543417+02
266	THRU	270	6.466362+02	6.324132+02	6.143908+02	5.951220+02	5.777671+02
271	THRU	275	5.627297+02	5.502677+02	5.401297+02	5.325091+02	5.273274+02
276	THRU	280	5.247268+02	2.965681+03	2.928752+03	2.858634+03	2.762559+03
281	THRU	285	2.650339+03	2.532911+03	2.420436+03	2.321111+03	2.238318+03
286	THRU	290	2.179262+03	2.130565+03	2.108367+03	2.093560+03	2.957577+03
291	THRU	295	2.889229+03	2.795509+03	2.685923+03	2.571099+03	2.460295+03
296	THRU	300	2.362112+03	2.200063+03	2.216307+03	2.172587+03	2.150286+03
301	THRU	305	3.035395+03	3.000874+03	2.935258+03	2.845265+03	2.739825+03
306	THRU	310	2.628971+03	2.521442+03	2.424584+03	2.343288+03	2.279641+03
311	THRU	315	2.235611+03	2.212922+03	3.098514+03	3.066335+03	3.005043+03
316	THRU	320	2.920922+03	2.822117+03	2.717543+03	2.615004+03	2.520980+03
321	THRU	325	2.440184+03	2.376162+03	2.331005+03	2.307251+03	3.168477+03
326	THRU	330	3.158741+03	3.102502+03	3.025844+03	2.934935+03	2.837570+03
331	THRU	335	2.739590+03	2.648657+03	2.568931+03	2.503244+03	2.455644+03
336	THRU	340	2.429509+03	4.015299+02	3.940206+02	3.817120+02	3.710517+02
341	THRU	345	3.649366+02	3.622472+02	3.880771+02	3.829769+02	3.747517+02
346	THRU	350	3.674854+02	3.630549+02	3.610342+02	3.942162+02	3.880168+02
351	THRU	355	3.780928+02	3.692993+02	3.639199+02	3.619854+02	3.742850+02
356	THRU	360	3.721523+02	3.687240+02	3.652931+02	3.627587+02	3.619516+02
361	THRU	365	3.725403+02	3.707908+02	3.679444+02	3.650058+02	3.627556+02
366	THRU	370	3.615671+02	3.709653+02	3.709970+02	3.709176+02	3.708880+02
371	THRU	375	3.708659+02	3.708545+02	3.793613+02	3.793592+02	3.793557+02
376	THRU	380	3.793520+02	3.793486+02	3.793468+02	3.743943+02	3.743884+02
381	THRU	385	3.743788+02	3.743686+02	3.743604+02	3.743560+02	3.839665+02
386	THRU	390	3.839661+02	3.839656+02	3.839649+02	3.839642+02	3.839639+02
391	THRU	395	3.849081+02	3.849043+02	3.849003+02	3.849003+02	3.843970+02
396	THRU	400	3.843944+02	3.954656+02	3.954655+02	3.954654+02	3.954654+02
401	THRU	405	3.954652+02	3.954651+02	4.002726+02	4.002719+02	4.002714+02
406	THRU	410	4.002708+02	4.002705+02	4.002707+02	3.986905+02	3.986899+02
411	THRU	415	3.986894+02	3.906891+02	3.986887+02	3.986888+02	4.571996+02
416	THRU	420	4.571994+02	4.571994+02	4.571994+02	4.571994+02	4.571996+02
421	THRU	425	4.264318+02	4.264318+02	4.264317+02	4.264317+02	4.264317+02
426	THRU	427	4.264317+02	-6.000000+01			

LOWEST 4.00000+00

APPENDIX D

Results from Computer Code RADHTG

1. Results from RADHTG for the ALRH during -38° lunar return reentry

2. Results from RADHTG for the ALRH during -90° lunar return reentry

APPENDIX D-1

Results from RADHTG for the ALRH during -38° lunar return reentry

```
QUIKTRAN AT YOUR SERVICE
LN03  READY
101. -READY       LOAD(RADHTG)
131. +READY       START(0)
102. =0 10                PROGRAM FOR CALCULATING CONVECTIVE AND RADIATIVE STAGNATION HEATING TO A REENTERING SPHERE
102. =    2
102. =    3                     (BASED ON EQUATIONS PROVIDED BY GENERAL ELECTRIC, PHILADELPHIA)
102. =    4
102. =    5
103. =0 15                                WRITTEN BY D W LARSON, 9513
103. =    2
103. =    3                                     SANDIA LABORATORY
103. =    4
103. =    5                                ALBUQUERQUE, NEW MEXICO
103. =    6
103. =    7
103. =    8
106. =0 20          RADIUS          ALTITUDE          VELOCITY          RADIANT          CONVECTIVE          TOTAL
106. =    2                                                             HEATING          HEATING             HEATING
106. =    3         (FEET)          (FEET)            (FT/SEC)          (BTU/SQ-FT-SEC)  (BTU/SQ-FT-SEC)     (BTU/SQ-FT-SEC)
108. =1 30
109. =1 40
126. =0 50          0.125           300000.0          36450.0           0.223            172.27              172.498
109. =1 40
126. =0 50          0.125           299307.0          36451.0           0.234            175.84              176.076
109. =1 40
126. =0 50          0.125           288129.0          36457.0           0.495            242.71              243.205
109. =1 40
126. =0 50          0.125           276955.0          36461.0           1.024            332.00              333.023
109. =1 40
126. =0 50          0.125           265785.0          36761.0           2.412            467.30              469.709
109. =1 40
126. =0 50          0.125           254621.0          36454.0           4.104            604.36              608.460
109. =1 40
126. =0 50          0.125           243466.0          36436.0           7.318            776.86              784.179
109. =1 40
126. =0 50          0.125           232323.0          36401.0           12.578           984.51              997.087
109. =1 40
126. =0 50          0.125           221199.0          36341.0           20.554           1223.90             1244.452
109. =1 40
126. =0 50          0.125           210105.0          36244.0           32.352           1503.10             1535.454
109. =1 40
126. =0 50          0.125           199057.0          36093.0           48.445           1818.17             1866.616
109. =1 40
126. =0 50          0.125           188062.0          35864.0           70.073           2189.14             2259.213
109. =1 40
126. =0 50          0.125           177163.0          35521.0           93.756           2595.58             2689.335
109. =1 40
126. =0 50          0.125           166395.0          35020.0           111.080          3022.28             3133.361
109. =1 40
126. =0 50          0.125           155818.0          34295.0           105.526          3462.64             3568.165
109. =1 40
126. =0 50          0.125           145511.0          33250.0           49.221           3899.86             3949.078
109. =1 40
126. =0 50          0.125           135591.0          31762.0           0.               4194.71             4194.711
109. =1 40
126. =0 50          0.125           126207.0          29725.0           0.               4209.06             4209.058
109. =1 40
126. =0 50          0.125           117535.0          27102.0           0.               3870.99             3870.995
109. =1 40
126. =0 50          0.125           109741.0          23995.0           0.               3189.35             3189.346
109. =1 40
126. =0 50          0.125           102937.0          20651.0           0.               2364.33             2364.331
109. =1 40
126. =0 50          0.125           97143.0           17402.0           0.               1598.68             1598.679
109. =1 40
126. =0 50          0.125           92292.0           14481.0           0.               1017.41             1017.414
109. =1 40
126. =0 50          0.125           88262.0           12002.0           0.               629.65              629.651
109. =1 40
126. =0 50          0.125           84916.0           9971.0            0.               383.92              383.917
109. =1 40
109. =BREAK  109.
131. +READY
```

APPENDIX D-2

Results from RADHTG for the ALRH during -90° lunar return reentry

START(0)

PROGRAM FOR CALCULATING CONVECTIVE AND RADIATIVE STAGNATION HEATING TO A REENTERING SPHERE

(BASED ON EQUATIONS PROVIDED BY GENERAL ELECTRIC, PHILADELPHIA)

WRITTEN BY D W LARSON, 9513

SANDIA LABORATORY

ALBUQUERQUE, NEW MEXICO

RADIUS (FEET)	ALTITUDE (FEET)	VELOCITY (FT/SEC)	RADIANT HEATING (BTU/SQ-FT-SEC)	CONVECTIVE HEATING (BTU/SQ-FT-SEC)	TOTAL HEATING (BTU/SQ-FT-SEC)
0.125	300000.0	36451.0	0.223	172.29	172.513
0.125	290862.0	36457.0	0.418	225.66	226.074
0.125	272647.0	36467.0	1.376	376.91	378.284
0.125	254429.0	36466.0	4.141	605.90	610.038
0.125	236215.0	36451.0	10.595	909.87	920.470
0.125	218017.0	36396.0	24.374	1310.00	1334.378
0.125	199864.0	36271.0	50.691	1819.00	1869.695
0.125	181803.0	36016.0	97.198	2475.98	2573.176
0.125	163895.0	35517.0	163.898	3303.98	3467.878
0.125	146394.0	34571.0	205.309	4309.43	4514.739
0.125	129532.0	32753.0	24.685	5274.06	5298.745
0.125	113907.0	29527.0	0.	5474.56	5474.559
0.125	100305.0	24696.0	0.	4368.16	4368.160
0.125	89348.0	19153.0	0.	2581.89	2581.892
0.125	81069.0	14164.0	0.	1244.83	1244.829
0.125	74993.0	10373.0	0.	551.56	551.561
0.125	70514.0	7720.0	0.	247.74	247.739

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