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MAGIC COMPUTER SIMULATION

VOLUME I. USER MANUAL

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Joint Technical
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Munitions Effectiveness

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ABSTRACT

The MAGIC computer simulation generates target description data consisting of item-by-item listings of the target's components and airspaces encountered by a large number of parallel rays emanating from any desired attack angle. A combinatorial geometry technique, which defines the locations and shapes of the various physical regions in terms of the intersections and unions of the volumes contained in a set of simple bodies, is used to represent complex target structures. A grid cell pattern is superimposed over the surface of the target and parallel rays are randomly located in each grid cell.

This User Manual contains:

(1) A detailed description of the input variables required to execute the program

(2) A description of the output

(3) A sample problem.

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These new manuals reflect the current state of the art and provide for future documentation maintenance on a page-by-page basis.

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Publication is carried out under the auspices of the Air Target Vulnerability Sub-Group of the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME). The Sub-Group membership includes:

Frank W. Sieve - Chairman, Naval Ordnance Systems Command

Donald W. Mowrer - Army Member, U. S. Army Ballistic Research Lab.

Orlando T. Johnson - Army Member, U. S. Army Ballistic Research Lab.

1/Lt. Abraham A. Santiago, Jr. - Air Force Member, Eglin AFB

Gerald B. Bennett, Jr. - Air Force Member, Wright Patterson AFB

Hubert W. Drake - Navy Member, Naval Weapons Center

W. Wallace Morton, Jr. - Navy Member, Naval Weapons Laboratory

Robert E. Gray - Chairman, Methodology Working Group, Naval Weapons Laboratory

SUMMARY

The MAGIC computer simulation generates target description data with the detail and completeness required for vulnerability studies. A combinatorial geometry technique is used in the simulation to represent a complex target structure. A large number of parallel rays, randomly located in grid cells, are traced through the target structure to produce item-by-item listings of the components and air spaces.

COMBINATORIAL GEOMETRY TECHNIQUE

The basic technique for a geometry description consists of defining the locations and shapes of the target physical regions (wall, equipment, etc.) utilizing the intersections and unions of the volumes of twelve simple body shapes. A special operator notation uses the symbols (+), (-), and (OR) to describe the intersections and unions. These symbols are used by the program to construct tables used in the ray-tracing portion of the program.

GEOMETRICAL DESCRIPTION

The user specifies the type and location of each body used to describe the target; and identifies physical regions in terms of these bodies. Each region is assigned an identification code for use with vulnerability analyses. A three-dimensional coordinate system is established in relation to the target, which is enclosed by a rectangular parallelepiped. A grid plane is established according to the attack angle desired, and parallel rays, starting randomly from each grid cell, are traced through the target.

INPUT

In the normal operating mode, target description data is input by cards. A portion of the routine converts the data to the form required for ray-tracing. The input data is checked; if errors are detected, messages are printed out. Error-free target description data may then be stored on magnetic tape and input in this form on subsequent production mode operations.

OUTPUT

The basic output is the results of the ray-tracing computations. A listing is obtained, for each grid cell, of the line-of-sight thickness for each geometrical region traversed, the obliquity of the ray with respect to the normal of the first surface of each region encountered, and the normal distance through each region.

OPTIONAL ROUTINES

Three optional routines are available to the user: special ray tracing used for target data checking; region volume calculations; and computing target presented area.

PROGRAMMING

The simulation, which is programmed using FORTRAN, requires a large-scale digital computer. The simulation is currently operational on both the CDC-6600 and BRL-BRLESC computers.

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SECTION I

INTRODUCTION

The MAGIC computer simulation generates target description data with the detail and completeness required for vulnerability studies. The target description data consists of item-by-item listings of the components and air spaces encountered by a large number of parallel rays emanating from any attack angle and passing through any type of target.

A combinatorial geometry technique is used to represent a complex three-dimensional target structure, such as a tank, in terms of sums, differences, and intersections of relatively simple bodies. The input for such a description consists of the geometric location and dimensions of the simple bodies followed by a region definition table consisting of a series of equations defining each region in terms of the simple bodies. In addition to the geometric description, a coded number is assigned to each region to identify its function.

The computer routine superimposes a grid cell pattern over the surface of the target, as viewed from the attack angle desired, randomly locating parallel rays in each grid cell. The computer traces each ray through the target; and each target item encountered is listed sequentially and identified as to ray location in the grid, target identification, line-of-sight thickness, normal thickness, angle of obliquity, identification of the air space following the target, and line-of-sight distance through the air space.

COMBINATORIAL GEOMETRY TECHNIQUE

The combinatorial geometry technique has been developed to produce a model that is both accurate and suitable for a ray-tracing analysis program. The basic technique for a geometry description requires defining the locations and shapes of the various physical regions (wall, equipment, etc.), utilizing the intersections and unions of the volumes of twelve simple bodies. The geometric bodies are as follows:

(1) Rectangular parallelepipied

(2) Box

(3) Sphere

(4) Right circular cylinder

(5) Right elliptical cylinder

(6) Truncated right angle cone

(7) Ellipsoid

(8) Right angle wedge

(9) Arbitrary convex polyhedron of four, five, or six sides

(10) Truncated elliptic cone

(11) Arbitrary surface

(12) Torus

A special operator notation uses the symbols (+), (-), and (OR) to describe the intersections and unions. These symbols are used by the program to construct tables used in the ray-tracing portion of the problem. If a body appears in a region description with a (+) operator, the region being described is wholly contained in the body. If a body appears in a region description with a (-) operator, the region being described is wholly outside the body. A region may be described in terms of several subregions lumped together by (OR) statements.

The technique of describing a physical region is best illustrated by examples. Imagine a mallet consisting of two cylinders. Call the mallet head solid number 1 and the handle solid number 2.

The two cylinders may be physically positioned and logically described in several ways. One way is to consider the handle and head as separate regions, as shown in Figure 1. The region description is region 1 = 1 and region 2 = 2-1.

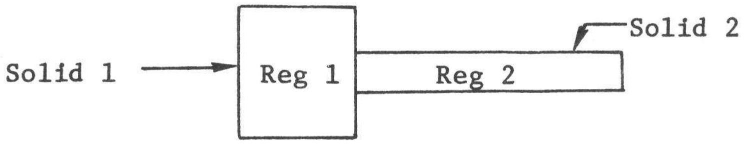


FIG. 1. Mallet with Handle and Head as Separate Regions

Another way is to think of the handle extending into the head, as shown in Figure 2. A logical method of describing this mallet is region 1 = 1-2 and region 2 = 2, indicating that the mallet head contains a cylindrical hole into which the handle is fitted.

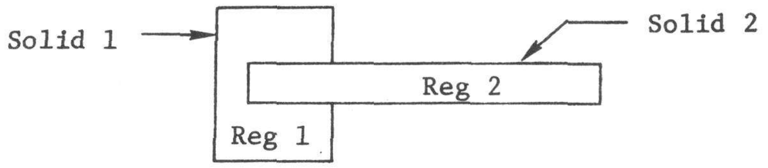


FIG. 2. Mallet with Handle Extending Into the Head

Now consider a description of a mallet physically similar to that in Figure 2 but whose handle consists of two types of material, one outside the mallet head and the other inside the head, as shown in Figure 3. A logical way to describe this is region 1 = 1-2, region 2 = 2-1, and region 3 = 1+2.

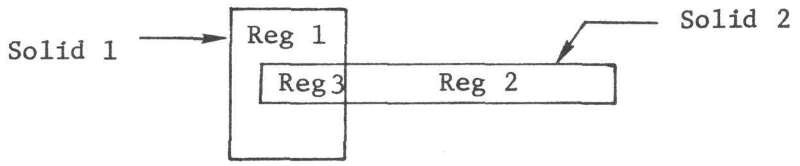


FIG. 3. Mallet with Handle Consisting of Two Types of Materials

A fourth way is to lump the mallet head and handle into one region, considering them to be like materials, as shown in Figure 4. The description then is region 1 = (OR) 1 (OR) 2. This means that a point in region 1 may be in either solid 1 or solid 2.

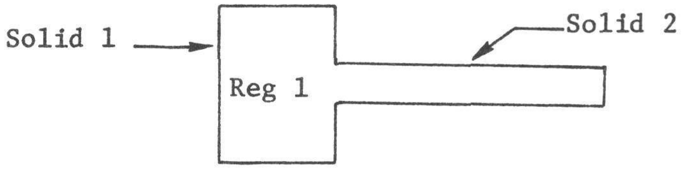


FIG. 4. Mallet with Head and Handle of Like Materials

A rule of construction imposes the additional restriction that region descriptions include negation (-) of buttressing surfaces not otherwise necessary to the logical description of the region. That is, if points on the surface of body 2 are common to parts of the surface of body 3, as shown in Figure 5, the description of region 200 is 200 = (+2) (-3). Region 300 is defined as 300 = (+3) (-2).

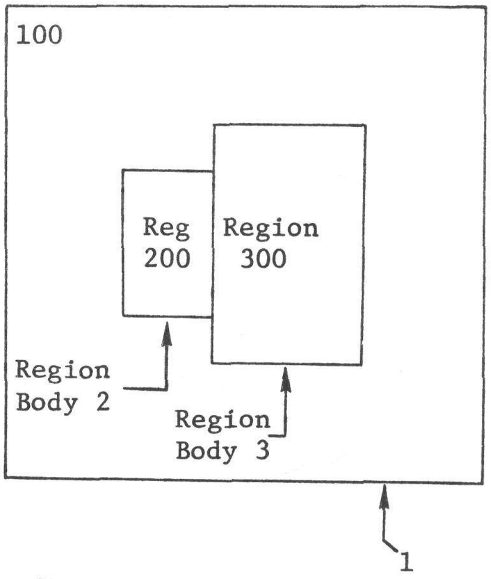


FIG. 5. Buttressing Surfaces

GEOMETRICAL DESCRIPTION

The user of the program must specify the geometrical description by establishing two tables. The first table describes the type and location of the set of bodies to be used. The second table identifies the physical region in terms of these bodies. The computer program converts these tables into the form required for ray tracing. Note well: all the space must be divided into regions, and no point may be in more than one region.

Coordinate System

The geometric figures used to define the target are located relative to one another by the use of a three-dimensional coordinate system superimposed on available engineering drawings. A readily identifiable reference point should be designated from which the three-dimensional coordinate system can easily be constructed. On armored vehicles such as tanks, the intersection of the turret datum line and the center lines of the turret forms a natural reference point for the coordinate system origin as illustrated by the simplified tank in Figure 6.

Rectangular Parallelepipeds (RPP)

Once the coordinate system is established, the target is inclosed in an environment consisting of rectangular parallelepipeds (RPP's). The RPP's are solid geometric figures used for gross subdivisions of the target environment, which consists of the air surrounding and the ground under the target.

Twelve RPP's are used for the nuclear analysis of targets, as shown in Figure 7, but only one RPP is required for conventional target analyses. Twelve RPP's should be considered for all target descriptions so as to standardize the target descriptions for use with either conventional or nuclear analyses.

Identification Codes

Each region is assigned an identification code for use with conventional vulnerability and MAGIC programs. A three-digit code is assigned to each component of the target, such as armor, gun tube; and a two-digit code is assigned to each space, such as inside air, outside air. A general division of identification codes might be as shown in Table 1. A component described using more than one region will have its ID assigned to each region.

Grid

All the rays that are traced through the target geometry originate in the grid plane, which is a plane divided into equal squares called grid cells and oriented so that a ray passed perpendicularly from the center of the plane

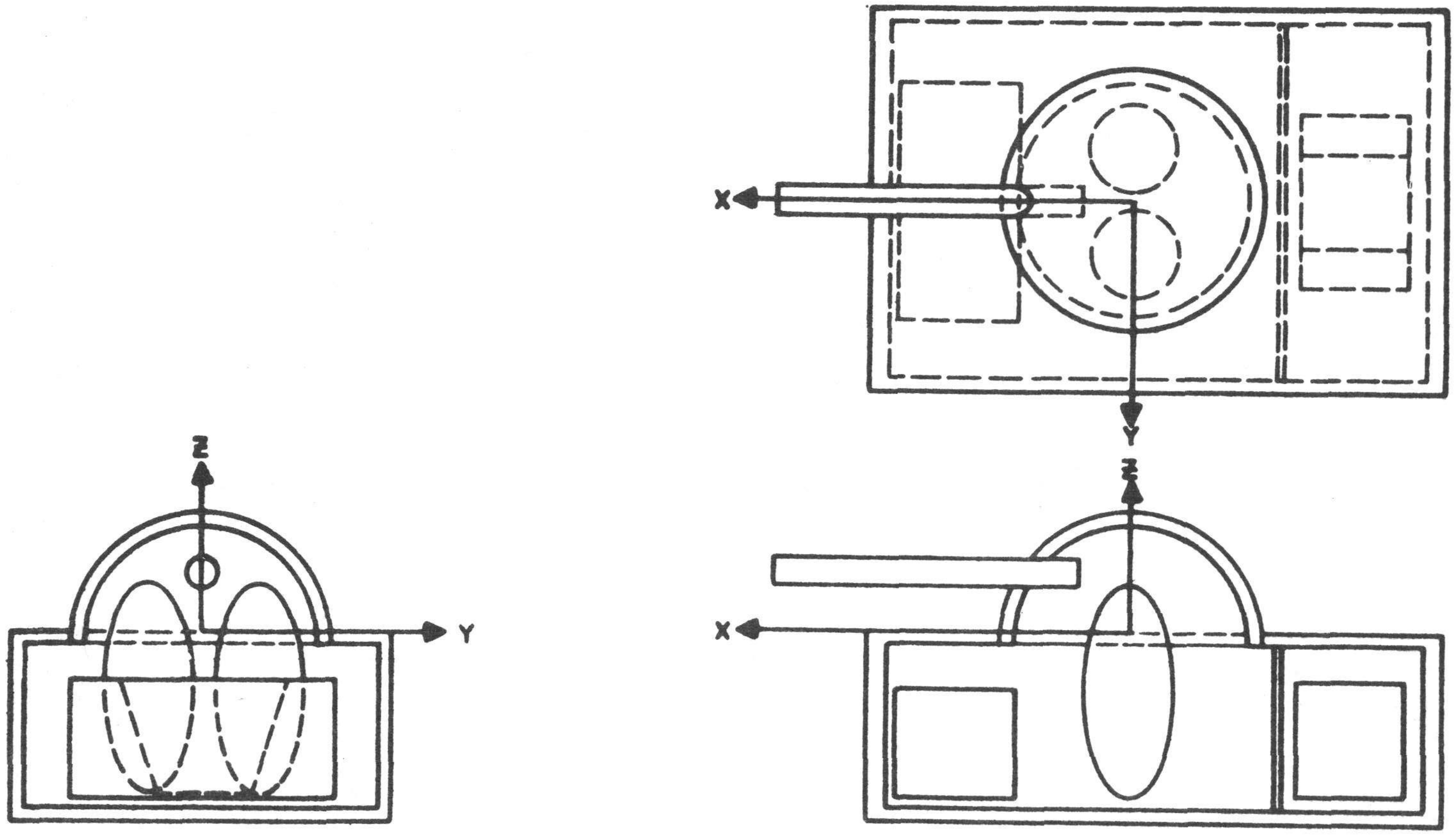


FIG. 6. Coordinate System Superimposed on Simplified Tank

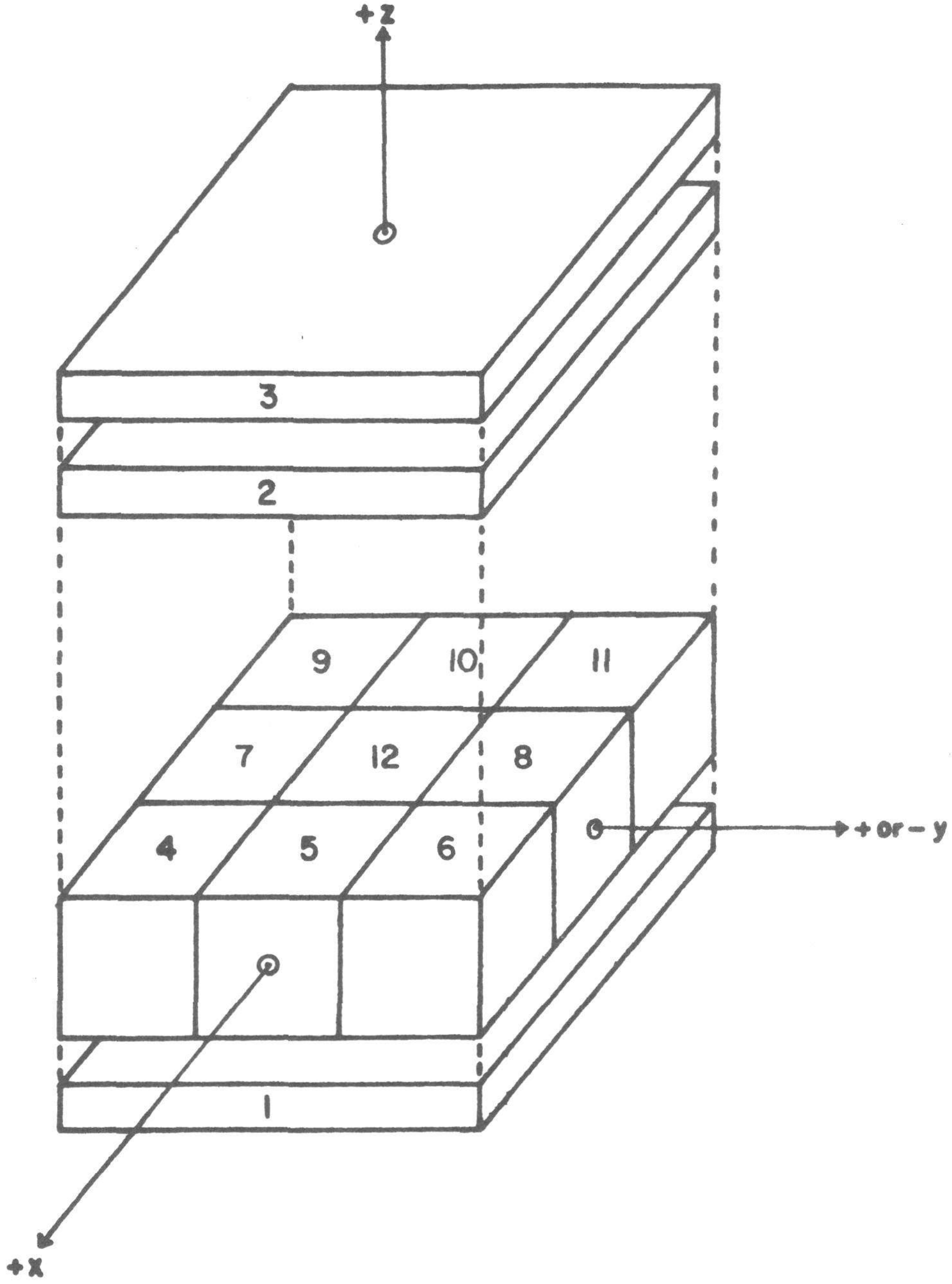


FIG. 7. Twelve RPP's

TABLE 1. Identification Codes

Component Codes

ID Codes	Type of Component
001-099	Internal components
100-199	Types of armor
200-299	Fuel components
300-399	Miscellaneous exterior components
400-499	Gun components
500-599	Track suspension components*
600-699	Wheel suspension components
700-799	Power train components
800-899	Miscellaneous components
900-998	Not used at present
999	The ground

*ID Code 501 is reserved for the track; the computer assigns 502 if the track edge is hit.

Space Codes

Space Number	Type of Space
00	Not used at present
01	External air
02	Crew compartment air
03	Not used at present
04	Not used at present
05	Engine compartment air
06	Not used at present
07	Not used at present
08	Not used at present
09	No further target

NOTE: The operation of the MAGIC program will not allow assigning different space codes to bounding regions. In other words, a ray passing through the geometry cannot pass directly from outside air (01) to inside air (02). There must be a three-digit coded item between different space regions.

to the target will intersect the target coordinate system origin. The grid plane is established with the following information: grid size, attack angle of the target, and back-off distance from the origin of the coordinate system.

The attack angle is specified in terms of an azimuth and elevation angle using a right-handed coordinate system. A positive azimuth angle is measured from the positive X axis in a counterclockwise direction when viewed from above, as shown in Figure 8. Elevation angles are measured from the X-Y plane positive upward.

The back-off distance is the distance from the origin of the coordinate system used in the target description to the grid plane. All the rays originating from a common grid plane must start in the same region; therefore, the grid plane must be placed within the bounds of one region. If the grid plane is to include the entire target, it must lie outside the target as described in the region description. If only a certain component of the target is to be considered (for instance, the engine of a tank), care must be taken to insure that the grid plane lies outside the engine as described, that it lies within the bounds of only one region, and that all rays end in a common region.

Cellular Output

The basic output of the MAGIC simulation consists of cellular output obtained from the ray tracing computations. The ray tracing phase is the process whereby rays (one for each cell) are traced perpendicularly from the grid plane through the target geometry. The calculated output for each ray consists of the line-of-sight thickness of each geometric region traversed, the obliquity (angle of incidence) of the ray with respect to the first surface of each region encountered (excluding air or spaces), and the normal or perpendicular distance through each region from the point of entry (excluding air or spaces). One unique feature of the program is that thicknesses of bounding geometric regions with like functional identifiers are cumulative. A representative vehicle section for target cell description data is shown in Figure 9.

Data Input Error

The simulation contains statements to check the validity of the target geometry data. Some of the errors are considered fatal and will cause execution to terminate, while others will be noted and special error messages printed. A tally is maintained of the non-fatal errors; if they exceed a specified number, execution terminates. Table 2 lists the error items and the subroutine in the simulation where the error check statement is located.

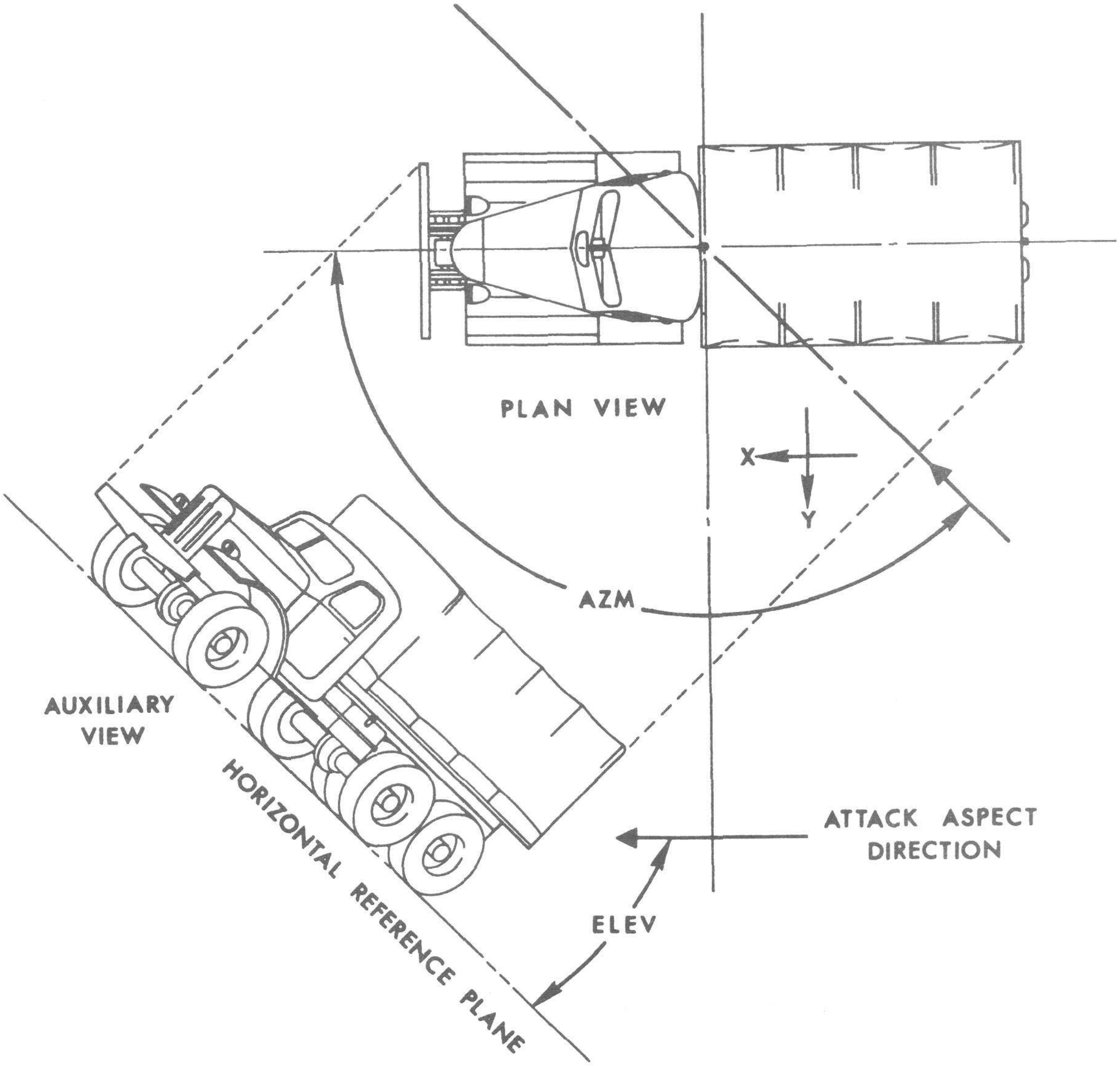


FIG. 8. Attack Angle Geometry

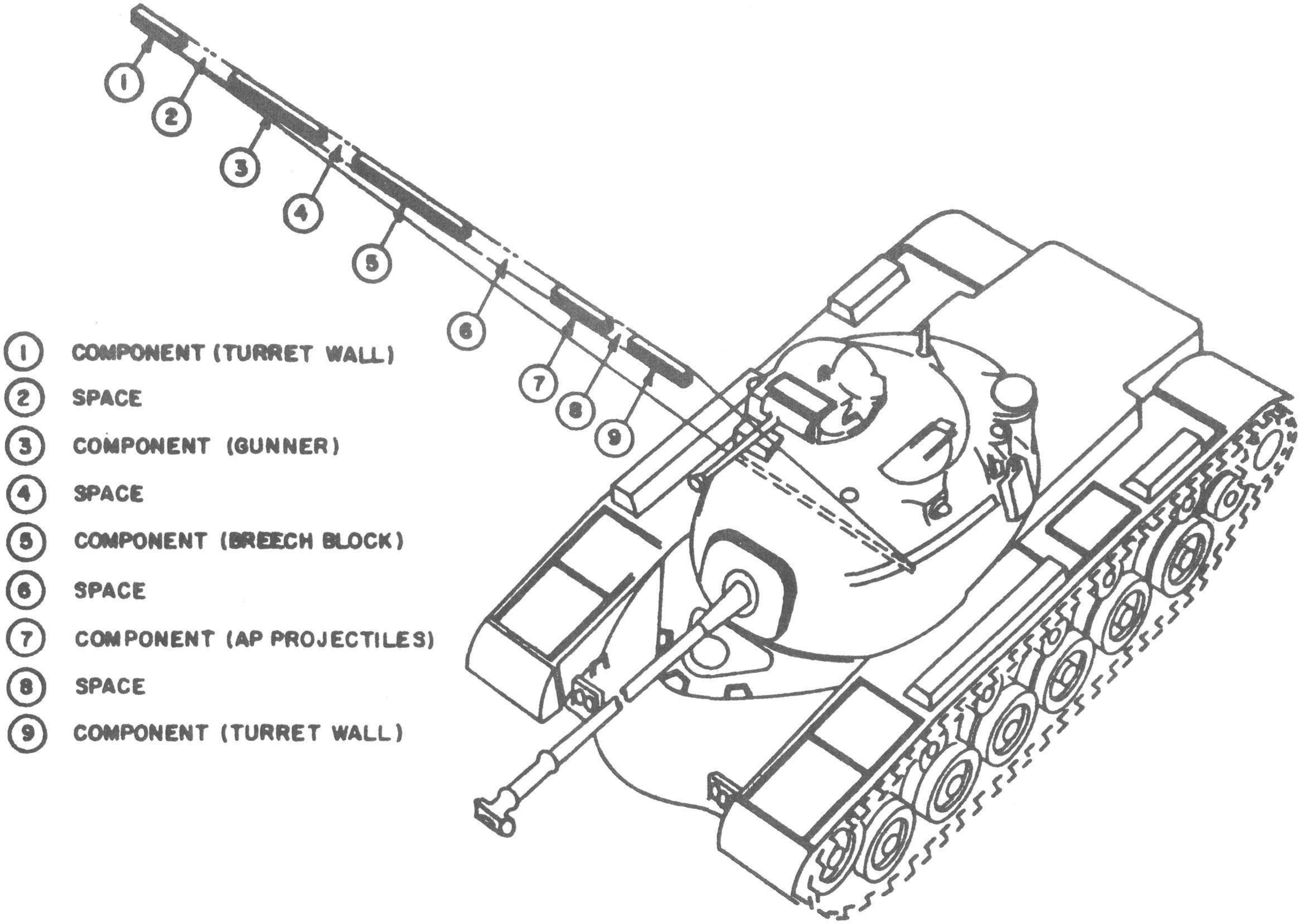


FIG. 9. Representative Vehicle Section for Target Cell Description Data

TABLE 2. Data Input Errors

Subroutine	Description	Error Type
GENI	Body card does not contain correct body abbreviation	Fatal
	Minor radius of torus equal to or greater than major radius	Non-fatal
	Semi-major and semi-minor axes of truncated elliptical cone are not perpendicular or height vector is parallel to base	Non-fatal
	Radii of upper and lower bases same for truncated elliptical cone	Non-fatal
	Vectors used to describe a box, right angle wedge, or truncated elliptical cone are not mutually perpendicular	Non-fatal
	Storage locations for body data exceed allowable value	Fatal
	Logical operator was not located	Fatal
	Storage locations for region data exceed allowable value	Fatal
	Number of regions in region table input does not match the number of regions specified	Fatal
	Number of body description cards does not match the number specified	Fatal
	Region description error	Fatal
	Storage for enter/leave table exceeded	Fatal
RPPIN	RPP description errors	Fatal

TABLE 2. (Concluded)

Subroutine	Description	Error Type
ALBERT	Undefined plane in arbitrary convex polyhedron (ARB) input	Non-fatal
	Four points describing a face of of ARB are not in a plane	Non-fatal
	Error in numering points of ARB	Non-fatal
VOLUM	Next region number negative	Fatal
MAIN	No storage available for region identification data	Fatal
CALC	Error in body type number	Fatal
	No normal found for arbitrary surface	Non-fatal
G1	Error in body type number	Non-fatal
	No intersect found in region	Non-fatal
	Error in body number of intersected RPP	Non-fatal
	Error in surface number of intersected RPP	Non-fatal
	No entries in region enter table	Non-fatal
	No region found for present point	Non-fatal
	Distance to next region is less than zero	Non-fatal
WOWI	Error in body type number	Non-fatal
ARS	Data in hit table is in error	Non-fatal
RPP	More than two surfaces of RPP were intersected	Non-fatal
AREA	Storage for area data exceeded	Fatal

OPTIONAL ROUTINES

Three optional subroutines--TESTG, VOLUM, and AREA--are available to the user for performing special computations.

Subroutine TESTG

This routine may be used to trace a specified number of rays in any portion of the target. These special computations are useful in checking the input data target geometry and region specifications.

Subroutine VOLUM

This routine may be used to compute the volume of each region contained within a specified portion of the target. An imaginary box is specified, and the volume of each region in the box is computed.

Subroutine AREA

This routine may be used to compute the presented area of the target as viewed from the specified attack angle. The presented area data is categorized according to the component identification number of the first component struck by the rays and to the total target.

SECTION II

INPUT

Three types of target description data are required by the MAGIC computer program. One type is the geometric figures that are used to approximate the solid bodies comprising the target. If these figures were put into a perspective drawing, they would look like a haphazard, generally unrecognizable collection of lines and surfaces. The second type of target description data combines the geometric figures into regions forming the actual components of the target. If each region were identified by a unique color or shading, the shapes that appear would closely resemble the components of the target being described. The third type of target description data assigns identification code numbers to the defined regions of the target.

These three types of description data are illustrated in Figure 10 and Tables 3, 4, and 5. Figure 10 shows the target as a simplified tank described by eleven geometric figures and eleven regions. Table 3 lists the 11 geometric figures used to represent the solid bodies.

TABLE 3. Bodies Used to Represent Tank

Body Number	Body Type
13	Box
14	Box
15	Sphere
16	Sphere
17	Right circular cylinder
18	Box
19	Box
20	Arbitrary convex polyhedron
21	Ellipsoid of revolution
22	Ellipsoid of revolution
23	Box

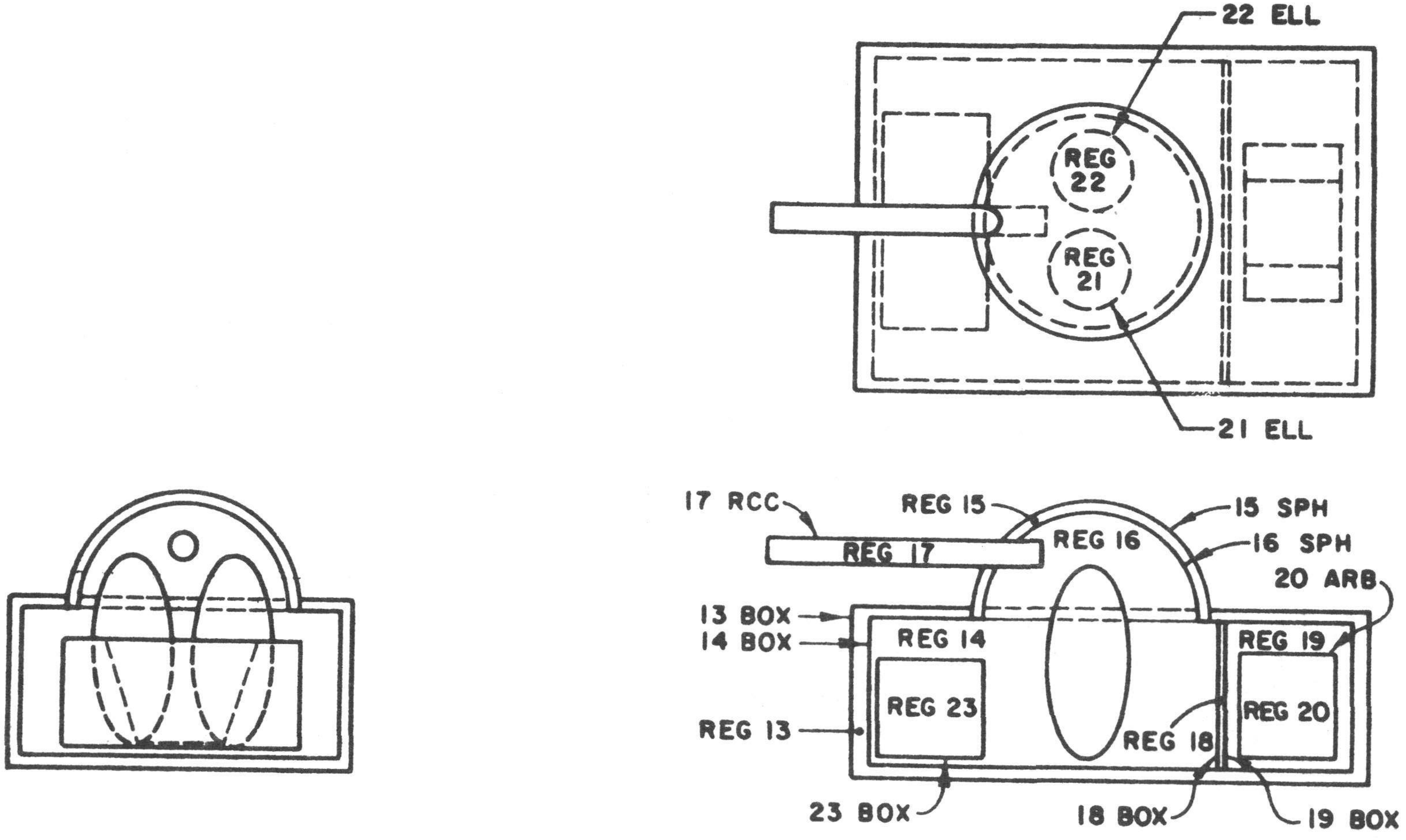


FIG. 10. Simplified Tank

Table 4 shows the manner in which the geometric figures are combined into regions forming the actual components.

TABLE 4. Region Table for Tank

Region Number	Body Numbers With Combinatorial Operators Used to Create Region
13	13 -14 -15 -18 -19
14	13 +14 -18 -21 -22 -23
15	15 -17 -14 -16
16	15 +16 -14 -17 -21 -22
17	17
18	13 +14 +18 -19
19	13 +14 +18 +19 -20
20	13 +14 +18 +19 +20
21	21
22	22
23	13 +14 +23

An explanation of region 15, the turret armor, shown in Figure 10, illustrates the logic of the region descriptions shown in Table 4. Region 15 is described in Table 4 as

Region 15 = 15 -17 -14 -16

Since the space being described lies within body 15 but does not include the space in body 16, the description contains a + 15 (the + sign being implied in this case) and a -16. The turret armor shell now must be cut off where it extends into the hull. A -14 cuts this shell off at the inside edge of the hull armor. Since the gun tube extends through the turret armor and has a different material and function, it requires a different code in a vulnerability analysis and should be "negated" from the turret armor region; thus we obtain the -17.

Table 5 lists the identification codes for the tank.

TABLE 5. Tank Identification Codes

Region Number	Item Code	Space Code	Description of Region
13	101		Steel armor hull
14		02	Inside air (crew)
15	102		Steel armor turret
16		02	Inside air (crew)
17	401		Gun barrel
18	334		Bulkhead
19		05	Inside air (engine)
20	701		Engine
21	041		Driver
22	001		Commander
23	007		Ammunition

A complex target requires a large amount of descriptive data. A portion of the MAGIC program is devoted to reading data cards and to checking and storing the data. A user option is to store the target description data on magnetic tape so that on subsequent program executions the target data processing portion of the MAGIC program will not be required.

DESCRIPTION OF INPUT

This section contains descriptions of the input variables required to execute the MAGIC program. The descriptions include the variable names, definitions, and data card formats. Following is a list of the data cards:

Card	Title	
1	Program Option Card	
2	Title Card for Target	
3	Target Input Constants	
4	Rectangular Parallelepiped (RPP)	
5	Body Description, Box (BOX)	
6	Body Description, Sphere (SPH)	
7	Body Description, Right Circular Cylinder (RCC)	
8	Body Description, Right Elliptical Cylinder (REC)	
9	Body Description, Truncated Right Angle Cone (TRC)	
10	Body Description, Ellipsoid of Revolution (ELL)	*
11	Body Description, Right Angle Wedge (RAW)	
12	Body Description, Arbitrary Convex Polyhedron (ARB)	
13	Body Description, Truncated Elliptic Cone (TEC)	
14	Body Description, Arbitrary Curved Surface (ARS)	
15	Body Description, Torus (TOR)	
16	Region Table Input	
17	Special Ray Tracing Input (Optional)	
18	Special Volume Input (Optional)	
19	Region Identification Data	
20	Specification Card	
21	Grid Cell Description	
22	Subroutine AREA Input (Optional)	

*Body description cards are used as required to describe the target. The type and arrangement will vary accordingly.

Program Option Card

CARD: 1

A B C D E F G

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION	
A	IRDTP4	ND*	I10	1-10	IRDTP4 ≠ 0	Processed target geometry data is to be entered from magnetic tape.
					IRDTP4 = 0	Target geometry data is to be entered from cards.
B	IWRTP4	ND	I10	11-20	IWRTP4 ≠ 0	Processed target geometry is to be stored on magnetic tape.
					IWRTP4 = 0	Processed target geometry will not be stored on magnetic tape.
C	ITESTG	ND	I10	21-30	ITESTG ≠ 0	Execute special ray tracing for a specified number of rays (see Card 17). This option is used for target data checkout.
					ITESTG = 0	Do not trace special rays.
D	IRAYSK	ND	I10	31-40	IRAYSK ≠ 0	Perform computations for a random number of grid cells.
					IRAYSK = 0	Perform computations for all grid cells.
E	ICARDI	ND	I10	41-50	Not Used	Leave blank.
		*Non-dimensional				

CARD: 1

Program Option Card (Concluded)

CARD: 1 (Concluded)

A B C D E F G

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
F	IENTLV	ND	I10	51-60	IENTLV $\neq 0$ Print out enter/leave tables generated by program. IENTLV = 0 Omit printout of enter/leave tables.
G	IVOLUM	ND	I10	61-70	IVOLUM $\neq 0$ Subroutine VOLUM will be executed to compute the volumes of each region contained within a specified portion of the target (see Card 18). IVOLUM = 0 Subroutine VOLUM will not be executed.

CARD: 1

Title Card for Target

CARD: 2

A

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IT(I)	ND	10A6	1-60	Alphameric characters representing the target's title. The total field width is 60 characters.

CARD: 2

Target Input Constraints

CARD: 3

A	B	C	D	E	F	G
1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70

71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	NRPP	ND	I10	1-10	Number of rectangular parallelepipeds (RPP's) used to describe the target's environment.
B	NTRIP	ND	I10	11-20	Not used.
C	NSCAL	ND	I10	21-30	Not used.
D	NBODY	ND	I10	31-40	Number of geometric figures, other than RPP's, used to describe the target regions. There must be NBODY body cards in the data deck.
E	NRMAX	ND	I10	41-50	Number of regions used to describe the target geometry. There must be NRMAX region description cards in the data deck.
F	IPRIN	ND	I10	51-60	IPRIN ≠ 0 Print processed target geometry that is stored in the MASTER-ASTER array.
					IPRIN = 0 Do not print processed target geometry.
G	IRCHEK	ND	I10	61-70	IRCHEK ≠ 0 Exercise check for duplicate region data.
					IRCHEK = 0 Omit check for duplicate region data.

CARD: 3

Rectangular Parallelepiped (RPP). One card for each RPP. Refer to Figure 11.

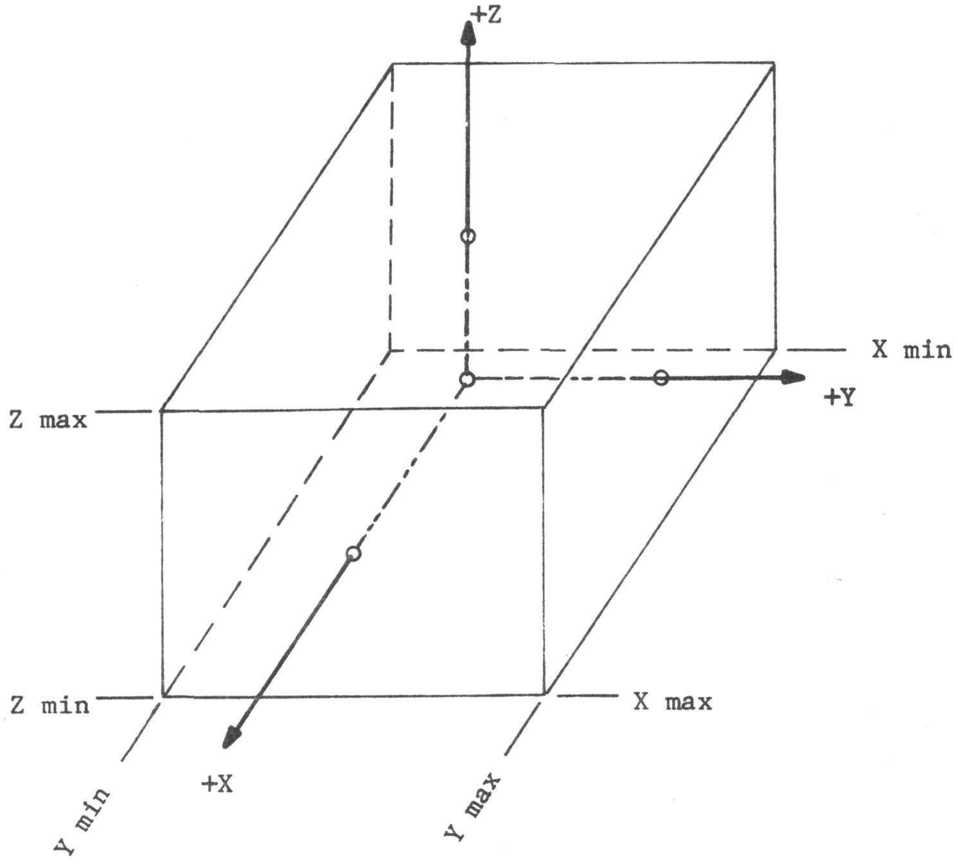
CARD: 4

A B C D E F

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
					<u>Note</u>: RPP cards must be arranged according to their ordinal numbers.
A	X(1)	Inches*	E12.6	1-12	X min boundary coordinate of RPP
B	X(2)	Inches	E12.6	13-24	X max boundary coordinate of RPP
C	X(3)	Inches	E12.6	25-36	Y min boundary coordinate of RPP
D	X(4)	Inches	E12.6	37-48	Y max boundary coordinate of RPP
E	X(5)	Inches	E12.6	49-60	Z min boundary coordinate of RPP
F	X(6)	Inches	E12.6	61-72	Z max boundary coordinate of RPP

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 4



Specify the maximum and minimum values of the X, Y, Z coordinates which bound the parallelepiped. A special requirement for the RPP is that the bounding planes must be parallel to the coordinate axes.

FIG. 11. Rectangular Parallelepiped Geometry

Body Description: BOX. First of two cards required for each box used.

CARD: 5A

A	B	C	D	E	F	G	H	I
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit <u>must</u> be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters BOX denoting that the body is a box.
C	IC(J)	ND	A4	7-10	Not used.
D	FX(1)	Inches*	F10.5	11-20	X, Y, and Z coordinates, respectively, of vertex V at one of the corners of the box (see Figure 12).
E	FX(2)	Inches	F10.5	21-30	
F	FX(3)	Inches	F10.5	31-40	
G	FX(4)	Inches	F10.5	41-50	X, Y, and Z components, respectively, of <u>one</u> of the mutually perpendicular vectors, $\overline{A}$, $\overline{B}$, and $\overline{C}$ (see Figure 12) representing the height, width, and length of the box.
H	FX(5)	Inches	F10.5	51-60	
I	FX(6)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 5A

Body Description: BOX. Second of two cards required for each box used.

CARD: 5B

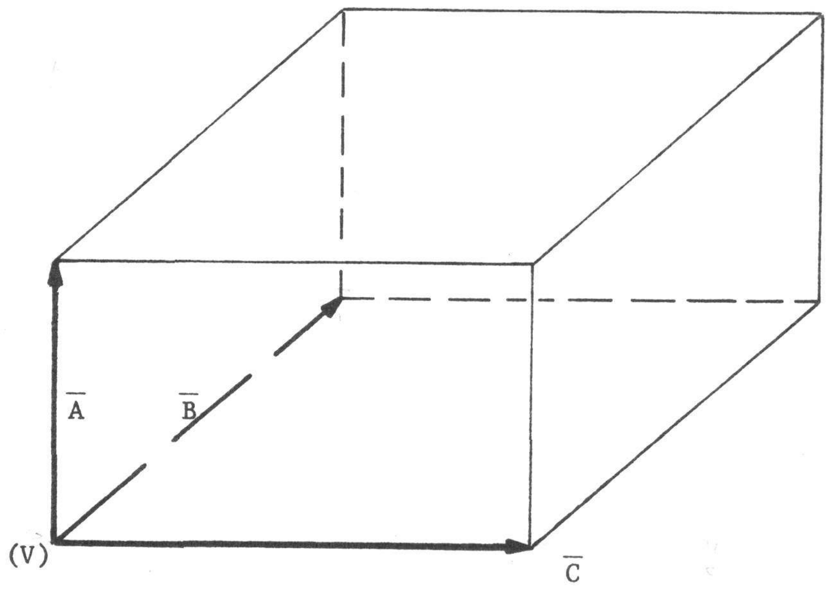
A B C D E F

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	FX(7)	Inches*	F10.5	11-20	X, Y, and Z components, respectively, of one of the mutually perpendicular vectors, $\overline{A}$, $\overline{B}$, and $\overline{C}$ (see Figure 12).
B	FX(8)	Inches	F10.5	21-30	
C	FX(9)	Inches	F10.5	31-40	
D	FX(10)	Inches	F10.5	41-50	X, Y, and Z components, respectively, of one of the mutually perpendicular vectors, $\overline{A}$, $\overline{B}$, and $\overline{C}$ (see Figure 12).
E	FX(11)	Inches	F10.5	51-60	
F	FX(12)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 5B



Specify the vertex, V, at one of the corners by giving the X, Y, Z coordinates. Specify the X, Y, Z components of the three mutually perpendicular vectors, $\overline{A}$, $\overline{B}$, and $\overline{C}$, representing the height, width, and length of the box. Note that the only geometric difference between a BOX and an RPP is that a BOX may be arbitrarily oriented, but the bounding planes of an RPP must be parallel to the coordinate axes. Also, the BOX and RPP serve different functional uses. The RPP may be used only to describe the enclosing environment regions of the target but not any portion of the target itself. The BOX is used for describing portions of the target.

Card Columns

Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 2	Solid Number	BOX	V_x	V_y	V_z	A_x	A_y	A_z
2 of 2	Blank		B_x	B_y	B_z	C_x	C_y	C_z
The three vectors, $\overline{A}$, $\overline{B}$, and $\overline{C}$, may be interchanged on the cards.								

FIG. 12. Box Input

Body Description: Sphere. One card for each sphere used.

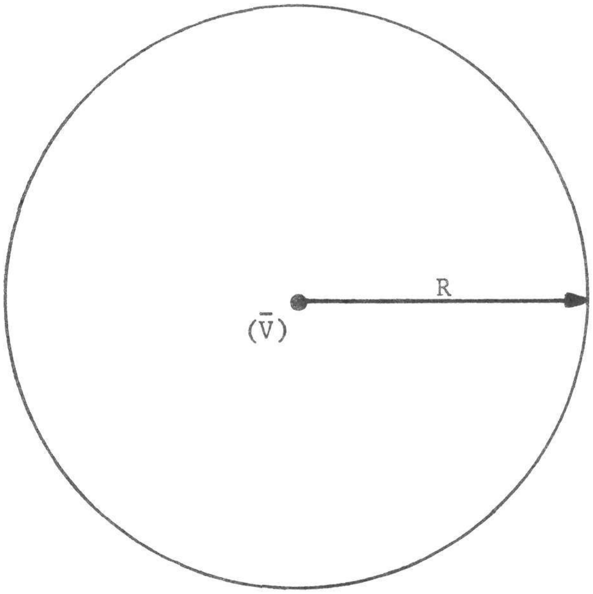
CARD: 6

A	B	C	D	E	F	G	
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters SPH denoting that the body is a sphere.
C	IC(J)	ND	A4	7-10	Not used.
D E F	FX(1) FX(2) FX(3)	Inches* Inches Inches	F10.5 F10.5 F10.5	11-20 21-30 31-40	X, Y, and Z coordinates, respectively, of vertex V at the center of the sphere (see Figure 13).
G	FX(4)	Inches	F10.5	41-50	Radius R of the sphere (see Figure 13).

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 6



Specify vertex $\bar{V}$ at the center and scalar R denoting the radius.

Number of Cards	Card Columns						
	1-3	4-6	11-20	21-30	31-40	41-50	
1 of 1	Solid Number	SPH	V_x	V_y	V_z	R	

FIG. 13. Sphere Input

Body Description: Right Circular Cylinder (RCC). First of two cards required for each RCC used.

CARD: 7A

A	B	C	D	E	F	G	H	I	
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters RCC denoting that the body is a right circular cylinder.
C	IC(J)	ND	A4	7-10	Not used.
D	FX(1)	Inches*	F10.5	11-20	X, Y, and Z coordinates, respectively, of the vertex, V, at the center of one base of the cylinder (see Figure 14).
E	FX(2)	Inches	F10.5	21-30	
F	FX(3)	Inches	F10.5	31-40	
G	FX(4)	Inches	F10.5	41-50	X, Y, and Z components, respectively, of height vector $\overline{H}$ (see Figure 14).
H	FX(5)	Inches	F10.5	51-60	
I	FX(6)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 7A

Body Description: Right Circular Cylinder (RCC). Second of two cards required for each RCC used.

CARD: 7B

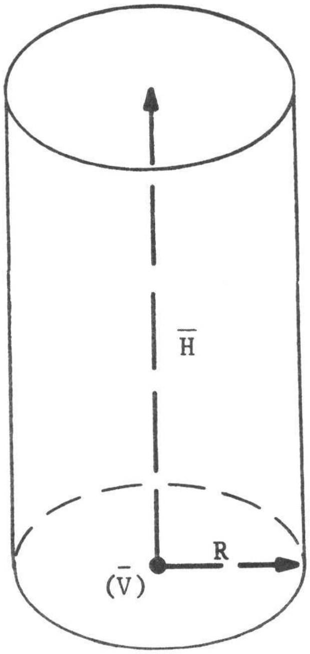
A

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	FX(7)	Inches*	F10.5	11-20	Radius R of the cylinder's base (see Figure 14).

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 7B



Specify vertex $\bar{V}$ at the center of one base, height vector $\bar{H}$, and scalar R denoting the base radius.

	Card Columns							
Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 2	**Solid Number**	RCC	V_x	V_y	V_z	H_x	H_y	H_z
2 of 2	Blank		R	Blank				

FIG. 14. Right Circular Cylinder Input

Body Description: Right Elliptical Cylinder (REC). First of two cards required for each REC used.

CARD: 8A

A	B	C	D	E	F	G	H	I	
1 2 3	4 5 6	7 8 9 10	11–20	21–30	31–40	41–50	51–60	61–70	71–80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters REC denoting that the body is a right elliptical cylinder.
C	IC(J)	ND	A4	7-10	Not used.
D	FX(1)	Inches*	F10.5	11-20	X, Y, and Z coordinates, respectively, of center V of the base ellipse (see Figure 15).
E	FX(2)	Inches	F10.5	21-30	
F	FX(3)	Inches	F10.5	31-40	
G	FX(4)	Inches	F10.5	41-50	X, Y, and Z components, respectively, of height vector $\overline{H}$ (see Figure 15).
H	FX(5)	Inches	F10.5	51-60	
I	FX(6)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 8A

Body Description: Right Elliptical Cylinder (REC). Second of two cards required for each REC used.

CARD: 8B

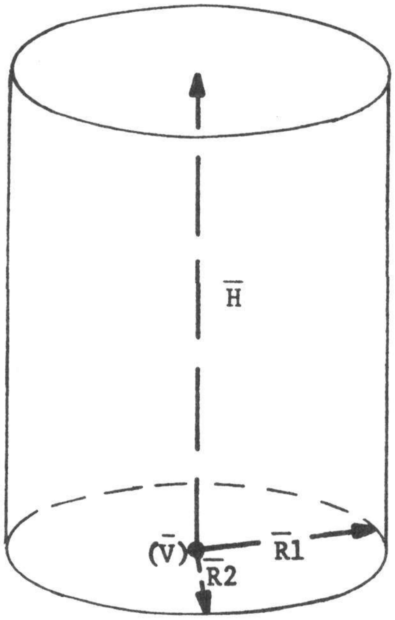
A B C D E F

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	FX(7)	Inches*	F10.5	11-20	X, Y, and Z components, respectively, of the vector $\overline{R1}$ defining the semi-major axis of the base ellipse (see Figure 15).
B	FX(8)	Inches	F10.5	21-30	
C	FX(9)	Inches	F10.5	31-40	
D	FX(10)	Inches	F10.5	41-50	X, Y, and Z components, respectively, of the vector $\overline{R2}$ defining the semi-minor axis of the base ellipse (see Figure 15).
E	FX(11)	Inches	F10.5	51-60	
F	FX(12)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 8B



Specify the coordinates of $\bar{V}$, the center of the base ellipse, height vector $\bar{H}$, and vectors $\overline{R1}$ and $\overline{R2}$ in the base plane defining the semi-major and semi-minor axes, respectively.

	Card Columns							
Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 2	**Solid Number**	REC	V_x	V_y	V_z	H_x	H_y	H_z
2 of 2	Blank		$R1_x$	$R1_y$	$R1_z$	$R2_x$	$R2_y$	$R2_z$

FIG. 15. Right Elliptical Cylinder Input

Body Description: Truncated Right Angle Cone (TRC). First of two cards required for each TRC used.

CARD: 9A

A	B	C	D	E	F	G	H	I	
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters TRC denoting that the body is a truncated right angle cone.
C	IC(J)	ND	A4	7-10	Not used.
D	FX(1)	Inches*	F10.5	11-20	X, Y, and Z coordinates, respectively, of vertex V at the center of the base of the cone (see Figure 16).
E	FX(2)	Inches	F10.5	21-30	
F	FX(3)	Inches	F10.5	31-40	
G	FX(4)	Inches	F10.5	41-50	X, Y, and Z components, respectively, of height vector $\overline{H}$ (see Figure 16).
H	FX(5)	Inches	F10.5	51-60	
I	FX(6)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 9A

Body Description: Truncated Right Angle Cone (TRC). Second of two cards required for each TRC used.

CARD: 9B

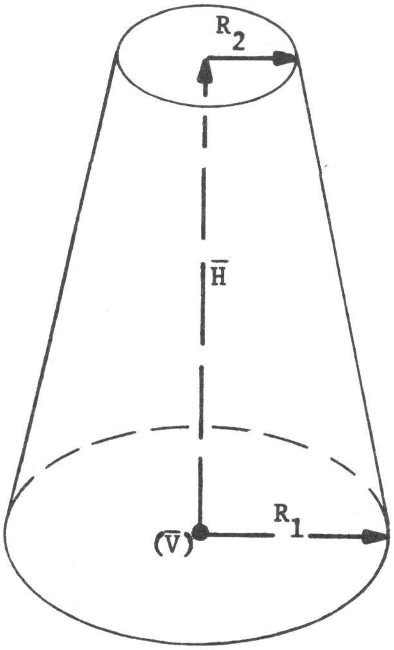
A B

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	FX(7)	Inches*	F10.5	11-20	Radius R1 of the larger base circle of the cone (see Figure 16).
B	FX(8)	Inches	F10.5	21-30	Radius R2 of the smaller base circle of the cone (see Figure 16).

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 9B



Specify vertex $\bar{V}$ at the center of the larger base, height vector $\bar{H}$, and scalars R_1 and R_2 denoting the radii of the larger and smaller bases, respectively.

Number of Cards	Card Columns 1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 2	Solid Number	TRC	V_x	V_y	V_z	H_x	H_y	H_z
2 of 2	Blank		R_1	R_2	Blank			

FIG. 16. Truncated Right Angle Cone Input

Body Description: Ellipsoid of Revolution (ELL). This is the first of two cards required for each ELL used.

CARD: 10A

A	B	C	D	E	F	G	H	I	
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters ELL denoting that the body is an ellipsoid of revolution.
C	IC(J)	ND	A4	7-10	Used to specify which characteristics of the ELL will be input. See below.
D E F	FX(1) FX(2) FX(3)	Inches* Inches Inches	F10.5 F10.5 F10.5	11-20 21-30 31-40	If IC(J) is blank, the X, Y, and Z coordinates of focus F1 are input (see Figure 17). If IC(J) is not blank, the X, Y, and Z coordinates of vertex V at the geometric center of the ELL are input (see Figure 17).
G H I	FX(4) FX(5) FX(6)	Inches Inches Inches	F10.5 F10.5 F10.5	41-50 51-60 61-70	If IC(J) is blank, the X, Y, and Z coordinates of focus F2 are input (see Figure 17). If IC(J) is not blank, input the X, Y, and Z coordinates of the vector $\overline{A}$ defining the semi-major axis (see Figure 17)

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 10A

Body Description: Ellipsoid of Revolution (ELL). This is the second of two cards required for each ELL used.

CARD: 10B

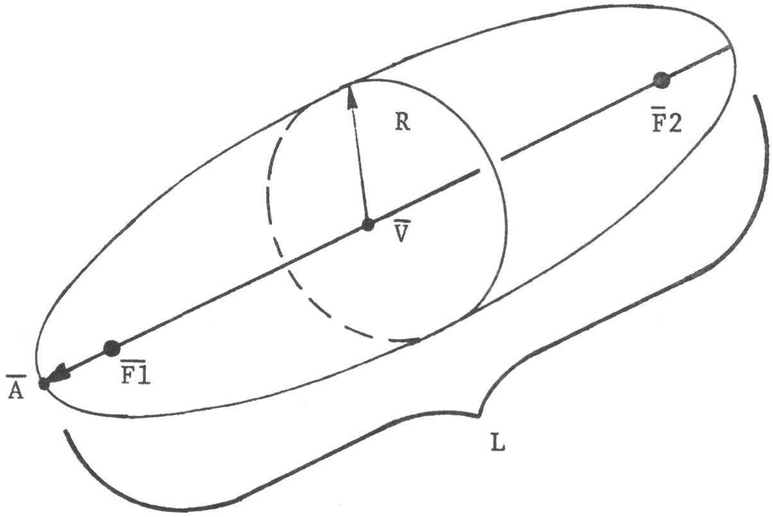
A

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	FX(7)	Inches*	F10.5	11-20	If (IC(J) is blank, length L of the major axis is input (see Figure 17). If IC(J) is not blank, radius R of the circular section taken at the center of the ellipsoid is input (see Figure 17).

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 10B



Specify either (1) the X, Y, Z coordinates of foci F1 and F2 and scalar L denoting the length of the major axis; or (2) the X, Y, Z coordinates of vertex $\overline{V}$ at the geometric center, the vector $\overline{A}$ defining the semi-major axis, and scalar R denoting the radius of the circular section taken at the center.

Card Columns

Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70	
1 of 2	Solid Number	ELL	$F1_x$	$F1_y$	$F1_z$	$F2_x$	$F2_y$	$F2_z$	IC(J) Blank*
2 of 2	Blank		L	Blank					

1 of 2	Solid Number	ELL	V_x	V_y	V_z	A_x	A_y	A_z	IC(J) Not Blank
2 of 2	Blank		R	Blank					

*The two foci may be interchanged in the card format.

FIG. 17. Ellipsoid of Revolution Input

Body Description: Right Angle Wedge (RAW). First of two cards required for each RAW used.

CARD: 11A

A	B	C	D	E	F	G	H	I	
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1 .
B	ITYPE	ND	A3	4-6	Alphameric characters RAW denoting that the body is a right angle wedge.
C	IC(J)	ND	A4	7-10	Not used.
D	FX(1)	Inches*	F10.5	11-20	X, Y, and Z coordinates, respectively, of vertex V at one of the right-angle corners (see Figure 18).
E	FX(2)	Inches	F10.5	21-30	
F	FX(3)	Inches	F10.5	31-40	
G	FX(4)	Inches	F10.5	41-50	X, Y, and Z components, respectively, of one of the legs, $\overline{A}$ or $\overline{B}$, of the right triangle (see Figure 18).
H	FX(5)	Inches	F10.5	51-60	
I	FX(6)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 11A

Body Description: Right Angle Wedge (RAW). Second of two cards required for each RAW used.

CARD: 11B

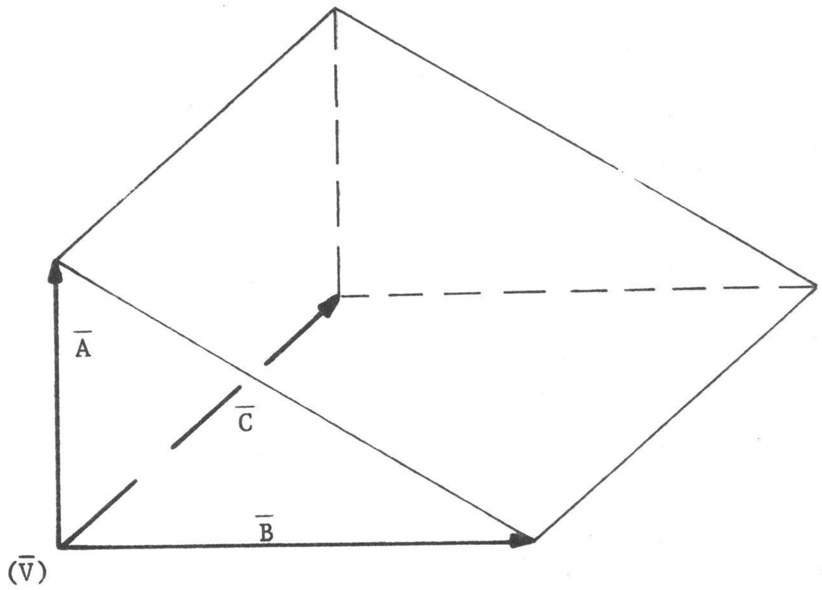
A B C D E F

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	FX(7)	Inches*	F10.5	11-20	X, Y, and Z components, respectively, of one of the legs, $\overline{A}$ or $\overline{B}$, of the right triangle (see Figure 18).
B	FX(8)	Inches	F10.5	21-30	
C	FX(9)	Inches	F10.5	31-40	
D	FX(10)	Inches	F10.5	41-50	X, Y, and Z components of vector $\overline{C}$ defining the width of the wedge (see Figure 18).
E	FX(11)	Inches	F10.5	51-60	
F	FX(12)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 11B



Specify vertex $\overline{V}$ at one of the right-angled corners by giving the X, Y, and Z coordinates. Specify the components of the three mutually perpendicular vectors, of which two, $\overline{A}$ and $\overline{B}$, are the legs of the right triangle formed, and the third, $\overline{C}$, is the width of the wedge.

	Card Columns							
Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 2	Solid Number	RAW	V_x	V_y	V_z	A_x	A_y	A_z
2 of 2	Blank		B_x	B_y	B_z	C_x	C_y	C_z
The two legs, $\overline{A}$ and $\overline{B}$, may be interchanged in the card format.								

FIG. 18. Right Angle Wedge Input

Body Description: Arbitrary Convex Polyhedron (ARB). First of five cards required for each ARB used.

CARD: 12A

A	B	C	D	E	F	G	H	I	
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters ARB denoting that the body is an arbitrary convex polyhedron.
C	IC(J)	ND	A4	7-10	Not used.
D	FX(1)	Inches*	F10.5	11-20	X, Y, and Z coordinates, respectively, of the first of eight vertices of the ARB (see Figures 19, 20, and 21).
E	FX(2)	Inches	F10.5	21-30	
F	FX(3)	Inches	F10.5	31-40	
G	FX(4)	Inches	F10.5	41-50	X, Y, and Z coordinates, respectively, of the second of eight vertices of the ARB (see Figures 19, 20, and 21).
H	FX(5)	Inches	F10.5	51-60	
I	FX(6)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 12A

Body Description: Arbitrary Convex Polyhedron (ARB). Repeat this card three times. Second, third, and fourth card of five required for each ARB.

CARD: 12B

A_1 A_2 A_3 B_1 B_2 B_3

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	AA(I,1)	Inches*	E10.3	11-20	X, Y, and Z coordinates of the Ith vertex of the ARB (see Figures 19, 20, and 21) where I=3, 5, or 7 for the third, fifth, or seventh point of the ARB.
	AA(I,2)	Inches	E10.3	21-30	
	AA(I,3)	Inches	E10.3	31-40	
B	AA(I,1)	Inches	E10.3	41-50	X, Y, and Z coordinates for the Ith vertex of the ARB (see Figures 19, 20, and 21) where I=4, 6, or 8 for the fourth, sixth, or eighth point of the ARB.
	AA(i,2)	Inches	E10.3	51-60	
	AA(I,3)	Inches	E10.3	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

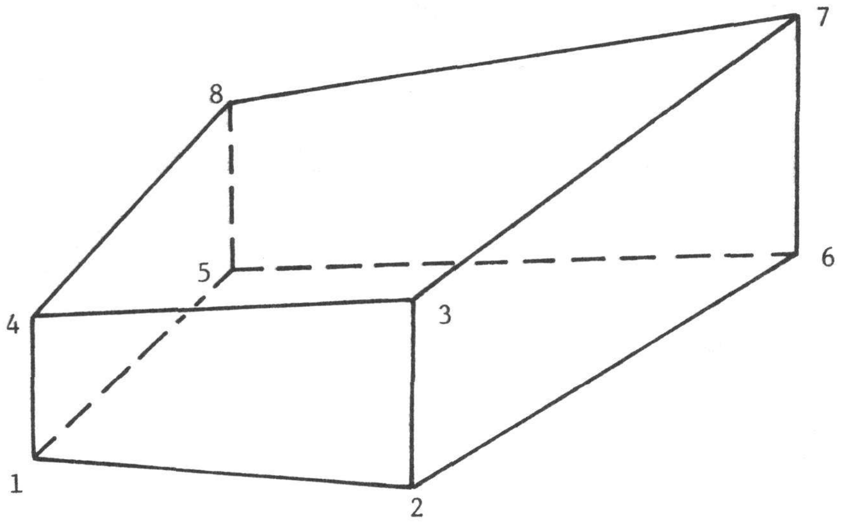
CARD: 12B

Body Description: Arbitrary Convex Polyhedron (ARB). Fifth of five cards required for each ARB used.

CARD: 12C

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IA(1,J)	ND	4A1	12-15	Four ordinal vertex numbers for first face of the ARB (see Figures 19, 20, and 21).
B	IA(2,J)	ND	4A1	17-20	Four ordinal vertex numbers for second face of the ARB (see Figures 19, 20, and 21).
C	IA(3,J)	ND	4A1	22-25	Four ordinal vertex numbers for third face of the ARB (see Figures 19, 20, and 21).
D	IA(4,J)	ND	4A1	27-30	Four ordinal vertex numbers for the fourth face of the ARB (see Figures 19, 20, and 21).
E	IA(5,J)	ND	4A1	32-35	Four ordinal vertex numbers for the fifth face of the ARB (see Figures 19, 20, and 21).
F	IA(6,J)	ND	4A1	37-40	Four ordinal vertex numbers for the sixth face of the ARB (see Figures 19, 20, and 21).

CARD: 12C

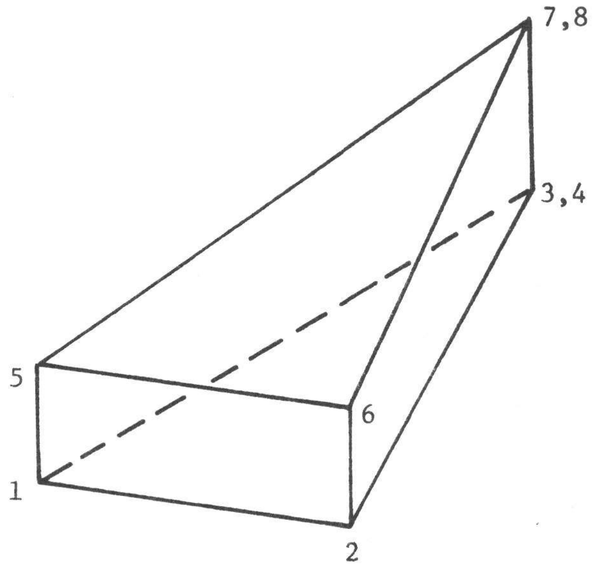


The arbitrary convex polyhedron may be a four-, five-, or six-faced figure, each face having either three or four vertices. The four vertices of a face must lie in a plane. An ordinal number (1 to 8) is assigned to each vertex. Each vertex is listed giving the X, Y, Z coordinates. For each face of the figure, list the four ordinal vertex numbers in a clockwise or counterclockwise direction.

Card Columns

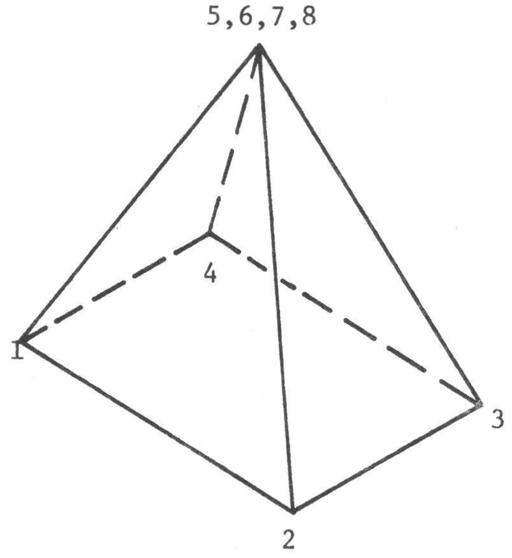
Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 5	Solid Number	ARB	1_x	1_y	1_z	2_x	2_y	2_z
2 of 5			3_x	3_y	3_z	4_x	4_y	4_z
3 of 5			5_x	5_y	5_z	6_x	6_y	6_z
4 of 5			7_x	7_y	7_z	8_x	8_y	8_z
			12-15	17-20	20-25	27-30	32-35	37-40
5 of 5			1234	5678	3487	1265	2376	1485

FIG. 19. Six-Faced Arbitrary Convex Polyhedron Input



6 VERTICES

Faces: 3124 7658 1375
2376 1265 1265



5 VERTICES

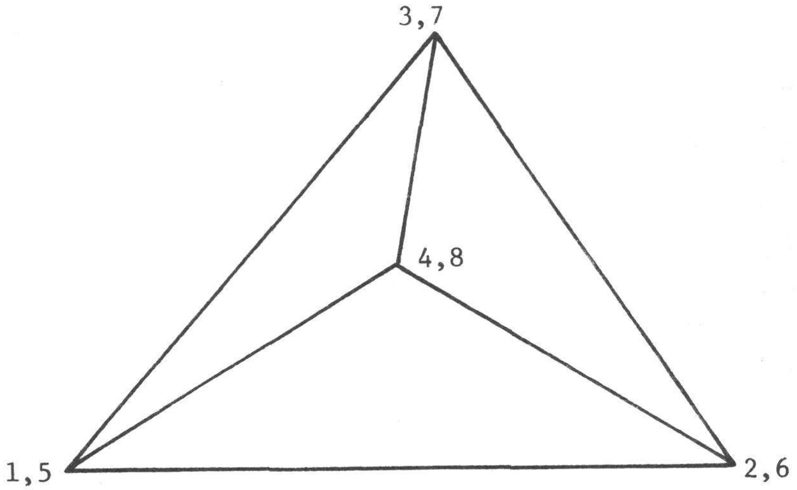
Faces: 1234 6435 6128
6237 7415 7415

Card Columns

Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 5	Solid Number	ARB	1_x	1_y	1_z	2_x	2_y	2_z
2 of 5			3_x	3_y	3_z	4_x	4_y	4_z
3 of 5			5_x	5_y	5_z	6_x	6_y	6_z
4 of 5			7_x	7_y	7_z	8_x	8_y	8_z
			12-15	17-20	22-25	27-30	32-35	37-40
5 of 5				Use Numbers Above				

Repeat one face to obtain the six faces required in the programs.

FIG. 20. Five-Faced Arbitrary Convex Polyhedron Input



	Card Column							
Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 5	Solid Number	ARB	1_x	1_y	1_z	2_x	2_y	2_z
2 of 5			3_x	3_y	3_z	4_x	4_y	4_z
3 of 5			5_x	5_y	5_z	6_x	6_y	6_z
4 of 5			7_x	7_y	7_z	8_x	8_y	8_z
			12-15	17-20	22-25	27-30	32-35	37-40
5 of 5			3127	2146	4328	1345	3127	3127
Repeat one face to obtain the six faces required in the programs.								

FIG. 21. Four-Faced Arbitrary Convex Polyhedron Input

Body Description: Truncated Elliptic Cone (TEC). First of three cards required for each TEC used.

CARD: 13A

A	B	C	D	E	F	G	H	I
1 2 3	4 5 6	7 8 9 10	11–20	21–30	31–40	41–50	51–60	61–70

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters TEC denoting that the body is a truncated elliptic cone.
C	IC(J)	ND	A4	7-10	Not used.
D	FX(1)	Inches*	F10.5	11-20	X, Y, and Z coordinates of vertex V at the center of the larger ellipse (see Figure 22).
E	FX(2)	Inches	F10.5	21-30	
F	FX(3)	Inches	F10.5	31-40	
G	FX(4)	Inches	F10.5	41-50	X, Y, and Z components of height vector $\overline{H}$ (see Figure 22). (NOTE: Height vector does not have to be perpendicular to the base plane.)
H	FX(5)	Inches	F10.5	51-60	
I	FX(6)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 13A

Body Description: Truncated Elliptic Cone (TEC). Second of three cards for each TEC used.

CARD: 13B

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	FX(7)	Inches*	F10.5	11-20	X, Y, and Z components of the vector $\overline{A}$ describing the semi-major axis of the larger ellipse (see Figure 22).
B	FX(8)	Inches	F10.5	21-30	
C	FX(9)	Inches	F10.5	31-40	
D	FX(10)	Inches	F10.5	41-50	X, Y, and Z components of the vector $\overline{B}$ describing the semi-minor axis of the larger ellipse (see Figure 22)
E	FX(11)	Inches	F10.5	51-60	
F	FX(12)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 13B

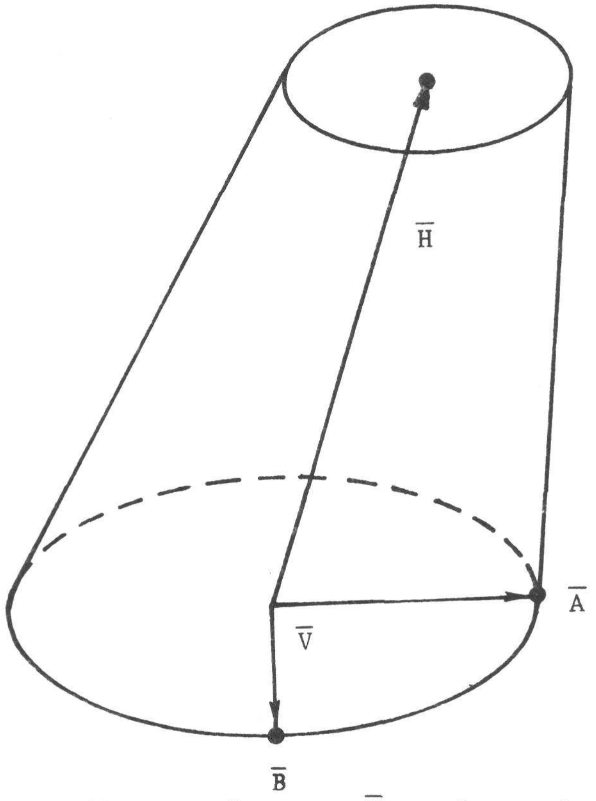
Body Description: Truncated Elliptic Cone (TEC). Third of three cards for each TEC.

CARD: 13C

A

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	FX(13)	NP	F10.5	11-20	P, the ratio of the larger ellipse to the smaller ellipse (see Figure 22).

CARD: 13C



Specify the coordinates of vertex $\overline{V}$ at the center of the larger ellipse; and the X, Y, and Z components of height vector $\overline{H}$ and vectors $\overline{A}$ and $\overline{B}$ describing the semi-major and semi-minor axes. Specify P, the ratio of the larger to the smaller ellipse. (NOTE: Height vector $\overline{H}$ does not have to be perpendicular to the base plane.)

Number of Cards	Card Column 1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 3	Solid Number	TEC	V_x	V_y	V_z	H_x	H_y	H_z
2 of 3			A_x	A_y	A_z	B_x	B_y	B_z
3 of 3			P					

FIG. 22. Truncated Elliptic Cone Input

Body Description: Arbitrary Curved Surface (ARS). First of n cards for each ARS.

CARD: 14A

A B

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters ARS denoting that the body is an arbitrary curved surface.

CARD: 14A

Body Description: Arbitrary Curved Surface (ARS). Second of n cards for each ARS.

CARD: 14B

A B

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	MAX	ND	I10	11-20	Number of curves which are to be input (see Figure 23).
B	NAX	ND	I10	21-30	Number of points to be input for each curve (see Figure 23).

CARD: 14B

Body Description: Arbitrary Curved Surface (ARS). Third through nth cards for each ARS.

CARD: 14C

A B C D E F

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	X(M,N)	Inches*	E10.3	11-20	X, Y, and Z coordinates, respectively, of the Nth point for the Mth curve (see Figure 23).
B	Y(M,N)	Inches	E10.3	21-30	
C	Z(M,N)	Inches	E10.3	31-40	
D	X(M,N+1)	Inches	E10.3	41-50	X, Y, and Z coordinates, respectively, of the N+1st point for the Mth curve (see Figure 23).
E	Y(M,N+1)	Inches	E10.3	51-60	
F	Z(M,N+1)	Inches	E10.3	61-70	

Repeat this card until all curves have been input. Total number of cards, n, required for each ARS =

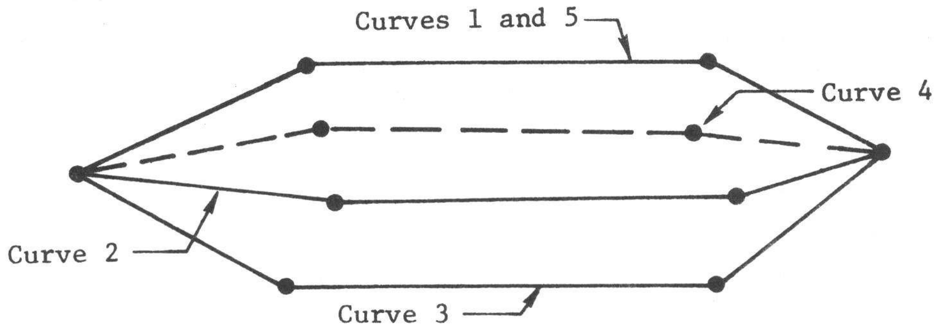
$$2 + M [(N + 1)/2]$$

(See Figure 23.)

NOTE: Begin each curve on a new card.

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 14C



Specify the number of curves (M) to be used and the number of points (N) to be used for each curve. A surface is constructed between curve 1 and curve 2, between curve 2 and curve 3, etc. The user must be sure that the described figure is closed and solid. Note that the first and last points are the same for all curves, and the first curve is identical to the last. Start each curve on a new card.

Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of n	Solid Number	ARS						
2 of n			M	N				
3 of n			X(1,1)	Y(1,1)	Z(1,1)	X(1,2)	Y(1,2)	Z(1,2)
⋮			⋮					
$2+\frac{N+1}{2}$ of n			X(1,N)	Y(1,N)	Z(1,N)			
			X(2,1)					
			⋮					
			X(M,1)					
			⋮					
$n=2+M\left(\frac{N+1}{2}\right)$			X(M,N)	Y(M,N)	Z(M,N)			

FIG. 23. Arbitrary Curved Surface Input

Body Description: Torus (TOR). First of two cards for each TOR.

CARD: 15A

A	B	C	D	E	F	G	H	I	
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IC(I)	ND	3A1	1-3	Alphameric characters representing the ordinal number of the body. The number must be left justified with no leading zeroes, i.e., the first digit must be in column 1.
B	ITYPE	ND	A3	4-6	Alphameric characters TOR denoting that the body is a torus.
C	IC(J)	ND	A4	7-10	Not used.
D	FX(1)	Inches*	F10.5	11-20	X, Y, and Z coordinates, respectively, of vertex V at the center of the torus (see Figure 24).
E	FX(2)	Inches	F10.5	21-30	
F	FX(3)	Inches	F10.5	31-40	
G	FX(4)	Inches	F10.5	41-50	X, Y, and Z components of normal $\overline{N}$ to the plane in which the locus of midpoints of the circular cross-sections lies (see Figure 24).
H	FX(5)	Inches	F10.5	51-60	
I	FX(6)	Inches	F10.5	61-70	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 15A

Body Description: Torus (TOR). Second of two cards for each TOR.

CARD: 15B

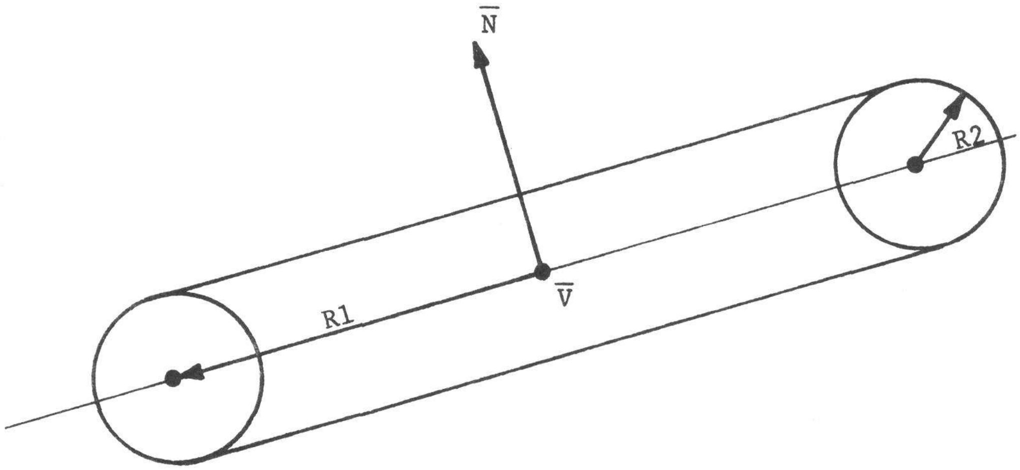
A (columns 11–20) B (columns 21–30)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	FX(7)	Inches*	F10.5	11-20	Distance R1 from the center of the torus to the mid-point of the circular cross-section (see Figure 24).
B	FX(8)	Inches	F10.5	21-30	Radius R2 of the circular cross-section (see Figure 24).

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 15B



Specify vertex $\overline{V}$ at the center of the torus, normal $\overline{N}$ to the plane in which the locus at mid-points of the circular cross-sections lies, and scalars R1, the distance from the center to the mid-point of the circular cross-section, and R2, the radius of the circular cross section.

	Card Column							
Number of Cards	1-3	4-6	11-20	21-30	31-40	41-50	51-60	61-70
1 of 2	Solid Number	TOR	V_x	V_y	V_z	N_x	N_y	N_z
2 of 2	Blank		R1	R2	Blank			

FIG. 24. Torus Input

Region Table Input. First card for describing each region.

CARD: 16A

A B C D E F G H I J K L M N O P Q R S

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IR	ND	I5	1-5	Region number
B	IA(1)	ND	A2	7-8	OR operator must be input in IA(1) if the OR operator appears elsewhere in region description.
C	IN(1)	ND	I5	9-13	Ordinal number of the body with the + or - operator as required. A + is implied if sign omitted.
D	IA(2)	ND	A2	14-15	OR operator if used with second term of region description.
E	IN(2)	ND	I5	16-20	Ordinal number of the body with the + or - operator as required.
F	IA(3)	ND	A2	21-22	Enter up to nine bodies and their operators. If more bodies are required to describe region, use additional cards as described on Card 16B.
G	IN(3)	ND	I5	23-27	
	⋮	⋮	⋮	⋮	
R	IA(9)	ND	A2	63-64	
S	IN(9)	ND	I5	65-69	

Region Table Input. Second and subsequent cards for describing each region.

CARD: 16B

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IA(N)	ND	A2	7-8	OR operator if used.
B	IN(N)	ND	I5	9-13	Ordinal number of the body with + or - operator as required.
C	IA(N)	ND	A2	14-15	Enter bodies and their operators as required for each region.
D	IN(N)	ND	I5	16-20	
	⋮	⋮	⋮	⋮	
Q	IA(N)	ND	A2	63-64	
R	IN(N)	ND	I5	65-69	

Note:

Follow the last region card with a card with -1 in columns 1-5 to signify the end of the region data.

CARD: 16B

Special Ray Tracing Input (Optional). First of n cards required.

CARD: 17A

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	NRAYS	ND	I10	1-10	Total number of rays to be processed.
B	NG1ERR	ND	I10	11-20	Maximum allowable number of errors. If NG1ERR is left blank, the computer assigns a value of 25.

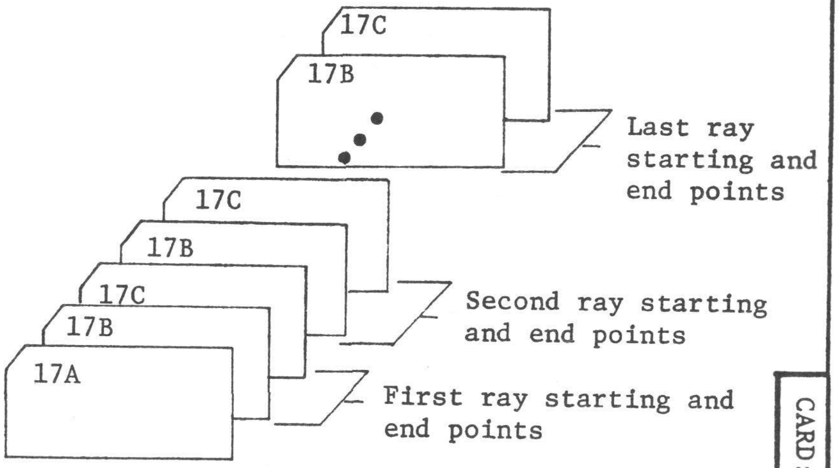
Note:

Optional special ray tracing computations are performed when ITESTG (columns 21-30 in Card 1) has a non-zero value. A specified number of rays are tracked through a specified portion of the target to verify that the region descriptions have been input properly. Errors discovered in target descriptions will be printed out. If errors in excess of the number specified by NG1ERR are found, execution of the special ray tracing will be terminated. The number (n) of cards required for this optional input is twice the number of rays specified plus one (see Card 17B).

Special Ray Tracing Input (Optional). Required for each ray specified.

CARD: 17B

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XB(1)	Inches*	E15.7	1-15	X, Y, and Z coordinates, respectively, of the ray's starting point.
B	XB(2)	Inches	E15.7	16-30	
C	XB(3)	Inches	E15.7	31-45	
D	IRSTRT	ND	I15	46-60	Region number which contains the ray's starting point.



*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 17B

Special Ray Tracing Input (Optional). Required for each ray specified.

CARD: 17C

A B C D

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XBF(1)	Inches*	E15.7	1-15	X, Y, and Z coordinates, respectively, of the ray's ending point.
B	XBF(2)	Inches	E15.7	16-30	
C	XBF(3)	Inches	E15.7	31-45	
D	IRFIN	ND	I15	46-60	Region number which contains the ray's ending point.

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 17C

Special Volume Input (Optional). First of six cards required.

CARD: 18A

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IR	ND	I10	1-10	Region number containing vertex XV located at the lower right corner of the box (see Figure 25).
B	NG1ERR	ND	I10	11-20	Maximum allowable number of errors. Note: Volume computations are optional and are performed only when IVOLUM (columns 61-70 in Card 1) is non-zero. A description of the volume computations and the geometry involved is shown in Figure 25. Errors discovered in target descriptions will be printed out. If errors in excess of the number specified are found, execution of the volume computations will be terminated.

CARD: 18A

Special Volume Input (Optional). Second of six cards required.

CARD: 18B

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XV(1)	Inches*	E20.8	1-20	X, Y, and Z coordinates, respectively, of the vertex of an imaginary box (see Figure 25).
B	XV(2)	Inches	E20.8	21-40	
C	XV(3)	Inches	E20.8	41-60	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 18B

Special Volume Input (Optional). Third of six cards required.

CARD: 18C

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XT(1)	Inches*	E20.8	1-20	X, Y, and Z coordinates, respectively, of the upper right corner of an imaginary box front (see Figure 25).
B	XT(2)	Inches	E20.8	21-40	
C	XT(3)	Inches	E20.8	41-60	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 18C

Special Volume Input (Optional). Fourth of six cards required. CARD: 18D

A B C

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XO(1)	Inches*	E20.8	1-20	X, Y, and Z coordinates, respectively, of the lower left corner of an imaginary box front (see Figure 25).
B	XO(2)	Inches	E20.8	21-40	
C	XO(3)	Inches	E20.8	41-60	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 18D

Special Volume Input (Optional). Fifth of six cards required.

CARD: 18E

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XA(1)	Inches*	E20.8	1-20	X, Y, and Z coordinates, respectively, of the lower right corner of an imaginary box back (see Figure 25).
B	XA(2)	Inches	E20.8	21-40	
C	XA(3)	Inches	E20.8	41-60	

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 18E

Special Volume Input (Optional). Sixth of six cards required.

CARD: 18F

A B

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	DOD	Inches*	E20.8	1-20	Horizontal dimension of grid cell (see Figure 25).
B	DT	Inches	E20.8	21-40	Vertical dimension of grid cell.

<u>Note</u>:

Volume of any region(s) may be input and compared with computed volume(s).

1-10	I10	IR1	Region
11-30	E20.8	VR	Volume of Region

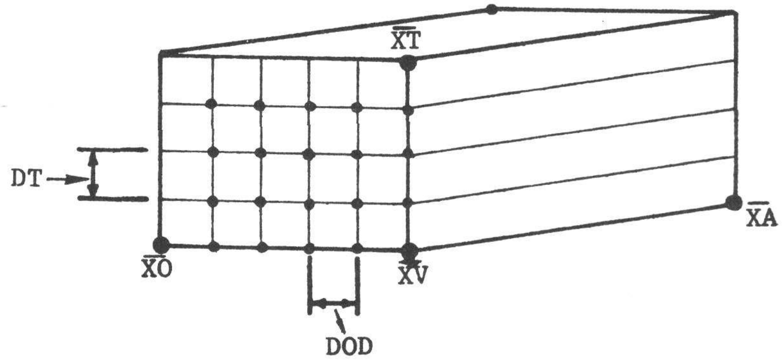
A blank card is needed to signal the end of these cards.

<u>If this option is not to be used, a blank card is needed.</u>

VOLUM requires at least seven cards.

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 18F



Special computations are performed to determine the volume of each region contained within an imaginary box. The box is defined by specifying the X, Y, and Z coordinates of vertex $\overline{XV}$ and three other corners, $\overline{XO}$, $\overline{XT}$, and $\overline{XA}$. Grid cells are established on the front face of the box by specifying the vertical and horizontal grid cell dimensions, DT and DOD, respectively.

Rays are traced from the lower right corner of each grid cell from the front to the back of the box, and the distances through each region are computed and stored in an array. When all rays have been traced and the total distances through each region accumulated, the region volumes are computed from the region distances and the cell dimensions.

FIG. 25. Special Volume Computation

Region Identification Data. One card for each region.

CARD: 19

	A	B	C	Blank	D	
	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76	77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	IRN	ND	I10	1-10	Ordinal number of the region being identified.
B	ICODE	ND	I10	11-20	Code number relating the region in question to a particular target component (see Table 6).
C	IDENT	ND	I10	21-30	Space code when region in question is air space (ICODE=0). Space codes have values between 1 and 9 (see Table 6). If region in question is related to a component (ICODE > 0), IDENT may be used as a component class identifier in following manner. Ident — Component Class 10 — Skirting material 20 — Hull and turret armor 30 — Target These class identifiers will be included in grid cell output.
D	A(I)	ND	6A6	41-76	Alphameric characters used to verbally describe the region in question. Follow last region identification card with a blank card.

CARD: 19

TABLE 6. Region Identification Codes

Component Codes	
ICODE	Type of Component
001-099	Refer to internal components
100-199	Refer to types of armor
200-299	Refer to fuel components
300-399	Refer to miscellaneous exterior components
400-499	Refer to gun components
500-599*	Refer to track suspension components
600-699	Refer to wheel suspension components
700-799	Refer to power train components
800-899	Refer to miscellaneous components
900-998	Not used at present
999	Soil, ground

Space Codes	
IDENT	Type of Space
01	External air
02	Crew compartment air
03	Not used at present
04	Not used at present
05	Engine compartment air
06	Not used at present
07	Not used at present
08	Not used at present
09	No further target

*ICODE = 501 is reserved for the track. The computer assigns 502 if the track edge is hit.

Specification Card

CARD: 20

A	B	C	D	
1 2 3 4 5	6 7 8 9 10	11 12 13 14 15	16 17 18 19 20	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	NOAA	ND	I5	1-5	Number of attack angles to be computed for grid cell output.
B	IWOT	ND	I5	6-10	IWOT ≠ 0. Grid cell data will be written on magnetic tape unit 1. IWOT = 0. No output on magnetic tape unit 1.
C	ITAPE8	ND	I5	11-15	ITAPE8 = 0. Grid cell data will be output on printer. ITAPE8 ≠ 0. Grid cell data output will be suppressed on printer, but G1 errors will be printed.
D	NAREA	ND	I5	16-20	Optional calls to Subroutine AREA will be made for the number of attack angles specified by NAREA. Subroutine AREA computes the presented area of the target as viewed from a specified attack angle. Additional input for Subroutine AREA is described on Cards 22A-22C.

CARD: 20

Grid Cell Description. First of three cards required for each attack angle.

CARD: 21A

A B C D E F G

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	NX	ND	I10	1-10	Number of horizontal cells in grid plane (see Figure 26).
B	NY	ND	I10	11-20	Number of vertical cells in grid plane (see Figure 26).
C	IRSTRT	ND	I10	21-30	Region number containing starting points of rays.
D	IENC	ND	I10	31-40	Region number containing ending points of rays.
E	NG1ERR	ND	I10	41-50	Maximum allowable number of target description errors. If errors in excess of NG1ERR are found, ray tracing terminates.
F	NSTART	ND	I10	51-60	Grid cell number of first ray to be traced (see Figure 26).
G	NEND	ND	I10	61-70	Grid cell number of last ray to be traced (see Figure 26).
H	ICENTR	ND	I10	71-80	$\neq 0$ Originate ray from center of cell $= 0$ Originate ray from random point in cell

CARD: 21A

Grid Cell Description. Second of three cards required for each attack angle.

CARD: 21B

A B C D E

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	A	Degrees	E12.8	1-12	Attack azimuth angle measured from the positive X axis in a counterclockwise direction.
B	E	Degrees	E12.8	13-24	Attack elevation angle measured from the X-Y plane positive upward.
C	ENGTH	Inches*	E12.8	25-36	Distance from coordinate system origin to the grid plane. Must be in the region specified by IRSTRT.
D	ZSHIFT	Inches	E12.8	37-48	Distance the grid plane is to be shifted in the Z direction.
E	GROUND	Inches	E12.8	49-60	Z coordinate of ground level. If Z coordinate of starting point of ray < GROUND, ray is not tracked.

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 21B

Grid Cell Description. Third of three cards required for each attack angle.

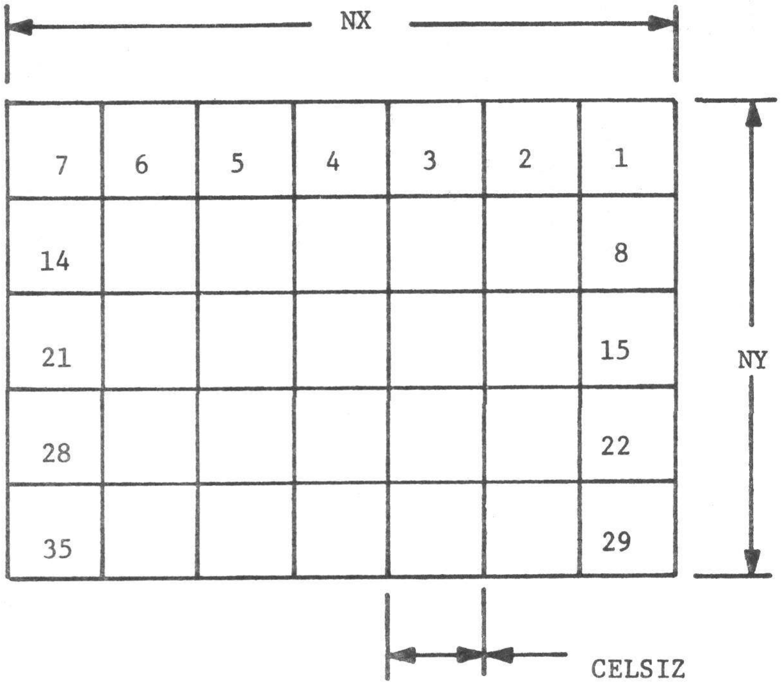
CARD: 21C

A B C

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XSHIFT	Inches*	E12.8	1-12	Distance grid plane is to be shifted in the X direction.
B	YSHIFT	Inches	E12.8	13-24	Distance grid plane is to be shifted in the Y direction.
C	CELSIZ	Inches	E12.8	25-36	Length and width of each cell in grid plane (see Figure 26). If CELSIZ is left blank, a 4-inch grid cell is used.

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 21C



Grid plane is specified by the number of grid cells in the horizontal and vertical directions, NX and NY, respectively, and the dimensions of the grid cells, CELSIZ. The cells are numbered starting in the upper right corner and incremented from right to left. The grid plane is assumed to be centered over the target coordinate origin at a backoff distance such that all rays originate in one region outside the target. The grid plane may be relocated by specifying a distance in the X, Y, and Z directions (XSHIFT, YSHIFT, ZSHIFT).

FIG. 26. Grid Plane Input

Subroutine AREA Input (Optional). First of three cards required for each attack angle.

CARD: 22A

A B C D E F G H I

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	NX	ND	I10	1-10	Number of horizontal cells in grid plane (see Figure 26).
B	NY	ND	I10	11-20	Number of vertical cells in grid plane (see Figure 26).
C	IRSTRT	ND	I10	21-30	Region number containing starting points of rays.
D	IENC	ND	I10	31-40	Region number containing ending points of rays.
E	NG1ERR	ND	I10	41-50	Maximum allowable number of target description errors. If errors in excess of NG1ERR are found, ray tracing terminates.
F	NSTART	ND	I10	51-60	Grid cell number of first ray to be processed (see Figure 26).
G	NEND	ND	I10	61-70	Not used.
H	CELLUN	ND	A2	71-72	Alphameric characters IN, FT, CM or M, representing inches, feet, centimeters, or meters, respectively, denoting the units which are used to specify grid cell dimensions.
I	AREAUN	ND	A2	73-74	Alphameric characters IN, FT, CM, or M representing square inches, square feet, square centimeters or square meters denoting the units of area desired. CELLUN and AREAUN may have different units. If CELLUN and AREAUN are blank, units of inches and square inches are used. The character M must be placed in column 71 or 73.

CARD: 22A

Subroutine AREA Input (Optional). Second of three cards required for each attack angle.

CARD: 22B

A	B	C	D	E	
1 2 3 4 5 6 7 8 9 10 11 12	13 14 15 16 17 18 19 20 21 22 23 24	25 26 27 28 29 30 31 32 33 34 35 36	37 38 39 40 41 42 43 44 45 46 47 48	49 50 51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	A	Degrees	E12.8	1-12	Attack azimuth angle measured from the positive X axis in a counterclockwise direction.
B	E	Degrees	E12.8	13-24	Attack elevation angle measured from the X-Y plane positive upward.
C	ENGTH	Inches*	E12.8	25-36	Distance from the coordinate system origin to the grid plane. Must be in the region specified by IRSTRT.
D	ZSHIFT	Inches	E12.8	37-48	Distance grid plane is to be shifted in Z direction.
E	GROUND	Inches	E12.8	49-60	Z coordinate of ground level. If Z coordinate of starting point of ray is < GROUND, ray is not tracked.

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 22B

Subroutine AREA Input (Optional). Third of three cards required for each attack angle.

CARD: 22C

A	B	C
1–12	13–24	25–36

ID	PARA	UNITS	FORMAT	COLUMNS	DESCRIPTION
A	XSHIFT	Inches*	E12.8	1-12	Distance grid plane is to be shifted in X direction.
B	YSHIFT	Inches	E12.8	13-24	Distance grid plane is to be shifted in Y direction.
C	CELSIZ	Various	E12.8	25-36	Length and width of each cell in grid plane (see Figure 26). Units may be inches, feet, centimeters, or meters as specified by CELLUM (see Card 22A). If CELSIZ is blank, a 4-inch grid cell is used.

*Any unit of length may be used (inches, feet, meters) for target data, but the units must be consistent throughout the input.

CARD: 22C

DATA DECK SETUP

Figure 27 illustrates the data deck setup for normal operation. In this case, the target geometry is input with the data set. For production mode operation, the target geometry will have been processed previously and stored on magnetic tape. The data deck setup for production mode operation is illustrated in Figure 28.

Figures 29, 30 and 31 illustrate the data deck setups used for the optional routines available.

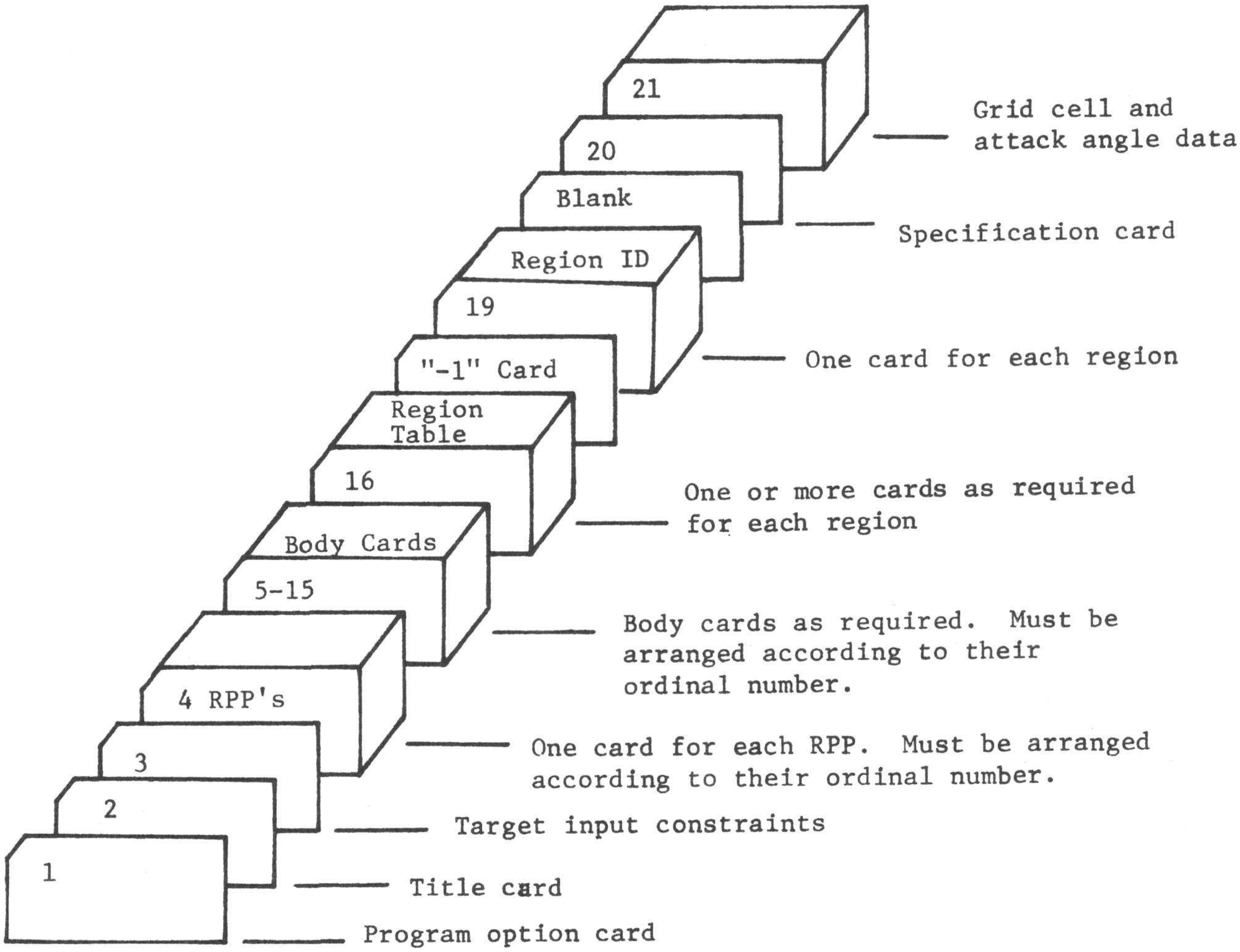


FIG. 27. Normal Mode Deck Set-Up

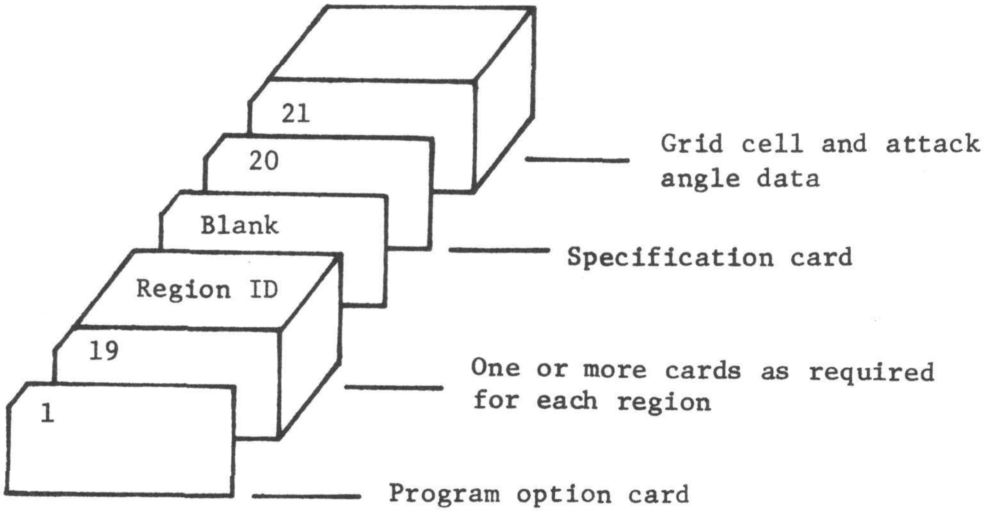
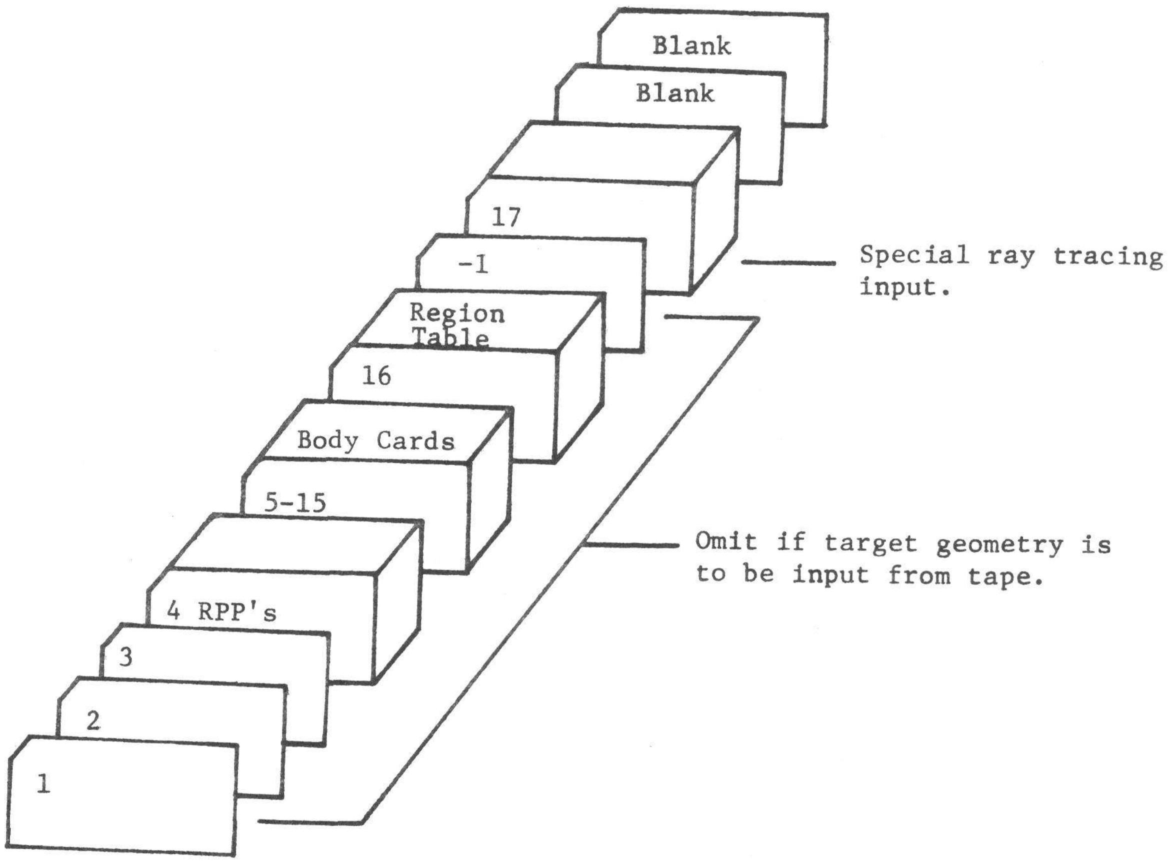


FIG. 28. Production Mode Deck Configuration



Special ray tracing input.

Omit if target geometry is to be input from tape.

FIG. 29. Special Ray Tracing Deck Setup

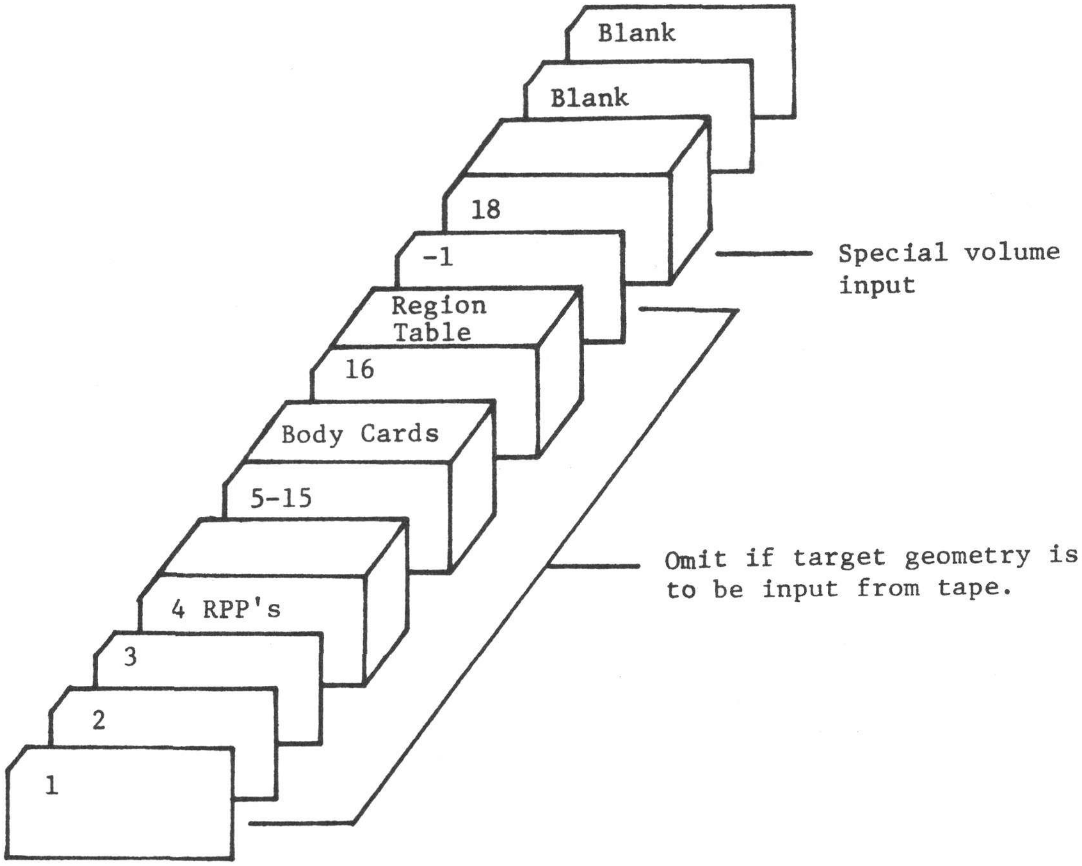


FIG. 30. Volume Computation Deck Setup

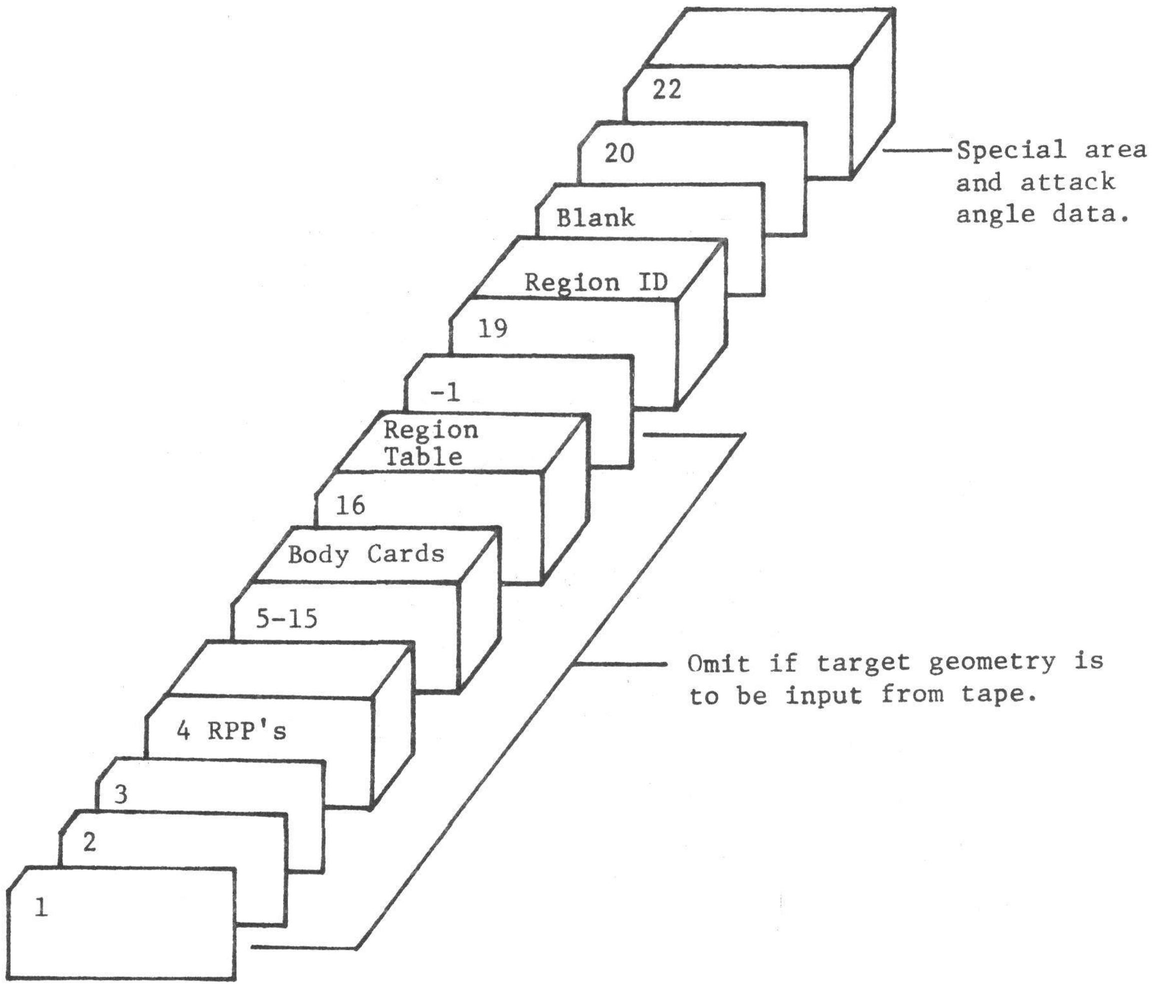


FIG. 31. Area Computation Deck Setup

SECTION III

OUTPUT

The output of the MAGIC program consists of two major groups of data. The first group consists of the target description data. This data is printed out during Subroutines MAIN and GENI and is used to provide a record of the body input and region description data. The second group of data consists of the ray tracing output from each cell of the grid plane. This data is printed out to provide a printed record and/or written on tape during Subroutines GRID and TRACK for subsequent vulnerability analysis.

Figure 32 illustrates the major portion of the first group of output data. This data consists of the input of the various bodies and their dimensions as well as information on the number of times each of the eleven body types was used in the target description. Also included are the values of the major pointers in the MASTER-ASTER array after the body data input. The major pointer names are defined as follows:

LBASE	beginning location of the MASTER-ASTER array, and the beginning location of the RPP pointer data
LRPPD	beginning location of the RPP minimum/maximum values
LABUT	beginning location of the abutting RPP data
LBODY	beginning location of the body pointer data
LBOD	beginning location of the body dimension pointers
LDATA	next available storage location after the body dimension pointers. Used as an index in storing data in the MASTER-ASTER array
LBOT	beginning location of the body dimension data before the body dimension data is moved in the ASTER array
NDQ	last storage location of the MASTER-ASTER array

```
THIS IS THE 11 APR 69 VERSION OF
THE BRLESC MAGIC PROGRAM  ******

BEGIN EXECUTION

ENTER GENI

START READING SOLID DATA

SAMPLE INPUT

     NO. OF RECTANGULAR PARALLELEPIPEDS          1
     NO. OF SOLIDS                              24
     MAX NO. OF REGIONS                         12

                                        RECTANGULAR PARALLELEPIPED INPUT
       1                  -10000.00000 10000.00000-10000.00000 10000.00000-10000.00000 10000.00000

                                            DESCRIPTION OF  SOLIDS
       2 2     BOX            75.00000   -36.00000    12.00000  -150.00000     0.00000     0.00000
                               0.00000    72.00000     0.00000     0.00000     0.00000    36.00000
       3 3     BOX            74.00000   -35.00000    13.00000  -148.00000     0.00000     0.00000
                               0.00000    70.00000     0.00000     0.00000     0.00000    34.00000
       4 4     ARB            75.00000   -36.00000    12.00000    75.00000    36.00000    12.00000
                              75.00000    36.00000    48.00000    75.00000   -36.00000    48.00000
                             100.00000     0.00000    12.00000   100.00000     0.00000    12.00000
                             100.00000     0.00000    12.00000   100.00000     0.00000    12.00000
                               1 2 3 4     6 4 3 5     6 1 2 8     6 2 3 7     7 4 1 5     7 4 1 5
       5 5     ARB           -75.00000   -36.00000    12.00000   -75.00000    36.00000    12.00000
                             -75.00000    36.00000    48.00000   -75.00000   -36.00000    48.00000
                            -100.00000   -24.00000    12.00000  -100.00000    24.00000    12.00000
                            -100.00000    24.00000    20.00000  -100.00000   -24.00000    20.00000
                               1 2 3 4     5 6 7 8     3 4 8 7     1 2 6 5     2 3 7 6     1 4 8 5
       6 6     ELL            20.00000     0.00000    48.00000   -20.00000     0.00000    48.00000
                              50.00000
       7 7     ELL   7         0.00000     0.00000    48.00000    24.00000     0.00000     0.00000
                              14.00000
       7 7     ELL   7       -19.49359     0.00000    48.00000    19.49359     0.00000    48.00000
                              48.00000
       8 8     RCC            60.00000   -36.00000    12.00000     0.00000     8.00000     0.00000
                              12.00000
       9 9     RCC            60.00000    36.00000    12.00000     0.00000    -8.00000     0.00000
                              12.00000
      10 10    RCC           -60.00000   -36.00000    12.00000     0.00000     8.00000     0.00000
                              12.00000
      11 11    RCC           -60.00000    36.00000    12.00000     0.00000    -8.00000     0.00000
                              12.00000
      12 12    BOX           -70.00000   -20.00000    15.00000    40.00000     0.00000     0.00000
                               0.00000    40.00000     0.00000     0.00000     0.00000    30.00000
      13 13    RAW           -70.00000   -20.00000    45.00000     0.00000     0.00000   -10.00000
                               0.00000    10.00000     0.00000    40.00000     0.00000     0.00000
      14 14    RAW           -70.00000    20.00000    45.00000     0.00000     0.00000   -10.00000
                               0.00000   -10.00000     0.00000    40.00000     0.00000     0.00000
      15 15    ARB           -70.00000   -10.00000    45.00000   -70.00000    10.00000    45.00000
                             -70.00000     0.00000    35.00000   -70.00000     0.00000    35.00000
                             -30.00000   -10.00000    45.00000   -30.00000    10.00000    45.00000
                             -30.00000     0.00000    35.00000   -30.00000     0.00000    35.00000
                               3 1 2 4     7 6 5 8     1 3 7 5     2 3 7 6     1 2 6 5     1 2 6 5
```

FIG. 32. Sample Problem Body Data

```
16 16    ARS                NUMBER OF CURVES                        M=         4
                            NUMBER OF POINTS PER CURVE              N=         5
                            NUMBER OF POINTS IN                    MN=        20
                            NUMBER OF POINTS STORED    NP=2N(M-1)=            30
                            TOTAL STORAGE             NSTR=4NP+82=           202
                     -70.0000     -20.0000     15.0000    -70.0000    -20.0000     15.0000
                     -70.0000     -20.0000     15.0000    -70.0000    -20.0000     15.0000
                     -70.0000     -20.0000     15.0000

                     -70.0000     -20.0000     15.0000    -70.0000    -10.0000     15.0000
                     -70.0000     -10.0000     25.0000    -70.0000    -20.0000     35.0000
                     -70.0000     -20.0000     15.0000

                     -30.0000     -20.0000     15.0000    -30.0000    -10.0000     15.0000
                     -30.0000     -10.0000     25.0000    -30.0000    -20.0000     35.0000
                     -30.0000     -20.0000     15.0000

                     -30.0000     -20.0000     15.0000    -30.0000    -20.0000     15.0000
                     -30.0000     -20.0000     15.0000    -30.0000    -20.0000     15.0000
                     -30.0000     -20.0000     15.0000
                            NUMBER OF TRIANGLES DESCRIBED                   28
                            NUMBER OF NON-DEGENERATE TRIANGLES              12
17 17    ARS                NUMBER OF CURVES                        M=         5
                            NUMBER OF POINTS PER CURVE              N=         4
                            NUMBER OF POINTS IN                    MN=        20
                            NUMBER OF POINTS STORED    NP=2N(M-1)=            32
                            TOTAL STORAGE             NSTR=4NP+82=           210
                     -70.0000      20.0000     15.0000    -70.0000     20.0000     15.0000
                     -30.0000      20.0000     15.0000    -30.0000     20.0000     15.0000

                     -70.0000      20.0000     15.0000    -70.0000     10.0000     15.0000
                     -30.0000      10.0000     15.0000    -30.0000     20.0000     15.0000

                     -70.0000      20.0000     15.0000    -70.0000     10.0000     25.0000
                     -30.0000      10.0000     25.0000    -30.0000     20.0000     15.0000

                     -70.0000      20.0000     15.0000    -70.0000     20.0000     35.0000
                     -30.0000      20.0000     35.0000    -30.0000     20.0000     15.0000

                     -70.0000      20.0000     15.0000    -70.0000     20.0000     15.0000
                     -30.0000      20.0000     15.0000    -30.0000     20.0000     15.0000
                            NUMBER OF TRIANGLES DESCRIBED                   30
                            NUMBER OF NON-DEGENERATE TRIANGLES              12
18 18    REC         0.00000      0.00000     24.00000     0.00000     0.00000     28.00000
                     0.00000      7.50000      0.00000     5.00000     0.00000      0.00000
19 19    SPH         0.00000      0.00000     52.00000     5.00000
20 20    TEC         0.00000     -7.50000     49.00000    20.00000     0.00000    -12.00000
                     0.00000      0.00000      3.00000     0.00000     2.00000      0.00000
                     2.00000
20 20    TEC         0.00000     -7.50000     49.00000    20.00000     0.00000    -12.00000
                     1.00000      0.00000      0.00000     0.00000     0.00000      1.00000
                     3.00000      2.00000      2.00000
21 21    TEC         0.00000      7.50000     49.00000    20.00000     0.00000    -12.00000
                     0.00000      0.00000      3.00000     0.00000     2.00000      0.00000
                     2.00000
21 21    TEC         0.00000      7.50000     49.00000    20.00000     0.00000    -12.00000
                     1.00000      0.00000      0.00000     0.00000     0.00000      1.00000
                     3.00000      2.00000      2.00000
```

FIG. 32. Sample Problem Body Data (Continued)

```
     22 22    TRC            -2.00000     -4.50000     27.00000     32,00000      0,00000    -12.00000
                              3.00000      2.00000
     23 23    TRC            -2.00000      4.50000     27.00000     32,00000      0,00000    -12.00000
                              3.00000      2.00000
     24 24    TOR            21.50000      0.00000     37.00000      1,00000      0,00000      0.00000
                              8.00000      1.00000
     24 24    TOR            21,50000      0.00000     37,00000      1,00000      0,00000      0.00000
                              8,00000      1.00000
     25 25    ARB            21.50000     -6.00000     33.50000     21.50000      6,00000     33.50000
                             21,50000      0.00000     44.00000     40,00000      0.00000     37.00000
                             21,50000     -6.00000     33.50000     21.50000      6,00000     33.50000
                             21,50000      0,00000     44,00000     40,00000      0,00000     37.00000
                              3 1 2 7      2 1 4 6      4 3 2 8      1 3 4 5      3 1 2 7      3 1 2 7

FINISH READING SOLID DATA

   BOX   SPH   RCC   REC   TRC   ELL   RAW   ARB   TEC   TOR   ARS
     3     1     4     1     2     2     2     4     2     1     2

LBASE  LRPPD  LABUT  LBODY   LBOD  LDATA   LBOT    NDQ
    1     13     15     15     90    158   9389  10000
```

FIG. 32. Sample Problem Body Data (Concluded)

Figure 33 illustrates the printed output during the region storage phase of Subroutine GENI. This data consists of a record of the region data description input, as well as information on preparation and checking of the region data. Also included are the values of major pointers used in the region description storage and pointers to reserved storage areas. The major pointer names are defined as follows:

LREGD	beginning location of the region pointer data
LREGL	beginning location of the operator/body number data for each region
LENLV	beginning location of the region enter/leave tables
LRIN	beginning location of the storage section reserved for entry intersect distance data
LROT	beginning location of the storage section reserved for exit intersect distance data
LIO	beginning location of the storage section reserved for Subroutine G1 working storage
LEGEOM	next available storage location at the end of the target geometry

Figure 34 illustrates the printed output during the region identification storage phase of the MAIN program. This data consists of a printed record of the component code or space code, and description, of each region of the target geometry. Also included is the value of pointer LIRFO, the beginning location of the region identification data in the MASTER array.

Figure 35 illustrates the first page of the ray tracing output from each cell of the grid plane for the first aspect angle computed. This data consists of several major items of information as follows:

(1) The number of aspect angles to be considered are printed out from the MAIN program.

(2) Information defining the grid plane and identifying the present attack aspect angle is printed out during Subroutine GRID with the following data:

NX	number of horizontal cells in grid plane
NY	number of vertical cells in grid plane

```
                                     REGION COMBINATION DATA
  1  (       1) (      -2) (      -4) (      -5) (      -6) (      -8) (      -9) (     -10) (     -11)
  2  (OR     2) (      -3) (      -7) (      -8) (      -9) (     -10) (     -11) (OR     4) (OR     5)
  3  (       6) (      -7) (      -2) (       0) (       0) (       0) (       0) (       0) (       0)
  4  (       8) (       0) (       0) (       0) (       0) (       0) (       0) (       0) (       0)
  5  (       9) (       0) (       0) (       0) (       0) (       0) (       0) (       0) (       0)
  6  (      10) (       0) (       0) (       0) (       0) (       0) (       0) (       0) (       0)
  7  (      11) (       0) (       0) (       0) (       0) (       0) (       0) (       0) (       0)
  8  (OR     3) (     -18) (     -19) (     -20) (     -21) (     -22) (     -23) (     -24) (     -25)
     (      -8) (      -9) (     -10) (     -11) (     -12) (OR     7) (     -18) (     -19) (     -20)
     (     -21) (     -24) (     -25) (OR    13) (OR    14) (OR    15) (OR    16) (OR    17) (       0)
  9  (       3) (      12) (     -13) (     -14) (     -15) (     -16) (     -17) (       0) (       0)
 10  (OR    18) (OR    19) (OR    20) (OR    21) (OR    22) (OR    23) (       0) (       0) (       0)
 11  (       3) (      24) (     -25) (       0) (       0) (       0) (       0) (       0) (       0)
 12  (       3) (      25) (       0) (       0) (       0) (       0) (       0) (       0) (       0)
FINISH READING REGION DATA

FINISH A PASS OF ENTER LEAVE TABLE      1

FINISH A PASS OF ENTER LEAVE TABLE      2

TOTAL ROOM FOR GEOMETRY DATA      LEGEOM=  1025

LREGD  LREGL  LENLV   LRIN   LROT    LIO LEGEOM
 770    782    851    950    975   1000   1025

LEAVING GENI
```

FIG. 33. Sample Problem Region Table

```
REGION TYPE DATA FOLLOWS              LIRFO=      9978
REGION       CODE      TYPE           DESCRIPTION

     1          0         1           OUTSIDE AIR
     2        100         0           BODY
     3        101         0           BUBBLE
     4        151         0           WHEEL RIGHT FRONT
     5        152         0           WHEEL LEFT FRONT
     6        153         0           WHEEL RIGHT REAR
     7        154         0           WHEEL LEFT REAR
     8          0         2           AIR INSIDE
     9        200         0           ENGINE
    10        300         0           MAN
    11        400         0           STEERING WHEEL
    12        401         0           STEERING SHAFT
```

FIG. 34. Sample Problem Region Identification

```
NUM OF ASPECT ANGLES FOR GRID IS     2

NX    37       NY    71       IRSTART     1      IENC     1      NSTART      1      NEND  2627      CELL SIZE    2.00

DATUM LINE AT Z=      0.000 WITH RESPECT TO THE ORIGIN
GROUND IS  AT Z=   -500.000 WITH RESPECT TO THE ORIGIN
XSHIFT IS  AT X=      0.000 WITH RESPECT TO THE ORIGIN
YSHIFT IS  AT Y=      0.000 WITH RESPECT TO THE ORIGIN

AZIMUTH       0.00000       ELEVATION       0.00000       BACK OFF DIST    200.00000

OPTION SET TO COMPUTE RANDOM POINT IN CELL

   4.0    62.0 30    10.50  -10.50 0 1 0 1  2   2 31     3.700   61.100
 101   4.89   0.99  74.5  2  11.22 101   4.89   1.00  82.0  9   0.00   2 31    2

   2.0    62.0 98     1.18   -1.18 0 1 0 0  1   1 31     2.900   62.700
 101   2.35   1.00  88.4  9   0.00   0   0.00   0.00   0.0  0   0.00   1 31    1

   0.0    62.0 50    12.18  -12.18 0 1 0 1  2   0 31     0.100   61.100
 101   3.71   0.98  71.5  2  16.93 101   3.71   0.99  77.6  9   0.00   0 31    2

  -2.0    62.0 63     9.78   -9.78 0 1 0 1  2  -1 31    -1.700   61.700
 101   5.79   0.99  75.7  2   7.98 101   5.79   1.00  84.4  9   0.00  -1 31    2

  -6.0    62.0 83     5.06   -5.06 0 1 0 0  1  -3 31    -5.300   61.700
 101  10.12   1.00  82.9  9   0.00   0   0.00   0.00   0.0  0   0.00  -3 31    1

   6.0    60.0 50    13.39  -13.39 0 1 0 1  2   3 30     6.100   59.100
 101   3.17   0.98  69.2  2  20.45 101   3.17   0.99  74.6  9   0.00   3 30    2

   4.0    60.0  6    13.34  -13.34 0 1 0 1  2   2 30     3.100   60.300
 101   3.19   0.98  69.3  2  20.31 101   3.19   0.99  74.8  9   0.00   2 30    2

   2.0    60.0 24    15.01  -15.01 0 1 0 1  2   1 30     1.500   59.900
 101   2.63   0.97  65.7  2  24.76 101   2.63   0.98  70.6  9   0.00   1 30    2

   0.0    60.0 52    16.05  -16.05 0 1 0 1  2   0 30     0.100   59.500
 101   2.36   0.97  63.3  2  27.37 101   2.36   0.98  68.0  9   0.00   0 30    2

  -2.0    60.0 61    16.19  -16.19 0 1 0 1  2  -1 30    -1.700   59.300
 101   2.33   0.97  63.0  2  27.73 101   2.33   0.98  67.6  9   0.00  -1 30    2

  -4.0    60.0 16    11.97  -11.97 0 1 0 1  2  -2 30    -4.700   60.300
 101   3.82   0.98  71.9  2  16.31 101   3.82   0.99  78.1  9   0.00  -2 30    2

  -6.0    60.0 85    11.84  -11.84 0 1 0 1  2  -3 30    -5.300   60.100
 101   3.90   0.98  72.1  2  15.90 101   3.90   0.99  78.4  9   0.00  -3 30    2

  10.0    58.0 92     6.65   -6.65 0 1 0 0  1   5 29    10.900   57.500
 101  13.31   0.99  80.6  9   0.00   0   0.00   0.00   0.0  0   0.00   5 29    1

   8.0    58.0  1    15.64  -15.64 0 1 0 1  2   4 29     7.100   57.300
 101   2.46   0.97  64.3  2  26.36 101   2.46   0.98  69.0  9   0.00   4 29    2

   6.0    58.0 20    17.63  -17.63 0 1 0 1  2   3 29     5.500   57.100
 101   2.02   0.97  59.2  2  31.22 101   2.02   0.97  63.5  9   0.00   3 29    2

   4.0    58.0 44    17.62  -17.62 0 1 0 1  2   2 29     3.900   57.900
 101   2.02   0.97  59.2  2  31.19 101   2.02   0.97  63.5  9   0.00   2 29    2
```

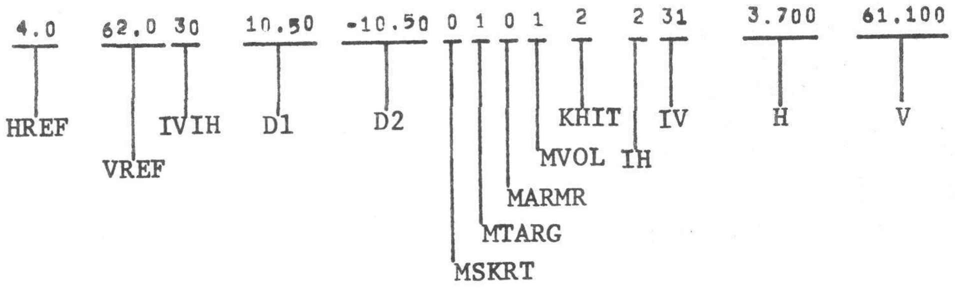
FIG. 35. First Page Cell Data Output, Case 1, Sample Problem

IRSTART	region number of attack plane
IENC	region number enclosing target and attack plane
NSTART	starting cell number for ray tracing (usually first cell)
NEND	last cell number for ray tracing (usually last cell)
CELL SIZE	horizontal and vertical dimensions of cells

(3) Information defining the ground level with respect to the origin, and the amount the origin and center of the grid plane is to be shifted in the x, y, and z direction are printed out during Subroutine GRID

(4) Information defining the aspect angle (azimuth and elevation) and the distance between the grid plane at the origin of the target and the attack plane from which the rays originate are printed out during Subroutine GRID.

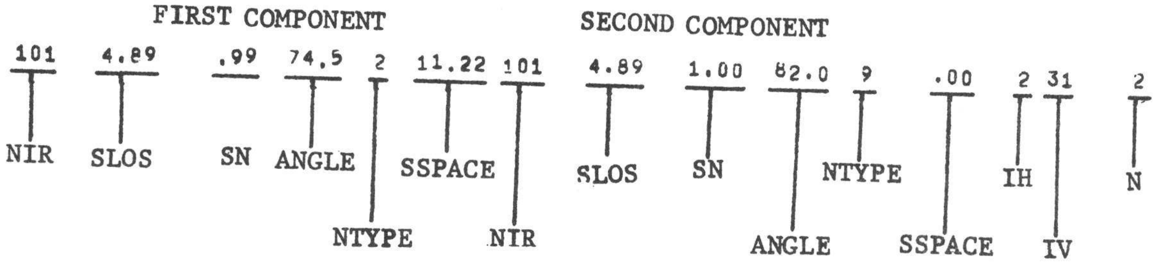
(5) The ray intersect data for each ray and the resulting component intersection data is printed out and recorded on magnetic tape during Subroutine TRACK. This is the primary data from the MAGIC program and is used by subsequent computer programs for vulnerability studies. There are two groups of data written out for each ray. The first group composes the first line of data and consists of grid cell and general ray data defined as follows:



HREF	horizontal distance from center of grid plane to center of specific grid cell
VREF	vertical distance from center of grid plane to center of specific grid cell
IVIH	two-digit random number

IVIH	two-digit random number
D1	distance from first intersect of target to center grid plane (positive if intersect occurs on front side of plane, negative if intersect occurs on back side of plane)
D2	distance from last intersect of target to center grid plane (negative if intersect occurs on back side of plane, positive if intersect occurs on front side of plane)
MSKRT	flag for indicating skirt material
MTARG	flag for indicating target
MARMR	flag for indicating armor
MVOL	flag for indicating interior volume
KHIT	number of components hit along ray
IH	horizontal grid cell number from center of grid plane
IV	vertical grid cell number from center of grid plane
H	horizontal distance from center of grid plane to random point in grid cell
V	vertical distance from center of grid plane to random point in grid cell

The next line(s) consists of the ray intersection data (two components per line) and composes the second group of data defined as follows:



NIR	region identification (component code)
SLOS	line-of-sight distance through region following intersect

SN	normal distance through region
ANGLE	angle between normal and ray at intersect
NTYPE	space code of following region
IH	horizontal grid cell number from center of grid plane
IV	vertical grid cell number from center of grid plane
N	consecutive number of component intersected by ray

(6) At the end of the grid cell data, the consecutive number of the aspect angle completed, the number of Subroutine G1 errors encountered, and the number zero component code errors are printed out during the MAIN program before processing the next aspect angle.

Figure 36 illustrates the first page of the ray tracing output for the second aspect angle computed.

```
END OF CASE    1

NUMBER OF 61 ERRORS ENCOUNTERED     0

NUMBER OF  0  ITEMS ENCOUNTERED     0

NX   51     NY   37     IRSTART    1     IENC    1     NSTART     1     NEND  1887     CELL SIZE   4.00

DATUM LINE AT Z=      0.000 WITH RESPECT TO THE ORIGIN
GROUND IS  AT Z=   -500.000 WITH RESPECT TO THE ORIGIN
XSHIFT IS  AT X=      0.000 WITH RESPECT TO THE ORIGIN
YSHIFT IS  AT Y=      0.000 WITH RESPECT TO THE ORIGIN

AZIMUTH     90.00000     ELEVATION      0.00000     BACK OFF DIST   200.00000

OPTION SET TO CHOOSE CENTER OF CELL

  12.0   60.0  0     5.40    -5.40 0 1 0 1  2   3 15   12.000   60.000
 101   3.67   0.98  67.1  2   3.46 101   3.67   0.98  82.2  9   0.00   3 15    2

   8.0   60.0  0     7.61    -7.61 0 1 0 1  2   2 15    8.000   60.000
 101   2.12   0.99  58.3  2  10.99 101   2.12   0.99  65.9  9   0.00   2 15    2

   4.0   60.0  0     8.67    -8.67 0 1 0 1  2   1 15    4.000   60.000
 101   1.85   1.00  54.3  2  13.65 101   1.85   1.00  60.5  9   0.00   1 15    2

   0.0   60.0  0     9.00    -9.00 0 1 0 1  2   0 15    0.000   60.000
 101   1.79   1.00  53.1  2  14.42 101   1.79   1.00  59.0  9   0.00   0 15    2

  -4.0   60.0  0     8.67    -8.67 0 1 0 1  2  -1 15   -4.000   60.000
 101   1.85   1.00  54.3  2  13.65 101   1.85   1.00  60.5  9   0.00  -1 15    2

  -8.0   60.0  0     7.61    -7.61 0 1 0 1  2  -2 15   -8.000   60.000
 101   2.12   0.99  58.3  2  10.99 101   2.12   0.99  65.9  9   0.00  -2 15    2

 -12.0   60.0  0     5.40    -5.40 0 1 0 1  2  -3 15  -12.000   60.000
 101   3.67   0.98  67.1  2   3.46 101   3.67   0.98  82.2  9   0.00  -3 15    2

  20.0   56.0  0     4.12    -4.12 0 1 0 0  1   5 14   20.000   56.000
 101   8.25   0.97  69.0  9   0.00   0   0.00   0.00   0.0  0   0.00   5 14    1

  16.0   56.0  0     8.30    -8.30 0 1 0 1  2   4 14   16.000   56.000
 101   1.60   0.97  49.9  2  13.40 101   1.60   0.97  55.3  9   0.00   4 14    2

  12.0   56.0  0    10.45   -10.45 0 1 0 1  2   3 14   12.000   56.000
 101   1.34   0.98  41.0  2  18.22 101   1.34   0.98  44.6  9   0.00   3 14    2

   8.0   56.0  0    11.75   -11.75 0 1 0 1  2   2 14    8.000   56.000
 101   1.25   0.99  35.9  2  21.00 101   1.25   0.99  38.8  9   0.00   2 14    2

   4.0   56.0  0    12.46   -12.46 0 1 0 1  2   1 14    4.000   56.000
 101   1.21   1.00  33.1  2  22.50 101   1.21   1.00  35.8  9   0.00   1 14    2

   0.0   56.0  0    12.69   -12.69 0 1 0 1  3   0 14    0.000   56.000
 101   1.20   1.00  32.2  2   8.49 300   6.00   5.00  53.1  2   8.49   0 14    2
 101   1.20   1.00  34.8  9   0.00   0   0.00   0.00   0.0  0   0.00   0 14    3

  -4.0   56.0  0    12.46   -12.46 0 1 0 1  2  -1 14   -4.000   56.000
 101   1.21   1.00  33.1  2  22.50 101   1.21   1.00  35.8  9   0.00  -1 14    2
```

FIG. 36. First Page Cell Data, Case 2, Sample Problem

SECTION IV

SAMPLE PROBLEM

PROBLEM DESCRIPTION

A simplified target representing a vehicle with a driver is used in the sample problem. At least one of each body type incorporated in the MAGIC simulation is used in the target description. Figure 37 shows the sample target and body types used in the region descriptions. Figure 38 contains a plotter description of the exterior surfaces and Figure 39 shows the interior surfaces.

SAMPLE PROBLEM INPUT

Data checksheets and table forms are used to illustrate the input parameters for the sample problem. A listing of the complete input data set is shown in Figure 40.

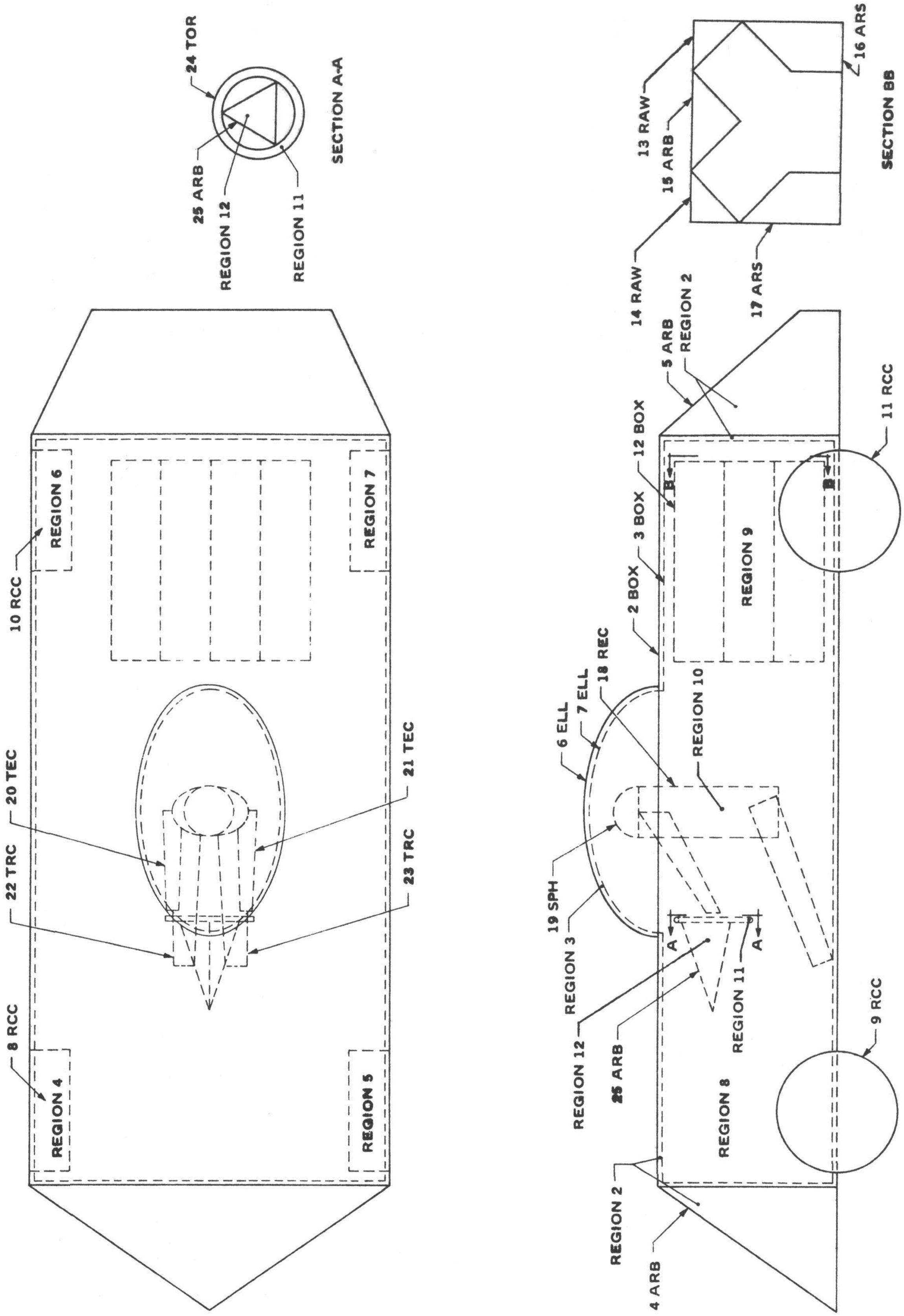


FIG. 37. Sample Target

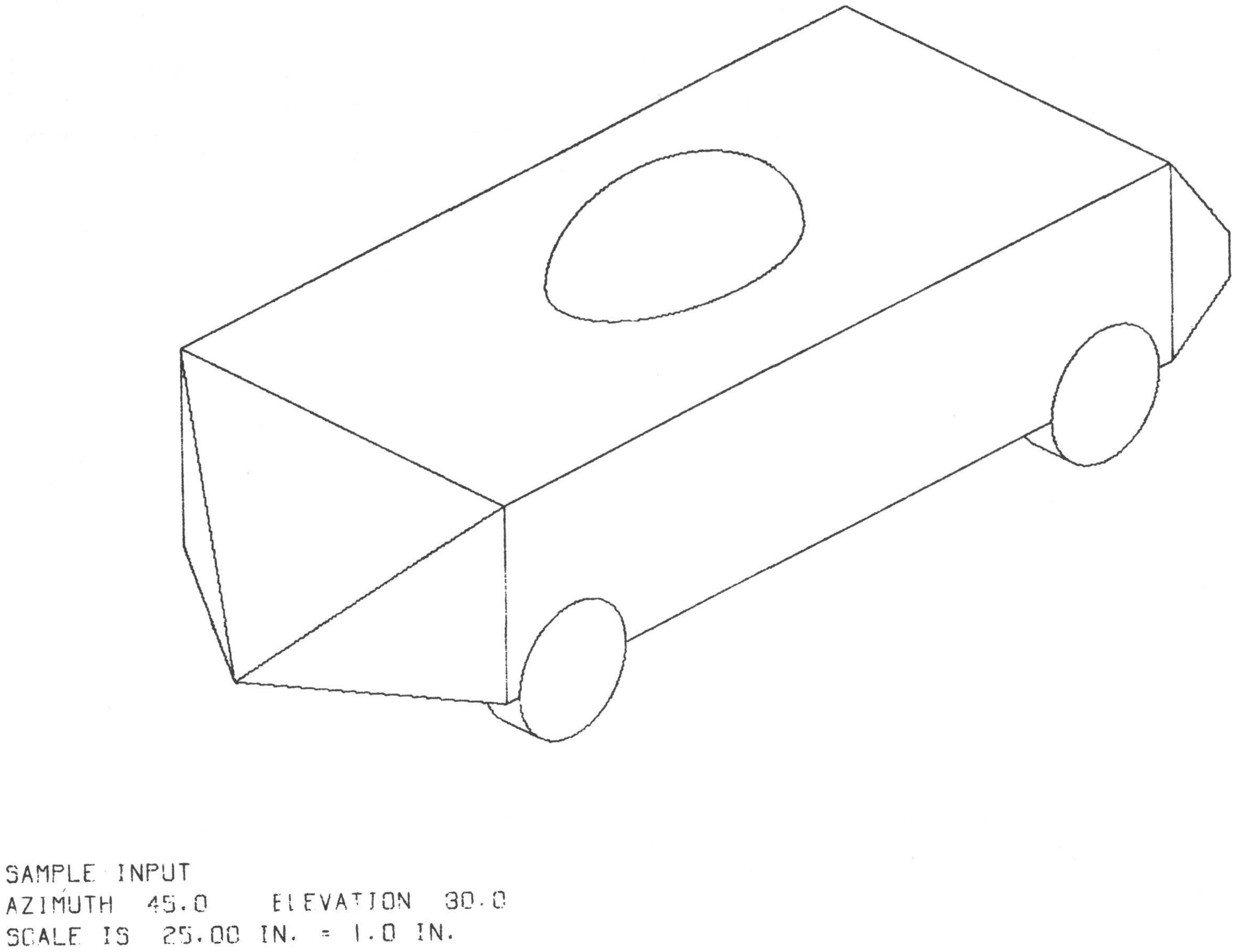
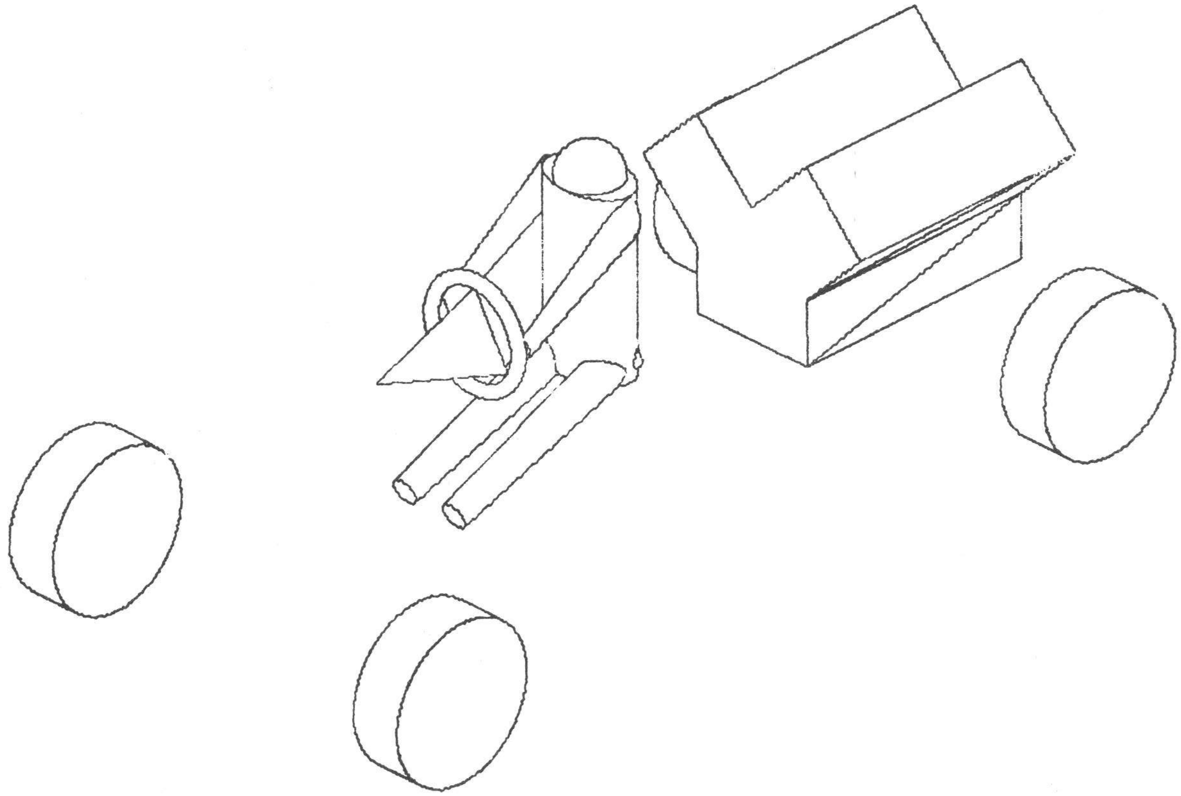


FIG. 38. Sample Target Exterior Surfaces



```
SAMPLE INPUT
AZIMUTH  45.0     ELEVATION  30.0
SCALE IS  25.00 IN. = 1.0 IN.
```

FIG. 39. Sample Target Interior Surfaces

DATA CHECKSHEET

CARD ID	PG	PARA	VALUE	CARD ID	PG	PARA	VALUE
1	20	IRDTP4	(blank)	16		USE	
	20	IWRTP4	(blank)			REGION	
	20	ITESTG	(blank)			TABLE	
	20	IRAYSK	(blank)				
	20	ICARDI	(blank)	17A	65	NRAYS	---
	21	IENTLV	(blank)		65	NGIERR	---
	21	IVOLUM	(blank)				
2	22	IT(I)	(Title)	17B	66	XB(1)	---
			"Sample		66	XB(2)	---
			Input"		66	XB(3)	---
					66	IRSTRT	---
				17C	67	XBF(1)	---
3	23	NRPP	1		67	XBF(2)	---
	23	NTRIP	(blank)		67	XBF(3)	---
	23	NSCAL	(blank)		67	IRFIN	---
	23	NBODY	24				
	23	NRMAX	12	17B	66	XB(1)	---
	23	IPRIN	(blank)		66	XB(2)	---
	23	IRCHEK	(blank)		66	XB(3)	---
					66	IRSTRT	---
4	24	X(1)	-10000.				
	24	X(2)	10000.	17C	67	XBF(1)	---
	24	X(3)	-10000.		67	XBF(2)	---
	24	X(4)	10000.		67	XBF(3)	---
	24	X(5)	-10000.		67	IRFIN	---
	24	X(6)	10000.				
5-15		USE					
		BODY					
		TABLE					

DATA CHECKSHEET

CARD ID	PG	PARA	VALUE	CARD ID	PG	PARA	VALUE
18A	68	IR	---				
	68	NG1ERR	---				
18B	69	XV(1)	---				
	69	XV(2)	---				
	69	XV(3)	---				
18C	70	XT(1)	---				
	70	XT(2)	---				
	70	XT(3)	---				
18D	71	XO(1)	---				
	71	XO(2)	---				
	71	XO(3)	---				
18E	72	XA(1)	---				
	72	XA(2)	---				
	72	XA(3)	---				
18F	73	DOD	---				
	73	DT					
19		USE	---				
		REGION	---				
		IDENT	---				
		TABLE	---				
20	77	NOAA	2				
	77	IWOT	(blank)				
	77	ITAPE8	(blank)				
	77	NAREA	(blank)				

DATA CHECKSHEET Grid Cell Description. Enter data for each attack angle desired.

CARD ID	PG	PARA	VALUE	CARD ID	PG	PARA	VALUE
21A	78	NX	37	21A	78	NX	51
	78	NY	71		78	NY	37
	78	IRSTRT	1		78	IRSTRT	1
	78	IENC	1		78	IENC	1
	78	NG1ERR	(blank)		78	NG1ERR	(blank)
	78	NSTART	(blank)		78	NSTART	(blank)
	78	NEND	(blank)		78	NEND	(blank)
	78	ICENTER	(blank)		78	ICENTER	1
21B	79	A	0.	21B	79	A	90.
	79	E	0.		79	E	0.
	79	ENGTH	200.		79	ENGTH	200.
	79	ZSHIFT	0.		79	ZSHIFT	0.
	79	GROUND	-500.		79	GROUND	-500.
21C	80	XSHIFT	0.	21C	80	XSHIFT	(blank)
	80	YSHIFT	0.		80	YSHIFT	(blank)
	80	CELSIZ	2.		80	CELSIZ	(blank)

DATA CHECKSHEET Area Input. Enter data for each attack angle desired.

CARD ID	PG	PARA	VALUE	CARD ID	PG	PARA	VALUE
22A	82	NX	---	22A	82	NX	---
	82	NY	---		82	NY	---
	82	IRSTRT	---		82	IRSTRT	---
	82	IENC	---		82	IENC	---
	82	NG1ERR	---		82	NG1ERR	---
	82	NSTART	---		82	NSTART	---
	82	NEND	---		82	NEND	---
	82	CELLUN	---		82	CEJLUN	---
	82	AREAUN	---		82	AREAUN	---
22B	83	A	---	22B	83	A	---
	83	E	---		83	E	---
	83	ENGTH	---		83	ENGTH	---
	83	ZSHIFT	---		83	ZSHIFT	---
	83	GROUND	---		83	GROUND	---
22C	84	XSHIFT	---	22C	84	XSHIFT	---
	84	YSHIFT	---		84	YSHIFT	---
	84	CELSIZ	---		84	CELSIZ	---

BODY TABLE

USED FOR: SAMPLE PROBLEM

Date: Aug. 1970

BODY			SCALARS AND VECTORS OF THE BODY						
(1) NO.	TYPE		X	Y	Z	X	Y	Z	IDENTIFICATION
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
2	BOX		75.	-36.	12.	-150.	0.	0.	BODY
2			0.	72.	0.	0.	0.	36.	
3	BOX		74.	-35.	13.	-148.	0.	0.	(1.0)
3			0.	70.	0.	0.	0.	34.	
4	ARB		75.	-36.	12.	75.	36.	12.	FRONT
4			75.	36.	48.	75.	-36.	48.	
4			100.	0.	12.	100.	0.	12.	
4			100.	0.	12.	100.	0.	12.	
4			1234 6435	6128 6237	7415 7415				
5	ARB		-75.	-36.	12.	-75.	36.	12.	REAR
5			-75.	36.	48.	-75.	-36.	48.	
5			-100.	-24.	12.	-100.	24.	12.	
5			-100.	24	20.	-100.	-24.	20.	
5			1234 5678	3487 1265	2376 1485				
6	ELL		20.	0.	48.	-20.	0.	48.	BUBBLE
6			50.						
7	ELL		0.	0.	48.	24.	0.	0.	(1.0)
7			14.						
8	RCC		-60.	-36.	12.	0.	8.	0.	WHEEL
8			12.						
9	RCC		60.	36.	12	0.	-8.	0.	WHEEL

(1) Must be left-adjusted

BODY TABLE

Page 2 of 4

USED FOR: SAMPLE PROBLEM

Date: Aug. 1970

BODY			SCALARS AND VECTORS OF THE BODY						
(1) NO.	TYPE		X	Y	Z	X	Y	Z	IDENTIFICATION
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
9			12.						
10	RCC		-60.	-36.	12.	0.	8.	0.	WHEEL
10			12.						
11	RCC		-60.	36.	12.	0.	-8.	0.	WHEEL
11			12.						
12	BOX		-70.	-20.	15.	40.	0.	0.	ENGINE
12			0.	40.	0.	0.	0.	30.	
13	RAW		-70.	-20.	45.	0.	0.	-10.	(ENGINE)
13			0.	10.	0.	40.	0.	0.	
14	RAW		-70.	20.	45.	0.	0.	-10.	(ENGINE)
14			0.	-10.	0.	40.	0.	0.	
15	ARB		-70.	-10.	45.	-70.	10.	45.	(ENGINE)
15			-70.	0.	35.	-70.	0.	35.	
15			-30.	-10.	45.	-30.	10.	45.	
15			-30.	0.	35.	-30.	0.	35.	
15			3124 7658	1375 2376	1265 1265				
16	ARS								
16			4	5					
16			-70.	-20.	15.	-70.	-20.	15.	1
16			-70.	-20.	15.	-70.	-20.	15.	2
16			-70.	-20.	15.				3

(1) Must be left-adjusted

BODY TABLE

Page 3 of 4

USED FOR: SAMPLE PROBLEM

Date: Aug. 1970

BODY			SCALARS AND VECTORS OF THE BODY						
(1) NO.	TYPE		X	Y	Z	X	Y	Z	IDENTIFICATION
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
16			-70.	-20.	15.	-70.	-10.	15.	4
16			-70.	-10.	25.	-70.	-10.	35.	5
16			-70.	-20.	15.				6
16			-30.	-20.	15.	-30.	-10.	15.	7
16			-30.	-10.	25.	-30.	-10.	35.	8
16			-30.	-20.	15.				9
16			-30.	-20.	15.	-30.	-20.	15.	10
16			-30.	-20.	15.	-30.	-20.	15.	11
16			-30.	-20.	15.				12
17	ARS								
17			5	4					
17			-70.	20.	15.	-70.	20.	15.	1
17			-30.	20.	15.	-30.	20.	15.	2
17			-70.	20.	15.	-70.	10.	15.	3
17			-30.	10.	15.	-30.	20.	15.	4
17			-70.	20.	15.	-70.	10.	25.	5
17			-30.	10.	25.	-30.	20.	15.	6
17			-70.	20.	15.	-70.	10.	35.	7
17			-30.	10.	35.	-30.	20.	15.	8
17			-70.	20.	15.	-70.	20.	15.	9
17			-30.	20.	15.	-30.	20.	15.	10

(1) Must be left-adjusted

BODY TABLE

Page 4 of 4

USED FOR: SAMPLE PROBLEM

Date: Aug. 1970

BODY			SCALARS AND VECTORS OF THE BODY						
(1) NO.	TYPE		X	Y	Z	X	Y	Z	IDENTIFICATION
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
18	REC		0.	0.	24.	0.	0.	28.	TRUNK
18			0.	7.5	0.	5.	0.	0.	
19	SPH		0.	0.	52.	5.			HEAD
20	TEC		0.	-7.5	49.	20.	0.	-12.	ARM
20			0.	0.	3.	0.	2.	0.	
20			2.						
21	TEC		0.	7.5	49.	20.	0.	-12.	ARM
21			0.	0.	3.	0.	2.	0.	
21			2.						
22	TRC		-2.	-4.5	27.	32.	0.	-12.	LEG
22			3.	2.					
23	TRC		-2.	4.5	27.	32.	0.	-12.	LEG
23			3.	2.					
24	TOR		21.5	0.	37.	1.	0.	0.	STEERING
24			8.	1.					WHEEL
25	ARB		21.5	-6.	33.5	21.5	6.	33.5	CENTER
25			21.5	0.	44.	40.	0.	37.	STEERING
25			21.5	-6.	33.5	21.5	6.	33.5	WHEEL
25			21.5	0.	44.	40.	0.	37.	
25			3127 2146	4328 1345	3127 3127				

(1) Must be left-adjusted

REGION TABLE

Page 1 of 1

Date AUG, 1970

USED FOR: SAMPLE PROBLEM

REGION NUMBER		OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	IDENTIFICATION
1 2 3 4 5	6	7 8	9 10 11 12 13	14 15	16 17 18 19 20	21 22	23 24 25 26 27	28 29	30 31 32 33 34	35 36	37 38 39 40 41	42 43	44 45 46 47 48	49 50	51 52 53 54 55	56 57	58 59 60 61 62	63 64	65 66 67 68 69	70 71 72 73 74 75 76 77 78 79 80
1			1		-2		-4		-5		-6		-8		-9		-10		-11	
2		OR	2		-3		-7		-8		-9		-10		-11	OR	4	OR	5	
3			6		-7		-2													
4			8																	
5			9																	
6			10																	
7			11																	
8		OR	3		-18		-19		-20		-21		-22		-23		-24		-25	
			-8		-9		-10		-11		-12	OR	7		-18		-19		-20	
			-21		-24		-25	OR	13	OR	14	OR	15	OR	16	OR	17			
9			3		12		-13		-14		-15		-16		-17					
10		OR	18	OR	19	OR	20	OR	21	OR	22	OR	23							
11			3		24		-25													
12			3		25															
-1																				

REGION IDENTIFICATION TABLE

Page 1 of 1

USED FOR: SAMPLE PROBLEM

Date Aug, 1970

REGION NUMBER	ITEM CODE	AIR SPACE CODE	BLANK	ALPHAMERIC DESCRIPTION OF REGION	IDENT
1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76	77 78 79 80
1		01		OUTSIDE AIR	
2	100			BODY	
3	101			BUBBLE	
4	151			WHEEL RIGHT FRONT	
5	152			WHEEL LEFT FRONT	
6	153			WHEEL RIGHT REAR	
7	154			WHEEL LEFT REAR	
8		02		AIR INSIDE	
9	200			ENGINE	
10	300			MAN	
11	400			STEERING WHEEL	
12	401			STEERING SHAFT	

```
                                                          2 OCT 70 PAGE      1

(blank card)
SAMPLE INPUT
         1                             24        12
-10000.      10000.     -10000.       10000.   -10000.        10000.
2  BOX     75.       -36.       12.      -150.      0.        0.        BODY
2           0.        72.        0.         0.      0.       36.
3  BOX     74.       -35.       13.      -148.      0.        0.        (1.0)
3           0.        70.        0.         0.      0.       34.
4  ARB     75.       -36.       12.        75.     36.       12.        FRONT
4          75.        36.       48.        75.    -36.       48.
4         100.         0.       12.       100.      0.       12.
4         100.         0.       12.       100.      0.       12.
4          1234 6435 6128 6237 7415 7415
5  ARB    -75.       -36.       12.       -75.     36.       12.        REAR
5         -75.        36.       48.       -75.    -36.       48.
5        -100.       -24.       12.      -100.     24.       12.
5        -100.        24.       20.      -100.    -24.       20.
5          1234 5678 3487 1265 2376 1485
6  ELL     20.         0.       48.       -20.      0.       48.        BUBBLE
6          50.
7  ELL  7  0.          0.       48.        24.      0.        0.        (1.0)
7          14.
8  RCC     60.       -36.       12.        -0.      8.        0.        WHEEL
8          12.
9  RCC     60.        36.       12.         0.     -8.        0.        WHEEL
9          12.
10 RCC    -60.       -36.       12.         0.      8.        0.        WHEEL
10         12.
11 RCC    -60.        36.       12.         0.     -8.        0.        WHEEL
11         12.
12 BOX    -70.       -20.       15.        40.      0.        0.        ENGINE
12          0.        40.        0.         0.      0.       30.
13 RAW    -70.       -20.       45.         0.      0.      -10.        (ENGINE)
13          0.        10.        0.        40.      0.        0.
14 RAW    -70.        20.       45.         0.      0.      -10.        (ENGINE)
14          0.       -10.        0.        40.      0.        0.
15 ARB    -70.       -10.       45.       -70.     10.       45.        (ENGINE)
15        -70.         0.       35.       -70.      0.       35.
15        -30.       -10.       45.       -30.     10.       45.
15        -30.         0.       35.       -30.      0.       35.
15         3124 7658 1375 2376 1265 1265
16 ARS
16                  4         5
16        -70.       -20.       15.       -70.    -20.       15.                 1
16        -70.       -20.       15.       -70.    -20.       15.                 2
16        -70.       -20.       15.                                              3
16        -70.       -20.       15.       -70.    -10.       15.                 4
16        -70.       -10.       25.       -70.    -20.       35.                 5
16        -70.       -20.       15.                                              6
16        -30.       -20.       15.       -30.    -10.       15.                 7
16        -30.       -10.       25.       -30.    -20.       35.                 8
16        -30.       -20.       15.                                              9
16        -30.       -20.       15.       -30.    -20.       15.                10
16        -30.       -20.       15.       -30.    -20.       15.                11
16        -30.       -20.       15.                                             12
17 ARS
17                  5         4
17        -70.        20.       15.       -70.     20.       15.                 1
17        -30.        20.       15.       -30.     20.       15.                 2
```

FIG. 40. Listing of Sample Problem Input

```
                                                             2 OCT 70 PAGE      2

17        -70.       20.       15.      -70.       10.       15.                3
17        -30.       10.       15.      -30.       20.       15.                4
17        -70.       20.       15.      -70.       10.       25.                5
17        -30.       10.       25.      -30.       20.       15.                6
17        -70.       20.       15.      -70.       20.       35.                7
17        -30.       20.       35.      -30.       20.       15.                8
17        -70.       20.       15.      -70.       20.       15.                9
17        -30.       20.       15.      -30.       20.       15.               10
18 REC     0.        0.        24.       0.        0.        28.      TRUNK
18         0.        7.5       0.        5.        0.        0.
19 SPH     0.        0.        52.       5.                           HEAD
20 TEC     0.      -7.5        49.       20.       0.       -12.      ARM
20         0.        0.        3.        0.        2.        0.
20         2.
21 TEC     0.        7.5       49.       20.       0.       -12.      ARM
21         0.        0.        3.        0.        2.        0.
21         2.
22 TRC    -2.       -4.5       27.       32.       0.       -12.      LEG
22         3.        2.
23 TRC    -2.        4.5       27.       32.       0.       -12.      LEG
23         3.        2.
24 TOR     21.5      0.        37.       1.        0.        0.       STEERING
24         8.        1.                                               WHEEL
25 ARB     21.5     -6.        33.5      21.5      6.        33.5     CENTER
25         21.5      0.        44.       40.       0.        37.      STEERING
25         21.5     -6.        33.5      21.5      6.        33.5     WHEEL
25         21.5      0.        44.       40.       0.        37.
25         3127 2146 4328 1345 3127 3127
    1       1     -2      -4      -5      -6      -8      -9    -10     -11
    2 OR    2     -3      -7      -8      -9     -10    -110R    40R     5
    3       6     -7      -2
    4       8
    5       9
    6      10
    7      11
    8 OR    3    -18     -19     -20     -21     -22     -23    -24     -25
           -8     -9     -10     -11     -120R     7     -18    -19     -20
          -21    -24     -250R   130R   140R   150R   160R   17
    9       3     12     -13     -14     -15     -16     -17
   10 OR   180R   190R   200R   210R   220R    23
   11       3     24     -25
   12       3     25
   -1
         1                  01           OUTSIDE AIR
         2       100                     BODY
         3       101                     BUBBLE
         4       151                     WHEEL RIGHT FRONT
         5       152                     WHEEL LEFT FRONT
         6       153                     WHEEL RIGHT REAR
         7       154                     WHEEL LEFT REAR
         8                  02           AIR INSIDE
         9       200                     ENGINE
        10       300                     MAN
        11       400                     STEERING WHEEL
        12       401                     STEERING SHAFT

    2
        37        71          1         1
 0.          0.          200.        0.          -500.
 0.           0.         2.
        51        37          1         1                                       1
 90.         0.          200.        0.          -500.
```

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FIG. 40. Listing of Sample Problem Input (Concluded)

APPENDIX

DATA CHECKSHEET

CARD ID	PG	PARA	VALUE
1	20	IRDTP4	
	20	IWRTP4	
	20	ITESTG	
	20	IRAYSK	
	20	ICARDI	
	21	IENTLV	
	21	IVOLUM	
2	22	IT(I)	
3	23	NRPP	
	23	NTRIP	
	23	NSCAL	
	23	NBODY	
	23	NRMAX	
	23	IPRIN	
	23	IRCHEK	
4	24	X(1)	
	24	X(2)	
	24	X(3)	
	24	X(4)	
	24	X(5)	
	24	X(6)	
5-15		USE	
		BODY	
		TABLE	

CARD ID	PG	PARA	VALUE
16		USE	
		REGION	
		TABLE	
17A	65	NRAYS	
	65	NGIERR	
17B	66	XB(1)	
	66	XB(2)	
	66	XB(3)	
	66	IRSTRT	
17C	67	XBF(1)	
	67	XBF(2)	
	67	XBF(3)	
	67	IRFIN	
17B	66	XB(1)	
	66	XB(2)	
	66	XB(3)	
	66	IRSTRT	
17C	67	XBF(1)	
	67	XBF(2)	
	67	XBF(3)	
	67	IRFIN	

DATA CHECKSHEET

CARD ID	PG	PARA	VALUE	CARD ID	PG	PARA	VALUE
18A	68	IR					
	68	NG1ERR					
18B	69	XV(1)					
	69	XV(2)					
	69	XV(3)					
18C	70	XT(1)					
	70	XT(2)					
	70	XT(3)					
18D	71	XO(1)					
	71	XO(2)					
	71	XO(3)					
18E	72	XA(1)					
	72	XA(2)					
	72	XA(3)					
18F	73	DOD					
	73	DT					
19		USE					
		REGION					
		IDENT					
		TABLE					
20	77	NOAA					
	77	IWOT					
	77	ITAPE8					
	77	NAREA					

DATA CHECKSHEET

Grid Cell Description. Enter data for each attack angle desired.

CARD ID	PG	PARA	VALUE	CARD ID	PG	PARA	VALUE
21A	78	NX		21A	78	NX	
	78	NY			78	NY	
	78	IRSTRT			78	IRSTRT	
	78	IENC			78	IENC	
	78	NG1ERR			78	NG1ERR	
	78	NSTART			78	NSTART	
	78	NEND			78	NEND	
	78	ICENTER			78	ICENTER	
21B	79	A		21B	79	A	
	79	E			79	E	
	79	ENGTH			79	ENGTH	
	79	ZSHIFT			79	ZSHIFT	
	79	GROUND			79	GROUND	
21C	80	XSHIFT		21C	80	XSHIFT	
	80	YSHIFT			80	YSHIFT	
	80	CELSIZ			80	CELSIZ	

DATA CHECKSHEET Area Input. Enter data for each attack angle desired.

CARD ID	PG	PARA	VALUE	CARD ID	PG	PARA	VALUE
22A	82	NX		22A	82	NX	
	82	NY			82	NY	
	82	IRSTRT			82	IRSTRT	
	82	IENC			82	IENC	
	82	NG1ERR			82	NG1ERR	
	82	NSTART			82	NSTART	
	82	NEND			82	NEND	
	82	CELLUN			82	CELLUN	
	82	AREAUN			82	AREAUN	
22B	83	A		22B	83	A	
	83	E			83	E	
	83	ENGTH			83	ENGTH	
	83	ZSHIFT			83	ZSHIFT	
	83	GROUND			83	GROUND	
22C	84	XSHIFT		22C	84	XSHIFT	
	84	YSHIFT			84	YSHIFT	
	84	CELSIZ			84	CELSIZ	

BODY TABLE

Page of

USED FOR:

Date:

BODY			SCALARS AND VECTORS OF THE BODY						
(1) NO.	TYPE		X	Y	Z	X	Y	Z	IDENTIFICATION
1 2 3	4 5 6	7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50	51 52 53 54 55 56 57 58 59 60	61 62 63 64 65 66 67 68 69 70	71 72 73 74 75 76 77 78 79 80

(1) Must be left-adjusted

REGION TABLE

Page of

Date

USED FOR:

REGION NUMBER		OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	OR	+ OR - BODY NUMBER	IDENTIFICATION
1 2 3 4 5	6	7 8	9 10 11 12 13	14 15	16 17 18 19 20	21 22	23 24 25 26 27	28 29	30 31 32 33 34	35 36	37 38 39 40 41	42 43	44 45 46 47 48	49 50	51 52 53 54 55	56 57	58 59 60 61 62	63 64	65 66 67 68 69	70 71 72 73 74 75 76 77 78 79 80

REGION IDENTIFICATION TABLE

Page of

USED FOR:

Date

REGION NUMBER	ITEM CODE	AIR SPACE CODE	BLANK	ALPHAMERIC DESCRIPTION OF REGION	IDENT
1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76	77 78 79 80

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