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Technical Report

MONTE CARLO CALCULATION OF
NEUTRON STREAMING THROUGH
TWO-LEGGED-DUCT ENTRANCEWAYS

June 1965

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U. S. NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California

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MONTE CARLO CALCULATION OF NEUTRON STREAMING THROUGH TWO-LEGGED-DUCT ENTRANCEWAYS

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by

• Leonard B. Gardner and Alan J. Mettler

ABSTRACT

Several techniques for calculating dose rates in the study of shelter entranceways are reported herein. Calculations have been verified by experiments. These calculations also determine neutron energy spectra, a parameter that is difficult to measure and which is very useful in gaining insight into the design of protective structures. Both the neutron flux spectra and dose rates are calculated for various positions along the centerline of a two-legged duct. Calculations were performed utilizing the ADONIS computer code which solves the Neumann approximation to the transport equation by Monte Carlo techniques. These Monte Carlo calculations were compared to second-leg calculations utilizing a semiempirical albedo formula, and were also compared to experimental measurements made with a tissue equivalent dosimeter. Included is a discussion of UNIGEOM, a generalized computer program for ADONIS geometry, designed to be run on the IBM 7094.

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The Laboratory invites comment on this report, particularly on the results obtained by those who have applied the information.

This work sponsored by the Defense Atomic Support Agency.

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INTRODUCTION

The U. S. Naval Civil Engineering Laboratory has for some time experimented with the streaming of nuclear radiation through the ducted entranceways of scale-model shelters, using 14.5-Mev neutrons as source particles. This energy approximates that of the prompt neutrons released in a fusion-type detonation.

There are many techniques for calculating the dose rate of streaming neutrons, and this report compares results of the ADONIS Monte Carlo calculations with albedo calculations. All of the calculations shown have been verified by experiment. The great advantage in employing calculations is that costly and time-consuming experiments are minimized.

The work reported herein is for the case of neutrons streaming through 3x3-foot-square and 11x11-inch-square two-legged concrete ducts. The 14.5-Mev neutron source was placed just inside the duct entrance.

ADONIS COMPUTER PROGRAM

ADONIS¹ is a Monte Carlo computer program for solving the Neumann approximation to the transport equation governing neutron and gamma-ray streaming. It is written in FORTRAN II, version 2, for the IBM 7090, and ten tapes are required. ADONIS treats a problem having up to a maximum of 80 regions which, when combined, must cover all XYZ space where each region is a parallelepiped. It is important to note that the geometry diagram 1 in Appendix C of the ADONIS manual contains an error in the designation of the coordinate system. Also, it is necessary that the exit from the duct be in the positive Y direction and into the highest numbered region.

The particle flux is divided into energy groups called bins, of which a maximum of 10 is permitted. For a neutron problem, approximately seven nuclides may be used; however, for a gamma-ray problem more nuclides are possible. These nuclides must completely describe the material composition of each parallelepiped. The composition of each region may differ, but the composition within a particular region is limited to a combination of, at most, five elements.

The geometric input required for ADONIS is time-consuming and complicated to prepare, even with the aid of various computer programs designed to simplify this task. In general, the geometry must be recomputed for each change in duct configuration. In many cases all that will be changed are dimensions such as length and

width of the legs, height of the duct, and the amount of material surrounding the duct. In order to facilitate the use of ADONIS in investigating the effects of such changes in duct parameters, a computer program was written which will accept the physical characteristics of the duct and as output will yield punched cards ready for an ADONIS run. These cards consist of the bounding plane cards (BPO), adjacent region cards (IRX), complex plane cards (CMX), and horizontal and vertical plane cards (H and V). They define the geometry of ADONIS. The BPO cards give the coordinates of the maximum and minimum extent of the regions along the axes. The IRX cards define which of the regions are back to back. The CMX cards define which of the regions back to more than one region.

Although subroutines called EASYGEOM and TEST G are available to facilitate preparing the input cards to ADONIS, mistakes are easily made in geometries as complex as those associated with duct problems. To remedy this situation, a computer program, UNIGEOM, was written at NCEL. The source deck of this program is listed in Table I. This program incorporates a modified EASYGEOM program as the main routine and TEST G and its subroutines as a subroutine. The bounding plane cards required as input to EASYGEOM are calculated from the physical parameters of the duct by means of a subroutine. The UNIGEOM program allows three such subroutines. The subroutines included in this report are for a two-legged duct and three-legged coplanar and non-coplanar ducts. Other configurations may be incorporated by substituting "duct" subroutines and appropriately changing the calling sequence in the main program.

ADONIS considers the following neutron interactions: isotropic and anisotropic elastic scattering, discrete and continuous inelastic scattering, scattering by hydrogen, and the $(n, 2n)$ reaction in beryllium absorption. The gamma portion of the ADONIS program considers the Compton scattering of photons where the photoelectric effect and pair production are regarded as absorption. Particle histories in ADONIS are terminated either when an absorption occurs, the particle is degraded below an arbitrary cut-off energy, a kill occurs due to splitting, or the particle escapes. Cross-section data used in ADONIS are called from an organized-element-data tape. A source-data tape containing the position coordinates, direction cosines, and the initial energy of the neutron or gamma-ray source is required in addition to the organized-element-data tape and the geometry-input data.

The source-data tape is generated for the case of either the point source incident radiation of neutrons or gamma rays by PSGEN, a program modified to be anisotropic; in the case of gamma rays produced by neutron interaction, the source-data tape is generated by the GASP¹ program. The input to PSGEN, which is modified to be a 2π source, describes the source as the probability that particles exist below a particular energy. The energy is evaluated for probabilities in 0.1 increments of probability from 0 to 1.0. ADONIS is called in through the IBM 7090 monitor system. ADONIS contains dump and edit procedures, selected by turning sense switch 1 "on" at the time these procedures are to be initiated. After dumping, ADONIS may be restarted. Turning sense switch 2 "on" prints on-line the particle history numbers; turning sense switches 3 and 4 "on" writes an off-line trace of each particle path on tape A3.

Particle splitting is employed to improve the efficiency of the calculation by assigning importance weights to each of the regions. Regardless of the importance selected for each region, if the ADONIS program is allowed to run for a sufficiently long time, the answers furnished by it will be approximately the same. However, in making many calculations it has been determined that the proper selection of weighting functions can significantly decrease the amount of running time required. The optimum value of importance for each region may best be selected by a semiempirical approach. First, the geometry is studied and a weight, inversely proportional to importance, is assigned to each region based upon the best knowledge of neutron or gamma-ray streaming available to the investigator. Using these values, the program is run for a short period of time, after which the calculated flux in each region is reviewed. The weight of the region is then adjusted in a way which will enhance the probability of neutrons going in the desired direction while reducing the probability of neutrons going in undesired directions.

It has been experienced that approximately five tries are necessary to optimize the weight for each region in a duct with two legs and approximately 10 tries for similar optimization in a duct with three non-coplanar legs. It should be emphasized that a proper selection of weight allows a greater percentage of computer time to be devoted to following particles of interest; thus, running time for statistically significant determinations of flux may be considerably reduced. A proper selection of importance functions and an adequate running time may be judged by comparing the standard deviation of particle flux to the flux for each energy bin and duct region. ADONIS calculates the flux and particle dose in each region. The latter is accomplished through either a fine or coarse response function. These two functions differ only in that for the fine function, the response is evaluated at the same energies used for cross sections on the element-data tape, and for the coarse function, the response is averaged over each energy bin. Also, the standard deviation of dose is evaluated only where fine response functions are used. The response function is simply a function that converts particle flux into dose such as relative biological effectiveness (RBE) for the case of neutrons.

ADONIS also provides, as output data for each region, the number of absorptions, births, degradations, and deaths; flux per energy bin; deviation of flux per energy bin; total number of reflected and transmitted particles; particle balance; absorption by element and region; and coarse dose per energy region. The neutron flux is reported as the track length per source particle per unit energy in energy interval j per unit volume for finite regions. In the case of regions infinitely bounded, the total flux is given.

Analysis of ADONIS Results

When ADONIS is restarted, each run prints only the flux and dose associated with that run, rather than the best estimate based upon total running time. It was, therefore, necessary to calculate these parameters as follows:

$$\bar{\phi} \approx \frac{\sum_{i=1}^n N_i \phi_i}{\sum_{i=1}^n N_i}$$

$$\sigma_{\phi} \approx \frac{\sqrt{\sum_{i=1}^n (N_i \phi_i)^2}}{\sum_{i=1}^n N_i}$$

$$\bar{D} \approx \frac{\sum_{i=1}^n N_i D_i}{\sum_{i=1}^n N_i}$$

$$\sigma_D = \sqrt{\sum_{j=1}^n \left\{ [\overline{RBE}_j (E_j) \Delta E_j]^2 \left[\left(\frac{1}{\sum_{i=1}^n N_i} \right)^2 \sum_{i=1}^n \{ N_i [\sigma_{ji}(\phi)]^2 \} \right] \right\}}$$

In the case of only one run,

$$\sigma_D = \sqrt{\sum_{j=1}^m \{ [\overline{RBE}_j (E_j) \Delta E_j]^2 [\sigma_j(\phi)]^2 \}}$$

where $\tilde{D}$ = best estimate of dose based upon n runs

ΔE_j = energy increment of j^{th} bin

N_i = number of histories of i^{th} run

n = number of runs

m = number of energy bins

$\text{RBE}_j(E)$ = relative biological effectiveness averaged over the energy range of the j^{th} bin

σ = standard deviation of dose for n^{th} run

$\tilde{\sigma}_D$ = best estimate of standard deviation of dose based upon n runs

$\sigma_j(\phi)$ = standard deviation of flux for j^{th} bin

$\tilde{\phi}$ = best estimate of flux based upon n runs

where D_0 is the incident dose due to the total number of particles emitted by the analytically simulated neutron source. Since the analytical treatment considers these to be emitted in one hemisphere, the value of incident dose is divided by 2π , the number of steradians in a hemisphere. In actual practice, ADONIS calculates the dose per incident source particle, and thus the associated value of incident dose is one source particle multiplied by the RBE of the source particle. This is numerically equal to the RBE of the source particle energy.

DESCRIPTION OF EXPERIMENTS

In experiments at NCEL, 14.5 Mev neutrons approximated the energy of neutrons released in a fusion-type detonation. Neutrons of this energy were available from a neutron generator utilizing the $T(d,n)He^4$ reaction. A two-legged duct 3 x 3 feet and a three-legged duct 11 x 11 inches were constructed for the experimental phases of this work. The latter was constructed in such a way that the orientation of the third leg could be altered to form either the coplanar or non-coplanar case. Plan and elevation drawings of these ducts, including dimensions, will be found in Figures 1, 2, and 3. The neutron source was approximated as a point source for the purpose of

calculations. In actuality, the active area of the target was a circle approximately 7/8 inch in diameter. Although this target radiated more or less isotropically, attention was taken to orient the geometry in such a way that the plane of the target was located concentric to the centerline of symmetry and perpendicular to the duct approximately one centimeter from the end of the first leg and inside the duct. The same location was used for theoretical calculations. These calculations were made for both the 3-foot and the 11-inch duct. However, experimental measurements were made only with the 3-foot duct, since the physical size of the dosimeter significantly perturbed the flux and in certain cases simply would not fit.

There is some present concern for the statistical variation of the experimentally measured dose rates, the calibration of the instrumentation utilized, and the determination of the incident dose, D_0 . Nonetheless, it is believed that these results are certainly accurate to within an order of magnitude. Although plans exist for repeating these measurements with more care and augmenting them with measurements performed with helium and argon-methane detectors and foil activation techniques, this will not be done for some time. Such work really has little bearing upon the comparison of ADONIS calculations reported herein, since it will, in all likelihood, simply add more significance to the determinations.

While reviewing the results of Doty's² experiments, Song³ observed that a semiempirical albedo formula could be utilized to fit the data. He utilized Monte Carlo results reported by Ballistic Research Laboratory⁴ in order to determine the constants of his formula. He then calculated the dose in the second leg of the 3-foot duct and found it to be in good agreement with Doty's experimentally measured values. While it is true that many different functions could undoubtedly fit Doty's data, a physical explanation of neutron streaming can be easily made utilizing albedo concepts. This was the motivating reason behind the albedo development for neutron streaming through ducts. For additional validity, Song calculated the dose in the second leg of the 11-inch duct, and the ADONIS program was utilized to determine the dose in both ducts by Monte Carlo calculations of the Neumann approximation to the transport equation.

MONTE CARLO CALCULATIONS

The program UNIGEOM (Table I), was written to calculate ADONIS input geometry from the physical parameters of the three duct configurations shown in Figures 1, 2, and 3. Since TEST G is incorporated in this program, the physical dimensions of the duct are checked for consistency, and the same diagnostics are written on the output tape as would be had EASYGEOM and TEST G been run as they were originally intended and not incorporated in the present program.

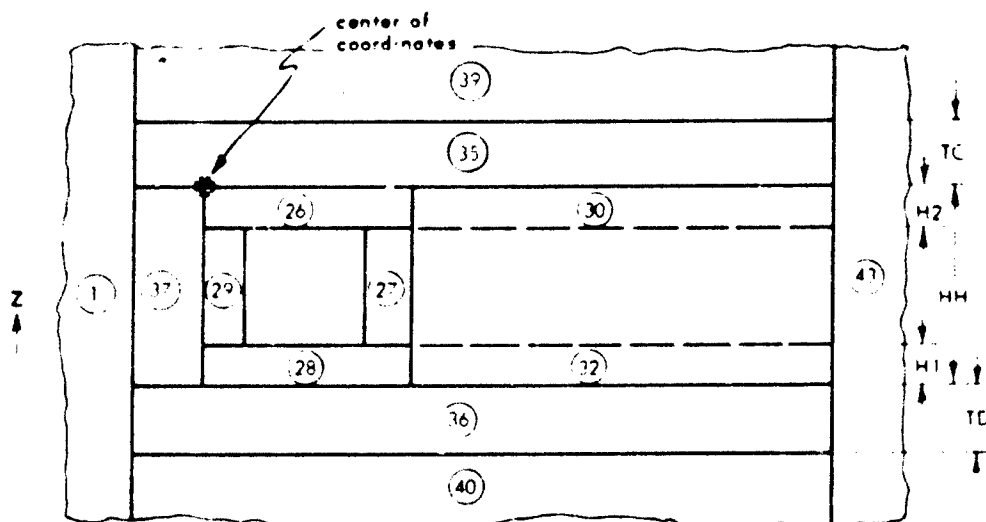
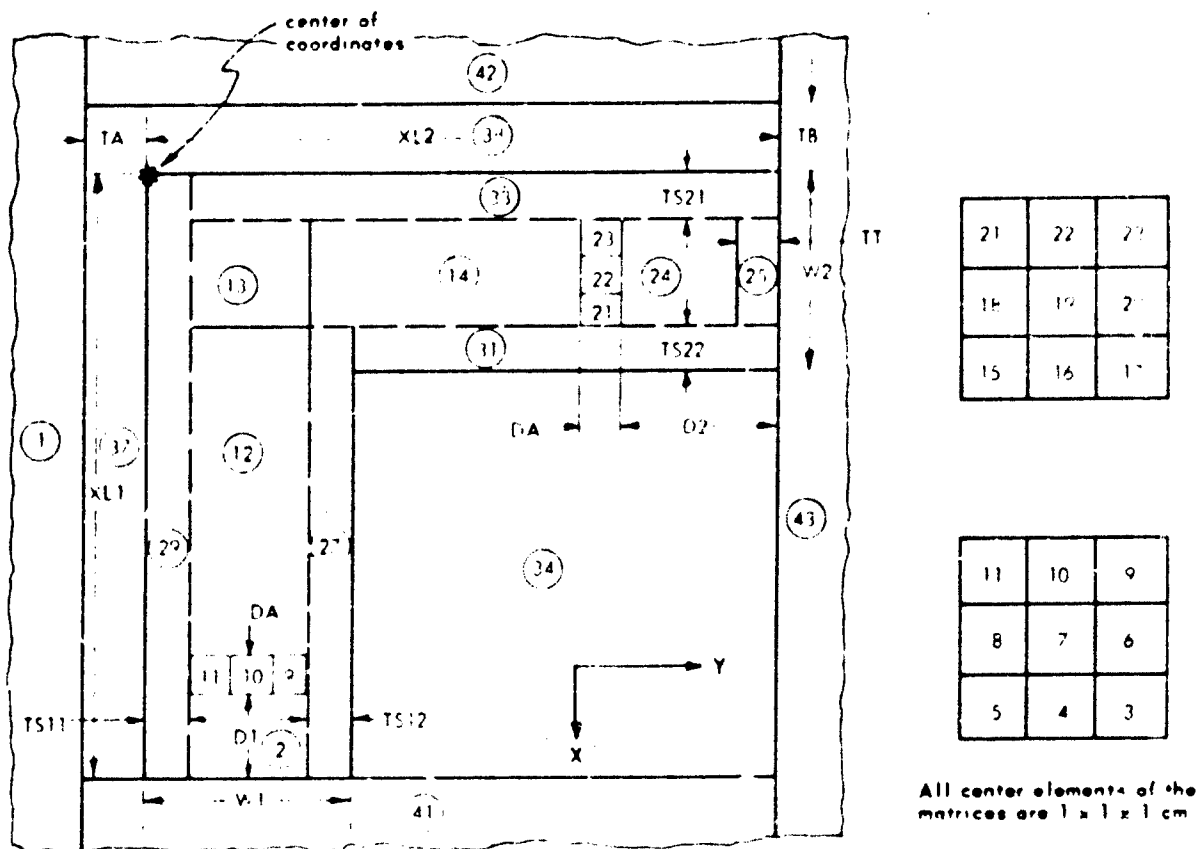
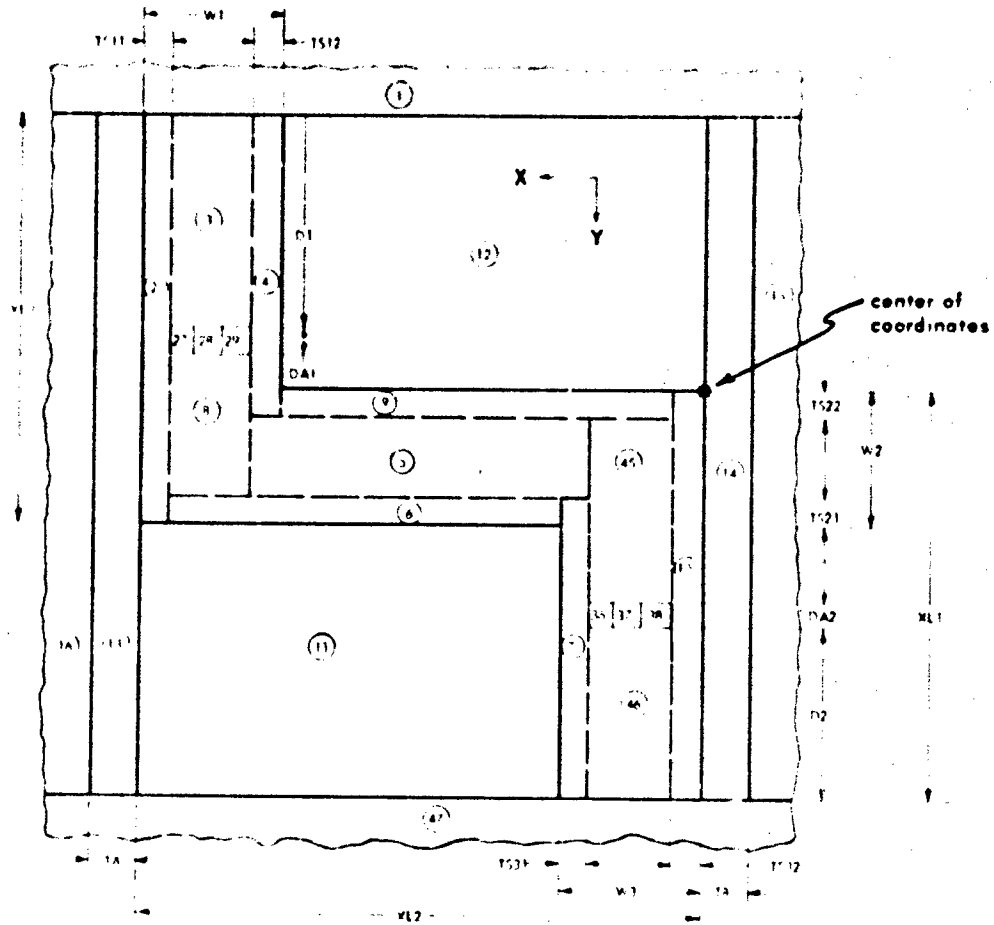


Figure 1. Two-legged duct with regions and physical parameters.



27	26	2
30	31	32
33	34	35

36	37	38
39	40	41
42	43	44

All center elements of the matrices are $1 \times 1 \times 1$ cm.

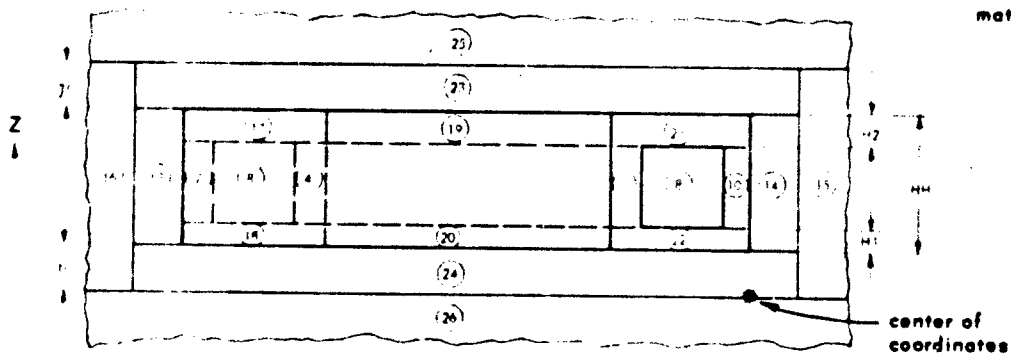


Figure 2. Three-legged coplanar duct with regions and physical parameters.

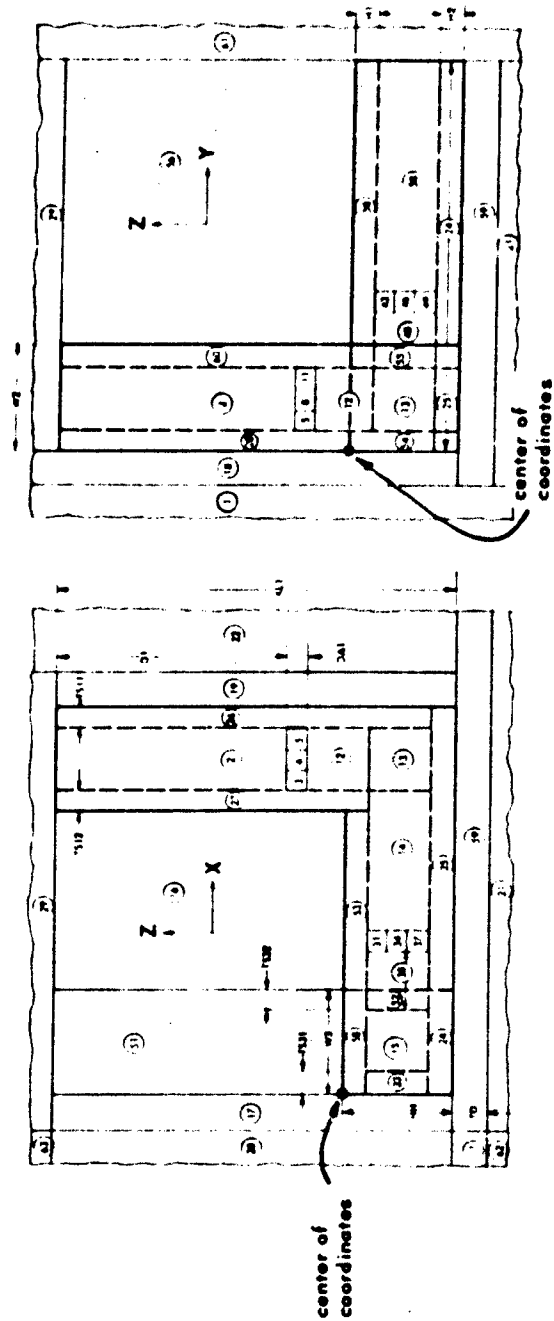
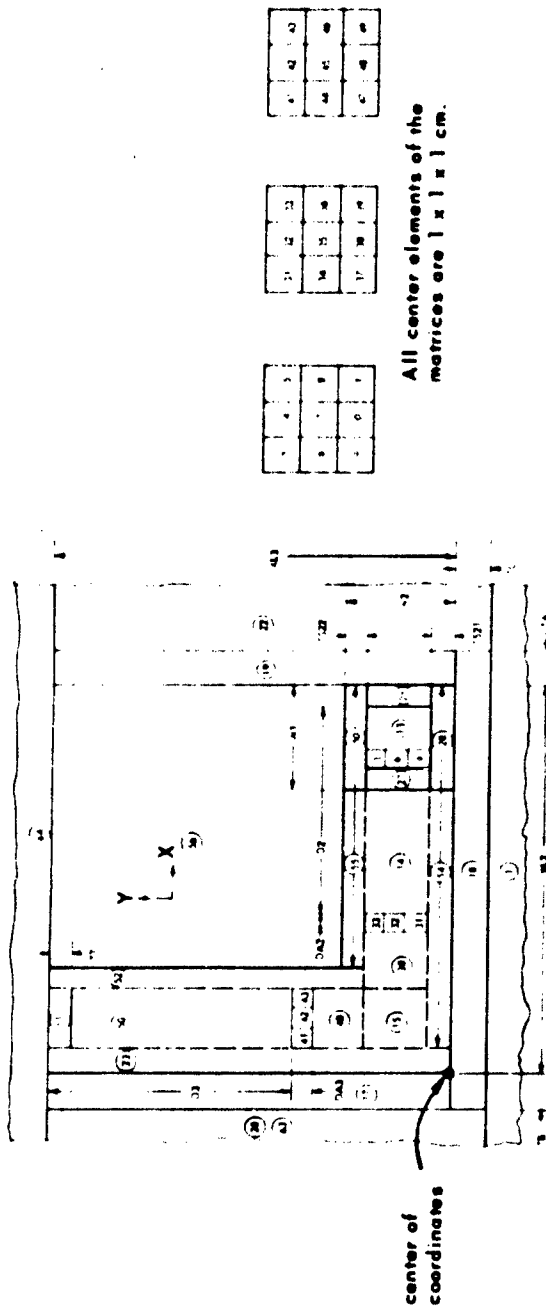


Figure 3. Three-legged non-coplanar duct with regions and physical parameters.

The appropriate geometry subroutine is indicated by a value on the first input card. Input data are read by the main program from tape A2 and are communicated to the proper routine through Common. Input data in the format F 10.5 are read in sequence XL1, XL2, XL3, W1, W2, W3, TS11, TS12, TS21, TS22, TS31, TS32, TT, D1, D2, D3, DA, DB, DC, DA1, DA2, DA3, TA, TB, TC, TD, HH, H1, H2, XX. Table II lists the values of these parameters for each of the three duct configurations. In some cases these values are zero, but for proper sequencing must be provided. All dimensions are given in centimeters to be consistent with ADONIS. The various regions in the duct are also identified in Figures 1, 2, and 3. It will be noted that a matrix of nine regions cuts each important leg in the duct. The center region of this matrix is an area 1 centimeter square and may be utilized as a detector region useful for comparing calculations to experimental dosimetry at a point. The geometry coordinates of the subroutine calculations are written as X(A, B), where A has the value given in the following table.

<u>Coordinate</u>	<u>Coordinate Number</u>
-X	1
+X	2
-Y	3
+Y	4
-Z	5
+Z	6

Coordinates are indicated by X(A, B), where A is the coordinate indicator and B is the region number.

This table also compares with values in ADONIS notation. The region number is given by B. The output of UNIGEOM is written on tapes A3 and B5, the latter of which is punched as geometry cards required for ADONIS input. First the BPO cards are punched, as identified in the preceding table, one card for each region. These coordinates are punched in E 14.5; next, the cards for the coordinates of each complex plane for both horizontal (H cards) and vertical (V cards) are punched. A complex bounding plane is created for the surface of one region if it is adjacent to the surfaces of more than one other region. One or more cards is devoted to the coordinates of the horizontal and vertical fields of each complex bounding plane. The adjacent region (IRX) cards and the complex plane (CMX) cards needed for ADONIS input are also provided by the program. Should there be an error in geometry or physical dimension that prevents the calculation of geometry, various diagnostics are provided. ADONIS input cards calculated by UNIGEOM for the parameters of Table II are listed in Table III. This information is provided as sample problems.

COMPARISON OF THEORY TO EXPERIMENT

Figure 4 shows the neutron energy flux calculated by ADONIS in several regions associated with the 11-inch two-legged duct, normalized by $D_0/2\pi$. These regions may be identified by referring to Figure 1. In Figure 4 it is seen that the flux, due to source neutrons, steadily decreases with distance along the first leg. A few source neutrons are also found in region 14, the region in the second leg adjacent to the corner. These neutrons must have arrived by direct penetration, grazing the inside corner of the duct. Had it been otherwise, their energy would have been degraded because of interaction. No source neutrons are found at other regions in the second leg.

It should be noted that the flux approximates a straight line on log-log graph paper for energies lower than ~ 1 Mev. In order to produce the results shown in Figure 4, it was necessary to operate the 7090 computer for approximately 23 hours. Because of this long operating time and the straight-line relationship noted, it was decided that in the future ADONIS runs the energy of the low-energy cut-off point would be raised. This should result in approximately the same statistical deviation with a much shorter running time.

The dose, corresponding to the flux shown in Figure 4, is shown in Figure 5 for the same energy regions. Here, the dose has been normalized as previously described, by dividing with $D_0/2\pi$. It should be noted that the dose in the first leg falls off as an inverse square function of distance, and in the second leg the dose falls off at a much steeper rate. This corresponds to similar results obtained during gamma streaming experiments. In Figure 5 are shown the values of dose calculated utilizing Song's semiempirical albedo formula. It is seen that the agreement is good.

Also shown in Figure 5 are the Monte Carlo/Albedo calculations at two lower source-particle energies, utilizing the Oak Ridge National Laboratory code. It is seen that the ORNL results do not agree too well and are consistently high. It should be noted that the assumptions of corner lip secondary source preclude utilizing the albedo formula for the corner region and makes the results of the region adjacent to the corner somewhat questionable. In Figure 6, the value of D/D_0 has been corrected to remove the effects of distance. This has been done by multiplying the normalized dose values shown in Figure 5 by the factor ℓ^n where ℓ is the length of the duct leg, and the exponent, n , is determined from the linear slope of the dose lines shown in Figure 5. If the duct were ideal and long, the figure resulting from this new calculation would ideally be a step discontinuity occurring at the corner region. Because of the small length for the duct (~ 140 centimeters), this idealized shape is not realized and the resultant S-shape is obtained.

In the preceding figures are seen the first collision, multiple collision, and rad tissue equivalence dose rates. In Figure 7, the flux spectrum resulting from ADONIS calculations is shown for the 3-foot duct where the leg length is longer than that for the 11-inch duct. Because of increased computer running time required for the larger

duct, the low-energy cut-off limit was increased to 1 kev and the computer running time was considerably decreased. This resulted in an increase in the standard deviation of the flux, as shown by the bounds of each of the bars comprising the histogram. This flux is very similar to that shown for the small 11-inch duct, and the slopes of the spectrum lines below 100 kev approximate those shown in Figure 4 between 100 kev and 1 Mev. There is considerable difference between the spectra shown for the large duct in Figure 7 and those shown for the small duct in Figure 4. It is felt that this could be explained by the fact that the increased length of the large duct affords a greater opportunity for neutron interaction and, thereby, degradation of energy spectra. Results from the two ducts are, however, similar.

In Figure 8 is shown the dose of the large duct, normalized as before, the dose calculations utilizing the semiempirical albedo formula of Song, the ORNL dose calculations, and the experimentally measured dose obtained by Doty. It is seen that Song's and Doty's work are in good agreement; yet their dose measurements are greater than those calculated by the ADONIS code and less than those calculated by the OSR ORNL code. It should be noted that up to this point the importance functions of the regions of the two-legged-duct problem were selected to eliminate most corner-lip diffusion.

Another Monte Carlo ADONIS calculation was performed, keeping all conditions similar to those in the previous calculation of the large duct, with the exception that the importance of the rectangular region between the two legs was now selected to allow diffusion over the entire rectangular region. The results of these calculations are shown in Figure 8 by the dashed lines. It is seen that these results lie somewhat above the results of Song and Doty and agree very well with ORNL calculations.

In Figure 9 is shown the dose corrected for fall-off because of length. This is done by multiplying the dose of Figure 9 by L^n as before. Here, the effect of the corner is more prominent, and the resulting curves more closely approximate the ideal step function. It thus appears that it is necessary to carefully consider the size of the corner lip secondary source for albedo calculations and, indeed, possibly include some diffusion effects. A great deal of caution should be exercised in fitting formulas, because when the standard deviations of the data are large — as found both experimentally and theoretically — it is usually possible to obtain what appears to be a good least-squares fit with almost any curve. On the other hand, it also appears that it is incorrect to assume maximum diffusion through the rectangular region; rather, it is believed that a more involved type of interaction is occurring between the two effects and that such interaction could be approximated by selecting the appropriate importance function for the rectangular region adjacent to both legs. Again, calculations which would verify this conclusion were not within the scope of the present work.

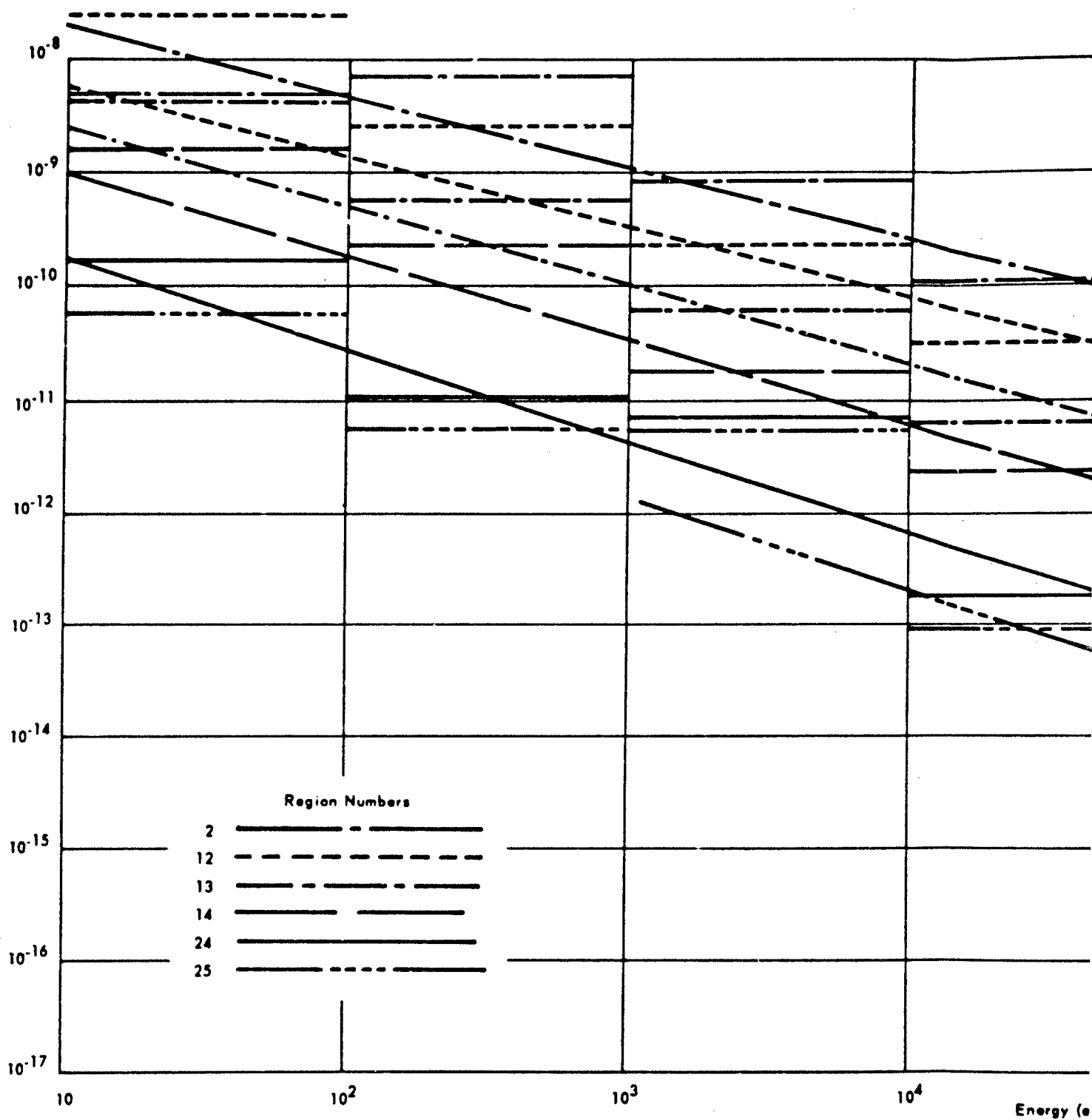
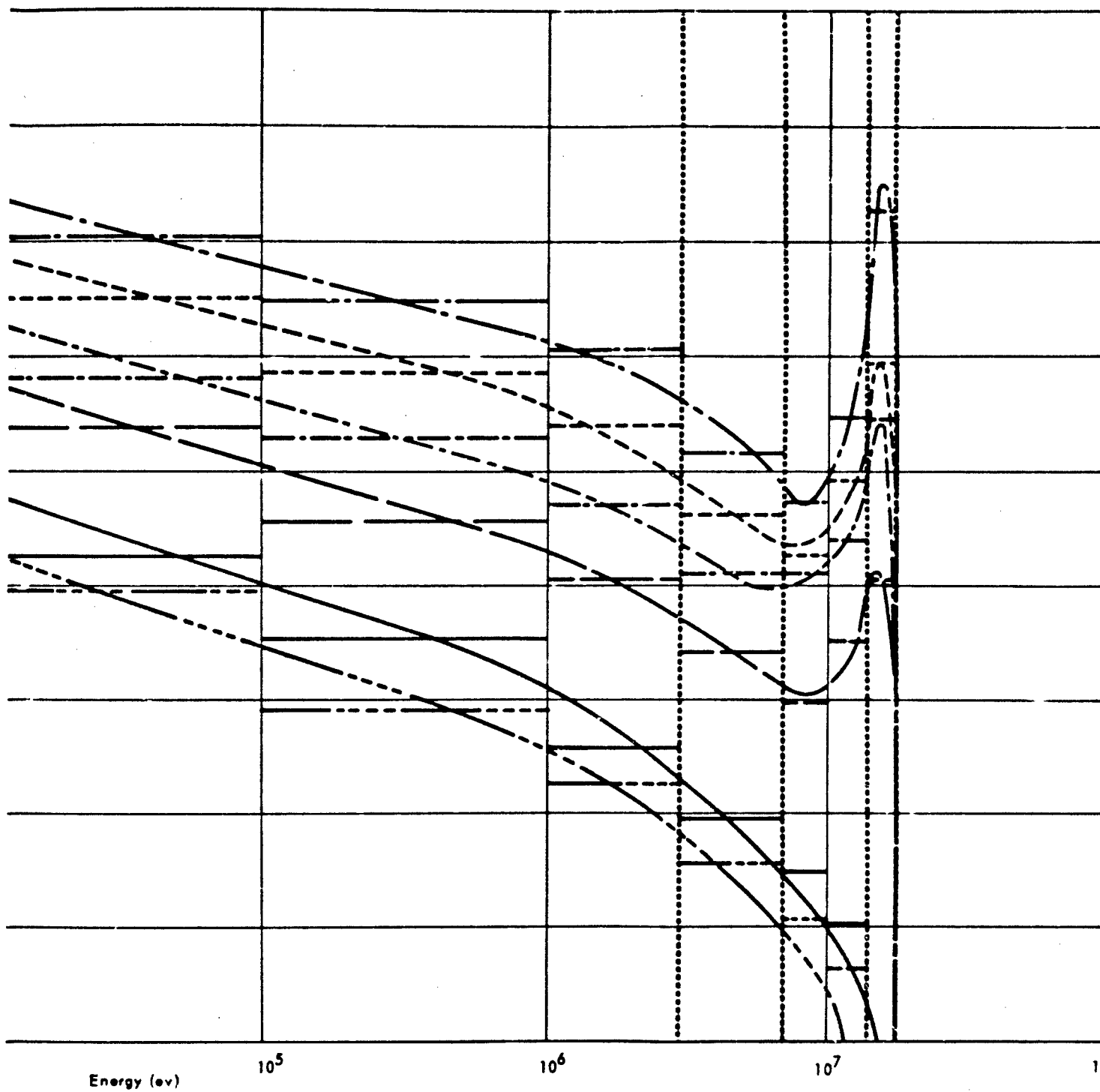


Figure 4. 11 x 11-inch duct



x 11-inch duct, neutron flux spectrum.



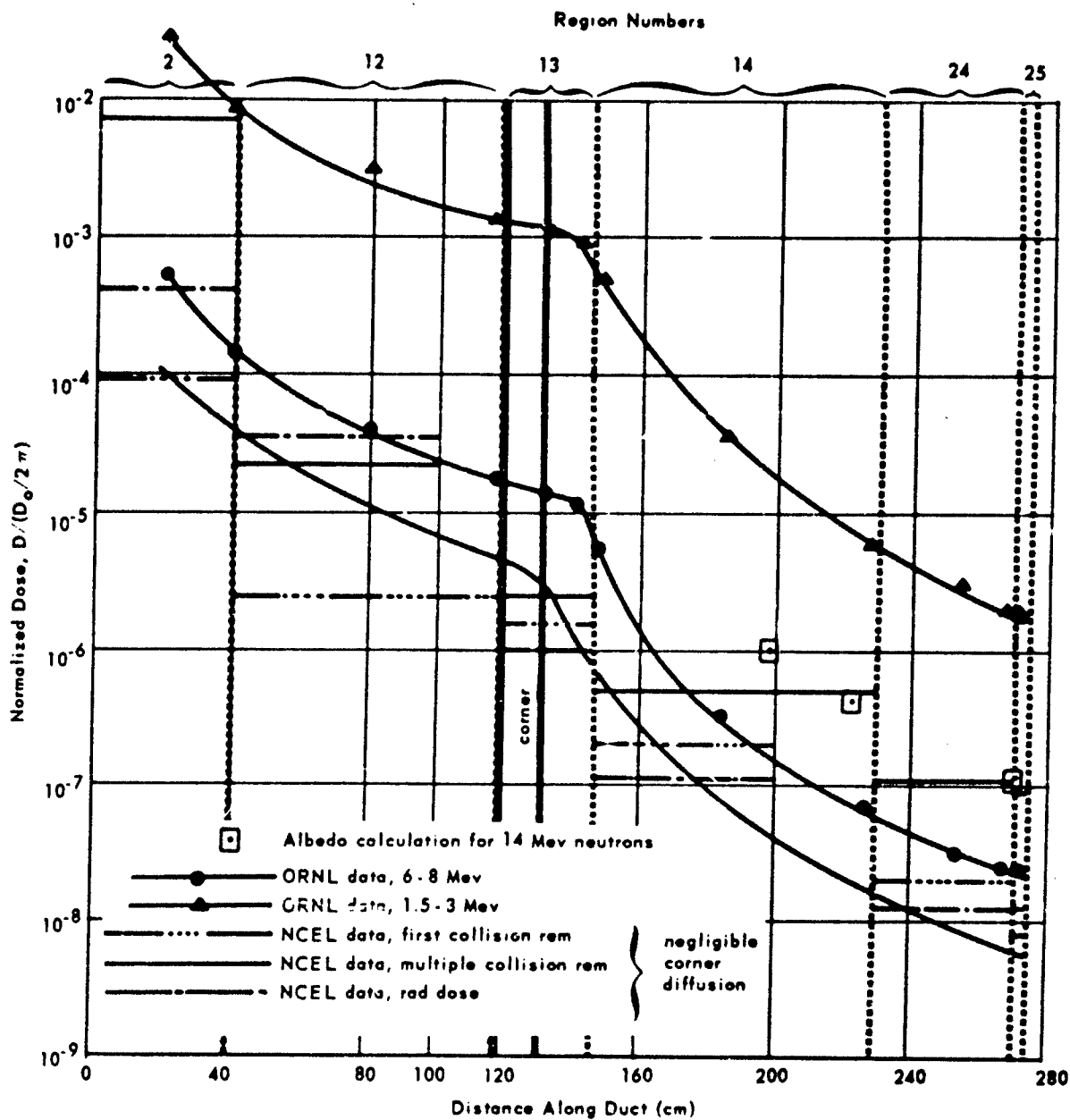


Figure 5. 11 x 11-inch duct, normalized neutron dose.

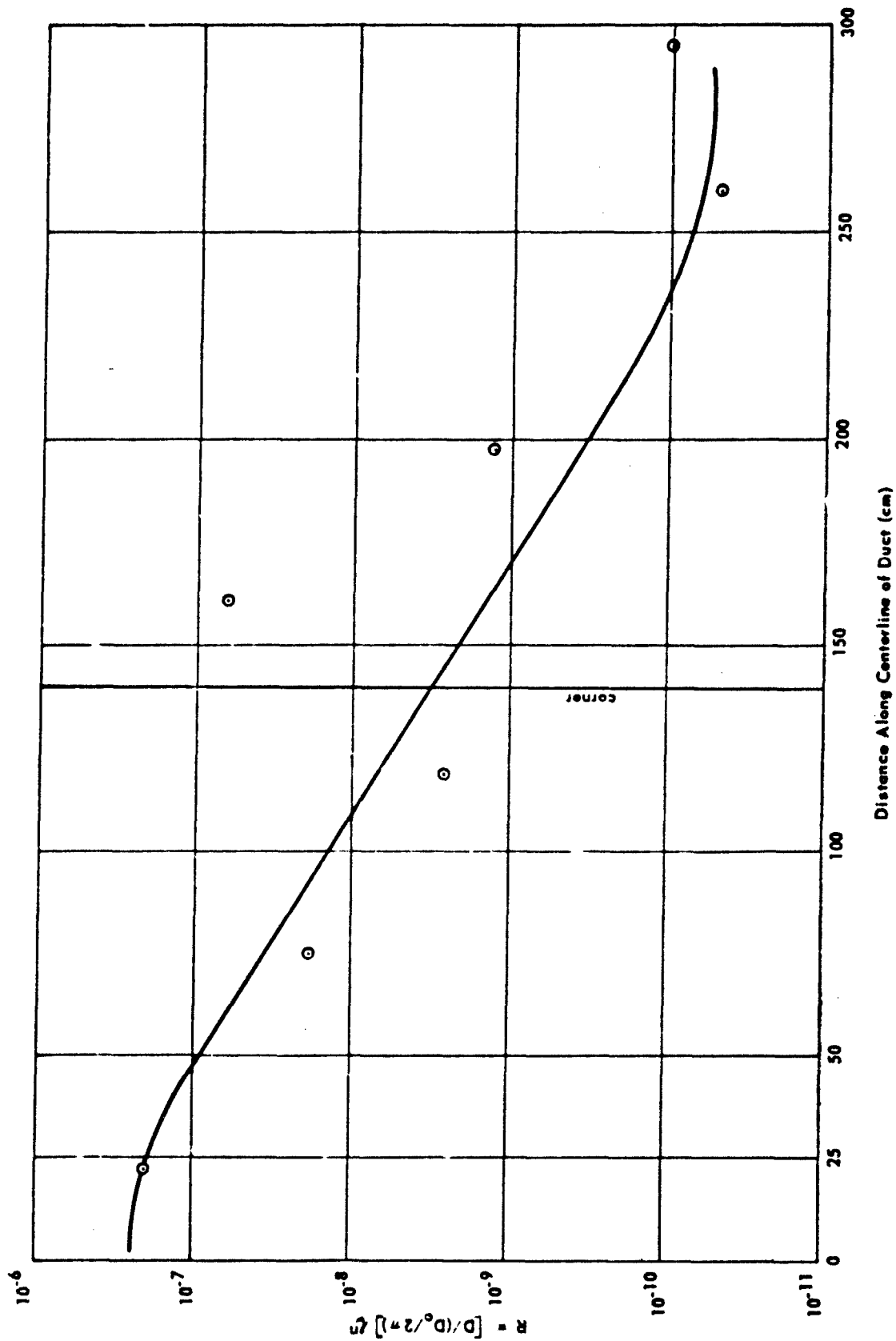


Figure 6. 11 x 11-inch duct, dose versus distance.

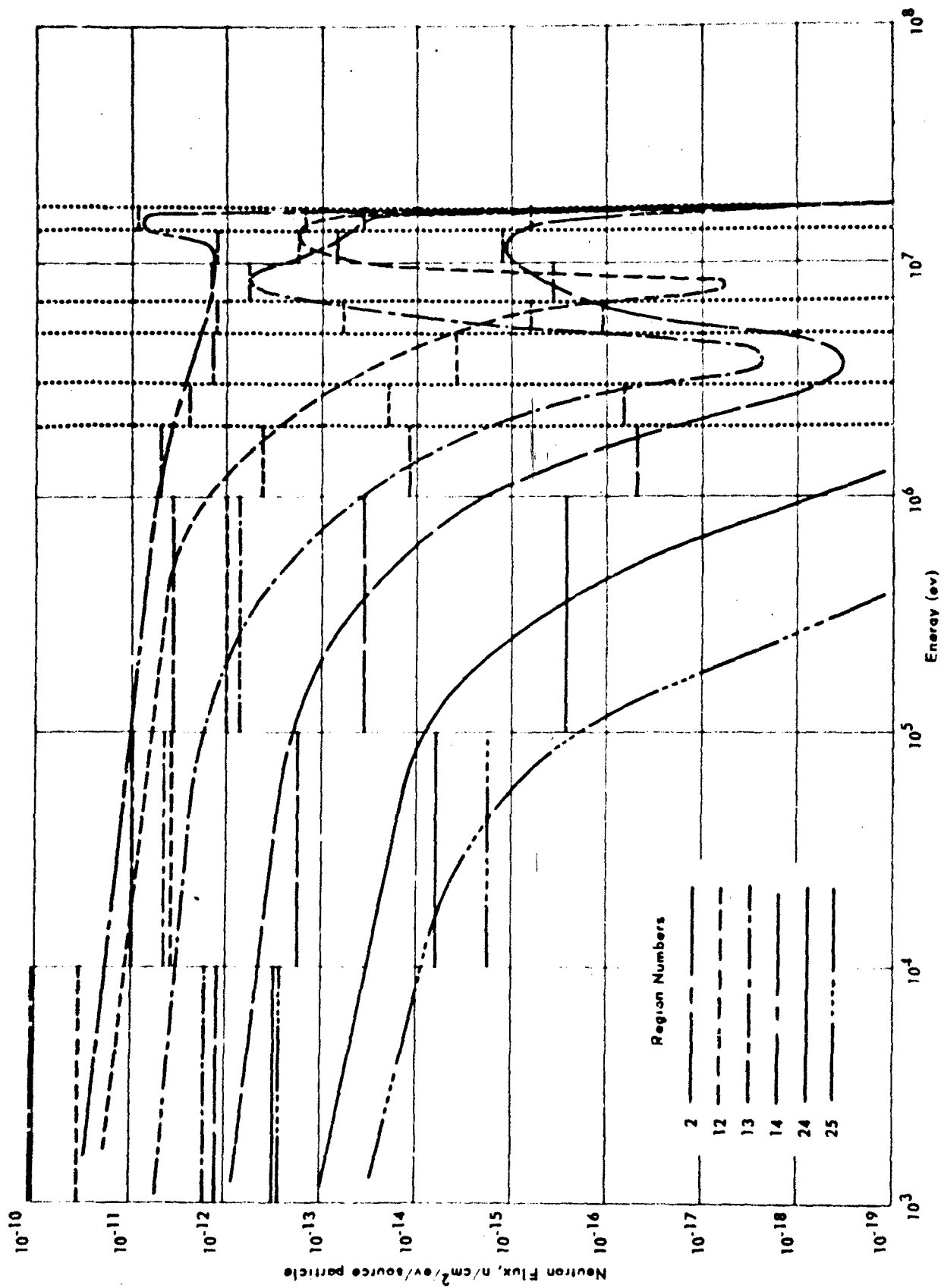


Figure 7. 3 x 3-foot duct, neutron flux spectrum.

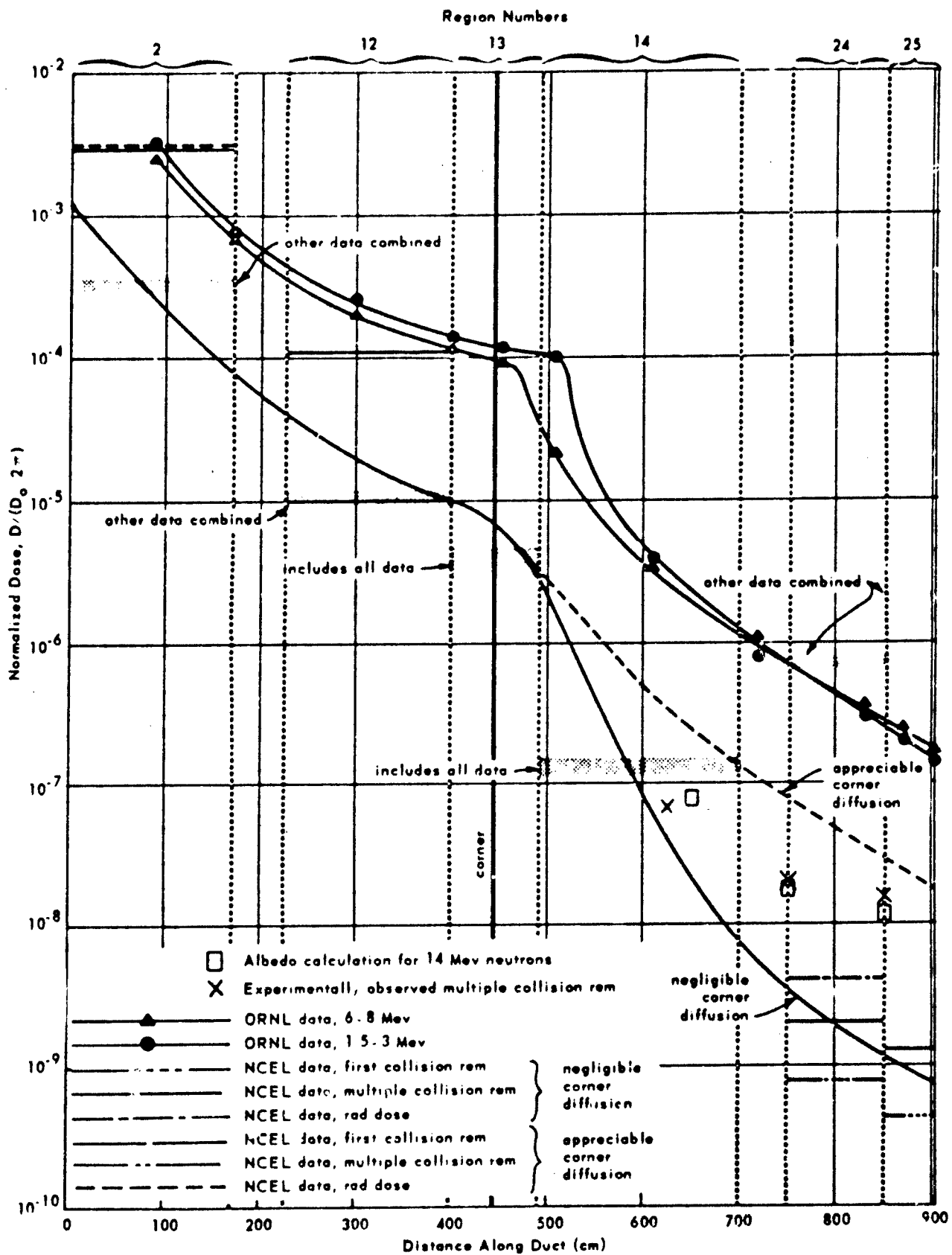


Figure 8. 3 x 3-foot duct, normalized neutron dose.

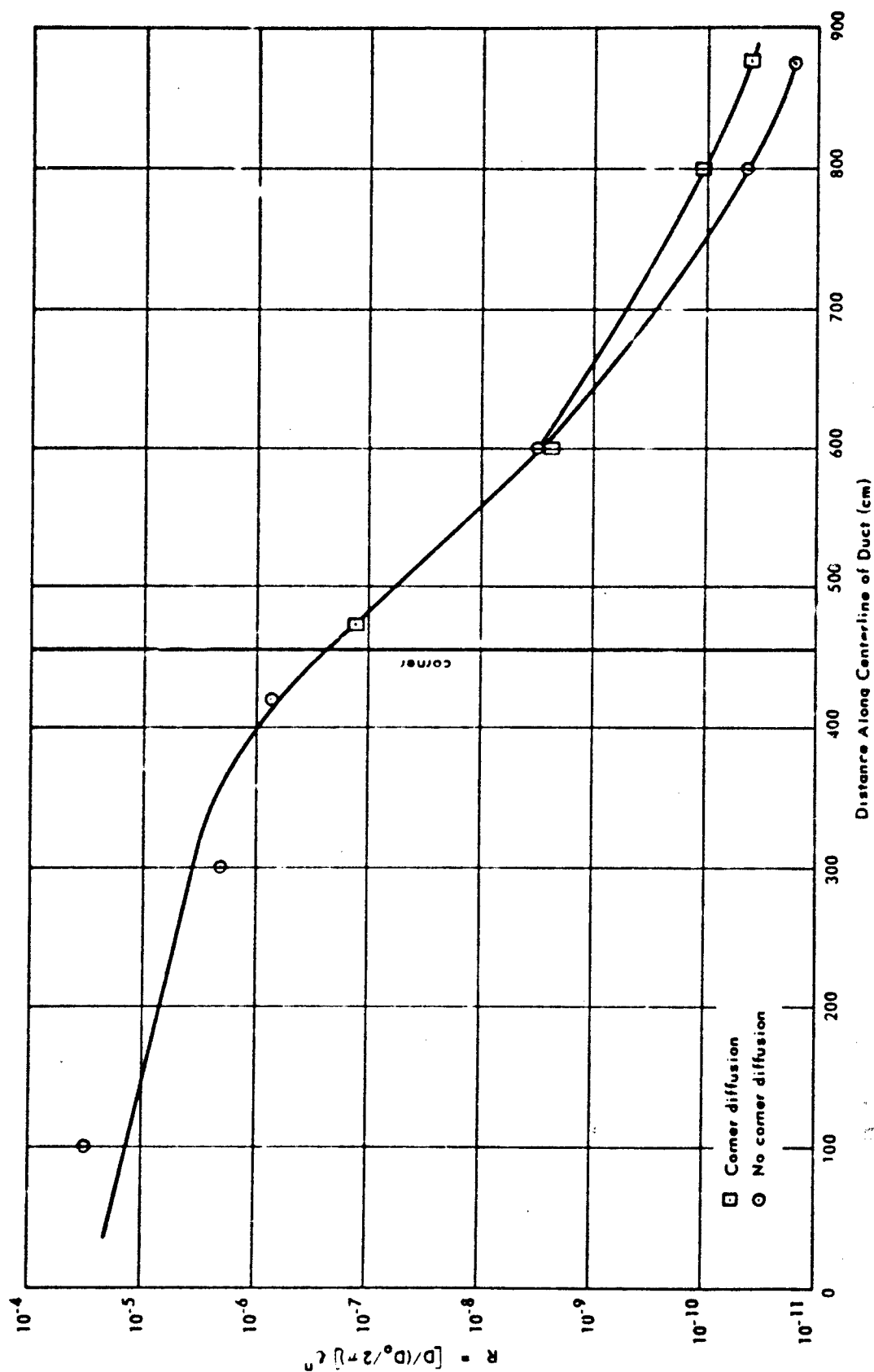


Figure 9. 3 x 3-foot duct, dose versus distance.

CONCLUSION AND RECOMMENDATIONS

The Monte Carlo calculations of neutron streaming through model ducted entranceways, performed utilizing the ADONIS code, and the Monte Carlo/Albedo calculations utilizing the ORNL code are in good agreement. Protection factors were found to be proportional to the duct cross-sectional area. It was found that albedo calculations of dose must be based upon a much greater corner penetration than previously assumed. This could decrease previously reported neutron protection factors by approximately a factor of 10. It remains, however, for these conclusions to be verified by carefully controlled experiments. By performing analytical calculations, as described, protection factors of structures may be readily determined with a fraction of the effort required by experimental methods. It is, however, necessary that all analytical techniques be verified by careful experiments. Once verified, the techniques may be freely applied in general extensions to the experiments.

It is recommended that the physics of neutron penetration between the first and second legs by methods other than streaming through the duct be more intensively investigated in order to establish the validity of albedo representations. It is also recommended that the ADONIS and ORNL codes be accepted as preferred analytical techniques for determining neutron streaming through ducted entranceways. The ADONIS code is applicable to most problems. The ORNL code, while requiring less running time, is applicable only to the case of a duct through a dense, infinitely bounded media, and thus it has limited practical applications.

ACKNOWLEDGMENTS

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NCEL Computer Laboratory, and the Point Mugu Computer Laboratory for their helpful assistance and cooperation in making the program runs described in the report. The latter are to be especially thanked since ADONIS requires running under FORTRAN II, version 2, necessitating a change in the machine room practice at Point Mugu.

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Table I. Listing of Source Deck for UNIGEOM With Subroutines

```

C      UNIFIED GEOMETRY FOR DUCTED SHIELDS
      DIMENSION X(6,100), KN(6,100), IK(6,100)
      DIMENSION IMX(116,25), V(116,10), H(116,10), INX(116,10,10)
      DIMENSION NR(3), NL(3),XR(3),XL(3)
      DIMENSION KIR(50), VV(50), HH(50)
      DIMENSION NH(116),NV(116)
      DIMENSION IPJ(30)
      COMMON X,IRX,H,V,INX,IERR
      COMMON IMAX,JMAX,IHMAX,IVMAX
      COMMON XL1,XL2,XL3,W1,W2,W3,IS11,IS12,IS21,IS22,IS31,IS32,II,D1,
102,D3,DA,DB,DC,DA1,DA2,DA3,TA,TB,TC,TD,HKH,H1,H2,XX
7999 DO 9000 J=1,10
      DO 9000 I=1,116
      H(I,J)=0.
9000 V(I,J)=0.
      READ INPUT TAPE 5,51,IMAX,IOP
51 FORMAT(5I10)
      DO 300 I=1,6
      DO 300 J=1,80
300 X(I,J)=0.
      READ INPUT TAPE 5,52,(XL1,XL2,XL3,W1,W2,W3)
      READ INPUT TAPE 5,52,(IS11,IS12,IS21,IS22,IS31,IS32)
      READ INPUT TAPE 5,52,(II,D1,D2,D3,DA,DB)
      READ INPUT TAPE 5,52,(DC,DA1,DA2,DA3,TA,TB)
      READ INPUT TAPE 5,52,(TC,TD,HKH,H1,H2,XX)
8001 GO TO (1000,1001,1002),IOP
1000 CALL L2
      GO TO 5010
1001 CALL L3Z
      GO TO 5010
1002 CALL L3NCP
52 FORMAT(6F10.5)
5010 IF(IMAX-80) 60,60,61
60 IFLAG=0

```

```

KEEP=0
JFLAG=0
J=1
IHMAX=0
IVMAX=0
MP=3
MPP=1
DO 3 I=1,100
DO 3 J=1,6
KN(J,I)=0
3  IRX(J,I)=0
IERR=0
IDEL=-1
DO 1 N=1,IMAX
DO 1 M=1,6
IDEL=-IDEL
IF(IDEL)44,45,47
47  MP=MP+2
MPP=MPP+2
IF(MP-6) 41,42,43
43  MP=1
41  IF(MPP-6)44,45,46
46  MPP=1
44  CONTINUE
KNT=KN(M,N)
K=0
IJ=N+1
MMP=M+IDEL
IF(N=IMAX) 10,11,12
10  DO 13 I=IJ,IMAX
14  IF(X(M,N)-X(MMP,I)) 13,14,13
15  IF(X(MP,N)-X(MP,I)) 15,16,17
16  IF(X(MP+1,N)-X(MP,I)) 13,13,16
17  IF(X(MP,N)-X(MP+1,I)) 16,13,13
18  IF(X(MPP,N)-X(MPP,I)) 18,19,20
19  IF(X(MPP+1,N)-X(MPP,I)) 13,13,19
20  IF(X(MPP,N)-X(MPP+1,I)) 19,13,13

```

```

19 K=K+1
   KIR(K) = I
   KN(MMP ,I) = KN(MMP ,I) + 1
   IF( KN(MMP ,I) - 2) 21,22,23
21 IRX(MMP ,I) = N
   GO TO 13
22 IF(KEEP) 451,452,453
453 JPIM=J
   J=IPJ(KEEP)
452 IMX(J,1)=IRX(MMP,I)
   IMX(J,2) = N
   IRX(MMP ,I) = -J
   IF(KEEP) 451,454,455
454 J=J+1
   GO TO 13
455 J=JPIM
   KEEP=KEEP-1
   GO TO 13
23 IF( IRX(MMP ,I))24,25,26
24 L = - IRX(MMP ,I)
   LP = KN(MMP ,I)
   IMX(L,LP) = N
13 CONTINUE
11 IF(KNT - 1) 101,102,103
102 IF(K - 1) 1,104,104
104 K = K+1
   KIR(K) = IRX(M,N)
   GO TO 107
101 IF(K - 1) 106,108,107
108 IRX(M,N) = KIR(K)
   GO TO 1
107 IH=1
   IV=1
   HM(IH) = X(MP,N)
   VV(IV) = X(MPP,N)
   DO 121 IC = 1,K
   ICM = KIR(IC)

```

```

IT = IH
IM = 0
HH(IT+1)=X(MP+1,ICM)
112 IF (HH(IH+1)-HH(IT))109,110,111
109 IM = IM+1
IF (IT = 1) 113, 113, 115
115 IT = IT-1
GO TO 112
111 IH=IH+1
IF ( IM ) 116,110,117
117 IT= IT+1
TEMP = HH(IT)
HH(IT)= HH(IH)
HH(IH)= TEMP
IM = IM-1
IF(IM) 118,110,117
110 IT = IV
IM = 0
VV(IV+1) = X(MPP+1,ICM)
124 IF(VV(IV+1) - VV(IT)) 120,121,122
120 IM=IM+1
IF(IT-1) 119,119,123
123 IT= IT -1
GO TO 124
122 IV = IV+1
IF ( IM ) 125,121,127
127 IT = IT +1
TEMP = VV(IT)
VV(IT) = VV(IV)
VV(IV)= TEMP
IM=IM-1
IF(IM) 128,121,127
121 CONTINUE
IF(X(MP+1,N)-HH(IH))180,130,131
180 IH=IH-1
183 IF(X(MP+1,N)-HH(IH))180,182,181
182 IF (IH-1)184,184,130

```

```

181 IF (IH) 189,189,188
188 IH=IH+1
    HH(IH)=X(MP+1,N)
130 IF (X(MPP+1,N)-VV(IV)) 185,132,133
185 IV=IV-1
    IF (X(MPP+1,N)-VV(IV)) 185,186,187
186 IF (IV-1) 190,132
187 IF (IV) 191,191,192
192 IV=IV+1
    VV(IV)=X(MPP+1,N)
132 IT= IH-1
    IF (JFLAG) 166,456,457
456 IF (KEEP) 166,457,458
458 JPIM=J
    J=IPJ(KEEP)
    JFLAG=1
    KEEP=KEEP-1
457 NH(J)=IT
    ITV = IV-1
    NV(J) = ITV
134 H(J,IT) = HH(IT+1)
    IF (IT-1) 135,136,137
137 IT=IT-1
    GO TO 134
136 V(J,ITV) = VV(ITV+1)
    IF (ITV-1) 138,139,140
140 ITV= ITV-1
    GO TO 136
139 DO 141 IK=1,K
    ICM =KIR(IK)
    MH = 1
146 IF (X(MP,ICM) - HH(MH)) 142,143,144
142 IF (MH - 1) 145,143,145
144 MH = MH+1
    IF (MH - IH) 146,147,147
143 LH=MH
151 IF (X(MP+1,ICM)- HH(LH+1)) 148,149,150

```

```

150 LH=LH+1
    IF(LH-IH) 151,149,152
148 IF(LH+1-IH) 153,149,153
149 MV = 1
158 IF( X(MPP,ICM) - VV(MV)) 154,155,156
154 IF(MV - 1) 157,155,157
156 MV=MV+1
    IF(MV - IV) 158,159,159
155 LV=MV
162 IF(X(MPP+1,ICM)-VV(LV+1))160,161,163
163 LV=LV+1
    IF(LV-IV)162,161,199
160 LV =LV+1
    IF (LV - IV) 162,164,164
161 DO 165 KV = MV, LV
    DO 165 KH = MH, LH
165 IN=(J, KH, KV) = ICM
141 CONTINUE
176 IRX(M,N)=-J
    IF(JFLAG) 166,167,168
167 J=J+1
    GO TO 169
168 J=JPIM
    JFLAG=0
169 IF( IHMAX - IH-1) 170,171,171
170 IHMAX = IH-1
    IF(IHMAX - 10) 171,171,172
171 IF(IVMAX-IV-1)173,471,471
173 IVMAX = IV-1
    IF(IVMAX-10) 471,471,175
471 IJ=-IRX(M,N)
    KTH=NH(IJ)
    KTV=NV(IJ)
    DO 486 KV=1,KTV
    DO 486 KH=1,KTH
    ICM=INX(IJ,KH,KV)
    IF(IRX(M,ICM))486,486,473

```

```

486 CONTINUE
GO TO 1
473 IOPP=IRX(M,ICM)
MID=M+IDEL
IF(IOPP-N) 474,472, 1
474 IF(IRX(MID ,IOPP)) 475,472, 1
475 IJP=-IRX(MID ,IOPP)
IF(NH(IJ)-NH(IJP)) 1,476, 1
476 IF(NV(IJ)-NV(IJP)) 1,477, 1
477 DO 478 IT=1,KTH
IF(H(IJP,IT)-H(IJ,IT)) 1,478, 1
478 CONTINUE
DO 479 IT=1,KTV
IF(V(IJP,IT)-V(IJ,IT)) 1,479, 1
479 CONTINUE
DO 480 ITV=1,KTV
DO 480 IT=1,KTH
IF(INX(IJ,IT,ITV)-INX(IJP,IT,ITV)) 1,480, 1
480 CONTINUE
IF(J-1-IJ) 472,481,482
482 IF(J-1-IJP) 472,483,484
484 KEEP=KEEP+1
IPJ(KEEP)=IJ
IF(KEEP-30) 487,472,472
481 IRX(M,N)=-IJP
GO TO 485
483 IRX(MID ,IOPP)=-IJ
485 J=J-1
GO TO 1
487 IRX(M,N)=-IJP
GO TO 1
472 IERR=472
GO TO 406
451 IERR=451
GO TO 406
106 IF(IFLAG - 1) 206,207,204
206 IFLAG = 1

```

```

ICNTR = 1
IDR = IDEL
203 NR(ICNTR) = M
   XR(ICNTR) = X(M,N)
   GO TO 202
207 IF(IDR - IDEL) 208,201,208
208 IFLAG = 2
   ICNTL = 1
205 NL(ICNTL) = M
   XL(ICNTL) = X(M,N)
202 IRX(M,N) = N
   GO TO 1
201 INT = 1
215 IF( M - NR(INT)) 209,210,209
210 IF(XR(INT) - X(M,N)) 211,202,211
209 IF(INT - ICNTR) 212,213,214
212 INT = INT+1
   GO TO 215
213 ICNTR = ICNTR+1
   IF(ICNTR - 3) 203, 203, 216
204 IF (IDR - IDEL) 217,201,217
217 INT = 1
224 IF( M - NL(INT)) 218,219,218
219 IF(XL(INT) - X(M,N)) 220,202,220
218 IF(INT - ICNTL) 221,222,223
221 INT = INT+1
   GO TO 224
222 ICNTL = ICNTL + 1
   IF( ICNTL - 3) 205,205,225
103 IF(K) 303, 304,304
304 JPIM = J
   J = -IRX(M,N)
   JFLAG = 1
305 DO 306 IT = 1,KNT
   K = K+1
306 KIR(K) = IMX(J,IT)
   GO TO 107

```


12 IERR= 12
GO TO 406
25 IERR= 25
GO TO 406
26 IERR= 26
GO TO 406
113 IERR=113
ASSIGN 176 TO KERRP
GO TO 800
116 IERR= 116
GO TO 406
118 IERR= 118
GO TO 406
119 IERR= 119
ASSIGN 176 TO KERRP
GO TO 800
125 IERR= 125
GO TO 406
128 IERR= 128
GO TO 406
131 IERR= 131
ASSIGN 799 TO KERRP
GO TO 800
133 IERR= 133
ASSIGN 799 TO KERRP
GO TO 800
135 IERR= 135
GO TO 406
138 IERR= 138
GO TO 406
145 IERR= 145
GO TO 406
147 IERR= 147
GO TO 406
152 IERR= 152
GO TO 406
153 IERR= 153

```

GO TO 406
157 IERR= 157
GO TO 406
159 IERR= 159
GO TO 406
164 IERR= 164
GO TO 406
166 IERR= 166
GO TO 406
172 IERR= 172
GO TO 406
175 IERR= 175
GO TO 406
211 IERR= 211
GO TO 406
214 IERR= 214
GO TO 406
216 IERR= 216
GO TO 406
220 IERR= 220
ASSIGN 690 TO KERR
GO TO 410
223 IERR= 223
GO TO 406
225 IERR= 225
GO TO 406
303 IERR= 303
GO TO 406
199 IERR=199
GO TO 406
500 IERR=500
GO TO 406
1 CONTINUE
JMAX=J-1
IF(IERR)500,501,502
501 EPSE=1.0E+09
EPSEE=1.0E+04

```

```

DO 2 I=1,6
DO 2 J=1,100
IF(ABSF(X(I,J))-EPSE)2,8,2
8 X(I,J)=X(I,J)/EPSEE
2 CONTINUE
DO 4 I=1,116
DO 4 J=1,10
IF(ABSF(H(I,J))-EPSE)4,5,4
5 H(I,J)=H(I,J)/EPSEE
4 CONTINUE
DO 6 I=1,116
DO 6 J=1,10
IF(ABSF(V(I,J))-EPSE)6,7,6
7 V(I,J)=V(I,J)/EPSEE
6 CONTINUE
CALL TESTG
IF(IERR) 6001,6001,502
6001 EPSEE=1.0E+05
EPSE=1.0E+04
DO 9222 I=1,6
DO 9222 J=1,100
IF(ABSF(X(I,J))-EPSEE)9222,9223,9222
9223 X(I,J)=X(I,J)*EPSE
9222 CONTINUE
WRITE OUTPUT TAPE 6,550,JMAX,IHMAX,IVMAX
WRITE OUTPUT TAPE 6,551,((X(M,N),M=1,6), N,N=1,IMAX)
WRITE OUTPUT TAPE 13,5551,((X(M,N),M=1,6), N,N=1,IMAX)
WRITE OUTPUT TAPE 6,552, ((IRX(M,N),M=1,6),N,N=1,IMAX)
WRITE OUTPUT TAPE 13,5552,((IRX(M,N),M=1,6),N,N=1,IMAX)
FBLANK=6060606060
FPLUS=2020202020
FMINUS=4040404040
WRITE OUTPUT TAPE 6,553
I=1
8030 DO 8050 N=1,JMAX
NM=NH(N)
WRITE OUTPUT TAPE 6,557,N,(H(N,M),M=1,NM)

```

```

DO 8040 M=1,NM
  ZZ=ABSF(H(N,M))
9224 IF(ZZ-999.99)8041,8041,8042
8041 IF(H(N,M))8043,8040,8046
8043 H(N,M)=H(N,M)-.005
  GO TO 8040
8046 H(N,M)=H(N,M)+.005
8040 CONTINUE
  WRITE OUTPUT TAPE 13,5557,(H(N,M),M=1,NM)
  GO TO 8050
8042 IF(ZZ-10000.)8051,8052,8051
8052 GO TO(8002,8003,8004,8005,8006,8007,8008,8009,8010,8011),M
8051 WRITE OUTPUT TAPE 13,5558,N,M,H(N,M)
8050 CONTINUE
  IF(I-1)8014,8013,8014
8013 DO 8012 N=1,JMAX
  NM=N(N)
  DO 8015 M=1,NM
8015 H(N,M)=V(N,M)
  ZZ=NH(N)
  NH(N)=NV(N)
8012 NV(N)=ZZ
  I=20
  GO TO 8030
8014 CONTINUE
  DO 505 J=1,JMAX
  NHP=NV(J)
  NVF=NH(J)
  WRITE OUTPUT TAPE 6,555, N,P,NVP,((INX(J,M,N),M=1,NHP),N=1,NVP)
505 WRITE OUTPUT TAPE 13,5559,NHP,NVP,((INX(J,M,N),M=1,NHP),N=1,NVP)
550 FORMAT(97HNUMBER OF COMPLEX SURFACES MAX NUMBER OF HORIZONTAL
1-- VERTICAL SURFACES PER COMPLEX SURFACE / 118,136,113)
551 FORMAT(21X21H BOUNDING PLANE INPUT /(6(1PE14.5),5HBPO 13))
5551 FORMAT(6E12.5,5HBPO 13)
552 FORMAT(21X 22H ADJACENT REGION INPUT /(6I10,12X 5HIRX 13))
5552 FORMAT(6I10,12X,5HIRX 13)
553 FORMAT(21X 18H HORIZONTAL INPUT //)

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554 FORMAT(21X 16H VERTICAL INPUT //)
555 FORMAT(24I3)
5559 FORMAT(24I3)
5555 FORMAT(21X 22H COMPLEX REGION INPUT //)
556 FORMAT(10E7.1)
5557 FORMAT(10F7.2)
557 FORMAT (14.10(1PE12.5))
5558 FORMAT(2I10,E12.5,18HEXCCEEDS 'F' FORMAT)
GO TO 799
42 IERR=42
GO TO 406
45 IERR=45
GO TO 406
184 IERR=184
ASSIGN 176 TO KERRP
GO TO 800
189 IERR=189
ASSIGN 176 TO KERRP
GO TO 800
190 IERR=190
ASSIGN 176 TO KERRP
GO TO 800
191 IERR=191
ASSIGN 176 TO KERRP
GO TO 800
61 IERR=61
GO TO 406
502 STOP 322
406 ASSIGN 799 TO KERRP
410 WRITE OUTPUT TAPE 6.650,IERR,M,N,J,K,X(M,N),(KIR(MNO),MNO=1,K)
650 FORMAT(17H1 ERROR NUMBER = 15/20H M N J K X(M,N) / 4I3,
1E15.5, //21X6HKIR(K) // 20I5)
WRITE OUTPUT TAPE 6.651, (IRX(MNO,MNO),MNO=1.6),(KN(MNP,MNO),
IMNP=1.6),NMO=1,IMAX)
GO TO KERRP,(176,690,799)
690 WRITE OUTPUT TAPE 6.652,X(M,N),XL(ICNTL)
X(M,N)=XL(ICNTL)

```

```

651 FORMAT(20X8HIRX(M,N)21X7HKN(M,N)/(10X6I3,10X6I3))
652 FORMAT(14X6HX(M,N) 5X1H= 11X9HXL(ICNTL)/E20.7,6XE20.7)
      GO TO 202
800 WRITE OUTPUT TAPE 6,850,IM,IH,IC,ICM,J,IV,(HH(MNO),MNO=1,IH)
      WRITE OUTPUT TAPE 6,52,(VV(NMO),NMO=1,IV)
      WRITE OUTPUT TAPE 6,52,HH(IH+1),HH(IT),VV(IV+1),VV(IT)
850 FORMAT(1H0,6I5/(6E15.5))
      GO TO 410
799 CONTINUE
801 GO TO 7999
8002 WRITE OUTPUT TAPE 13,8602,(H(N,M),M=1,NM)
      GO TO 8050
8003 WRITE OUTPUT TAPE 13,8603,(H(N,M),M=1,NM)
      GO TO 8050
8004 WRITE OUTPUT TAPE 13,8604,(H(N,M),M=1,NM)
      GO TO 8050
8005 WRITE OUTPUT TAPE 13,8605,(H(N,M),M=1,NM)
      GO TO 8050
8006 WRITE OUTPUT TAPE 13,8606,(H(N,M),M=1,NM)
      GO TO 8050
8007 WRITE OUTPUT TAPE 13,8607,(H(N,M),M=1,NM)
      GO TO 8050
8008 WRITE OUTPUT TAPE 13,8608,(H(N,M),M=1,NM)
      GO TO 8050
8009 WRITE OUTPUT TAPE 13,8609,(H(N,M),M=1,NM)
      GO TO 8050
8010 WRITE OUTPUT TAPE 13,8610,(H(N,M),M=1,NM)
      GO TO 8050
8011 WRITE OUTPUT TAPE 13,8611,(H(N,M),M=1,NM)
      GO TO 8050
9111 FORMAT(9HERROR 322)
8602 FORMAT(F7.0,9F7.2)
8603 FORMAT(F7.2,F7.0,8F7.2)
8604 FORMAT(2F7.2,F7.0,7F7.2)
8605 FORMAT(3F7.2,F7.0,6F7.2)
8606 FORMAT(4F7.2,F7.0,5F7.2)
8607 FORMAT(5F7.2,F7.0,4F7.2)

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```

8608 FORMAT(6F7.2,F7.0,3F7.2)
8609 FORMAT(7F7.2,F7.0,2F7.2)
8610 FORMAT(8F7.2,F7.0,F7.2)
8611 FORMAT(9F7.2,F7.0)
      END

```

```

SUBROUTINE TESTG
COMMON A,IRX,H,V,MX,IERR
COMMON IRMAX,MPMAX,LMAX,MMAX
COMMON XO,W,BADMAL,IRPRIM,SM,KM,IM,IR,XSI
COMMON NFIRST,NLAST,IRSTRT,IETAG,ICDMPT,JMAX,JSIGM,ECUT
COMMON PINF,IRT,MC,MR,EPSI,ISWM
DIMENSION A(6,100),H(116,10),V(116,10),MX(116,10,10),IRX(6,100)
DIMENSION XO(3),W(3),MC(80),MR(80),X1(3),X2(3),S(100),K(100)
DIMENSION I(100),X(3,100),IRP(100)
      1 FORMAT(5H IRS=12.6H IRF=12)
      2 FORMAT(4H X1=1PE14.7,1P2E17.7)
      3 FORMAT(4H X2=1PE14.7,1P2E17.7)
      4 FORMAT(3H W=1PE14.7,1P2E17.7)
      5 FORMAT(79H N X(1,N) X(2,N) X(3,N)
      X S(N) K I IRP)
      6 FORMAT(14,1P4E16.7,2I3,I5)
      7 FORMAT(5H0ISW=I3)
      9 FORMAT (E14.7,5I3)
     10 FORMAT (6E12.7)
     11 FORMAT(10E7.4)
     12 FORMAT (24I3)
     13 FORMAT (6I10)
      EPSI=.001
      ISWM=3
      40 ISW=1

```

```

43 IRS=1
45 IRF=1
   IF (IRS-(IRMAX+1)) 42, 82, 81
82 IF (ISW-ISWM) 84,86,80
84 PRINT 7, ISW
   ISW=ISW+1
   GO TO 43
42 IF (IRF-(IRMAX+1)) 46,44,85
44 IRS=IRS+1
   GO TO 45
86 PRINT 7, ISW
   RETURN
61 BADMAL=SQRTF((X2(1)-X1(1))*2+(X2(2)-X1(2))*2+(X2(3)-X1(3))*2)
47 DO 47 I=1,3
   W(I)=(X2(I)-X1(I))/BADMAL
   IR=IRS
   DO 62 I=1,3
62 X0(I)=X1(I)
24 CALL G1
49 S(J)=SM
   K(J)=KM
   I(J)=IM
48 IF (SM-BADMAL) 20, 21, 21
20 CALL G2
   IF ( IRPRIM ) 30,30,101
101 CONTINUE
   DO 52 I=1,3
52 X(I,J)=X0(I)
   IRP (J)=IRPRIM
   J=J+1
   IF (J-100) 51,30,30
51 BADMAL = BADMAL -SM
   IR=IRPRIM
   IF ( IRPRIM-80 ) 24,24,30
80 RETURN
81 RETURN
85 RETURN

```



```

21 SM=BADMAL
DO 26 I=1,3
26 X0(I)=X0(I)+W(I)*SM
DO 29 I=1,3
27 IF(ABSF(1.-X2(I)/X0(I))-EPSI)29,29,30
29 CONTINUE
31 IRF = IRF+1
GO TO 42
30 WRITE OUTPUT TAPE 6,1, IRS,IRF
WRITE OUTPUT TAPE 6,2,(X1(I),I=1,3)
WRITE OUTPUT TAPE 6,3,(X2(I),I=1,3)
WRITE OUTPUT TAPE 6,4,(W(I),I=1,3)
WRITE OUTPUT TAPE 6,5
WRITE OUTPUT TAPE 6,6,(N,(X(:,N),I=1,3),S(N),K(N),I(N),
X IRP (N), N=1,J)
IF(J-100)100,201,201
201 IERR=10
100 GO TO 31
46 DO 60 I=1,3
CALL RANDOM(XSI,1)
X1(I)=A(2*I-1,IRS)+XSI*(A(2*I,IRS)-A(2*I-1,IRS))
CALL RANDOM(XSI,1)
60 X2(I)=A(2*I-1,IRF)+XSI*(A(2*I,IRF)-A(2*I-1,IRF))
J=1
GO TO 61
END
SUBROUTINE G2
COMMON A,IRX,H,V,MX,IERR
COMMON IRMAX,MPMAX,LMAX,MMAX
COMMON X0,W,BADMAL,IRPRIM,SM,KM,IM,IR,XSI
COMMON NFIRST,NLAST,IRSTRT,IETAG,ICDPT,JMAX,JSIGM,ECUT
COMMON PINF,IRI,MC,MR,EPSI,ISWM
DIMENSION A(6,100),H(116,10),V(116,10),MX(116,10,10),IRX(6,100)
DIMENSION X0(3),W(3),MC(80),MR(80),X1(3),X2(3),S(100),K(100)
DIMENSION I(100),X(3,100),IRP(100)
DO 1 I=1,3
IF(I-IM) 2,1,2

```

```

2 X0(I)=X0(I)+W(I)*SM
1 CONTINUE
  X0(IM)=A(KM,IR)
  IF(IRX(KM,IR)) 4,15,3
3 IRPRIM = IRX(KM,IR)
  GO TO 14
4 IF(IM-2) 5,6,7
5 XH=X0(3)
  XV=X0(2)
  GO TO 8
6 XH = X0(1)
  XV = X0(3)
  GO TO 8
7 XH = X0(2)
  XV = X0(1)
8 L=1
  M = 1
  MPRIM = XABSF(IRX(KM,IR))
11 IF(XH-H(MPRIM,L))10,10,9
9 L = L+1
  GO TO 11
10 IF(XV-V(MPRIM,M)) 12, 12, 13
13 M = M+1
  GO TO 10
12 IRPRIM = MX(MPRIM,L,M)
14 RETURN
15 STOP 15
END
SUBROUTINE G1
COMMON A,IRX,H,V,MX,IERR
COMMON IRMAX,MPMAX,LMAX,MMAX
COMMON X0,W,BADMAL,IRPRIM,SM,KM,IM,IR,XSI
COMMON NFIRST,NLAST,IRSTRI,IETAG,ICDPT,JMAX,JSIGM,ECUT
COMMON PINF,IRT,MC,MR,EPSI,ISWM
DIMENSION A(6,100),H(116,10),V(116,10),MX(116,10,10),IRX(6,100)
DIMENSION X0(3),W(3),MC(80),MR(80),X1(3),X2(3),S(100),K(100)
DIMENSION I(100),X(3,100),IRP(100)

```

```

IF DIVIDE CHECK 1.1
1 SM=1.E9
  K=1
  DO 37 I=1.3
    IF(A(K,IR)-X0(I)) 32,33,32
    32 S=(A(K,IR)-X0(I))/W(I)
    IF DIVIDE CHECK 2.3
    2 KDEL=2
    GO TO 37
    3 IF(S)33,38,34
    34 KDEL =2
    GO TO 35
    33 K=K+1
    KDEL =1
    S=(A(K,IR)-X0(I))/W(I)
    IF DIVIDE CHECK 37.35
    35 IF(S-SM) 36,36,37
    36 SM=S
    KM=K
    IM=I
    37 K=K+KDEL
    RETURN
    38 STOP 46
    END

```

```

SUBROUTINE L2
DIMENSION X(6,100),IRX(6,100),H(116,10),V(116,10),INX(116,10,10)
COMMON X,IRX,H,V,INX,IERF
COMMON IMAX,JMAX,IHMAX,IVMAX
COMMON XL1,XL2,XL3,W1,W2,W3,IS11,IS12,IS21,IS22,IS31,IS32,IT,D1,
1D2,D3,DA,DB,DC,DA1,DA2,DA3,IA,IB,IC,ID,IH,H1,H2,XX

```

```

XINF=1.0E+09
2000 A=W1-TS11-TS12
      IF(A)2001,2001,2002
2001 WRITE OUTPUT TAPE 6,3001
2002 CONTINUE
2003 B=W2-TS21-TS22
      IF(B)2004,2004,2005
2004 WRITE OUTPUT TAPE 6,3002
2005 CONTINUE
2006 C=XL1-D1+DA
      IF(C)2007,2007,2008
2007 WRITE OUTPUT TAPE 6,3003
2008 CONTINUE
2009 E=XL2-D2-DA
      IF(E)2010,2010,2011
2010 WRITE OUTPUT TAPE 6,3004
2011 CONTINUE
2012 F=HH-H1-H2
      IF(F)2013,2013,2014
2013 WRITE OUTPUT TAPE 6,3005
2014 CONTINUE
2015 G=HH-H1-H2-DC
      IF(G)2016,2016,2017
2016 WRITE OUTPUT TAPE 6,3006
2017 CONTINUE
2018 P=W1-TS11-TS12-DB
      IF(P)2019,2019,2020
2019 WRITE OUTPUT TAPE 6,3007
2020 CONTINUE
2021 Q=W2-TS21-TS22-DB
      IF(Q)2022,2022,2023
2022 WRITE OUTPUT TAPE 6,3007
2023 CONTINUE
      X(4,24)=XL2-TT
      X(3,25)=XL2-TT
      X(4,25)=XL2
      X(3,26)=0.

```

X(4,26)=W1
X(3,27)=W1-TS12
X(4,27)=W1
X(3,28)=0.
X(4,28)=W1
X(3,29)=0.
X(4,29)=TS11
X(3,30)=W1
X(3,31)=W1
X(3,32)=W1
X(3,33)=TS11
X(3,34)=W1
X(3,35)=-TA
X(3,36)=-TA
X(3,37)=-TA
X(4,30)=XL2
X(4,31)=XL2
X(4,32)=XL2
X(4,33)=XL2
X(4,34)=XL2
X(4,35)=XL2
X(4,36)=XL2
X(4,38)=XL2
X(4,39)=XL2
X(4,40)=XL2
X(4,37)=0.
X(3,38)=0.
X(3,39)=-TA
X(3,40)=-TA
X(3,41)=-TA
X(4,41)=XL2
X(3,42)=-TA
X(4,42)=XL2
X(3,43)=XL2
X(4,43)=XINF
X(5,1)=-XINF
X(6,1)=XINF

X(5,2)=-HH+H2
 X(5,3)=-HH+H2
 X(5,4)=-HH+H2
 X(5,5)=-HH+H2
 X(6,2)=-H1
 X(1,1)=-XINF
 X(2,1)=XINF
 X(1,2)=XL1-D1
 X(2,3)=X(1,2)
 X(2,4)=X(1,2)
 X(2,5)=X(1,2)
 X(2,6)=X(1,2)
 X(2,7)=X(1,2)
 X(2,8)=X(1,2)
 X(2,9)=X(1,2)
 X(2,10)=X(1,2)
 X(2,11)=X(1,2)
 X(2,21)=XL1
 X(2,26)=XL1
 X(2,27)=XL1
 X(2,28)=XL1
 X(2,29)=XL1
 X(2,34)=XL1
 X(2,35)=XL1
 X(2,36)=XL1
 X(2,37)=XL1
 X(2,40)=XL1
 X(1,41)=XL1
 X(1,3)=XL1-D1-DA
 X(1,4)=X(1,3)
 X(1,5)=X(1,3)
 X(1,6)=X(1,3)
 X(1,7)=X(1,3)
 X(1,8)=X(1,3)
 X(1,9)=X(1,3)
 X(1,10)=X(1,3)
 X(1,11)=X(1,3)

```

X(2,12)=X(1,3)
X(1,12)=W2-TS22
X(2,13)=X(1,12)
X(2,14)=X(1,12)
X(2,15)=X(1,12)
X(2,18)=X(1,12)
X(2,21)=X(1,12)
X(2,24)=X(1,12)
X(2,25)=X(1,12)
X(1,27)=X(1,12)
X(1,31)=X(1,12)
X(1,13)=TS21
X(1,14)=TS21
X(1,17)=TS21
X(1,20)=TS21
X(1,23)=TS21
X(1,24)=TS21
X(1,25)=TS21
X(2,33)=TS21
X(1,15)=TS21+(W2-TS21-TS22)/2.+0.5
X(2,16)=X(1,15)
X(1,18)=X(1,15)
X(2,19)=X(1,15)
X(1,21)=X(1,15)
X(2,22)=X(1,15)
X(1,16)=X(1,15)-1.
X(2,17)=X(1,16)
X(1,19)=X(1,16)
X(2,20)=X(1,16)
X(1,22)=X(1,16)
X(2,23)=X(1,16)
X(1,26)=0.
X(1,28)=0.
X(1,29)=0.
X(1,30)=0.
X(2,30)=W2
X(2,31)=W2

```

```

X(1,32)=0.
X(2,32)=W2
X(1,33)=0.
X(1,34)=W2
X(1,35)=-TB
X(1,36)=-TB
X(1,37)=-TB
X(1,38)=-TB
X(2,38)=0.
X(1,39)=-XINF
X(2,39)=XLI
X(1,40)=-XINF
X(2,41)=XINF
X(1,42)=-XINF
X(2,42)=-TB
X(1,43)=-XINF
X(2,43)=XINF
X(3,1)=-XINF
X(4,1)=-TA
X(3,2)=TS11
X(4,2)=W1-TS12
X(4,3)=X(4,2)
X(4,6)=X(4,2)
X(4,9)=X(4,2)
X(4,12)=X(4,2)
X(4,13)=X(4,2)
X(3,14)=X(4,2)
X(3,3)=TS11+(W1-TS11-TS12)/2.+0.5
X(4,4)=X(3,3)
X(3,6)=X(3,3)
X(4,7)=X(3,3)
X(3,9)=X(3,3)
X(4,10)=X(3,3)
X(3,4)=X(3,3)-1.
X(4,5)=X(3,4)
X(3,7)=X(3,4)
X(4,8)=X(3,4)

```



```

X(3,10)=X(3,4)
X(4,11)=X(3,4)
X(3,5)=TS11
X(3,8)=TS11
X(3,11)=TS11
X(3,12)=TS11
X(3,13)=TS11
X(4,14)=XL2-D2-DA
X(3,15)=X(4,14)
X(3,16)=X(4,14)
X(3,17)=X(4,14)
X(3,18)=X(4,14)
X(3,19)=X(4,14)
X(3,20)=X(4,14)
X(3,21)=X(4,14)
X(3,22)=X(4,14)
X(3,23)=X(4,14)
X(4,15)=XL2-D2
X(4,16)=X(4,15)
X(4,17)=X(4,15)
X(4,18)=X(4,15)
X(4,19)=X(4,15)
X(4,20)=X(4,15)
X(4,21)=X(4,15)
X(4,22)=X(4,15)
X(4,23)=X(4,15)
X(3,24)=X(4,15)
X(6,3)=-H1-(HH-H1-H2)/2.-0.5
X(6,4)=X(6,3)
X(6,5)=X(6,3)
X(5,6)=X(6,3)
X(5,7)=X(6,3)
X(5,8)=X(6,3)
X(6,6)=X(6,3)+1.
X(6,7)=X(6,6)
X(6,8)=X(6,6)
X(6,9)=-H1

```

X(6,10)=-H1
 X(6,11)=-H1
 X(6,12)=-H1
 X(6,13)=-H1
 X(6,14)=-H1
 X(5,9)=X(6,6)
 X(5,10)=X(6,6)
 X(5,11)=X(6,6)
 X(5,12)=-HH+H2
 X(5,13)=X(5,12)
 X(5,14)=X(5,12)
 X(5,15)=X(5,12)
 X(5,16)=X(5,12)
 X(5,17)=X(5,12)
 X(6,15)=X(6,3)
 X(6,16)=X(6,3)
 X(6,17)=X(6,3)
 X(5,18)=X(6,3)
 X(5,19)=X(6,3)
 X(5,20)=X(6,3)
 X(6,21)=-H1
 X(6,22)=-H1
 X(6,23)=-H1
 X(6,18)=X(6,6)
 X(6,19)=X(6,6)
 X(6,20)=X(6,6)
 X(5,21)=X(6,6)
 X(5,22)=X(6,6)
 X(5,23)=X(6,6)
 X(5,24)=-HH+H2
 X(5,25)=X(5,24)
 X(5,27)=X(5,24)
 X(6,28)=X(5,24)
 X(5,29)=X(5,24)
 X(5,31)=X(5,24)
 X(6,32)=X(5,24)
 X(5,33)=X(5,24)

X(6,24)=-H1
 X(6,25)=-H1
 X(5,26)=-H1
 X(6,26)=0.
 X(6,27)=-H1
 X(5,28)=-HH
 X(6,29)=-H1
 X(5,30)=-H1
 X(6,30)=0.
 X(6,31)=-H1
 X(5,32)=-HH
 X(6,33)=-H1
 X(5,34)=-HH
 X(6,34)=0.
 X(5,35)=0.
 X(5,35)=TC
 X(5,36)=-HH-TD
 X(6,36)=-HH
 X(5,37)=-HH
 X(6,37)=0.
 X(5,38)=-HH
 X(6,38)=0.
 X(5,39)=TC
 X(6,39)=XINF
 X(5,40)=-XINF
 X(6,40)=-HH-TD
 X(5,41)=-XINF
 X(6,41)=XINF
 X(5,42)=-HH-TD
 X(6,42)=TC
 X(5,43)=-XINF
 X(6,43)=XINF

RETURN

3001 FORMAT(19HNEG THICKNESS LEG 1)
 3002 FORMAT(19HNEG THICKNESS LEG 2)
 3003 FORMAT(16HNEG LENGTH LEG 1)
 3004 FORMAT(16HNEG LENGTH LEG 2)

```

3005 FORMAT(10HNNEG HEIGHT)
3006 FORMAT(19HNNEG DETECTOR HEIGHT)
3007 FORMAT(18HNNEG DETECTOR WIDTH)
END

```

```

SUBROUTINE L3Z
  DIMENSION X(6,100),IRX(6,100),H(116,10),V(116,10),INX(116,10,10)
  COMMON X,IRX,H,V,INX,IERR
  COMMON IMAX,JMAX,IHMAX,IVMAX
  COMMON XL1,XL2,XL3,W1,W2,W3,TS11,TS12,TS21,TS22,TS31,TS32,TT,D1,
    ID2,D3,DA,DB,DC,DA1,DA2,DA3,TA,TB,TC,TD,HH,H1,H2,XX
  XINF=1.E+09
  2000 A=W1-TS11-TS12
    IF(A)2001,2001,2002
  2001 WRITE OUTPUT TAPE 6,3001
  2002 CONTINUE
  2003 B=W3-TS31-TS32
    IF(B)2004,2004,2005
  2004 WRITE OUTPUT TAPE 6,3002
  2005 CONTINUE
  2006 C=W2-TS31-TS32
    IF(C)2007,2007,2008
  2007 WRITE OUTPUT TAPE 6,3003
  2008 CONTINUE
  2009 E=XL3-D1-DA1
    IF(E)2010,2010,2011
  2010 WRITE OUTPUT TAPE 6,3004
  2011 CONTINUE
  2012 F=XL1-D2-DA2
    IF(F)2013,2013,2014
  2013 WRITE OUTPUT TAPE 6,3005

```

```

2014 CONTINUE
2015 G=XL2-W1-W3
      IF(G)2016,2016,2017
2016 WRITE OUTPUT TAPE 6,3006
2017 CONTINUE
2018 P=HH-H1-H2
      IF(P)2019,2019,2020
2019 WRITE OUTPUT TAPE 6,3007
2020 CONTINUE
      X(1,3)=XL2-W1+TS12
      X(1,29)=X(1,3)
      X(1,32)=X(1,3)
      X(1,35)=X(1,3)
      X(2,4)=X(1,3)
      X(2,5)=X(1,3)
      X(1,8)=X(1,3)
      X(2,3)=XL2-TS11
      X(2,27)=X(2,3)
      X(2,30)=X(2,3)
      X(2,33)=X(2,3)
      X(1,2)=X(2,3)
      X(2,6)=X(2,3)
      X(2,8)=X(2,3)
      X(1,45)=TS32
      X(1,46)=TS32
      X(2,45)=W5-TS31
      X(2,36)=X(2,45)
      X(2,39)=X(2,45)
      X(2,42)=X(2,45)
      X(2,46)=X(2,45)
      X(1,5)=X(2,45)
      X(1,7)=X(2,45)
      X(1,47)=-XINF
      X(2,47)=XINF
      X(1,27)=XL2-TS11-(W1-TS11-TS12)/2.+0.5
      X(2,28)=X(1,27)
      X(1,30)=X(1,27)

```

```

X(1,28)=X(1,27)-1.
X(2,29)=X(1,28)
X(1,31)=X(1,28)
X(2,31)=X(2,28)
X(2,32)=X(2,29)
X(1,33)=X(1,27)
X(1,34)=X(1,28)
X(2,34)=X(2,28)
X(2,35)=X(2,29)
X(1,36)=W3-TS31-(W3-TS31-TS32)/2.+5
X(2,37)=X(1,36)
X(1,39)=X(1,36)
X(2,40)=X(1,36)
X(2,43)=X(1,36)
X(1,37)=X(1,36)-1.
X(2,38)=X(1,37)
X(1,40)=X(1,37)
X(2,41)=X(1,37)
X(1,43)=X(1,37)
X(2,44)=X(1,37)
X(1,42)=X(1,36)
X(1,38)=TS32
X(1,41)=TS32
X(1,44)=TS32
X(1,1)=-XINF
X(2,1)=XINF
X(2,2)=XL2
X(1,4)=XL2-W1
X(2,9)=X(1,4)
X(2,12)=X(1,4)
X(1,17)=X(1,4)
X(1,18)=X(1,4)
X(2,19)=X(1,4)
X(2,20)=X(1,4)
X(1,6)=W3
X(2,7)=W3
X(1,9)=TS32

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```

X(1,10)=0.
X(2,10)=TS32
X(1,11)=W3
X(2,11)=XL2
X(1,12)=0.
X(1,13)=XL2
X(2,13)=XL2+TA
X(1,16)=X(2,13)
X(2,23)=X(2,13)
X(2,24)=X(2,13)
X(1,14)=-TB
X(2,14)=0.
X(1,15)=-XINF
X(2,15)=-TB
X(2,16)=XINF
X(2,17)=XL2
X(2,18)=XL2
X(1,19)=W3
X(1,20)=W3
X(1,21)=0.
X(2,21)=W3
X(1,22)=0.
X(2,22)=W3
X(1,23)=-TB
X(1,24)=-TB
X(1,25)=-XINF
X(2,25)=XINF
X(1,26)=-XINF
X(2,26)=XINF
X(3,31)=-XL3+W2
X(4,31)=-XL3+W2+DI
X(3,27)=X(4,3)
X(3,28)=X(4,3)
X(3,29)=X(4,3)
X(3,30)=X(4,3)
X(3,31)=X(4,3)
X(3,32)=X(4,3)

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```

X(3,33)=X(4,3)
X(3,34)=X(4,3)
X(3,35)=X(4,3)
X(4,46)=XL1
X(3,47)=XL1
X(4,47)=XINF
X(3,8)=-XL3+W2+D1+DA1
X(4,27)=X(3,8)
X(4,28)=X(3,8)
X(4,29)=X(3,8)
X(4,30)=X(3,8)
X(4,31)=X(3,8)
X(4,32)=X(3,8)
X(4,33)=X(3,8)
X(4,34)=X(3,8)
X(4,35)=X(3,8)
X(4,8)=W2-TS21
X(4,5)=X(4,8)
X(3,6)=X(4,8)
Y(3,7)=X(4,8)
X(3,45)=TS22
X(4,45)=XL1-D2-DA2
X(3,36)=X(4,45)
X(3,37)=X(4,45)
X(3,38)=X(4,45)
X(3,39)=X(4,45)
X(3,40)=X(4,45)
X(3,41)=X(4,45)
X(3,42)=X(4,45)
X(3,43)=X(4,45)
X(3,44)=X(4,45)
X(3,46)=XL1-D2
X(4,36)=X(3,46)
X(4,37)=X(3,46)
X(4,38)=X(3,46)
X(4,39)=X(3,46)
X(4,40)=X(3,46)

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X(4,41)=X(3,46)
X(4,42)=X(3,46)
X(4,43)=X(3,46)
X(4,44)=X(3,46)
X(3,1)=-X[NF
X(4,1)=-XL3+W2
X(3,2)=X(4,1)
X(3,4)=X(4,1)
X(3,12)=X(4,1)
X(3,13)=X(4,1)
X(3,14)=X(4,1)
X(3,15)=X(4,1)
X(3,16)=X(4,1)
X(3,17)=X(4,1)
X(3,18)=X(4,1)
X(3,23)=X(4,1)
X(3,24)=X(4,1)
X(3,25)=X(4,1)
X(3,26)=X(4,1)
X(4,21)=W2
X(4,4)=TS22
X(3,51)=TS22
X(4,6)=W2
X(4,7)=XL1
X(3,9)=0.
X(4,9)=TS22
X(3,10)=0.
X(4,10)=XL1
X(3,11)=W2
X(4,11)=XL1
X(4,12)=0.
X(4,13)=XL1
X(4,14)=XL1
X(4,15)=XL1
X(4,16)=XL1
X(4,17)=W2
X(4,18)=W2

```

X(3,19)=0.
 X(4,19)=W2
 X(3,20)=0.
 X(4,20)=W2
 X(3,21)=0.
 X(4,21)=XL1
 X(3,22)=0.
 X(4,22)=XL1
 X(4,23)=XL1
 X(4,24)=XL1
 X(4,25)=XL1
 X(4,26)=XL1
 X(5,17)=TC+HH-H2
 X(5,19)=X(5,17)
 X(5,21)=X(5,17)
 X(6,3)=X(5,17)
 X(6,8)=X(5,17)
 X(6,45)=X(5,17)
 X(6,46)=X(5,17)
 X(6,17)=TC+HH
 X(6,19)=X(6,17)
 X(6,21)=X(6,17)
 X(5,23)=X(6,17)
 X(6,18)=TC+H1
 X(6,20)=X(6,18)
 X(6,22)=X(6,18)
 X(5,3)=X(6,18)
 X(5,8)=X(6,18)
 X(5,45)=X(6,18)
 X(5,46)=X(6,18)
 X(5,33)=X(6,18)
 X(5,34)=X(6,18)
 X(5,35)=X(6,18)
 X(5,42)=X(6,18)
 X(5,43)=X(6,18)
 X(5,44)=X(6,18)
 X(5,2)=X(6,18)

```

X(5,4)=X(6,18)
X(5,5)=X(6,18)
X(5,6)=X(6,18)
X(5,7)=X(6,18)
X(5,9)=X(6,18)
X(5,10)=X(6,18)
X(6,11)=X(6,17)
X(6,12)=X(6,17)
X(6,13)=X(6,17)
X(6,14)=X(6,17)
X(6,23)=TC+HH+TD
X(5,25)=X(6,23)
X(6,15)=X(6,23)
X(6,16)=X(6,23)
X(5,18)=TC
X(5,20)=TC
X(5,22)=TC
X(5,24)=0.
X(6,24)=TC
X(6,25)=XINF
X(5,26)=-XINF
X(6,26)=0.
X(5,47)=-XINF
X(6,47)=XINF
X(5,27)=TC+H1+(HH-H1*H2)/2+.5
X(5,28)=X(5,27)
X(5,29)=X(5,27)
X(6,30)=X(5,27)
X(6,31)=X(5,27)
X(6,32)=X(5,27)
X(5,36)=X(5,27)
X(5,37)=X(5,27)
X(5,38)=X(5,27)
X(6,39)=X(5,27)
X(6,40)=X(5,27)
X(6,41)=X(5,27)
X(5,30)=X(5,27)-1.

```

```

X(5,31)=X(5,30)
X(5,32)=X(5,30)
X(6,33)=X(5,30)
X(6,34)=X(5,30)
X(6,35)=X(5,30)
X(5,39)=X(5,30)
X(5,40)=X(5,30)
X(5,41)=X(5,30)
X(6,42)=X(5,30)
X(6,43)=X(5,30)
X(6,44)=X(5,30)
X(6,27)=TC+HH-H2
X(6,28)=X(6,27)
X(6,29)=X(6,27)
X(6,36)=X(6,27)
X(6,37)=X(6,27)
X(6,38)=X(6,27)
X(6,2)=X(6,27)
X(5,4)=X(6,27)
X(6,5)=X(6,27)
X(6,6)=X(6,27)
X(6,7)=X(6,27)
X(6,9)=X(6,27)
X(6,10)=X(6,27)
X(5,1)=-XINF
X(6,1)=XINF
X(5,11)=TC
X(5,12)=TC
X(5,13)=TC
X(5,14)=TC
X(5,15)=0.
X(5,16)=0.

```

```

RETURN

```

```

3001 FORMAT(19HNEG THICKNESS LEG 3)
3002 FORMAT(19HNEG THICKNESS LEG 3)
3003 FORMAT(19HNEG THICKNESS LEG 1)
3004 FORMAT(16HNEG LENGTH LEG 3)

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3005 FORMAT(16HNEG LENGTH LEG 1)
3006 FORMAT(16HNEG LENGTH LEG 2)
3007 FORMAT(10HNEG HEIGHT
      END

```

```

SUBROUTINE L3NCP
  DIMENSION X(6,100),IRX(6,100),H(116,10),V(116,10),INA(116,10,10)
  COMMON X,IRX,H,V,INX,IERR
  COMMON IMAX,JMAX,IHMAX,IVMAX
  COMMON XL1,XL2,XL3,W1,W2,W3,TS11,TS12,TS21,TS22,TS31,TS32,TF,D1,
1D2,D3,DA,DB,DC,DA1,DA2,DA3,TA,TB,TC,TD,HH,H1,H2,XX
  XINF=1.E+09
  X(6,18)=XL1-HH
  X(1,20)=-XINF
  X(2,20)=-TB
  X(3,20)=-TC
  X(4,20)=XL3
  X(5,20)=-HH
  X(6,20)=XL1-HH
  X(1,21)=-TB
  X(2,21)=XINF
  X(3,21)=-TC
  X(4,21)=XL3
  X(5,21)=-XINF
  X(6,21)=-TD-HH
  X(1,61)=-XINF
  X(2,61)=-TB
  X(3,61)=-TC
  X(4,61)=XL3
  X(5,61)=-HH-TD
  X(6,61)=-HH

```

X(1,22)=XL2+TA
X(2,22)=XINF
X(3,22)=-TC
X(4,22)=XL3
X(5,22)=-HH
X(6,22)=XL1-HH
X(1,59)=-TB
X(2,59)=XINF
X(3,59)=-TC
X(4,59)=XL3
X(5,59)=-HH-TD
X(6,59)=-HH
X(1,29)=-TB
X(2,29)=XINF
X(3,29)=-TC
X(4,29)=XL3
X(5,29)=XL1-HH
X(6,29)=XINF
X(1,62)=-XINF
X(2,62)=-TB
X(3,62)=-TC
X(4,62)=XL3
X(5,62)=-XINF
X(6,62)=-TD-HH
X(1,64)=-XINF
X(2,64)=XINF
X(3,64)=XL3
X(4,64)=XINF
X(5,64)=-XINF
X(6,64)=XINF
X(1,63)=-XINF
X(2,63)=-TB
X(3,63)=-TC
X(4,63)=XL3
X(5,63)=XL1-HH
X(6,63)=XINF
X(1,2)=XL2-W1+TS12

```

X(1,3)=X(1,2)
X(1,6)=X(1,2)
X(1,9)=X(1,2)
X(1,12)=X(1,2)
X(1,13)=X(1,2)
X(2,27)=X(1,2)
X(2,18)=XL2+TA
X(1,4)=X(1,2)+(W1-TS12-TS11)/2.-.5
X(1,7)=X(1,4)
X(1,10)=X(1,4)
X(1,5)=X(1,4)+1.
X(1,8)=X(1,5)
X(1,11)=X(1,5)
X(1,14)=XL2-TS11-D2
X(1,15)=TS31
X(1,16)=W3
X(1,17)=-TB
X(1,18)=-TB
X(1,19)=CL2
X(1,23)=0.
X(1,24)=0.
X(1,25)=W3
X(1,26)=XL2-TS11
X(1,27)=XL2-W1
X(1,28)=X(1,27)
X(1,30)=W3-TS32
X(1,52)=X(1,30)
X(1,31)=XL2-TS11-D2-DA2
X(1,32)=X(1,31)
X(1,33)=X(1,31)
X(1,34)=X(1,31)
X(1,35)=X(1,31)
X(1,39)=X(1,31)
X(1,38)=X(1,31)
X(1,37)=X(1,31)
X(1,36)=X(1,31)
X(1,40)=TS31

```

X(1,50)=TS31
 X(1,51)=TS31
 X(1,53)=W3
 X(1,54)=0.
 X(1,55)=W3
 X(1,56)=W3
 X(1,57)=0.
 X(1,58)=0.
 X(1,60)=XL2-W1
 X(2,53)=X(1,60)
 X(2,2)=XL2-TS11
 X(2,3)=X(1,4)
 X(2,6)=X(1,4)
 X(2,9)=X(1,4)
 X(2,4)=X(1,5)
 X(2,7)=X(1,5)
 X(2,10)=X(1,5)
 X(2,5)=XL2-TS11
 X(2,8)=X(2,5)
 X(2,11)=X(2,5)
 X(2,12)=X(2,5)
 X(2,13)=X(2,5)
 X(2,14)=X(1,2)
 X(2,15)=W3-TS32
 X(2,16)=XL2-W1
 X(2,17)=0.
 X(2,19)=XL2+TA
 X(2,23)=TS31
 X(2,24)=W3
 X(2,25)=XL2
 X(2,26)=XL2
 X(2,27)=X(1,2)
 X(2,28)=XL2
 X(2,30)=XL2-D2-TS11-DA2
 X(2,31)=XL2-TS11-D2
 X(2,32)=X(2,31)
 X(2,33)=X(2,31)

X(2,34)=X(2,31)
X(2,35)=X(2,31)
X(2,36)=X(2,31)
X(2,37)=X(2,31)
X(2,38)=X(2,31)
X(2,39)=X(2,31)
X(2,40)=W3-TS32
X(2,50)=X(2,40)
X(2,51)=X(2,40)
X(2,52)=W3
X(2,54)=XL2
X(2,55)=XL2
X(2,56)=XL2
X(2,57)=W3
X(2,58)=W3
X(2,60)=XL2
X(3,2)=TS21
X(3,3)=TS21
X(3,4)=TS21
X(3,5)=TS21
X(3,6)=TS21+(W2-TS21-TS22)/2.-.5
X(3,7)=X(3,6)
X(3,8)=X(3,6)
X(3,32)=X(3,6)
X(3,35)=X(3,6)
X(3,38)=X(3,6)
X(4,3)=X(3,6)
X(4,4)=X(3,6)
X(4,5)=X(3,6)
X(4,31)=X(3,6)
X(4,34)=X(3,6)
X(4,37)=X(3,6)
X(3,9)=X(3,6)+1.
X(3,10)=X(3,9)
X(3,11)=X(3,9)
X(3,33)=X(3,9)
X(3,36)=X(3,9)

X(3,39)=X(3,9)
X(4,6)=X(3,9)
X(4,7)=X(3,9)
X(4,8)=X(3,9)
X(4,32)=X(3,9)
X(4,35)=X(3,9)
X(4,38)=X(3,9)
X(3,12)=TS21
X(3,13)=TS21
X(3,14)=TS21
X(3,15)=TS21
X(3,16)=0.
X(3,17)=0.
X(3,18)=-TC
X(3,19)=0.
X(3,23)=TS21
X(3,24)=0.
X(3,25)=0.
X(3,26)=TS21
X(3,27)=TS21
X(3,28)=0.
X(3,30)=TS21
X(3,31)=TS21
X(3,34)=TS21
X(3,37)=TS21
X(3,53)=TS21
X(3,40)=W2-TS22
X(3,52)=X(3,40)
X(3,55)=X(3,40)
X(3,60)=X(3,40)
X(4,2)=X(3,40)
X(4,9)=X(3,40)
X(4,10)=X(3,40)
X(4,11)=X(3,40)
X(4,12)=X(3,40)
X(4,13)=X(3,40)
X(4,14)=X(3,40)

X(4,15)=X(3,40)
X(4,16)=X(3,40)
X(4,26)=X(3,40)
X(4,27)=X(3,40)
X(4,30)=X(3,40)
X(4,33)=X(3,40)
X(4,35)=X(3,40)
X(4,39)=X(3,40)
X(4,50)=X(3,40)
X(4,51)=X(3,40)
X(4,54)=0.
X(4,56)=W2
X(4,57)=0.
X(4,58)=TS21
X(4,11)=TC
X(4,16)=W2
X(4,17)=XL3
X(4,18)=0.
X(4,19)=XL2
X(4,23)=XL3
X(4,24)=XL3
X(4,40)=XL3-D3-DA3
X(4,50)=XL3-TT
X(4,51)=XL3
X(4,52)=XL3
X(4,53)=W2-TS21
X(4,28)=TS21
X(4,54)=TS21
X(4,55)=W2
X(4,56)=XL3
X(4,57)=XL3
X(4,58)=XL3
X(4,60)=W2
X(5,1)=XINF
X(5,2)=XL1-C1-F1
X(5,3)=X(5,2)-DA1
X(5,4)=X(5,3)

X(5,5)=X(5,3)
 X(5,6)=X(5,3)
 X(5,7)=X(5,3)
 X(5,8)=X(5,3)
 X(5,9)=X(5,3)
 X(5,10)=X(5,3)
 X(5,11)=X(5,3)
 X(5,12)=-H1
 X(5,13)=-HH+H2
 X(5,14)=X(5,13)
 X(5,15)=X(5,13)
 X(5,23)=X(5,13)
 X(5,26)=X(5,13)
 X(5,30)=X(5,13)
 X(5,37)=X(5,13)
 X(5,38)=X(5,13)
 X(5,39)=X(5,13)
 X(5,40)=X(5,13)
 X(5,50)=X(5,13)
 X(5,51)=X(5,13)
 X(5,52)=X(5,13)
 X(5,54)=X(5,13)
 X(5,16)=0.
 X(5,17)=-HH
 X(5,18)=-HH
 X(5,19)=-HH
 X(5,24)=-HH
 X(5,25)=-HH
 X(5,27)=-H1
 X(5,28)=0.
 X(5,31)=-H1-(HH-H1-H2)/2+.5
 X(5,32)=X(5,31)
 X(5,33)=X(5,31)
 X(6,34)=X(5,31)
 X(6,35)=X(5,31)
 X(6,36)=X(5,31)
 X(5,41)=X(5,31)

X(5,34)=X(5,31)-1.
 X(5,35)=X(5,34)
 X(5,36)=X(5,34)
 X(6,37)=X(5,34)
 X(6,38)=X(5,34)
 X(6,39)=X(5,34)
 X(5,53)=-H1
 X(5,55)=-HH
 X(5,56)=-HH
 X(5,57)=0.
 X(5,58)=-H1
 X(5,60)=0.
 X(6,2)=XL1-HH
 X(6,16)=X(6,2)
 X(6,17)=X(6,2)
 X(6,19)=X(6,2)
 X(6,26)=X(6,2)
 X(6,27)=X(6,2)
 X(6,28)=X(6,2)
 X(6,56)=X(6,2)
 X(6,57)=X(6,2)
 X(6,60)=X(6,2)
 X(6,24)=-HH+H2
 X(6,25)=X(6,24)
 X(6,53)=0.
 X(6,54)=0.
 X(6,55)=0.
 X(6,58)=0.
 X(6,3)=X(6,2)-D1
 X(6,4)=X(6,3)
 X(6,5)=X(6,3)
 X(6,6)=X(6,3)
 X(6,7)=X(6,3)
 X(6,8)=X(6,3)
 X(6,9)=X(6,3)
 X(6,10)=X(6,3)
 X(6,11)=X(6,3)

X(6,12)=XL1-D1-DA1-HH
X(6,13)=-H1
X(6,14)=-H1
X(6,15)=-H1
X(6,23)=-H1
X(6,30)=-H1
X(6,31)=-H1
X(6,32)=-H1
X(6,33)=-H1
X(6,40)=-H1
X(6,50)=-H1
X(6,51)=-H1
X(6,52)=-H1
X(1,41)=TS31
X(2,41)=TS31+(W3-TS31-TS32)/2.-.5
X(3,41)=XL3-D3-DA3
X(4,41)=XL3-D3
X(6,41)=-H1
X(1,44)=X(1,41)
X(2,44)=X(2,41)
X(3,44)=X(3,41)
X(4,44)=X(4,41)
X(5,44)=X(5,41)-1.
X(6,44)=X(5,41)
X(1,47)=X(1,41)
X(2,47)=X(2,41)
X(3,47)=X(3,41)
X(4,47)=X(4,41)
X(5,47)=-HH+H2
X(6,47)=X(5,44)
X(1,42)=X(2,41)
X(2,42)=X(2,41)+1.
X(3,42)=X(3,41)
X(4,42)=X(4,41)
X(5,42)=X(5,41)
X(6,42)=X(6,41)
X(1,45)=X(2,41)

```

X(2,45)=X(2,41)+1.
X(3,45)=X(3,44)
X(4,45)=X(4,44)
X(5,45)=X(5,44)
X(6,45)=X(6,44)
X(1,48)=X(2,41)
X(2,48)=X(2,41)+1.
X(3,48)=X(3,47)
X(4,48)=X(4,47)
X(5,48)=X(5,47)
X(6,48)=X(6,47)
X(1,43)=X(2,42)
X(2,43)=W3-TS32
X(3,43)=X(3,41)
X(4,43)=X(4,41)
X(5,43)=X(5,41)
X(6,43)=X(6,41)
X(1,46)=X(2,42)
X(2,46)=W3-TS32
X(3,46)=X(3,44)
X(4,46)=X(4,44)
X(5,46)=X(5,44)
X(6,46)=X(6,44)
X(1,49)=X(2,42)
X(2,49)=W3-TS32
X(3,49)=X(3,47)
X(4,49)=X(4,47)
X(5,49)=X(5,47)
X(6,49)=X(6,47)
X(2, 1)=XINF
X(6, 1)=XINF
X(1, 1)=-XINF
X(3, 1)=-XINF
RETURN
END

```

Table II. Physical Parameters of Ducts

Parameters	Subroutine		
	L2 (Two-Legged)	L3Z (Three-Legged Coplanar)	L3NCP (Three-Legged Non-Coplanar)
First Card			
Columns 9 & 10 ^{1/}	43	47	64
Column 20 ^{2/}	1	2	3
XL1	200 cm ^{3/}	167 cm ^{3/}	150 cm ^{3/}
XL2	190	151	210
XL3	0	141	200
W1	92	72.39	100
W2	100	80.01	61
W3	0	72.39	62
TS11	29	16.51	35
TS12	35.6	27.94	36
TS21	35.6	16.51	16
TS22	35.6	35.56	17
TS31	0	27.94	16
TS32	0	16.51	17
TT	1	0	1
D1	41.0	10	38
D2	41.0	9	84
D3	0	0	51
DA	1.0	0	0
DB	1.0	0	0
DC	1.0	0	0
DA1	0	1.0	1.0
DA2	0	1.0	1.0
DA3	0	0	1.0
TA	61	61	60
TB	61	61	61
TC	61	61	59
TD	61	61	60
HH	60.9	60.96	73
H1	16.5	16.51	28
H2	16.5	16.51	17
XX	0	0	0

^{1/} Total number of regions

^{2/} Subroutine number

^{3/} Duct dimensions

70

38	41	37	-6	28	26
38	34	26	43	-15	35
-12	34	27	43	32	30
38	34	28	43	36	13
38	-5	29	43	-27	-23
-25	41	-17	43	36	35
42	41	1	43	-24	39
42	41	1	43	40	-25
42	41	1	-20	36	35
42	-19	37	43	36	35
39	41	1	43	-29	39
40	41	1	43	40	-30
-14	41	1	43	41	41
42	-28	1	43	40	39
43	43	-22	43	43	43
-61.00	200.00100000.				
-30.95	-29.95 -16.50				
158.00	159.00 200.00				
29.00	42.20 43.20	56.40 92.00			
-30.95	-29.95 -16.50				
35.60	64.40 158.00	159.00 200.00			
29.00	42.20 43.20	56.40 92.00			
-16.50					
49.50	50.50 64.40				
92.00	148.00				
92.00	148.00				
-30.95	-29.95 -16.50				
148.00	149.00 189.00	190.00			
-121.90	-60.30 -44.40	-16.50	0.	61.00100000.	
148.00	149.00 189.00	190.00			
100.00	200.00				
200.00					
100.00	200.00				
-44.40	-16.50				
0.	200.00				
100.00	200.00				
-61.00	0.				
	35.60	64.40 100.00	200.00100000.		

92.00	190.00		
0.	92.00	190.00	
-44.40	-16.50	0.	
0.	92.00	190.00	
92.00	190.00		
-60.90	0.	61.00	
190.00			
190.00			
-121.90	-60.90	0.	61.00100000.
42.20	43.20	56.40	
-30.95	-29.95	-16.50	
35.60	64.40	158.00	159.00 200.00
56.40	148.00	149.00	189.00 190.00
-30.95	-29.95	-16.50	
35.60	64.40	158.00	159.00 200.00
92.00	148.00		
-30.95	-29.95	-16.50	
64.40			
64.40			
148.00	149.00	189.00	190.00
35.60	49.50	50.50	64.40 100.00
0.	29.00	56.40	92.00 190.00
35.60	49.50	50.50	64.40 100.00
0.			
-44.40	-16.50	0.	
-16.50			
29.00	92.00	190.00	
-44.40	-16.50	0.	
-44.40			
-121.90	-60.90	-44.40	-16.50 0.
35.60			61.00100000.
0.	100.00	200.00	
190.00			
0.	100.00	200.00	
35.60			
0.	190.00		
-61.00	200.00		

[illegible]

-0.1000E 10 0.10000E 10-0.10000E 10-0.60990E 02-0.10000E 10 0.10000E 10 0.10000E 10
0.13449E 03 0.15100E 03-0.60990E 02 0.30010E 02 0.77510E 02 0.77510E 02 0.10545E 03
0.10655E 03 0.13449E 03-0.60990E 02-0.50990E 02 0.77510E 02 0.77510E 02 0.10545E 03
0.78610E 02 0.10655E 03-0.60990E 02 0.35560E 02 0.77510E 02 0.77510E 02 0.10545E 03
0.44450E 02 0.10655E 03 0.35560E 02 0.63500E 02 0.77510E 02 0.77510E 02 0.10545E 03
0.72390E 02 0.13449E 03 0.63500E 02 0.80010E 02 0.77510E 02 0.77510E 02 0.10545E 03
0.44450E 02 0.72390E 02 0.63500E 02 0.16700E 03 0.77510E 02 0.77510E 02 0.10545E 03
0.10655E 03 0.13449E 03-0.49990E 02 0.63500E 02 0.77510E 02 0.77510E 02 0.10545E 03
0.16510E 02 0.78610E 02 0. 0.35560E 02 0.77510E 02 0.77510E 02 0.10545E 03
0. 0.16510E 02 0. 0.16700E 03 0.77510E 02 0.77510E 02 0.10545E 03
0.72390E 02 0.15100E 03 0.80010E 02 0.16700E 03 0.61000E 02 0.12196E 03
0. 0.78610E 02-0.60990E 02 0. 0.61000E 02 0.61000E 02 0.12196E 03
0.15100E 03 0.21200E 03-0.60990E 02 0.16700E 03 0.61000E 02 0.12196E 03
-0.61000E 02 0. 0.60990E 02 0.16700E 03 0.61000E 02 0.12196E 03
-0.1000E 10-0.61000E 02-0.60990E 02 0.16700E 03 0. 0.18296E 03
0.21200E 03 0.10000E 10-0.60990E 02 0.16700E 03 0. 0.18296E 03
0.78610E 02 0.15100E 03-0.60990E 02 0.80010E 02 0.10545E 03 0.12196E 03
0.78610E 02 0.15100E 03-0.60990E 02 0.80010E 02 0.61000E 02 0.77510E 02
0.72390E 02 0.78610E 02 0. 0.90010E 02 0.10545E 03 0.12196E 03
0.72390E 02 0.78610E 02 0. 0.80010E 02 0.61000E 02 0.77510E 02
0. 0.72390E 02 0. 0.16700E 03 0.10545E 03 0.12196E 03
0. 0.72390E 02 0. 0.16700E 03 0.16700E 03 0.12196E 03
-0.61000E 02 0.21200E 03-0.60990E 02 0.16700E 03 0.18296E 03 0.10000E 10
-0.61000E 02 0.21200E 03-0.60990E 02 0.16700E 03 0.18296E 03 0.10000E 10
-0.10000E 10 0.10000E 10-0.60990E 02 0.16700E 03 0. 0.61000E 02
-0.10000E 10 0.10000E 10-0.60990E 02 0.16700E 03 0.18296E 03 0.10000E 10
0.12102E 03 0.13449E 03-0.50990E 02-0.49990E 02 0.91980E 02 0.10545E 03
0.12002E 03 0.12102E 03-0.50990E 02-0.49990E 02 0.91980E 02 0.10545E 03
0.10655E 03 0.12002E 03-0.50990E 02-0.49990E 02 0.91980E 02 0.10545E 03
0.12102E 03 0.13449E 03-0.50990E 02-0.49990E 02 0.91980E 02 0.10545E 03
0.12002E 03 0.12102E 03-0.50990E 02-0.49990E 02 0.91980E 02 0.10545E 03
0.10655E 03 0.12002E 03-0.50990E 02-0.49990E 02 0.91980E 02 0.10545E 03
0.12102E 03 0.13449E 03-0.50990E 02-0.49990E 02 0.91980E 02 0.10545E 03
0.12002E 03 0.12102E 03-0.50990E 02-0.49990E 02 0.91980E 02 0.10545E 03

25	25	1	47	-39	25
26	26	1	47	26	-38
28	2	3	8	30	17
29	27	3	8	31	17
4	28	3	8	32	17
31	2	3	8	33	27
32	30	3	8	34	28
4	31	3	8	35	29
34	2	3	8	18	30
35	33	3	8	18	31
4	34	3	8	18	32
37	7	45	46	39	21
38	36	45	46	40	21
10	37	45	46	41	21
40	7	45	46	42	36
41	39	45	46	43	37
10	40	45	46	44	38
43	7	45	46	22	39
44	42	45	46	22	40
10	43	45	46	22	41
10	-19	5	-44	22	21
10	7	-44	47	22	21
47	47	-29	47	47	47
-61.00	0.	78.61	106.55	134.49	151.00
90.98	91.98	105.45	212.00	100000.	
120.02	121.02	134.49			
-51.00	-50.00	35.56	63.50	30.01	
-51.00	-50.00	35.56	63.50	80.01	
105.45					
90.98	91.98	105.45			
105.45					
78.61	106.55				
72.39	106.55				
63.50					
63.50					
106.55	134.49				
78.61	134.49	151.00			

35.56	63.50	80.01		
80.01				
35.56	63.50	80.01		
80.01				
105.45				
90.98	91.98	105.45		
105.45				
35.56	63.50	157.00	158.00	167.00
35.56	63.50	157.00	158.00	167.00
44.45	78.61			
35.56				
35.56				
90.98	91.98	105.45		
16.51	72.39	78.61		
-61.00	C.	16.51	44.45	72.39 151.00 212.00100000.
77.51	105.45	121.96		
77.51	105.45	121.96		
77.51	105.45	121.96		
77.51	105.45	121.96		
0.	80.01	167.00		
0.	80.01	167.00		
61.00	121.96	182.96		
61.00	121.96	182.96		
167.00				
167.00				
121.96				
77.51				
121.96				
77.51				
29.98	30.08	44.45		
0.	61.00	77.51	105.45	121.96 182.96100000.
-51.00	-50.00	63.50	80.01	
90.98	91.98	105.45		
106.55	120.02	121.02	134.49	151.00
106.55	120.02	121.02	134.49	151.00
0.	35.56			
-51.00	-50.00	35.56		

35.56	63.50		
105.45			
105.45			
72.39	78.61	106.55	
72.39	78.61	106.55	
105.45			
77.51	105.45	121.96	
78.61			
78.61	134.49		
78.61			
78.61	134.49		
63.50	157.00		
157.00	158.00	167.00	
80.01	167.00		
16.51	29.98	30.98	44.45 72.39
16.51	29.98	30.98	44.45 72.39
105.45			
72.39	78.61		
72.39	78.61		
35.56	157.00	158.00	167.00
77.51	105.45	121.96	
0.	61.00	77.51	105.45 121.96 182.96100000.
167.00			
80.01	167.00		
0.	167.00		
0.			
0.	72.39	78.61	151.00 212.00
0.	72.39	78.61	151.00 212.00
167.00			
167.00			
-61.00	212.00	100000.	
-61.00	212.00	100000.	
0.	80.01		
0.	80.01		
80.01	167.00		
80.01	167.00		
90.98	91.98	105.45	

[illegible]

80

7	27	9	10	27	14	-11	23	57	20	20	-21	20	62	-22	17	17	24	-6	-32	16	63	15	30	30	30	30	30	30	30	30	30	23	23	41	42	23	
26	10	11	26	26	26	13	30	-14	-17	22	22	-19	21	22	-24	-27	19	19	-3	19	29	-11	14	14	14	14	14	14	14	14	14	14	52	42	43	52	45
5	6	7	8	-8	54	54	54	18	18	1	18	1	1	1	54	18	18	-30	-33	18	1	54	54	31	32	54	34	35	54	37	38	15	40	40	40	40	
11	60	60	60	-9	55	55	40	56	64	-18	64	64	64	64	64	64	55	-31	-34	-4	64	-36	32	33	55	35	36	55	38	39	55	-39	56	50	50	50	
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44	46	40	50	48	42
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47	49	40	50	24	45
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23	52	-39	51	24	58
23	52	50	64	24	58
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17	19	18	-5	-29	-35
-40	19	-10	56	59	-46
-42	19	-45	64	59	29
17	-47	18	64	-43	29
17	-44	54	64	-26	57
61	59	1	64	21	-20
16	19	-7	56	55	29
61	59	1	64	52	20
62	21	1	64	62	61
63	29	1	64	20	63
64	64	-23	54	64	64
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29.50	30.50	44.00			
38.00	39.00	77.00			
146.00	160.00	161.00	175.00	210.00	
16.00	45.00	62.00	90.00	91.00	110.00
-28.00	38.00	39.00	77.00		146.00
146.00	160.00	161.00	175.00	210.00	175.00
175.00					210.00
175.00					
90.00	91.00	110.00	146.00	175.00	
-42.50	-41.50	-28.00			
16.00	29.50	30.50	44.00		
44.00					
77.00					
16.00	44.00	61.00			
0.	16.00	44.00	61.00	200.00	
-56.00	-28.00	0.	77.00		

0.	62.00	110.00	210.00	270.00
77.00				
0.	44.00	61.00	200.00	
-56.00	0.	77.00		
77.00				
-61.00	0.	16.00	45.00	62.00 210.00 270.001000000.
-42.50	-41.50	-28.00		
16.00	44.00	148.00	149.00	199.00 200.00
44.00	148.00	149.00	199.00	200.00
-56.00				
44.00				
16.00				
210.00				
210.00				
0.	77.00			
146.00				
146.00				
16.00				
62.00	90.00			
29.50	30.50	44.00		
44.00				
30.00	31.00	45.00		
-56.00	-28.00	0.		
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0.				
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61.00				
77.00				
16.00	200.00			
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160.00	161.00	175.00		
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-42.50	-41.50	-28.00	0.	
29.50	30.50	44.00		

38.00	39.00	77.00	
0.	38.00		
0.	38.00		
-56.00	-42.50	-41.50	-28.00 0.
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90.00	91.00	146.00	175.00 210.00
110.00	146.00		
16.00	44.00	61.00	
110.00			
0.	62.00	110.00	146.00 175.00 210.00 270.001000000.
16.00	200.00		
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0.	200.00		
0.	62.00	210.00	270.001000000.
16.00	44.00	61.00	200.00
C.	200.00		
-133.00	-73.00	-56.00	-28.00 0. 77.001000000.
44.00	148.00	149.00	199.00 200.00
16.00	30.00	31.00	45.00 62.00
16.00	30.00	31.00	45.00 62.00
44.00	61.00	200.00	
62.00	90.00		
62.00	210.00		
0.	77.00		
0.	77.00		
44.00			
0.	77.00		
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62.00	110.00	210.00	
-28.00			
90.00	91.00	110.00	
62.00	90.00		
-42.50	-41.50	-28.00	
61.00			
148.00	149.00	199.00	200.00
200.00			
61.00	200.00		

