9.2.012

1620 GENERAL PROGRAM LIBRARY

Relocation Offsets

9.2.012

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1620 USERS GROUP PROGRAM REVIEW AND EVALUATION

(fill out in typewriter or pencil, do not use ink)

Program No.________________ Date________________

Program Name:____

1. Does the abstract adequately describe what the program is and what it does? Yes___ No___
   Comment____

2. Does the program do what the abstract says? Yes___ No___
   Comment____

3. Is the Description clear, understandable, and adequate? Yes___ No___
   Comment____

4. Are the Operating Instructions understandable and in sufficient detail? Yes___ No___
   Comment____
   Are the Sense Switch options adequately described (if applicable)? Yes___ No___
   Are the mnemonic labels identified or sufficiently understandable? Yes___ No___
   Comment____

5. Does the source program compile satisfactorily (if applicable)? Yes___ No___
   Comment____

6. Does the object program run satisfactorily? Yes___ No___
   Comment____

7. Number of test cases run______. Are any restrictions as to data, size, range, etc. covered adequately in description? Yes___ No___
   Comment____

8. Does the Program Meet the minimal standards of the 1620 Users Group? Yes___ No___
   Comment____

9. Were all necessary parts of the program received? Yes___ No___
   Comment____

10. Please list on the back any suggestions to improve the usefulness of the program. These will be passed onto the author for his consideration.

Please return to:

Mr. Richard L. Pratt
Data Corporation
7500 Old Xenia Pike
Dayton, Ohio 45432

Your Name____________________

Company____________________

Address____________________

User Group Code____________________

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11/09/64

RELOCATION OFFSETS

PROGRAM MANUAL

P. O. Roberts
CIVIL ENGINEERING SYSTEMS LABORATORY
Massachusetts Institute of Technology

October, 1961
Publication 147

Sponsored by
Massachusetts Department of Public Works
in co-operation with
U. S. Bureau of Public Roads
Contract 1017-Mass HPS-1(16)

DECK KEY

Deck	1	Source Relocation Offsets Pt. II
Deck	2	Source Relocation Offsets Pt. I
Deck	3	Object Relocation Offsets Pt. I
Deck	4	Object Relocation Offsets Pt. II

1620 9.2.012

ACKNOWLEDGEMENTS

The author wishes to gratefully acknowledge the research support provided by the Massachusetts Department of Public Works in cooperation with the U.S. Bureau of Public Roads. The support has made possible investigations in the economical location and design of highway facilities in the search for new and better methods of highway engineering.

RELOCATION OFFSETS

by
P. O. Roberts
Assistant Professor of Civil Engineering
M.I.T. Civil Engineering Systems Laboratory

Purpose

Frequently during the course of designing a highway or railroad, situations arise in which the design engineer would like to change the alignment that has been chosen. This can occur because of a misjudgment of the quantities incurred or because of a change in the design situation, such as the continued growth of a subdivision or opposition of the public to the destruction of a park or historic building. Frequently, the change involved is small enough that the original survey information is still valid and usable.

Whatever the reason for the change, the work involved in recomputation is formidable. New geometry must be calculated. Equivalent stations on the new centerline must be calculated and offset distance from the original survey line, or base line, to the new centerline must be established. These offsets are then used for correcting the cross section sheets. The program is designed to relieve the burden of computation which alignment changes place on the engineer. See Figure 1.

Description

The program is accomplished in two parts. Part One computes the geometry of the baseline and the new centerline, given the state plane coordinates of the P.I.'s and one parameter defining each curve. Part Two works with the table of geometry prepared by Part One and computes the centerline stations and offsets for each baseline station.

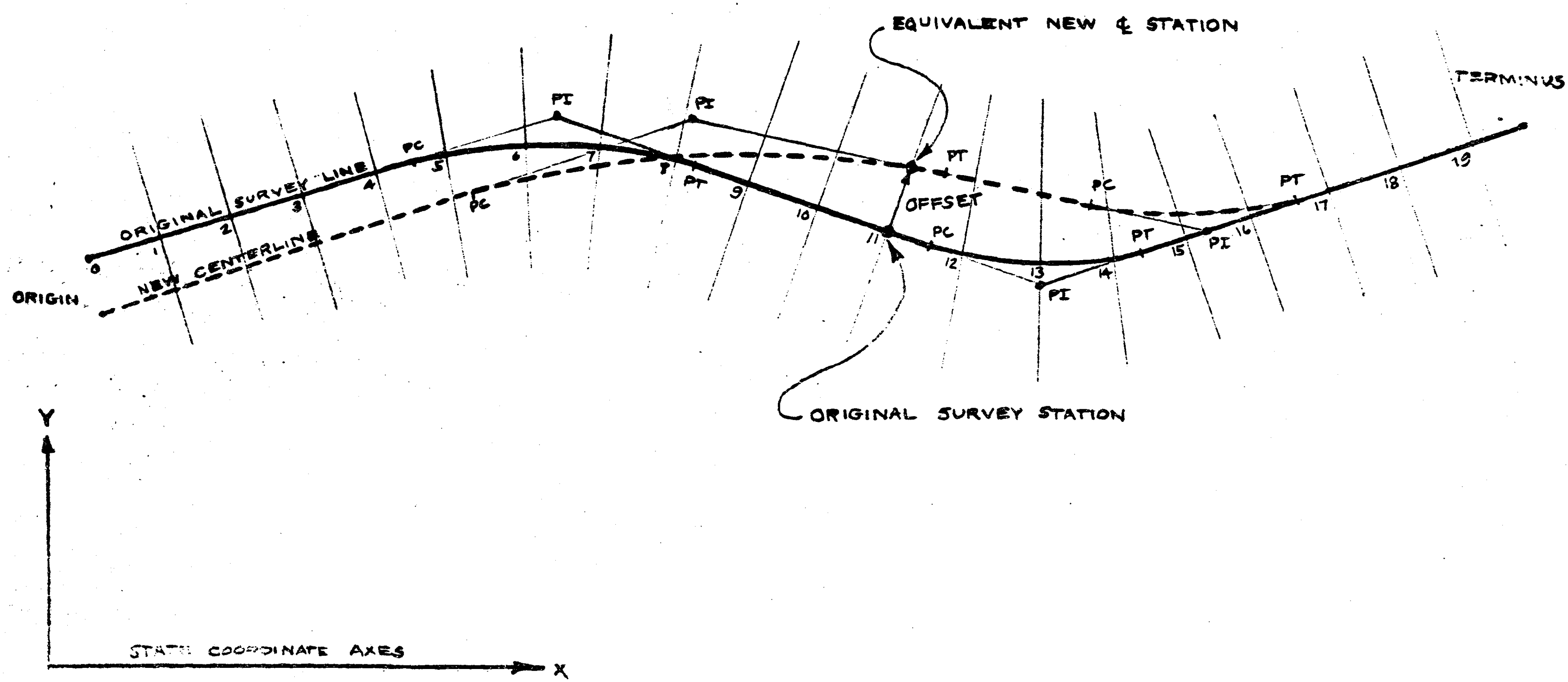

EQUIVALENT NEW ℄ STATION
TERMINUS
ORIGIN
ORIGINAL SURVEY LINE
NEW CENTERLINE
OFFSET
ORIGINAL SURVEY STATION
PC
PT
PI
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
Y
X
STATE COORDINATE AXES

FIGURE 1

4

Program Operation - Part One

The geometry computation is performed as follows:

1. The point identification, state plane coordinates of the P.I., and either the radius, the degree of curvature, the tangent length, or the external distance is given for each P.I. on the baseline.

2. The cards containing this information are read in and stored in memory. The geometry computations are performed and punched out P.I. by P.I.

3. The program then cycles back to the beginning and reads the same information for each P.I. on the centerline.

4. As the output for each P.I. is computed and output, a geometry table is built up in memory. The P.C., P.T., and P.I. stations, the azimuth of each line, and the deflection angle at each turning point are output for use by the engineer.

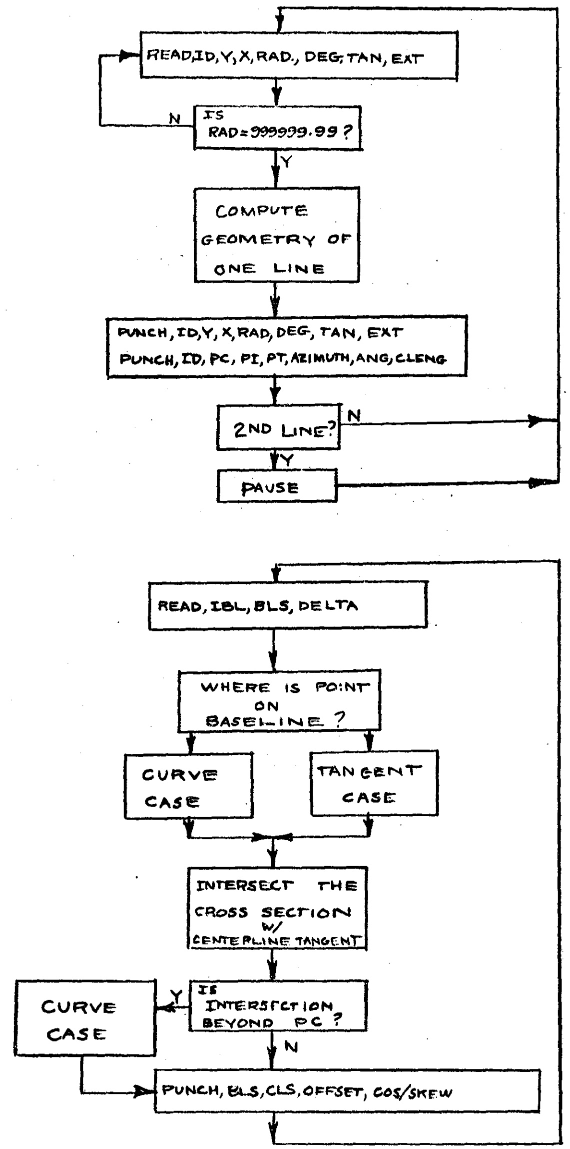
Program Operation - Part Two

The second program operates with the geometry table left in memory by program one and with a starting baseline station number and increment of advance.

1. The baseline station number is used to compute the coordinates of that point on the baseline and the azimuth of the cross section located at that point.

2. The line originating at the point where the cross section crosses the baseline and with an azimuth normal to the baseline is intersected with the centerline. The station of intersection offset and skew are determined. This information is output for each increment as designated on the input.

RELOCATION OFFSETS
MACRO BLOCK DIAGRAM



PART 1
GEOMETRY

PART 2
OFFSETS

Features

1. The station number of the origin is placed in the radius field on the input card.

2. Only one of the curve parameters need be specified. The others are entered as zero. If more than one is entered, the first is used

3. The termini of both baseline and centerline alignments are indicated by placing 999999.99 in the radius field of the input card.

4. Several baselines and/or centerlines can be handled continuously. Intermediate termini of each line are indicated by 888888.88 in the radius field.

5. After an intermediate terminus, the radius field of the following card is expected to contain the origin station number of the new line. If this number is zero, the terminus station of the previous line is assigned.

6. The starting station and the increment of advance of the stations on the baseline are specified on the first input card to part two. The stationing is automatically increased by the amount of the increment until the stationing exceeds the value on the next card, or until the baseline numbers fail to match. When this happens, the values on the second card replace those in memory.

Restrictions

1. A total of 30 P.I. points can be handled. P.I. points include origins and termini as well as P.I.'s on both the centerline and baseline.

2. All values on the input cards must be entered as either a number or as zero. They may not be left blank.

3. Accuracy is determined by the number of significant digits in the input. Eight significant digits are accepted by the program.

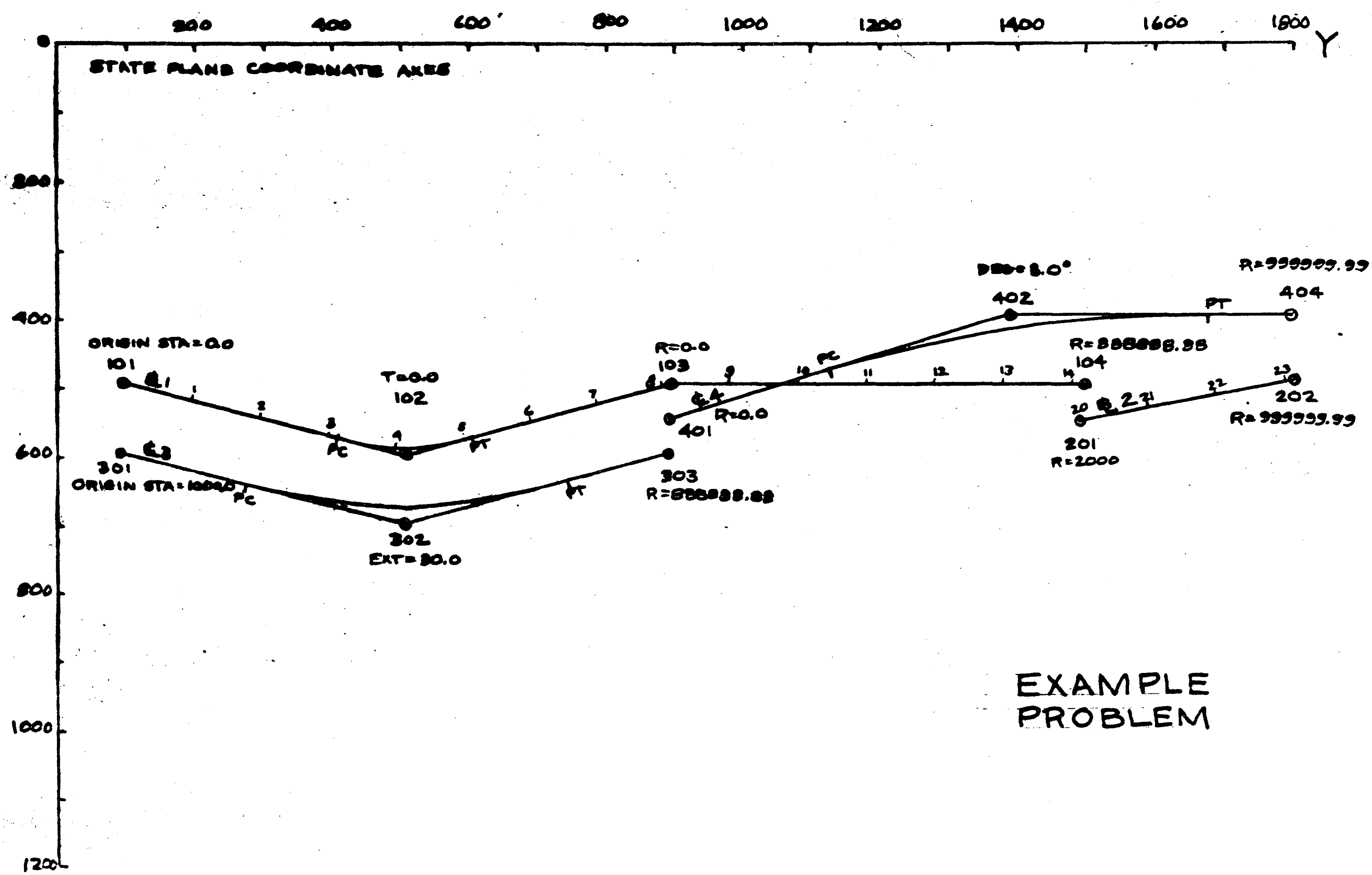
4. Each P.I. must be numbered with a four digit ID number. The units and tens position should contain the point number (which is not used by the program). The hundreds and thousands digits must contain the baseline or centerline number. These numbers must match those on the part two input cards.

5. Situations in which the baseline and centerline are going in opposite directions should be avoided. The program will not establish an intersection when the azimuths of the two lines involved are more than 90 degrees apart.

Operating Instructions

1. PARITY switch on STOP.
2. I/O switch on STOP.
3. O Flow switch on PROGRAM.
4. Program Switches
   Switch 1 on for typed output
   Margins - 14 and 95
   Tabs- 22, 34, 46, 58, 70, 82
5. Press - RESET.
6. Ready read hopper with Part One Program followed by geometry input cards.
7. Press - LOAD.
8. Ready punch hopper with blanks.
9. Press - PUNCH START.
10. When program has read all cards and punched output, it will stop with a 48 in the operation register.
11. Press - RESET.
12. Ready read hopper with Part Two Program followed by the Baseline Station input cards.
13. Press - LOAD.
14. Program will stop on a 37 read instruction in the operation register after punching output.

EXAMPLE PROBLEM


STATE PLANE COORDINATE AXES
Y
X
200
400
600'
800
1000
1200
1400
1600
1800
200
400
600
800
1000
1200
ORIGIN STA=0.0
101
T=0.0
102
R=0.0
103
R=888888.88
104
PC
PT
301
ORIGIN STA=100
302
EXT=30.0
303
R=888888.88
401
R=0.0
402
= 8.0°
404
R=999999.99
201
R=2000
202
R=999999.99
EXAMPLE
PROBLEM

RELOCATION OFFSETS

INPUT FORM 1

ENGINEER PO2
DATE 14 Oct 61
PROJECT EXAMPLE

GEOMETRY INPUT

POINT NUMBER	X	Y	ORIGIN STA, RADIUS OR TERMINUS	DEGREE OF CURVATURE	TANGENT DISTANCE	EXTERNAL DISTANCE
101	500.0	100.0	0.0	0.0	0.0	0.0
102	600.0	500.0	0.0	0.0	100.0	0.0
103	500.0	900.0	0.0	0.0	0.0	0.0
104	500.0	1500.0	888888.88	0.0	0.0	0.0
201	550.0	1500.0	2000.0	0.0	0.0	0.0
202	500.0	1800.0	999999.99	0.0	0.0	0.0
301	600.0	100.0	1000.0	0.0	0.0	0.0
302	700.0	500.0	0.0	0.0	0.0	30.0
303	600.0	900.0	888888.88	0.0	0.0	0.0
401	550.0	900.0	0.0	0.0	0.0	0.0
402	400.0	1400.0	0.0	3.0	0.0	0.0
403	400.0	1800.0	999999.99	0.0	0.0	0.0

NOTE:
1. All points must have point numbers with appropriate ℄ or ℄ numbers.
2. A value of 999999.99 in the radius column terminates the line.
3. A value of 888888.88 in the radius column sets up an intermediate terminus.

ENGINEER POR
DATE 14 OCT 61
PROJECT EXAMPLE

RELOCATION OFFSETS

INPUT FORM 2

BASELINE INPUT

BASELINE NUMBER	BASELINE STATION		INCREMENT OF ADVANCE	
1	0	0	100	0
1	1400	0	100	0
2	2000	0	10	0
2	2110	0	9000	0

NOTE: If all stations are odd set Increment of Advance arbitrarily large.

RELOCATION OFFSETS OUTPUT DATA

GEOMETRY OUTPUT

POINT	X/PC	Y/PI	R/PT	D/AZ	T/ANG	E/CLENG
101	500.00000	100.00000	.00000000	.00000000	.00000000	.00000000
101	.00000000	.00000000	.00000000	14.036246	.00000000	.00000000
102	600.00000	500.00000	399.99993	14.323947	99.999994	12.310558
102	312.31042	412.31041	508.29335	345.96376	-28.072491	195.98293
103	500.00000	900.00000	.00000000	.00000000	.00000000	.00000000
103	820.60377	820.60377	820.60377	.00000000	14.036246	.00000000
104	500.00000	1500.0000	888888.88			
104	1420.6036	1420.6036	1420.6036			
201	550.00000	1500.0000	2000.0000	.00000000	.00000000	.00000000
201	2000.0000	2000.0000	2000.0000	350.53768	.00000000	.00000000
202	500.00000	1800.0000	999999.99			
202	2304.1379	2304.1379	2304.1379			
301	600.00000	100.00000	1000.0000	.00000000	.00000000	.00000000
301	1000.0000	1000.0000	1000.0000	14.036246	.00000000	.00000000
302	700.00000	500.00000	974.77287	5.8778595	243.69325	30.000000
302	1168.6172	1412.3104	1646.2143	345.96376	-28.072491	477.59718
303	600.00000	900.00000	888888.88			
303	1814.8315	1814.8315	1814.8315			
401	550.00000	900.00000	1814.8315	.00000000	.00000000	.00000000
401	1814.8315	1814.8315	1814.8315	343.30076	.00000000	.00000000
402	400.00000	1400.0000	1909.8593	3.0000000	280.30781	20.460514
402	2056.5387	2336.8465	2613.1801	.00000000	16.699245	556.64148
403	400.00000	1800.0000	999999.99			
403	2732.8722	2732.8722	2732.8722			

OFFSETS OUTPUT

BL	BL STA	CL STA	OFF	COS ANG
1	100.00000	1075.7464	97.014230	1.0000000
1	200.00000	1175.7490	96.988070	.99997324
1	300.00000	1275.9644	91.109430	.99394231
1	400.00000	1394.9944	82.391260	.99991534
1	500.00000	1516.2619	88.469440	.99366932
1	600.00000	1618.4773	96.619620	.99959515
1	700.00000	1718.4814	97.014238	1.0000000
1	800.00000	1848.5383	48.193600	.99982753
1	900.00000	1897.7233	26.182357	.95782552
1	1000.0000	2002.1264	-3.8179427	.95782552
1	1100.0000	2106.3430	-33.139600	.96499239
1	1200.0000	2209.2707	-57.446400	.97771940
1	1300.0000	2311.0171	-76.144900	.98751011
1	1400.0000	2411.9016	-89.402200	.99445141
2	2010.0000	2419.3218	-140.43650	.99797536
2	2020.0000	2429.3468	-139.77230	.99762776
2	2030.0000	2439.3705	-139.05580	.99725273
2	2040.0000	2449.3992	-138.28730	.99685002
2	2050.0000	2459.4393	-137.46500	.99641932
2	2060.0000	2469.4779	-136.59000	.99596115
2	2070.0000	2479.5207	-135.66200	.99547526
2	2080.0000	2489.5717	-134.68100	.99496141
2	2090.0000	2499.6241	-133.64680	.99441993
2	2100.0000	2509.6747	-132.55890	.99385099
2	2110.0000	2519.7393	-131.41890	.99325370

SOURCE LANGUAGE LISTING

```
C      RELOCATION OFFSETS / PART 1
C      P. O. ROBERTS / JULY,1961
C      MIT CIVIL ENGINEERING SYSTEMS LABORATORY
C      SW 1 ON FOR TYPED OUTPUT / MAR 14,95 / TABS 22,34,46,58,70,82
       DIMENSION ID (31),Y(30),X(30),R(30),PC(30),PI(30),PT(30),OFFD(3)
       DIMENSION D(30),T(30),E(30)
C      INITIALIZE
 100   I=0
C      READ ROUTINE
       DO 262 N=1,2
       ID(31)=J
       DO 120 J=1,30
       I=I+1
       READ,ID(I),X(I),Y(I),R(I),D(I),T(I),E(I)
       IF(R(I)-999999.98)120,140,140
 120   CONTINUE
 140   I=I-J+1
 200   ISW1=1
       ISW3=1
       RI=R(I)
       PI(I)=RI
       PC(I)=RI
       PT(I)=RI
       C=0.0
       T(I)=0.
 201   ISW4=1
       GO TO 10
 206   IF(ISW1-2)248,210,210
 248   ISW1=2
```



```
       ANGIO=0.0
       ALENG=0.0
       GO TO 232
 210   ANGI= AZ-AZO
 212   IF(ANGI-3.1415927) 211,211,214
 211   ANGI=ANGI+6.2831854
       GO TO 212
 214   ANGI=ANGI-6.2831854
       IF(ANGI)208,209,209
 208   DS=-1.0000000
       GO TO 205
 209   DS=1.0000000
 205   ANG=ANGI/2.
C      FIND WHICH IS GIVEN
       IF(R(I))221,216,221
 216   IF(D(I))221,217,219
 217   IF(T(I))221,218,220
 218   IF(E(I))221,222,223
C      IF D IS GIVEN
 219   R(I)=5729.5780/D(I)
       GO TO 221
C      IF T IS GIVEN
 220   R(I)=T(I)*COS(ANG)/SIN(ANG)*DS
       GO TO 221
C      IF E IS GIVEN
 223   R(I)=E(I)/(1./COS(ANG)-1.)
       GO TO 221
C      IF NONE ARE GIVEN
```

```
222  D(I)=0.0
     GO TO 215
221  D(I)=5729.5780/R(I)
215  T(I)=R(I)*(SIN(ANG)/COS(ANG))*DS
     PC(I)=PI(I)-T(I)
     ALENG=ANGI*R(I)*DS
     PT(I)=PC(I)+ALENG
     E(I)=(1./COS(ANG)-1.)*R(I)
     ANGIO=ANGI*57.295780
232  AZOUT= AZ*57.295780
     IF(SENSE SWITCH 1)233,234
233  PRINT,ID(I),X(I),Y(I),R(I),D(I),T(I),E(I)
     PRINT,ID(I),PC(I),PI(I),PT(I),AZOUT,ANGIO,ALENG
     GO TO 235
234  PUNCH,ID(I),X(I),Y(I),R(I),D(I),T(I),E(I)
     PUNCH,ID(I),PC(I),PI(I),PT(I),AZOUT,ANGIO,ALENG
235  PI(I+1)=PT(I)-T(I)+C
     AZO=AZ
     I=I+1
240  IF(R(I)-888888.87)242,244,244
242  CONTINUE
     GO TO 201
244  PC(I)=PI(I)
     PT(I)=PI(I)
     IF(SENSE SWITCH 1)245,246
245  PRINT,ID(I),X(I),Y(I),R(I)
     PRINT,ID(I),PC(I),PI(I),PT(I)
     GO TO 260
```



```
246  PUNCH,ID(I),X(I),Y(I),R(I)
     PUNCH,ID(I),PC(I),PI(I),PT(I)
260  IF(R(I)-999999.98)250,262,262
262  CONTINUE
     PAUSE
     GO TO 100
250  I=I+1
     IF(R(I))200,252,200
252  R(I)=PI(I-1)
     GO TO 200
C    AZIMUTH DISTANCE SUBROUTINE
10   A=X(I+1)-X(I)
     B=Y(I+1)-Y(I)
     PIE=3.1415927
11   C=SQR(A**2+B**2)
     IF(A)15,12,15
12   IF(B)13,14,14
13   AZ=PIE
     GO TO 18
14   AZ=0.0
     GO TO 18
15   ANG=ATN(B/A)
16   IF(A)19,12,17
17   AZ=(PIE/2.0)-ANG
     GO TO 18
19   AZ=(1.5*PIE)-ANG
18   GO TO (206,100),ISW4
     END
```

```
C     RELOCATION OFFSETS / PART 2
C     P. O. ROBERTS / JULY,1961
C     MIT CIVIL ENGINEERING SYSTEMS LABORATORY
      DIMENSION ID (31),Y(30),X(30),R(30),PC(30),PI(30),PT(30),OFFD(3)
C     READ TERRAIN
      K=ID(31)+1
      J=1
      STA=-888888.88
      READ,IBLB,BLSB,DELTB
      IBL=IBLB
  408 STA=BLSB
      READ,IBLA,BLSA,DELTA
      IF(J-1)409,509,409
  442 BLSB=BLSB+DELTB
      STA=BLSB
      IBL=IBLB
  409 IF(IBLA-IBLB)420,410,420
  410 IF(STA-BLSA)500,500,420
  420 BLSB=BLSA
      IBLB=IBLA
      DELTB=DELTA
      GO TO 408
C     COMPUTE COORDINATES ON BASELINE
  509 BLSB=BLSB-DELTB
  510 J=J+1
      I=J
C     GEOMETRY SUBROUTINE
      ISW1=1
      I=I-1
```



```
  202 ISW2=1
      ISW3=1
      ISW4=1
C     GO TO AZ DIS 1
C     AZIMUTH DISTANCE SUBROUTINE
   10 A=X(I+1)-X(I)
      B=Y(I+1)-Y(I)
   11 C=SQR(A**2+B**2)
      AZ=0.0
      IF(C-.00001)18,18,12
   12 ANG=1.0
      IF(B)3,4,4
    3 ANG=-1.0
    4 B=ABSF(A/C)
      P=SQR(ABSF(1.0-B)/2.)
      AZ=SINF(P)
      DO 14 L=1,50
      ANGI=P-SINF(AZ)
      IF(ANGI-.1E-05)15,15,14
   14 AZ=AZ+ANGI
   15 AZ=(ANG*AZ)*2.
      IF(A)17,16,16
   16 AZ=1.5707964-AZ
      GO TO 18
   17 AZ=4.7123890+AZ
   18 GO TO(206,605,660,685),ISW2
  206 IF(ISW1-2)207,210,201
  207 AZB=AZ
```

```
      I=I+1
      ISW1=2
  500 I=J
      PCI=PC(I)
      AZO=AZB
C     CHECK FOR MATCHING BASELINES
      IF(IBL*2-(ID(I-1)/100+ID(I)/100))510,515,510
  515 IF(STA-PT(I-1))442,520,520
  520 IF(R(I)-888888.88)525,530,530
  525 IF(STA-PCI)530,530,545
  210 ANGI= AZ-AZO
C     ADJUST ANGLES TO LESS THAN 180 DEGREES
  212 IF(ANGI-3.1415927) 211,211,214
  211 ANGI=ANGI+6.2831854
      GO TO 212
  214 ANGI=ANGI-6.2831854
      IF(ISW4-1)204,204,690
C     COMPUTE SIGN OF DEFLECTION ANGLE
  204 DS=1.0
      IF(ANGI)208,205,205
  208 DS=-1.0
  205 ANG=ANGI/2.
C     COMPUTE CURVE TANGENT
      RI=R(I)
      TANG=RI*(SIN(ANG)/COS(ANG))*DS
      AZ=AZO+3.1415927
C     FIND COORDINATES OF PC
      DIS=TANG
```



```
      ISW5=1
      XI=X(I)
      YI=Y(I)
C     GO TO COORD 1
C     COMPUTE COORDINATES SUBROUTINE
   20 XI=XI+DIS*SIN(AZ)
      YI=YI+DIS*COS(AZ)
      GO TO (216,217,540,680),ISW5
  216 PCX=XI
      PCY=YI
C     FIND COORDINATES OF CIRCLE CENTER
      AZ=AZO+DS*1.5707964
      DIS=RI
      ISW5=2
      GO TO 20
C     GO TO COORD 2
  217 XO=XI
      YO=YI
      PCAZ=AZ
      IF(ISW3-2) 550,655,690
C     TANGENT CASE
  530 DIS=PI(I)-STA
      AZMIT=AZO+1.5707964
      ISW5=3
      AZ=AZO+3.1415927
      XI=X(I)
      YI=Y(I)
      GO TO 20
```

```
C     GO TO COORD 3
 545  IF(STA-PT(I))202,510,510
C     CURVE CASE
 550  ANG=(STA-PCI)/RI
      XI=XO
      YI=YO
      DIS=DS*(-RI)
      AZMIT=AZO+1.5707964+DS*ANG
      AZ=AZMIT
      ISW5=3
      GO TO 20
C     STORE BASELINE COORDINATES
 540  CORDX=XI
      CORDY=YI
C     COMPUTE INTERSECTION ON CENTERLINE
 600  I=K
 601  ISW2=2
      GO TO 10
C     GO TO AZ DIS 2
 605  I=I+1
      AZ1=AZMIT
      AZ2=AZ+3.1415927
      A=X(I)-CORDX
      B=Y(I)-CORDY
      C=SIN(AZ1-AZ2)
      IF(C+.00001)632,638,638
 638  OFF=888888.88
      DIS=-888888.88
```



```
      GO TO 610
C     COMPUTE OFFSET FROM BL TO CL AND DISTANCE FROM PI
 632  DO 636 L=1,2
      DIS=OFF
      OFF=(A*COS(AZ1)-B*SIN(AZ1))/C
 636  AZ1=AZ2
 610  ANG=AZ
      CLS=PI(I)-DIS
C     IS INTERSECTION BEYOND THE PC
      IF(CLS-PC(I))625,625,640
C     IS ALIGNMENT FINISHED
 640  IF(R(I)-888888.88)642,642,442
 641  I=I+1
 642  IF(ID(I)/100-ID(I+1)/100)641,645,641
 645  AZO=AZ
      K=I-1
      GO TO 601
C     IS ALIGNMENT BEYOND THE PREVIOUS PT
 625  IF(CLS-PT(I-1))628,626,626
 626  IF(I-K-1)698,698,697
 697  K=K+1
      GO TO 698
 628  IF(I-K-1)650,442,650
C     INTERSECTION ON CURVE
 650  I=I-1
      ISW3=2
      ISW4=1
      GO TO 210
```

```
C     GO TO LAST PART OF GEOM 2
 655  A=XO-CORDX
      B=YO-CORDY
      ISW2=3
      GO TO 11
C     GO TO LAST PART OF AZ DIS 3
C     COMPUTE CURVE OFFSET
 660  ANG=AZ-AZMIT
      A=C*COS(ANG)
      B=C*SIN(ANG)
      OFF=A-DS*SQR(RI**2-B**2)
C     GET COORDINATES OF INTERSECTION POINT
      XI=CORDX
      YI=CORDY
      AZ=AZMIT
      DIS=OFF
      ISW5=4
      GO TO 20
C     GO TO COORD 4
C     GET AZIMUTH OF RADIUS
 680  A=XO-XI
      B=YO-YI
      ISW2=4
      GO TO 11
C     GO TO AZ DIS 4
C     COMPUTE ANGLE SUBTENDED
 685  ANGI=AZ-PCAZ
      ISW4=3
```



```
      GO TO 212
C     GO TO GEOM 3
C     COMPUTE CLS AND LOCAL AZIMUTH FOR CURVE INTERSECTION
 690  CLS=PC(I)+ANGI*RI*DS
      ANG=AZO+ANGI
 698  ANG =SIN(AZMIT-ANG)
      IF(SENSE SWITCH 1)699,700
 699  PRINT,IBL,STA,CLS,OFF,ANG
      GO TO 442
 700  PUNCH,IBL,STA,CLS,OFF,ANG
      GO TO 442
      END
```

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C      RELOCATION OFFSETS / PART 1
C      P. O. ROBERTS / JULY,1961
C      MIT CIVIL ENGINEERING SYSTEMS LABORATORY
C      SW 1 ON FOR TYPED OUTPUT / MAR 14,95 / TABS 22,34 46 58,70,82
       DIMENSION ID (31),Y(30),X(30),R(30),PC(30),PI(30),PT(30),OFFD(3)
       DIMENSION D(30),T(30),E(30)
C      INITIALIZE
  100  I=0
C      READ ROUTINE
       D- 262 N=1,2
       ID(31)=J
       DO 120 J=1,30
       I=I+1
       READ,ID(I),X(I),Y(I),R(I),D(I),T(I),E(I)
       IF(R(I)-999999.98)120,140,140
  120  CONTINUE
  140  I=I-J+1
  200  ISW1=1
       ISW3=1
       RI=R(I)
       PI(I)=RI
       PC(I)=RI
       PT(I)=RI
       C=0.0
       T(I)=0.
  201  ISW4=1
       GO TO 10
  206  IF(ISW1-2)248,210,210
  248  ISW1=2
       ANGIO=0.0
       ALENG=0.0
       GO TO 232
  210  ANGI= AZ-AZO
  212  IF(ANGI-3.1415927) 211,211,214
  211  ANGI=ANGI+6.2831854
       GO TO 212
  214  ANGI=ANGI-6.2831854
       IF(ANGI)208,209,209
  208  DS=-1.0000000
       GO TO 205
  209  DS=1.0000000
  205  ANG=ANGI/2.
C      FIND WHICH IS GIVEN
       IF(R(I))221,216,221
  216  IF(D(I))221,217,219
  217  IF(T(I))221,218,220
  218  IF(E(I))221,222,223
C      IF D IS GIVEN
  219  R(I)=5729.5780/D(I)
       GO TO 221
C      IF T IS GIVEN
  220  R(I)=T(I)*COS(ANG)/SIN(ANG)*DS
       GO TO 221
C      IF E IS GIVEN
  223  R(I)=E(I)/(1./COS(ANG)-1.)
       GO TO 221
C      IF NONE ARE GIVEN
  222  D(I)=0.0
       GO TO 215
  221  D(I)=5729.5780/R(I)
  215  T(I)=R(I)*(SIN(ANG)/COS(ANG))*DS
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      PC(I)=PI(I)-T(I)
      ALENG=ANGI*R(I)*DS
      PT(I)=PC(I)+ALENG
      E(I)=(1./COS(ANG)-1.)*R(I)
      ANGIO=ANGI*57.295780
  232 AZOUT= AZ*57.295780
      IF(SENSE SWITCH 1)233,234
  233 PRINT,ID(I),X(I),Y(I),R(I),D(I),T(I),E(I)
      PRINT,ID(I),PC(I),PI(I),PT(I),AZOUT,ANGIO,ALENG
      GO TO 235
  234 PUNCH,ID(I),X(I),Y(I),R(I),D(I),T(I),E(I)
      PUNCH,ID(I),PC(I),PI(I),PT(I),AZOUT,ANGIO,ALENG
  235 PI(I+1)=PT(I)-T(I)+C
      AZO=AZ
      I=I+1
  240 IF(R(I)-888888.87)242,244,244
  242 CONTINUE
      GO TO 201
  244 PC(I)=PI(I)
      PT(I)=PI(I)
      IF(SENSE SWITCH 1)245,246
  245 PRINT,ID(I),X(I),Y(I),R(I)
      PRINT,ID(I),PC(I),PI(I),PT(I)
      GO TO 260
  246 PUNCH,ID(I),X(I),Y(I),R(I)
      PUNCH,ID(I),PC(I),PI(I),PT(I)
  260 IF(R(I)-999999.98)250,262,262
  262 CONTINUE
      PAUSE
      GO TO 100
  250 I=I+1
      IF(R(I))200,252,200
  252 R(I)=PI(I-1)
      GO TO 200
C     AZIMUTH DISTANCE SUBROUTINE
   10 A=X(I+1)-X(I)
      B=Y(I+1)-Y(I)
      PIE=3.1415927
   11 C=SQR(A**2+B**2)
      IF(A)15,12,15
   12 IF(B)13,14,14
   13 AZ=PIE
      GO TO 18
   14 AZ=0.0
      GO TO 18
   15 ANG=ATN(B/A)
   16 IF(A)19,12,17
   17 AZ=(PIE/2.0)-ANG
      GO TO 18
   19 AZ=(1.5*PIE)-ANG
   18 GO TO (206,100),ISW4
      END
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C     RELOCATION OFFSETS / PART 2
C     P. O. ROBERTS / JULY,1961
C     MIT CIVIL ENGINEERING SYSTEMS LABORATORY
      DIMENSION ID (31),Y(30),X(30),R(30),PC(30),PI(30),PT(30),OFFD(3)
C     READ TERRAIN
      K=ID(31)+1
      J=1
      STA=-888888.88
      READ,IBLB,BLSB,DELTB
      IBL=IBLB
  408 STA=BLSB
      READ,IBLA,BLSA,DELTA
      IF(J-1)409,509,409
  442 BLSB=BLSB+DELT
      STA=BLSB
      IBL=IBLB
  409 IF(IBLA-IBLB)420,410,420
  410 IF(STA-BLSA)500,500,420
  420 BLSB=BLSA
      IBLB=IBLA
      DELTB=DELTA
      GO TO 408
C     COMPUTE COORDINATES ON BASELINE
  509 BLSB=BLSB-DELTB
  510 J=J+1
      I=J
C     GEOMETRY SUBROUTINE
      ISW1=1
      I=I-1
  202 ISW2=1
      ISW3=1
      ISW4=1
C     GO TO AZ DIS 1
C     AZIMUTH DISTANCE SUBROUTINE
   10 A=X(I+1)-X(I)
      B=Y(I+1)-Y(I)
   11 C=SQR(A**2+B**2)
      AZ=0.0
      IF(C-.00001)18,18,12
   12 ANG=1.0
      IF(B)3,4,4
    3 ANG=-1.0
    4 B=ABSF(A/C)
      P=SQR(ABSF(1.0-B)/2.)
      AZ=SINF(P)
      DO 14 L=1,50
      ANGI=P-SINF(AZ)
      IF(ANGI-.1E-05)15,15,14
   14 AZ=AZ+ANGI
   15 AZ=(ANG*AZ)*2.
      IF(A)17,16,16
   16 AZ=1.5707964-AZ
      GO TO 18
   17 AZ=4.7123890+AZ
   18 GO TO(206,605,660,685),ISW2
  206 IF(ISW1-2)207,210,201
  207 AZB=AZ
      I=I+1
      ISW1=2
  500 I=J
      PCI=PC(I)
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      AZO=AZB
C     CHECK FOR MATCHING BASELINES
      IF(IBL*2-(ID(I-1)/100+ID(I)/100))510,515,510
  515 IF(STA-PT(I-1))442,520,520
  520 IF(R(I)-888888.88)525,530,530
  525 IF(STA-PCI)530,530,545
  210 ANGI= AZ-AZO
C     ADJUST ANGLES TO LESS THAN 180 DEGREES
  212 IF(ANGI-3.1415927) 211,211,214
  211 ANGI=ANGI+6.2831854
      GO TO 212
  214 ANGI=ANGI-6.2831854
      IF(ISW4-1)204,204,690
C     COMPUTE SIGN OF DEFLECTION ANGLE
  204 DS=1.0
      IF(ANGI)208,205,205
  208 DS=-1.0
  205 ANG=ANGI/2.
C     COMPUTE CURVE TANGENT
      RI=R(I)
      TANG=RI*(SIN(ANG)/COS(ANG))*DS
      AZ=AZO+3.1415927
C     FIND COORDINATES OF PC
      DIS=TANG
      ISW5=1
      XI=X(I)
      YI=Y(I)
C     GO TO COORD 1
C     COMPUTE COORDINATES SUBROUTINE
   20 XI=XI+DIS*SIN(AZ)
      YI=YI+DIS*COS(AZ)
      GO TO (216,217,540,680),ISW5
  216 PCX=XI
      PCY=YI
C     FIND COORDINATES OF CIRCLE CENTER
      AZ=AZO+DS*1.5707964
      DIS=RI
      ISW5=2
      GO TO 20
C     GO TO COORD 2
  217 XO=XI
      YO=YI
      PCAZ=AZ
      IF(ISW3-2) 550,655,690
C     TANGENT CASE
  530 DIS=PI(I)-STA
      AZMIT=AZO+1.5707964
      ISW5=3
      AZ=AZO+3.1415927
      XI=X(I)
      YI=Y(I)
      GO TO 20
C     GO TO COORD 3
  545 IF(STA-PT(I))202,510,510
C     CURVE CASE
  550 ANG=(STA-PCI)/RI
      XI=XO
      YI=YO
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      DIS=DS*(-RI)
      AZMIT=AZO+1.5707964+DS*ANG
      AZ=AZMIT
      ISW5=3
      GO TO 20
C     STORE BASELINE COORDINATES
  540 CORDX=XI
      CORDY=YI
C     COMPUTE INTERSECTION ON CENTERLINE
  600 I=K
  601 ISW2=2
      GO TO 10
C     GO TO AZ DIS 2
  605 I=I+1
      AZ1=AZMIT
      AZ2=AZ+3.1415927
      A=X(I)-CORDX
      B=Y(I)-CORDY
      C=SIN(AZ1-AZ2)
      IF(C+.00001)632,638,638
  638 OFF=888888.88
      DIS=-888888.88
      GO TO 610
C     COMPUTE OFFSET FROM BL TO CL AND DISTANCE FROM PI
  632 DO 636 L=1,2
      DIS=OFF
      OFF=(A*COS(AZ1)-B*SIN(AZ1))/C
  636 AZ1=AZ2
  610 ANG=AZ
      CLS=PI(I)-DIS
C     IS INTERSECTION BEYOND THE PC
      IF(CLS-PC(I))625,625,640
C     IS ALIGNMENT FINISHED
  640 IF(R(I)-888888.88)642,642,442
  641 I=I+1
  642 IF(ID(I)/100-ID(I+1)/100)641,645,641
  645 AZO=AZ
      K=I-1
      GO TO 601
C     IS ALIGNMENT BEYOND THE PREVIOUS PT
  625 IF(CLS-PT(I-1))628,626,626
  626 IF(I-K-1)698,698,697
  697 K=K+1
      GO TO 698
  628 IF(I-K-1)650,442,650
C     INTERSECTION ON CURVE
  650 I=I-1
      ISW3=2
      ISW4=1
      GO TO 210
C     GO TO LAST PART OF GEOM 2
  655 A=XO-CORDX
      B=YO-CORDY
      ISW2=3
      GO TO 11
C     GO TO LAST PART OF AZ DIS 3
C     COMPUTE CURVE OFFSET
  660 ANG=AZ-AZMIT
```

```
      A=C*COS(ANG)
      B=C*SIN(ANG)
      OFF=A-DS*SQR(RI**2-B**2)
C     GET COORDINATES OF INTERSECTION POINT
      XI=CORDX
      YI=CORDY
      AZ=AZMIT
      DIS=OFF
      ISW5=4
      GO TO 20
C     GO TO COORD 4
C     GET AZIMUTH OF RADIUS
  680 A=XO-XI
      B=YO-YI
      ISW2=4
      GO TO 11
C     GO TO AZ DIS 4
C     COMPUTE ANGLE SUBTENDED
  685 ANGI=AZ-PCAZ
      ISW4=3
      GO TO 212
C     GO TO GEOM 3
C     COMPUTE CLS AND LOCAL AZIMUTH FOR CURVE INTERSECTION
  690 CLS=PC(I)+ANGI*RI*DS
      ANG=AZO+ANGI
  698 ANG =SIN(AZMIT-ANG)
      IF(SENSE SWITCH 1)699,700
  699 PRINT,IBL,STA,CLS,OFF,ANG
      GO TO 442
  700 PUNCH,IBL,STA,CLS,OFF,ANG
      GO TO 442
      END
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COMPUTER TECHNOLOGY