

12211C

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PROGRAM DESCRIPTION I

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Program Title ROAD GRADE COMPUTER *On Cards*

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LINES= 207 BYTES= 434 SIZE= 09

Program Description, Equations, Variables PROGRAM COMPUTES STATIONS AND ELEVATIONS FOR
SYMMETRICAL AND UNSYMMETRICAL VERTICAL CURVES AND ALSO FOR STRAIGHT GRADES. FOR
VERTICAL CURVES--PROGRAM WILL COMPUTE TURNING POINT STATION AND ELEVATION. WILL
SOLVE FOR STATION ELEVATION OR IF A STATION INTERVAL DISTANCE IS INPUTED, PROGRAM
WILL AUTOMATICALLY OUTPUT SUCCESSIVE STATIONS AND ELEVATIONS UNTIL END OR
PVT. STATION IS OUTPUTED. DATA IS OUTPUTED IN STANDARD FORM: STA=12+56.67
NOT 1256.67!

Necessary Accessories HP-41 WITH ONE MEMORY UNIT. CARD READER AND PRINTER ARE OPTIONAL!

Operating Limits and Warnings FOR STRAIGHT GRADE SOLUTION--BEGINNING STATION MUST BE SMALLER
THAN ENDING STATION! AUTOMATIC OUTPUT OPTION ASSUMES THAT PVT. STATION IS
LARGER THAN LAST STATION INPUTED AND WILL NOT OUTPUT PAST END OR PVT STATION!!

Reference(s) HP-67/97 SURVEY PAC PROGRAM--VERTICAL CURVE AND GRADES.
ROUTE LOCATION AND DESIGN, 5th ed. by THOMAS F. HICKERSON

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LIST OF TERMS USED

L= Total horizontal distance, in feet, from PVC STATION to PVT STATION.

PVC STATION= Beginning point of vertical curve.

PVT STATION= Ending point of vertical curve.

PVI STATION= Intersection point of tangents.

BEG STA= Beginning point station for straight grade.

END STA= End point station for straight grade.

G, +/-%= GRADE, in per cent(%), for straight grade.

G1, +/-%= BEGINNING GRADE, in per cent(%), from PVC STATION to PVI STATION for vertical curve solution.

G2, +/-%= ENDING GRADE, in per cent(%), from PVI STATION to PVT STATION for vertical curve solution.

ELEV or EL= ELEVATION on curve or on tangent for given station.

PVC ELEV= Elevation of PVC STATION on curve.

PVI ELEV= Elevation of PVI STATION on tangent.

PVT ELEV= Elevation of PVT STATION on curve.

BEG ELEV= Beginning point station elevation on tangent.

END ELEV= Ending point station elevation on tangent.

EL= (STRAIGHT GRADE SOLUTION) Elevation of given station on tangent.

EL= (SYMMETRICAL VERTICAL CURVE SOLUTION) Elevation of given station on vertical curve.

TRN PT. IS= STATION at which the highest or lowest point on a vertical curve is found.

TRN PT.=NONE= NO TURNING POINT IS POSSIBLE!

INTERVAL DISTANCE= Distance between stations for automatically output of stations and related elevations.

UNSYMMETRICAL VERTICAL CURVE SOLUTION

EXAMPLE: We will take this unsymmetrical curve and make it into two symmetrical curves.

FIND ALL DATA:

GIVEN: $G_1 = +5\%$ $G_2 = -5\%$
 $l_1 = 400$ ft. $l_2 = 600$ ft.

PVI STATION = 20+00.00
 PVI ELEVATION = 100.00 ft.

Determine elevation at PVC Station = $400' \times +0.05 = 20$ ft.
 ELEV. = PVI ELEV - 20 ft. = 100 ft. - 20 ft. = 80 ft.

Determine elevation at PVT Station = $600' \times -0.05 = 30$ ft.
 ELEV. = PVI ELEV - 30 ft. = 100 ft. - 30 ft. = 70 ft.

Determine station at PVC Station = PVI STAT. - $l_1 = 20+00 - 4+00 = 16+00.00$

Determine station at PVT Station = PVI STAT. + $l_2 = 20+00 + 6+00 = 26+00.00$

Determine grade between PVC STATION AND PVT STATION.

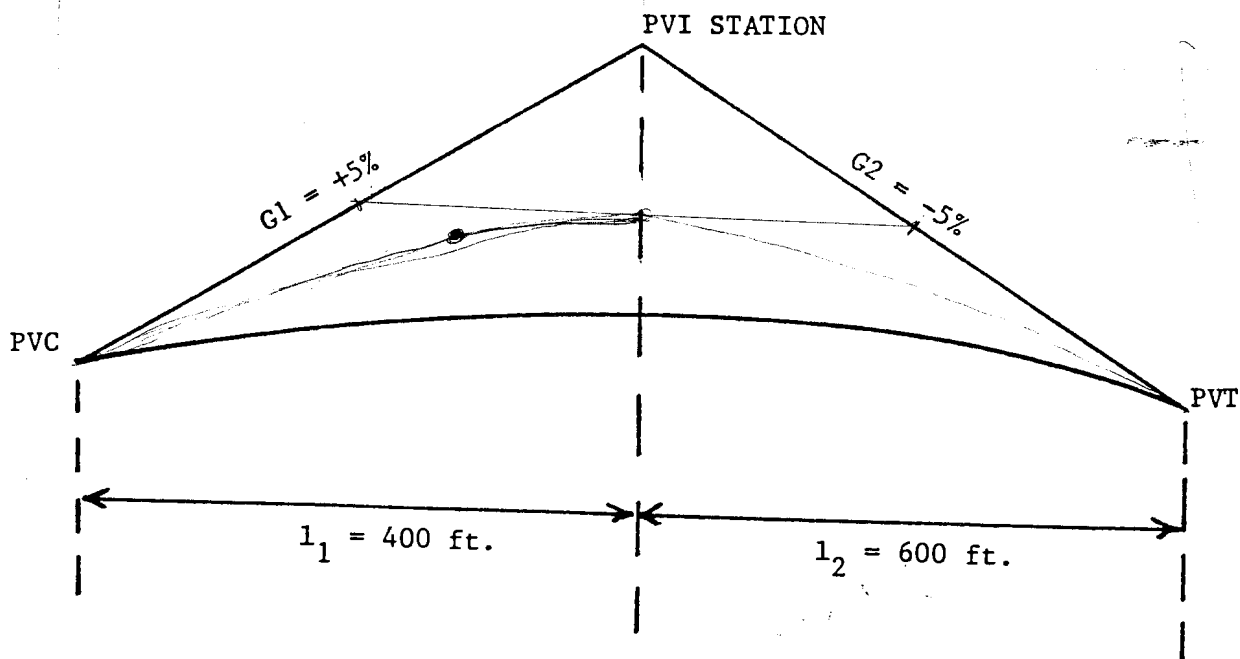
$$\frac{80' - 70'}{400 + 600} = -1\% \text{ (NEGATIVE BECAUSE PVT ELEV. IS LOWER THAN PVC ELEV. -- } 70' \text{ lower than } 80' \text{!!!)}$$

THEREFORE: CURVE 1 *****

$G_1 = +5\%$ $G_2 = -1\%$ $L = 400$ ft.
 PVC STATION = 16+00 at Elev. = 80.00 ft.
 PVT STATION = 20+00 at Elev. = 88.00 ft.

CURVE 2 *****

$G_1 = -1\%$ $G_2 = -5\%$ $L = 600$ ft.
 PVC STATION = 20+00 at Elev. = 88.00 ft.
 PVT STATION = 26+00 at Elev. = 70.00 ft.



USER INSTRUCTIONS

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P	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	XEQ "GC"			S.G.? V.C.?
2A	FOR STAIGHT GRADE SOLUTION		"A"	BEG STA↑ ELEV
2B	FOR SYMMETRICAL VERTICAL CURVE SOLUTION		"C"	PVC STA↑ ELEV
**	** STRAGHT GRADE SOLUTION *****			
3	Input Beginning Station	STA	ENTER↑	
	Input Beginning Station Elevation	ELEV	R/S	END STA?
4A	Ending Station KNOWN	STA	R/S	G, +/-%
4B	Ending Station UNKNOWN		R/S	G, +/-%
	IF NO ENDING STATION IS INPUTED, AND INTERVAL DISTANCE IS INPUTED--PROGRAM WILL OUTPUT UNTIL R/S IS HIT!!!			
5	Input GRADE, in %	G,+/-%	R/S	BEG STA=
			R/S	EL=
6			R/S	NXT STA? I=
7A	INPUT NEXT STATION	STA	R/S	STA=
			R/S	EL=
			GO TO STEP 6	
7B	INPUT STATION INTERVAL DISTANCE	DIST	CHS	
	NOTE: INTERVAL DISTANCE IS ADDED TO LAST STATION INPUTED!!			

USER INSTRUCTIONS

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STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	NOTE: IF NO END STATION WAS INPUTED, (WITH PRINTER)--WILL OUTPUT, UNTIL R/S IS HIT!! FOR NEXT CURVE--GO TO STEP 1!!		R/S	STA=
			R/S	EL=
			R/S	STA=
			R/S	EL=
			R/S	etc.....
	NOTE: IF END STATION WAS INPUTED		R/S	END STA=
			GO TO STEP 6	EL=
7C	TO GO TO NEXT GRADE OR CURVE SOLUTION		R/S	S.G.? V.C.??
			GO TO STEP 2	
**	** SYMMETRICAL VERTICAL CURVE SOLUTION *			
3A	Input PVC Station	STA	ENTER↑	
	Input PVC Station Elevation	ELEV	GO TO STEP 5	
3B	PVC STATION IS UNKNOWN!		R/S	PVI STA↑ ELEV
4	Input PVI Station	STA	ENTER↑	
	Input PVI Station Elevation	ELEV	GO TO STEP 5	
5			R/S	G2, +/-%
6	Input G2, (ENDING GRADE), in %	G2,+/-%	R/S	G1, +/-%
7	Input G1, (BEGINNING GRADE), in %	G1,+/-%	R/S	L, IN FT.?
8	Input L, IN FEET ONLY!	L	R/S	PVC STA=
			R/S	EL=

USER INSTRUCTIONS

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STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	TURNING POINT--YES!		R/S	*TRN PT. IS*
			R/S	STA=
			R/S	EL=
	GO TO STEP 9			
	TURNING POINT--NO!		R/S	*TRN PT.=NONE*
			GO TO STEP 9	
9			R/S	NXT STA? I=-
10A	INPUT NEXT STATION	STA	R/S	STA=
			R/S	EL=
			GO TO STEP 9	
10B	INPUT STATION INTERVAL DISTANCE	DIST.	CHS	
			R/S	STA=
			R/S	EL=
			R/S	STA=
			R/S	EL=
			R/S	etc.....
			R/S	PVT STA=
			R/S	EL=
			GO TO STEP 9	
			10C	TO GO TO NEXT GRADE OR CURVE SOLUTION
GO TO STEP 2				

Sample Problem (Sketch if Desired)

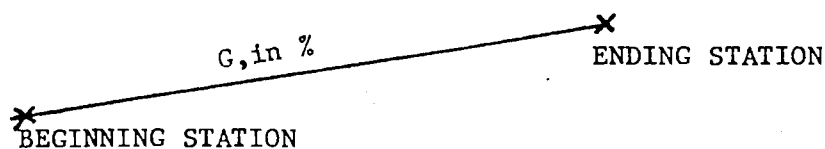
STRAIGHT GRADE SOLUTION

GIVEN: BEGINNING STATION= 12+38.42
 BEGINNING STATION ELEVATION= 85.00'
 ENDING STATION= 15+26.97
 G,+/-%= +5%

SOLUTION: WITHOUT PRINTER

Display	Input	Function	Comments
S.G.? V.C.? -		XEQ "GC"	START PROGRAM
BEG STA↑ ELEV	1238.42	"A"	Press "↵" key! STEP 2A
	85.00	ENTER ↑	BEGINNING STATION
END STA?	1526.97	R/S	BEGINNING STATION ELEVATION
G,+/-%	5.00	R/S	INPUT ENDING STATION-STEP 4A
BEG STA=12+38.42		R/S	INPUT GRADE, IN % STEP 5
EL=85.000		R/S	
NXT STA? I=-	1300.00	R/S	NEXT STATION STEP 7A
STA=13+00.00		R/S	
EL=88.079		R/S	
NXT STA? I=-	-100.00	R/S	INPUT INTERVAL DISTANCE STEP 7B
STA=14+00.00		R/S	
EL=93.079		R/S	
STA=15+00.00		R/S	
EL=98.079		R/S	
END STA=15+26.97		R/S	
EL=99.428		R/S	
NXT STA? I=-	1426.87	R/S	NEXT STATION STEP 7A
STA=14+26.87		R/S	
EL=94.423		R/S	
NXT STA? I=-		R/S	STEP 7C
S.G.? V.C.?			NEXT CURVE OR GRADE SOLUTION

STRAIGHT GRADE SOLUTION



NO END STATION INPUTED!

END STATION INPUTED!

SOLUTION: WITH PRINTER--(NORMAL MODE)

	Function	
S.G.? V.C.?	XEQ "GC"	S.G.? V.C.?
BEG STA+ELEV	XEQ A	BEG STA+ELEV
1,238.42 ENTER↑		1,238.42 ENTER↑
85.000 RUN		85.00 RUN
END STA?		END STA?
1,526.97 RUN		1,526.97 RUN
G, +/- %		G, +/- %
5.000 RUN		5.00 RUN
BEG STA=12+38.42		BEG STA=12+38.42
EL=85.000		EL=85.000
NXT STA? I=-		NXT STA? I=-
1,300.000 RUN		1,250.000 RUN
STA=13+00.00		STA=12+50.00
EL=88.879		EL=85.579
NXT STA? I=-		NXT STA? I=-
-100.000 RUN		1,300.000 RUN
STA=14+00.00		STA=13+00.00
EL=93.079		EL=88.079
STA=15+00.00		NXT STA? I=-
EL=98.079		-100.000 RUN
STA=16+00.00		STA=14+00.00
EL=103.079		EL=93.079
STA=17+00.00		STA=15+00.00
EL=108.079		EL=98.079
		END STA=15+26.97
		EL=99.428
		NXT STA? I=-

Sample Problem (Sketch if Desired)

SYMMETRICAL VERTICAL CURVE

GIVEN: PVC STATION= 12+24.00
 PVC STATION ELEVATION= 114.97
 G2, +/--%= +2.4%
 G1, +/--%= -5.1%
 L, in feet= 400.00'

SOLUTION: WITHOUT PRINTER

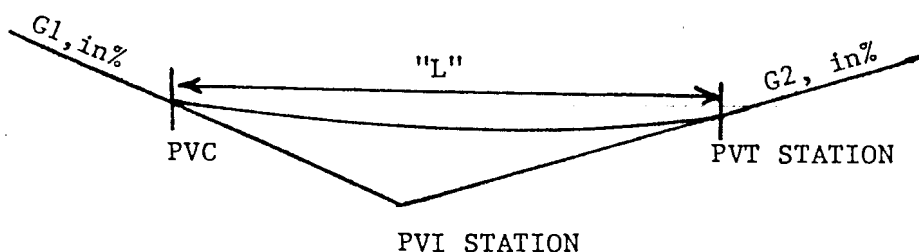
Display	Input	Function	Comments
S.G.? V.C.? -		XEQ "GC"	START PROGRAM
PVC STA $\uparrow$ ELEV	1224.00	"C"	Press " $\sqrt{x}$ " key! STEP 2B
	114.97	ENTER $\uparrow$	PVC STATION
G2, +/--%	2.4	R/S	PVC STATION ELEVATION
G1, +/--%	-5.1	R/S	ENDING GRADE, IN % STEP 6
L, IN FT.?	400.00	R/S	BEGINNING GRADE, IN % STEP 7
PVC STA=12+24.00		R/S	
EL=114.970		R/S	
TRN PT. IS		R/S	TURNING POINT--YES!!
STA=14+96.00		R/S	
EL=108.034		R/S	
NXT STA? I=-	1300.00	R/S	NEXT STATION STEP 10A
STA=13+00.00		R/S	
EL=111.636		R/S	
NXT STA? I=-	-100.00	R/S	INPUT INTERVAL DISTANCE STEP 10B
STA=14+00.00		R/S	
EL=108.898		R/S	
STA=15+00.00		R/S	
EL=108.036		R/S	
STA=16+00.00		R/S	
EL=109.048		R/S	
PVT STA=16+24.00		R/S	
EL=109.570		R/S	
NXT STA? I=-	1487.98	R/S	NEXT STATION STEP 10A
STA=14+87.98		R/S	
EL=108.040		R/S	
NXT STA? I=-		R/S	STEP 10C
S.G.? V.C.?			NEXT CURVE OR GRADE SOLUTION

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Sample Problem (Sketch if Desired)

SYMMETRICAL VERTICAL CURVE



SOLUTION: WITH PRINTER--(NORMAL MODE)

		Function	
	XEQ "GC"		NXT STA? I=-
S.G.? V.C.?			-50.000 RUN
	XEQ C		STA=13+50.00
PVC STA+ELEV			EL=110.035
1.224.000 ENTER↑			
114.970 RUN			STA=14+00.00
G2, +/- %			EL=108.899
2.400 RUN			
G1, +/- %			STA=14+50.00
-5.100 RUN			EL=108.233
L, IN FT.?			
400.000 RUN			STA=15+00.00
			EL=108.035
PVC STA=12+24.00			
EL=114.970			STA=15+50.00
			EL=108.307
TRH PT. IS			
STA=14+96.00			STA=16+00.00
EL=108.034			EL=109.046
NXT STA? I=-			PVT STA=16+24.00
1.300.000 RUN			EL=109.570
STA=13+00.00			
EL=111.638			NXT STA? I=-

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS	LINES= 207	STATUS	BYTES= 434		
R00=BEGINNING OR PVC STATION R01=BEGINNING OR PVC ELEVATION R02=G1/100 R03=END OR PVT STATION R04=INTERVAL DISTANCE R05=L, IN FEET R06= <u>100(G2 - G1)</u> L R07=GIVEN STATION R08=GIVEN ELEVATION	SIZE 09 ENG DEG	TOT. REG. 71 FIX 2/3 SCI RAD GRAD	USER MODE ON XX OFF		
	FLAGS				
	#	INIT S/C	SET INDICATES	CLEAR INDICATES	
	00	C	INTERVAL DIST. INPUTED	INTERVAL DIST. NOT INPUTED	
	01	C	GRADE SOLUTION	VERTICAL CURVE SOLUTION	
	02	S	PVC INPUTED	PVI INPUTED	
	03	C	END STATION OUTPUTED		
	04	C	PVT STATION OUTPUTED		
	05	S	VERTICAL CURVE SOLUTION		
	06	C	TRN PT.--YES	TRN PT.--NO	
	07	C	G2= +	G1= +	
	21	S	WITH PRINTER-- PRINT AND GO! WITHOUT PRINTER-- VIEW AND STOP!!		
	22	S	NUMERICAL DATA INPUTED	NUMERICAL DATA NOT INPUTED	
	27	S	USER KEYBOARD "ON"		
	29	S	FIX Ø--COMMA AND PERIOD DISPLAYED	FIX Ø--COMMA AND PERIOD NOT-- DISPLAYED!	
	ASSIGNMENTS				
	FUNCTION		KEY	FUNCTION	KEY
	GRADE SOLUTION		"A"	VERTICAL CURVE SOLUTION	"C"

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COMMENTS

COMMENTS		COMMENTS	
01+LBL "GC"		45+LBL 01	
02 SF 21		46 "G2,+/-Z"	
03 SF 27		47 PROMPT	
		48 X<0?	
04+LBL 07		49 SF 06	
05 0		50 X>0?	
06 STO 01		51 SF 07	
07 STO 08		52 1 E2	
08 "S.G.? V.C.?"		53 /	
09 PROMPT		54 ENTER↑	
		55 "G1,+/-Z"	
10+LBL A	LBL "A"	56 PROMPT	
11 CF 00		57 X<0?	
12 "BEG"	GRADE SOLUTION	58 CF 06	
13 XEQ 04		59 X>0?	
14 CLX		60 CF 07	
15 "END STA?"		61 FS?C 07	
16 PROMPT		62 SF 06	
17 STO 03		63 1 E2	
18 "G,+/-Z"		64 /	
19 PROMPT		65 STO 02	
20 1 E2		66 -	
21 /		67 "L, IN FT.?"	
22 STO 02		68 PROMPT	
23 SF 01		69 STO 05	
24 RCL 00		70 /	
25 ADV		71 STO 06	
26 "BEG"		72 RCL 05	
27 XEQ 10		73 FS? 02	LINES 073-086
28 GTO 06		74 GTO 01	
		75 2	SOLVE FOR PVC
29+LBL C	LBL "C"	76 /	STATION AND
30 CF 00		77 RCL 00	ELEVATION.
31 CF 01	VERTICAL CURVE	78 X<>Y	
32 CF 06	SOLUTION	79 -	
33 CF 07		80 STO 00	
34 SF 05		81 STO 07	
35 SF 02		82 LASTX	
36 "PVC"		83 RCL 02	
37 XEQ 04		84 *	
38 FS?C 22		85 ST- 01	
39 GTO 01		86 ST- 08	
40 "PVI"			
41 XEQ 04			
42 FC?C 22			
43 GTO C			
44 CF 02			

PROGRAM LISTING

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COMMENTS

COMMENTS

87+LBL 01		125+LBL 08	LBL 08
88 RCL 05	LINEs 088-091	126 RCL 04	LINEs 125-135
89 RCL 00	SOLVE FOR	127 RCL 07	CHECKS TO SEE IF
90 +	PVT STATION.	128 +	GIVEN STATION
91 STO 03		129 RCL 03	IS GREATER THAN
92 SF 02		130 X=0?	END OR PVT
93 RCL 00		131 GTO 01	STATION
94 ADV		132 X<=Y?	
95 XEQ 00		133 XEQ 03	
96 ADV		134 X<=Y?	
97 *-TRN PT.-		135 GTO 05	
98 FC? 06			
99 *-NONE*-		136+LBL 01	
100 FS? 06		137 X<Y	
101 *-IS*-		138 GTO 05	
102 AVIEW			
103 FC? 06		139+LBL 03	LBL 03
104 GTO 06		140 FS? 01	LINEs 139-145
105 RCL 00	LINEs 105-109	141 SF 03	
106 RCL 02	SOLVE FOR TURNING	142 FS?C 05	OUTPUT END OR
107 RCL 06	POINT STATION.	143 SF 04	PVT STATION.
108 /		144 CF 00	
109 -		145 RTN	
110 GTO 05			
		146+LBL 05	LBL 05
111+LBL 06		147 STO 07	LINEs 146-166
112 ADV		148 RCL 00	
113 FS? 00		149 -	
114 GTO 08		150 ENTER†	SOLVE FOR GIVEN
115 CF 22		151 ENTER†	STATION
116 -NXT STA? I=-		152 RCL 06	ELEVATION AND
117 PROMPT		153 FS? 01	OUTPUTS.
118 FC? 22		154 CLX.	
119 GTO 07		155 *	
120 X>0?		156 2	
121 GTO 05		157 /	
122 ABS		158 RCL 02	
123 SF 00		159 +	
124 STO 04		160 *	
		161 RCL 01	
		162 +	
		163 STO 08	
		164 RCL 07	
		165 XEQ 00	
		166 GTO 06	

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COMMENTS

COMMENTS

167+LBL 04	LBL 04
168 CF 22	LINES 167-176
169 *- STA+LEV-	
170 PROMPT	INPUT GIVEN
171 STO 01	STATION ROUTINE.
172 STO 08	
173 X<>Y	
174 STO 00	
175 STO 07	
176 RTH	
177+LBL 00	LBL 00
178 CLA	LINES 177-209
179+LBL 10	OUTPUT ROUTINE
180 FS?C 02	FOR GIVEN STATION
181 -PVC-	AND GIVEN
182 FS?C 03	ELEVATION.
183 -END-	
184 FS?C 04	
185 -PVT-	
186 *- STA=-	
187 I E2	LINES 187-204
188 /	
189 INT	OUTPUTS:
190 FIX 0	
191 CF 29	STA=XX+XX.XX
192 ARCL X	
193 SF 29	NOTE:
194 *-+*	IF STATION IS
195 FIX 2	LESS THAN TEN,
196 LASTX	AN 0 IS ADDED.
197 FRC	
198 I E2	9.09 IS DISPLAYED
199 *	AS:
200 I E1	
201 X>Y?	STA=0+09.09
202 *-0-	NOT
203 ARCL Y	STA=9.09
204 RVIEW	
205 FIX 3	
206 -EL=-	
207 ARCL 08	
208 RVIEW	
209 .END.	
CAT 1	
LBL*GC	
.END.	434 BYTES

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