AUTO RANGER CALIBRATION

K+E

82 0020

Weatherproof Field Book

"Rite in the Rain" paper
32 pages

4⅝" x 7¼"

Keuffel & Esser Co., Morristown, N. J. 07960 Made in U.S.A.

CURVE FORMULAS

$T = R \tan \frac{1}{2} I$

$T = \frac{50 \tan \frac{1}{2} I}{\text{Sin. } \frac{1}{2} D}$

$\text{Sin. } \frac{1}{2} D = \frac{50}{R}$

$\text{Sin. } \frac{1}{2} D = \frac{50 \tan \frac{1}{2} I}{T}$

$R = T \cot. \frac{1}{2} I$

$R = \frac{50}{\text{Sin. } \frac{1}{2} D}$

$E = R \text{ ex. sec } \frac{1}{2} I$

$E = T \tan \frac{1}{4} I$

$\text{Chord def.} = \frac{\text{chord}^2}{R}$

$\text{No. chords} = \frac{I}{D}$

Tan. def. = ½ chord def.

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve. very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.) and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

RIGHT ANGLE TRIANGLES. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10.10^2 \div 200 = .5$. $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$. $100 - 3.125 = 96.875 =$ Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

LEVELING. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574\,d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{2}{3}d^2$. The combined correction is negative.

PROBABLE ERROR. If d_1, d_2, d_3, etc. are the discrepancies of various results from the mean, and if Σd^2 = the sum of the squares of these differences and n = the number of observations, then the probable error of the mean $= \pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$

MINUTES IN DECIMALS OF A DEGREE

1′	.0167	11′	.1833	21′	.3500	31′	.5167	41′	.6833	51′	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20′	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

INCHES IN DECIMALS OF A FOOT

1-16	3-32	⅛	3-16	¼	5-16	⅜	7/16	½	9/16	⅝	11/16	¾	13/16	⅞	15/16
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0365	.0417	.0469	.0521	.0573	.0625	.0677	.0729	.0781

1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

AUTO RANGER CALIBRATION

16 MAY 1979 AUTORANGER CHK

HUDSON P.C. AIRPORT BASE LINE

WARD T

INST ON A			
AB	99.89	90°32'	99.88
AC	552.14	90°20'	552.13
INST ON B			
BC	452.14	90°13'	452.14
BA	100.04	89°47'	100.04
INST ON C			
CA	552.12	89°51'	552.12
CB	452.26	89°54'	452.26

AVE AB $\frac{99.88 + 100.04}{2} = 99.96$ = HA

AVE BC $\frac{452.14 + 452.26}{2} = 452.20$ = HB

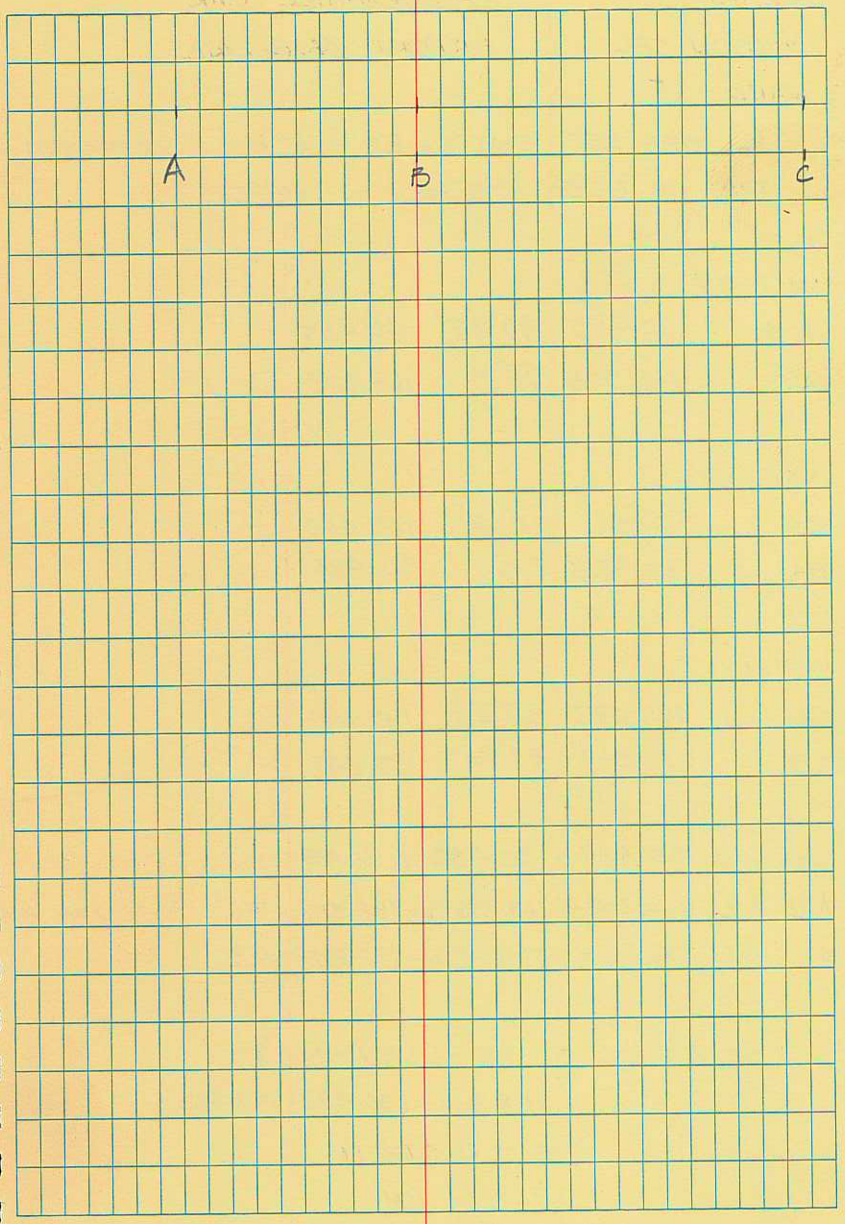
AVE AC $\frac{552.13 + 552.12}{2} = 552.12$ = HC

CORRECTION = HC − (HA + HB)

552.12 − (99.96 + 452.20)

−.04 = −0.012 M

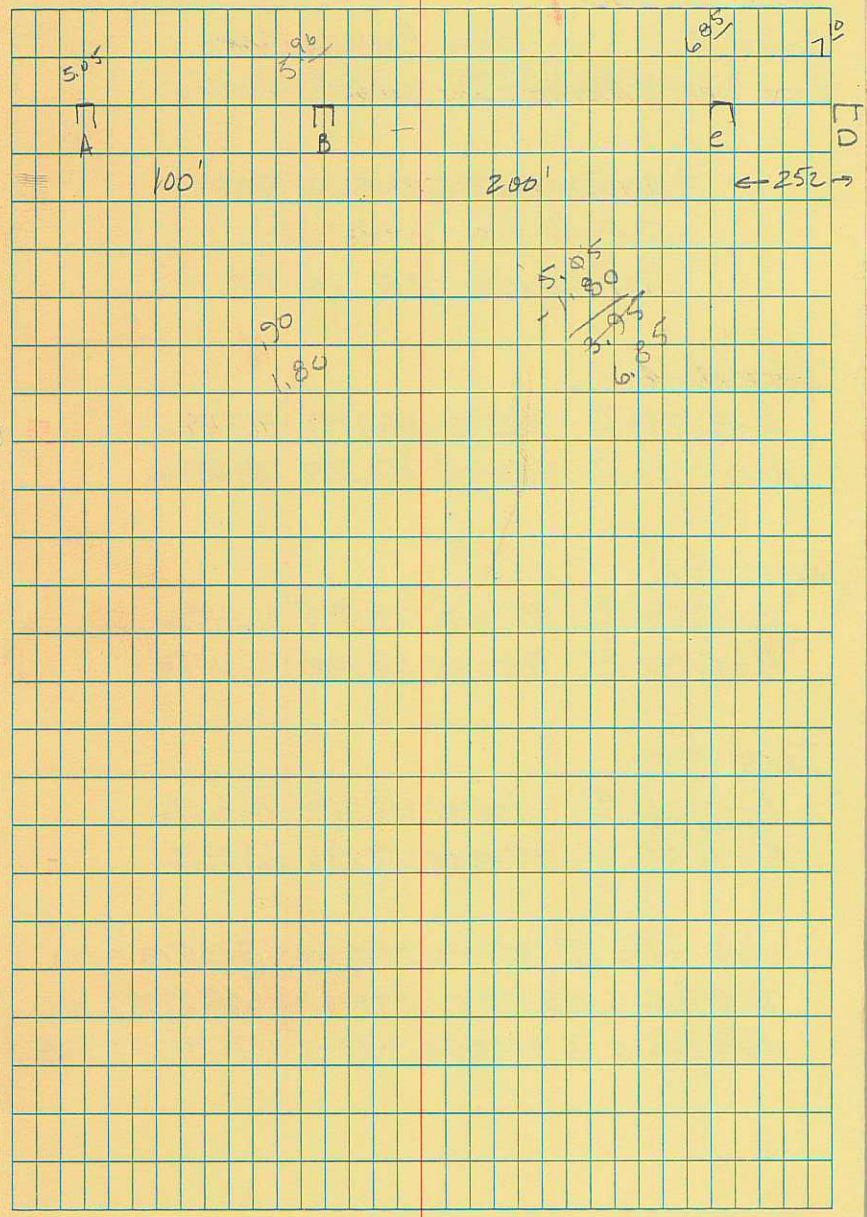
STAMPED CORRECTION = +.012 M



24 MAY - SETTING MONUMENT 200' FROM B
300' FROM A

MEASURED 200' ON LINE WITH A & B SET MONUMENT
ON 3½' STEEL PIPE ON LINE AND AT GRADE
WITH A & B. PPM = 50.
OFFSET - 12 MM

INST ON C	91.358		
MIRROR ON A	31	89°39'	299.74
MIRROR ON B	60.867 ~~199.70~~	89 38'	199.70
			100.04'



APRIL 27, 1982

SCOTT T AUTO RANGER CHECK

ROSS P AIRPORT BASE LINE

ALL OFFSET SWITCH ARE -

P.P.M IS 2X10

DIST. WILL BE IN FT.

INST @ A

A-B	299.79	90°28'15"	299.7799'	91.3729m
A-C	552.13	90°14'15"	552.1253'	168.2878m

INST @ B

B-A	299.69	89°34'05"	299.6815'	91.3429m
B-C	252.34	90°00'30"	252.3400'	76.9132m

INST @ C

C-B	252.37	90°05'35"	252.3696	76.9223m
C-A	552.16	89°48'00"	552.1566'	168.2973m

AVE A-B = 91.3429 + 91.3729 ÷ 2 = 91.3579 = MA

AVE A-C = 168.2975 + 168.2878 ÷ 2 = 168.2926 = MC

AVE B-C = 76.9223 + 76.9132 ÷ 2 = 76.9177 = MB.

CORRECTION = MC - (MA + MB)

168.2926 - (91.3579 + 76.9177)

+0.0170

31 MAY 79 SALT LAKE COUNTY WARM, CLEAR

HUDSON PC BASE LINE BAR. P: 30.05

WARD X TEMP 62°

DISTANCES IN METERS PPM = 30

Ci = 8.5" = 21.59 CM = 215.9 MM

INST ON PIER 1

R MIRROR ON PIER 2 49.977 = ~~MARK TO MARK~~ SLOPE DIST

MIRROR IS SINGLE CK = 2.5" = 6.35 CM = 63.5 MM

CORRECTED SLOPE DISTANCE = 49.984

ERROR = 0.007 M

MIRROR ON PIER 3 SINGLE PRISM CK = 2.5" = 63.5 MM

~~MARK TO MARK~~ SLOPE ~~DIS~~ DISTANCE = 149.963 91°35'

CORRECTED SLOPE DIST = 150.002

ERROR = .045 M

MIRROR ON PIER 4 SINGLE PRISM CK = 63.5 MM

SLOPE D = 349.927 M 91°15'

S.L.C. BASE LINE

INST ON PIER 1

TRI PRISM OFFSET 40 CK = 2.75" = 69.85 MM = 6.985 CM = .06985 M

MIRROR ON PIER 4 (OFFSET -12 ON INST)

MEASURED DIST = 349.937

CORR. SLOPE D = 349.974

MIRROR ON PIER 4 (OFFSET +12 ON INST)

MEAS. DISTANCE = 349.963

CORR. SLOPE DIST = 349.974 = .011 M = .04'

DIFFERENCE .011 M SHORT

MIRROR ON PIER 3 OFFSET @ INST = +12

MEAS. DIST = 150.011

CORR. SLOPE = 150.005 .006 M = .02'

DIFF. = .006 M LONG

MIRROR ON PIER 3 OFFSET INST = -12

MEAS. DIST. = 149.987

CORR. SLOPE = 150.005

SLC. BASE LINE TEMP = 70°

PPM = 4

INST ON PIER 1

NEW TRIPRISM

00777

ON PIER 2 MEAS. DIST = 49.959

COR. SLOPE DIST = 49.983

SHORT .024

.08'

R

PIER 5 MEAS. DIST. = 599.914

COR. SLOPE DIST = 599.959

DIFFERENCE = .046 = .15'

PIER 6 MEAS DIST = 999.888

COR SLOPE DIST = 999.948

DIFF ~~long~~ = .060 MM

short .196'

PIER 7 MEAS DIST = 1499.940

COR. SLOPE DIST = 1499.995

DIFF. Short = .055 = .180'

PIER 8 MEAS. DIST = 1999.975

COR. SLOPE DIST = 2000.052

DIFF Short = 0.077 .252'

1.4 cm = .5
2.5 .2

PIER 5 OLD TRIPRISM = MEAS. DIST =

SAME CK 599.900

14 MM DIFFERENCE.

PIER 5 SINGLE PRISM = 599.905

9-15-80 CALC. CHECK AFTER ED.M. REPAIRS P.WARD J.PARRISH

A-B	99.84	90°42'	99.83
A-C	552.13	90°14'	552.13
B-C	452.13	90°12'	452.13
B-A	99.82	89°51'	99.82
C-A	552.14	89°51'	552.14
C-B	452.09	89°52'	452.09
MA -			99.82
MB -			452.11
MC -			552.13

MC - (MA + MB)

552.13 - (99.82 + 452.11

-.20 .06

9 JUNE

BAR. PR. 30.12
TEMP = 60°
PPM = 30

NEW TRIPRISM Ck = 2.75"
AUTORANGER ON TH 43 Ci = 15.5
INST ON PIER 1

	MEAS SLOPE	CORRECT SLOPE	
MIRROR ON 2	49.989	49.981	LONG 8MM
MIRROR ON 3	150.009	150.005	LONG 4MM
ON 4	349.966	349.974	SHORT 6MM
ON 5		~~599.69~~ 960	
ON 6	999.913	999.949	SHORT 36
ON 7	1499.949	1499.995	SHORT 46
	1999.983	2000.052	SHORT 69
ON 8			

SINGLE P. = 49.969 –
68 =

150.008 1
009 1111
10 11
11

.966 ≡ –
7

STA 6
911 969 –
.19 08 –
.16 .13 –
.14 .13
.13 .13
12 10
12 –
14 –
11

7 1499.949 – 946
949 = 45 53
– 48 50
51

8 1999.984
985 –
978
984
980

87
84 –
985
983 –
981 –
980
980
976

27 JUNE — AIRPORT BASE LINE — TEMP = 82°

FIRST USE SINCE REPAIRED — BAR. = 30.21

HUDSON

OFFSET = +12

INST ON	MIRROR ON	SINGLE PRISM	NEW TRI PRISM	
A				
	B	30.480 ~~30.487~~	30.497	
	C	91.385	91.405	
	D		168.337	552.27
B	A	30.480	30.488	
	C	60.900	60.919	
C				
	B	60.895	60.909	.14
	A	91.384	91.391	.17

30.492 + 60.914 = 91.398

91.406 — -08

30.480 + 60.897 = 91.385 (+02)

91.385 - 91.377 = +12 ~~+10~~

552.28
29

168 338
339
337

487
486

~~30~~ 30516 9
30 497
8

30 483
82
81
80

86 91.405
85
04
91 383
384

60 900
899

91.392
91
90

60.918
19
20

30.488
89

08
909

60.910
11

30.480
1

91384
83
82
81
80
79
78

ATMOS. + OFFSET = 0

INST ON	MIRROR	
~~M~~ A	~~B~~	
	B	30.471
	C	91.371

INST ON		
B	C	60.880
	A	30.461

INST ON		
C	A	91.361
	B	60.883

$M_{AB} = \frac{30.471 + 30.461}{2} = 30.466$

$M_B = \frac{60.880 + 60.883}{2} = 60.882$

$M_C = \frac{91.371 + 91.361}{2} = 91.366$

$(M_A + M_B) - M_C = 0$

$(30.466 + 60.882) - 91.366 =$

$91.348 - 91.366 = 18$

470 ~~+~~ 472 ✓ 73

91 371 ✓✓✓✓✓ 73✓ 72 ✓✓

30.461✓ 62 ✓✓✓✓ 63 ✓✓✓ 61✓✓ 40 ✓✓✓ 59✓

60.884 883 81 ✓ 80 ✓ 79 ✓ 78 ✓✓✓✓ 59 ✓ 60 ✓✓✓

81✓✓ 82✓✓ 83 ✓✓✓

79 ✓✓✓ 80 ✓✓✓✓ 81 ✓✓✓ 77 82

91.361 ✓✓✓✓ 62✓

46 60.8 85✓ 84 ✓✓✓ 83 ✓✓✓✓ 82

CORR. = +18 USE +12

4

60.895 ✓✓✓✓✓

96 ✓✓

Sta	Sta	+	HI	−	Elev
					4500
		5.11			
			4505.11		
				13.02	4492.09

91.369 3.81 3.58 .068

23

112 E 200 S NEWTON BEN. ASHLEY

for elev.

elev runway closest to and pointing west

lat long home elev.

FT Rod

① 299.73
.73
.71 (.71)
.71
.71
.71

② 299.83
.85
.84
.84 (.84)
.84

③ 299.86
.84
.83 .83
.82
.83

④ .74
.74
.75 .74
.74
.74

⑤ .75
.74
.75 .745
.73
.75

⑥ .75
.73
.74
.74 (.74)
.74

91 359
359
358
358
358
358
356
356
356
357

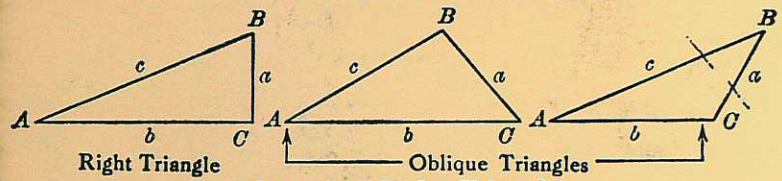
299 73
73
71
71
71
71
71

299.7799' = x
1' = 30.48

91.3729m

1' = 30.48cm
1m = 100cm

TRIGONOMETRIC FORMULAS



Solution of Right Triangles

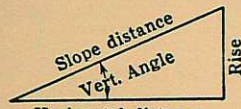
For Angle A. $\sin = \frac{a}{c}$, $\cos = \frac{b}{c}$, $\tan = \frac{a}{b}$, $\cot = \frac{b}{a}$, $\sec = \frac{c}{b}$, $\operatorname{cosec} = \frac{c}{a}$

Given	Required	
a, b	A, B, c	$\tan A = \frac{a}{b} = \cot B,\ c = \sqrt{a^2 + b^2} = a\sqrt{1 + \frac{b^2}{a^2}}$
a, c	A, B, b	$\sin A = \frac{a}{c} = \cos B,\ b = \sqrt{(c+a)(c-a)} = c\sqrt{1 - \frac{a^2}{c^2}}$
A, a	B, b, c	$B = 90° - A,\ b = a \cot A,\ c = \frac{a}{\sin A}$
A, b	B, a, c	$B = 90° - A,\ a = b \tan A,\ c = \frac{b}{\cos A}$
A, c	B, a, b	$B = 90° - A,\ a = c \sin A,\ b = c \cos A$

Solution of Oblique Triangles

Given	Required	
A, B, a	b, c, C	$b = \frac{a \sin B}{\sin A},\ C = 180° - (A + B),\ c = \frac{a \sin C}{\sin A}$
A, a, b	B, c, C	$\sin B = \frac{b \sin A}{a},\ C = 180° - (A + B),\ c = \frac{a \sin C}{\sin A}$
a, b, C	A, B, c	$A + B = 180° - C,\ \tan \frac{1}{2}(A - B) = \frac{(a-b)\tan \frac{1}{2}(A+B)}{a+b},\ c = \frac{a \sin C}{\sin A}$
a, b, c	A, B, C	$s = \frac{a+b+c}{2},\ \sin \frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{bc}},\ \sin \frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{ac}},\ C = 180° - (A+B)$
a, b, c	Area	$s = \frac{a+b+c}{2},\ \text{area} = \sqrt{s(s-a)(s-b)(s-c)}$
A, b, c	Area	$\text{area} = \frac{bc \sin A}{2}$
A, B, C, a	Area	$\text{area} = \frac{a^2 \sin B \sin C}{2 \sin A}$

REDUCTION TO HORIZONTAL



Horizontal distance = Slope distance multiplied by the cosine of the vertical angle. Thus: slope distance = 319.4 ft. Vert. angle = 5° 10′. Since cos 5° 10′ = .9959, horizontal distance = 319.4 × .9959 = 318.09 ft.

Horizontal distance also = Slope distance minus slope distance times (1 − cosine of vertical angle). With the same figures as in the preceding example, the following result is obtained. Cosine 5° 10′ = .9959. 1 − .9959 = .0041. 319.4 × .0041 = 1.31. 319.4 − 1.31 = 318.09 ft.

When the rise is known, the horizontal distance is approximately the slope distance less the square of the rise divided by twice the slope distance. Thus: rise = 14 ft., slope distance = 302.6 ft. Horizontal distance $= 302.6 - \frac{14 \times 14}{2 \times 302.6} = 302.6 - 0.32 = 302.28$ ft.