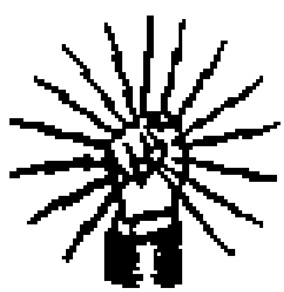
DAV'S BENDING BOOK

REVISION II



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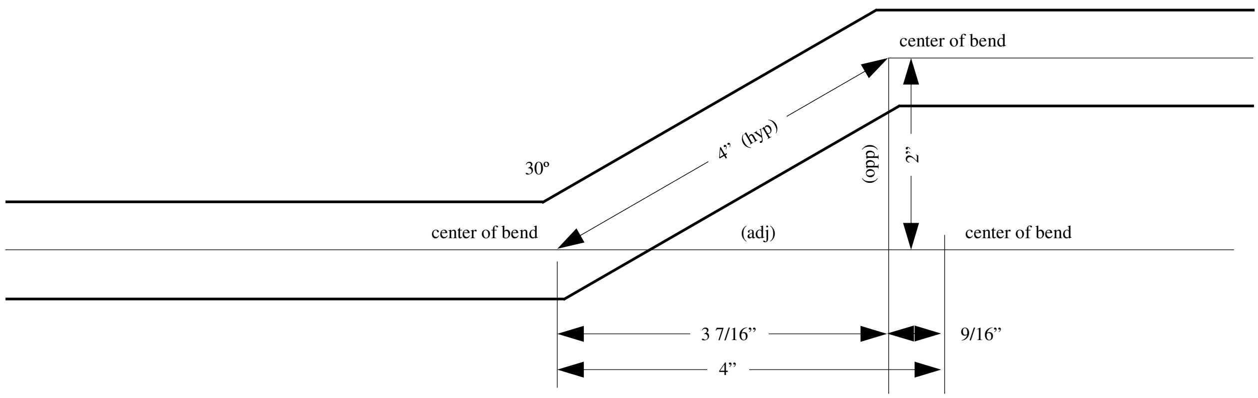
Acknowledgment:

This little book was created from many different books, but mainly from the one that has helped me to bend conduit for many years. Thank you to the man that wrote "Professor Brown's Guide to Conduit Bending"

To Determine Offset Loss (amount that conduit is shortened by bending an offset)



- Find the length between bends

  $\sin\Theta = \frac{opp}{hyp}$ $\quad$ $hyp = opp \times \frac{1}{\sin\Theta}$ $\quad$ $hyp = opp \times \csc\Theta$

  2” (height of offset)
  x 2 (csc 30º)
  4” (hyp - length between bends)

- There is more than one way to find the (adj):

  use the cosΘ

  $\cos\Theta = \frac{adj}{hyp}$

  $adj = \cos\Theta \times hyp$

  adj = .866
  x 4
  3.46 or 3 7/16”

  use Pythagorean theorem

  $hyp^2 = adj^2 + opp^2$

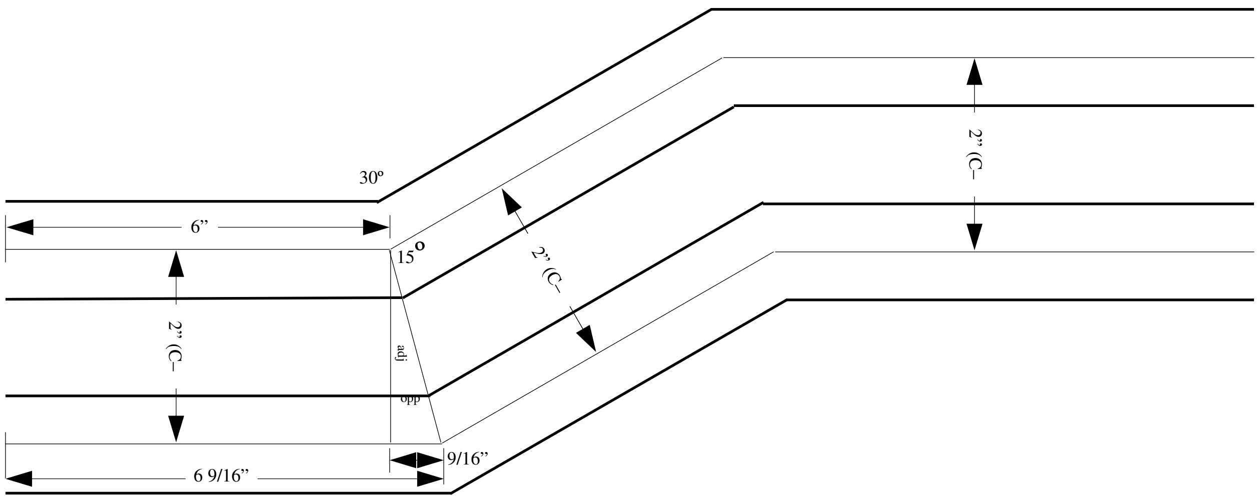
  $adj = \sqrt{hyp^2 - opp^2}$

  $adj = \sqrt{16 - 4}$ = 3.46 or 3 7/16”

- Subtract the side (adj) from the distance between bends (hyp) this gives you the shrink in conduit. Use this when you have to cut and thread before bending or when you want the center of your bend to fall out at a specific location.

  4“ – 3 7/16” = 9/16”

Parallel Offsets Progression of Bends



When bending two or more offsets it is necessary to advance the centers of the bends for the progressive conduits in order to maintain an equal center to center spacing.

Multiply the (C-C) measurement of the conduits by the tangent of 1/2 the bend angle. Add this figure to the center of bend measurement of 1st conduit. This will be center of bend measurement of the 2nd conduit. Advance the center of bend measurement of each succeeding conduit by this figure.

Example:

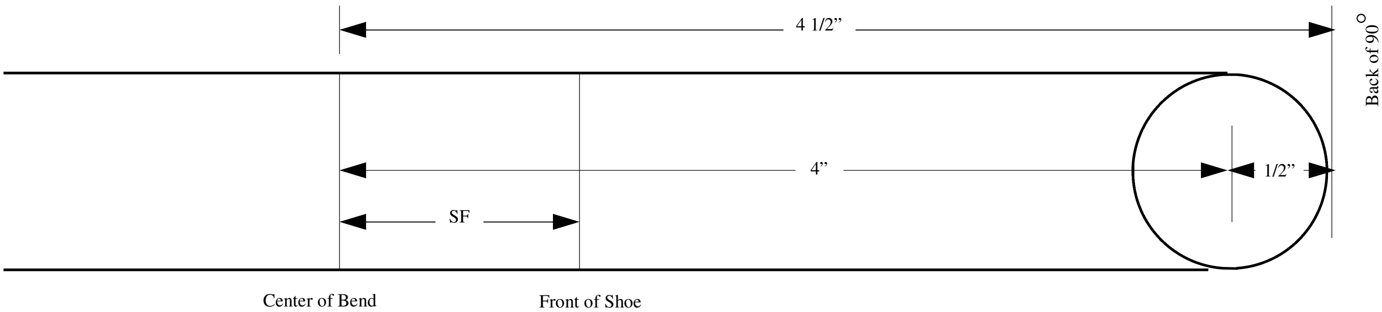
$$\tan\Theta = \frac{opp}{adj}$$

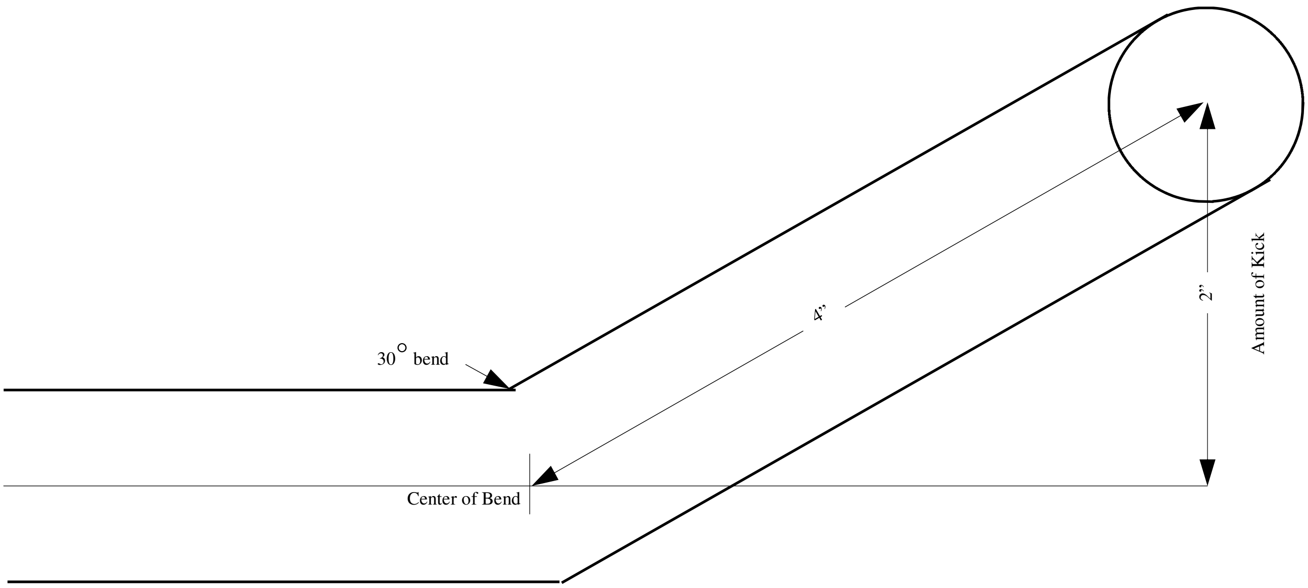
opp = tan 15º x adj (C-C)

opp = .2679 x 2”

opp =.5358’ or 9/16”

To Bend Kicks to Any Given Angle





After determining angle to use, bend this angle in a piece of scrap conduit. Measure from the front of the shoe to the center of the bend. This is the shoe factor (SF). Multiply the cosecant of the bend angle by the amount of kick. Add 1/2 O.D. of the conduit. This is the center of the bend measured from the back of the 90°. Deduct the (SF) figure and place the front of bending shoe on this mark. Pull through proper amount of travel for desired angle.

Example:

30° Kick
2” amount of kick

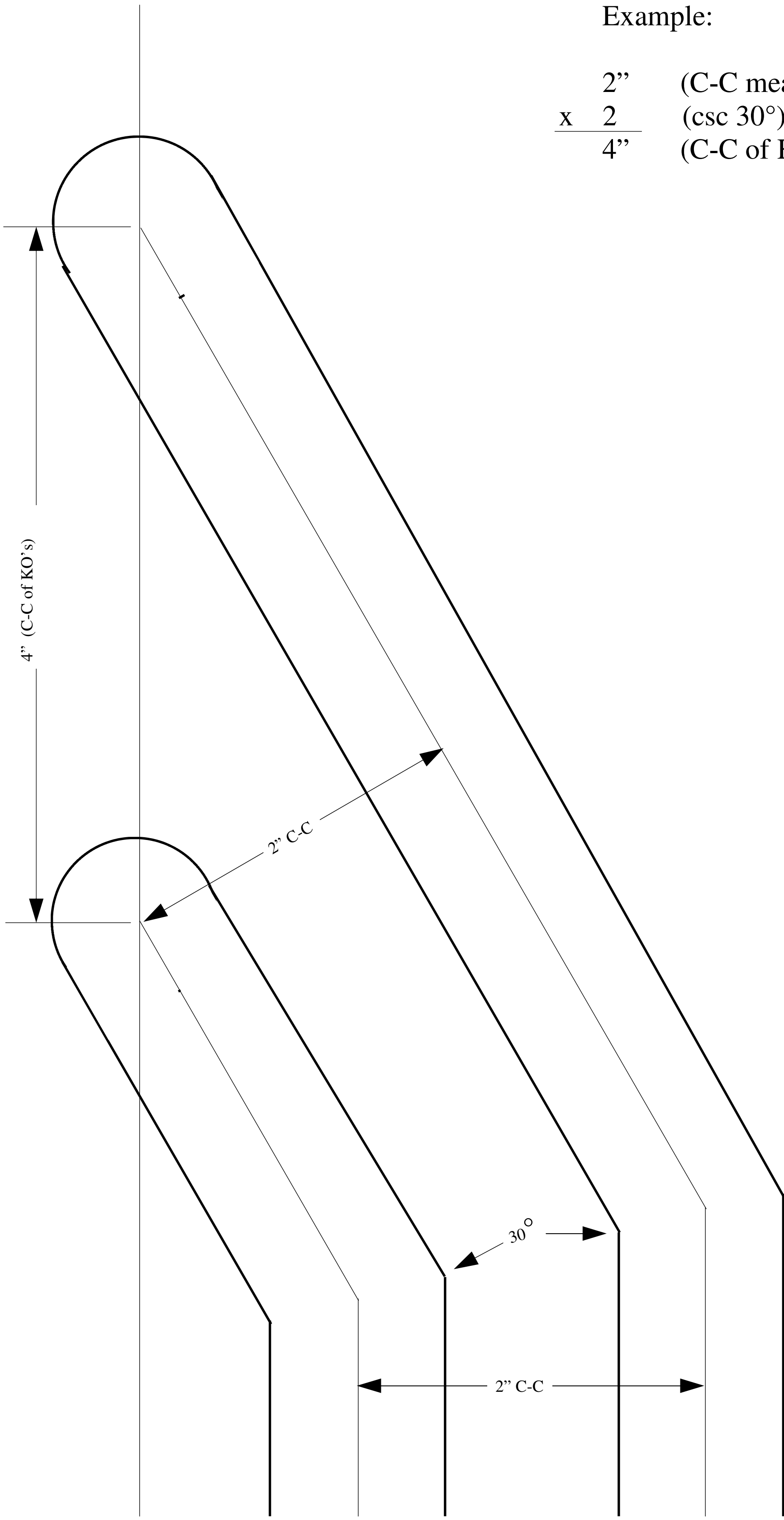
2”	(amt of kick)
x 2	(csc 30°)
4”	
+ 1/2	(1/2 O.D.)
4 1/2”	(Center of Bend)
- SF	
Front of Shoe	

Kicks with Conduits Running Parallel to Cabinet

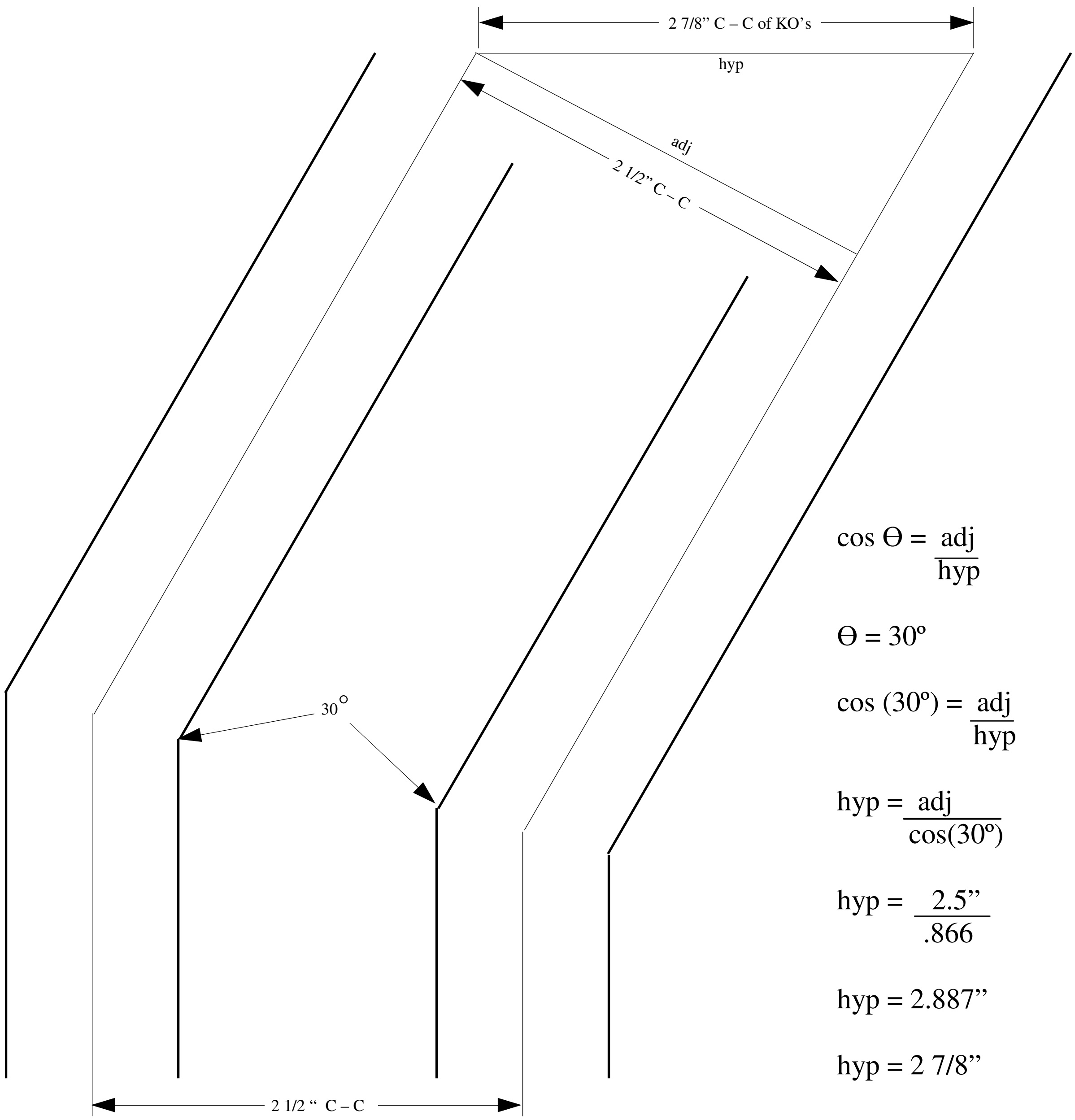
To find centers of KO’s in cabinet and maintain centers (2”) of conduits, multiply center to center (C-C) measurement by the cosecant of the bend angle.

Example:

	2”	(C-C measurement)
x	2	(csc 30°)
	4”	(C-C of KO’s)



Kicks with Conduits running Perpendicular to Cabinet



$$\cos \Theta = \frac{\text{adj}}{\text{hyp}}$$

$$\Theta = 30^{\circ}$$

$$\cos(30^{\circ}) = \frac{\text{adj}}{\text{hyp}}$$

$$\text{hyp} = \frac{\text{adj}}{\cos(30^{\circ})}$$

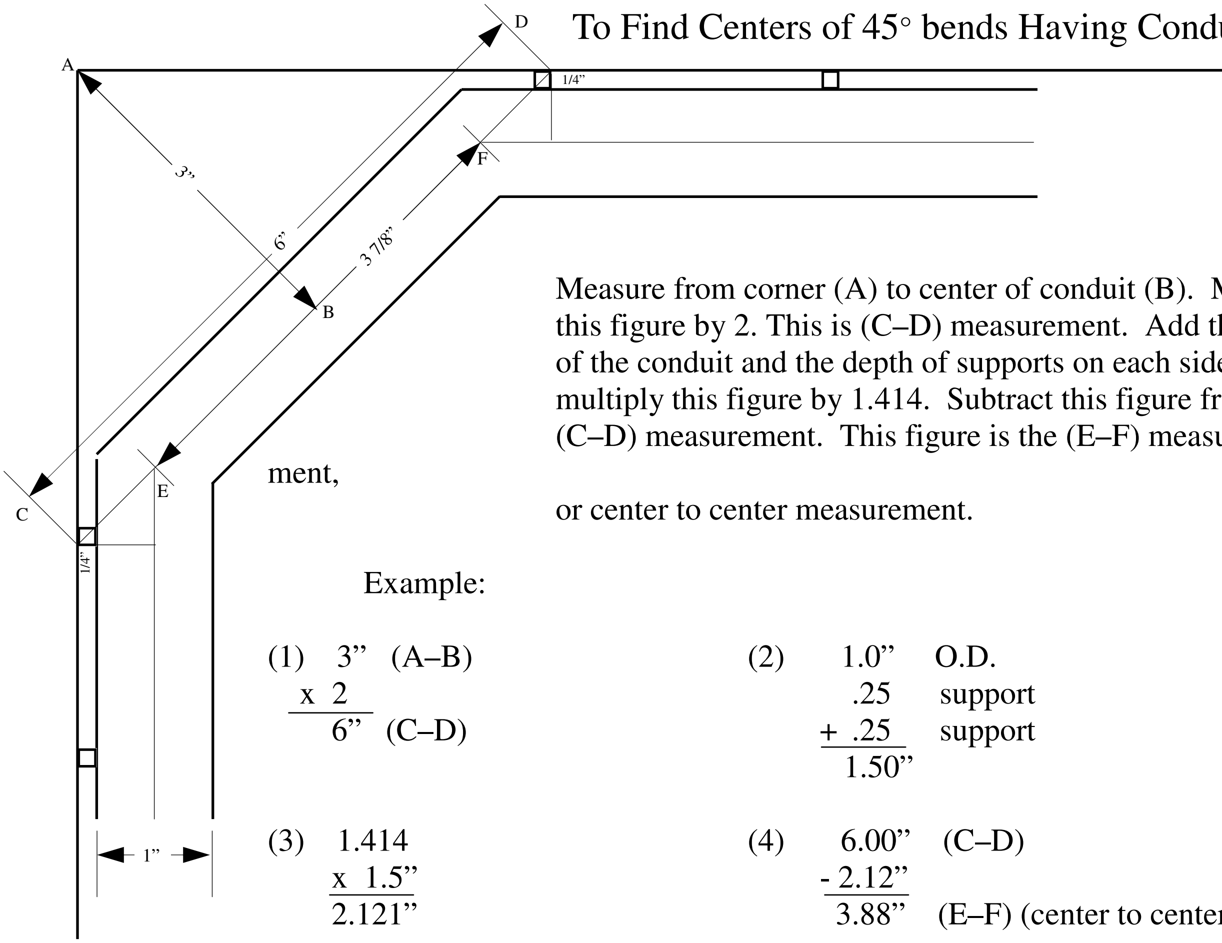
$$\text{hyp} = \frac{2.5''}{.866}$$

$$\text{hyp} = 2.887''$$

$$\text{hyp} = 2\ 7/8''$$

To find centers of KO’s in the cabinet and maintain centers (2 1/2”) of conduits, divide the (C – C) measurement by the cosine bend angle.

To Find Centers of 45° bends Having Conduit Supports



Measure from corner (A) to center of conduit (B). Multiply this figure by 2. This is (C–D) measurement. Add the O.D. of the conduit and the depth of supports on each side and multiply this figure by 1.414. Subtract this figure from the (C–D) measurement. This figure is the (E–F) measure-ment, or center to center measurement.

Example:

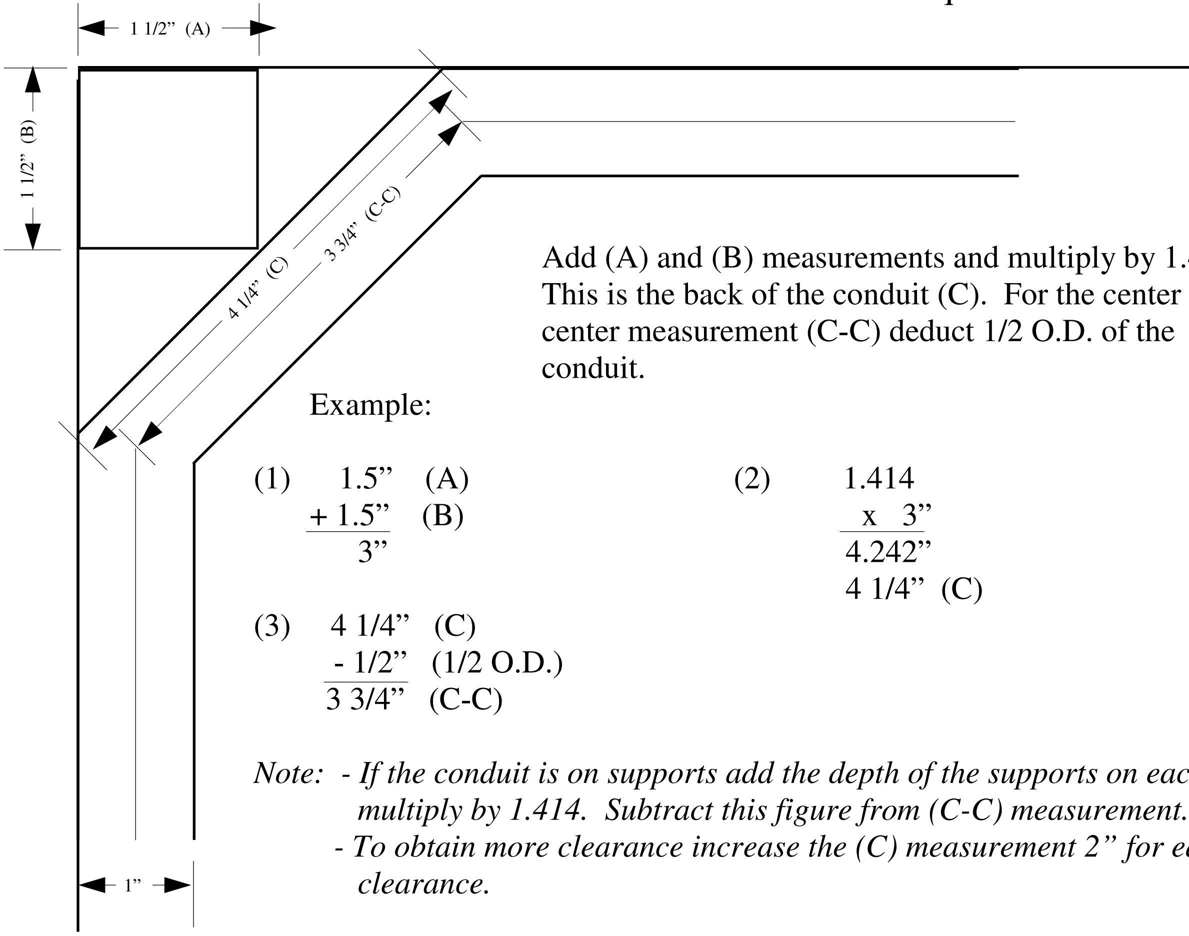
(1) 3" (A–B)
x 2
6" (C–D)

(2) 1.0" O.D.
.25 support
+ .25 support
1.50"

(3) 1.414
x 1.5"
2.121"

(4) 6.00" (C–D)
- 2.12"
3.88" (E–F) (center to center)

To Find Centers of 45* bends with Square Obstruction



Add (A) and (B) measurements and multiply by 1.414 This is the back of the conduit (C). For the center to center measurement (C-C) deduct 1/2 O.D. of the conduit.

Example:

(1) 1.5" (A)
+ 1.5" (B)
3"

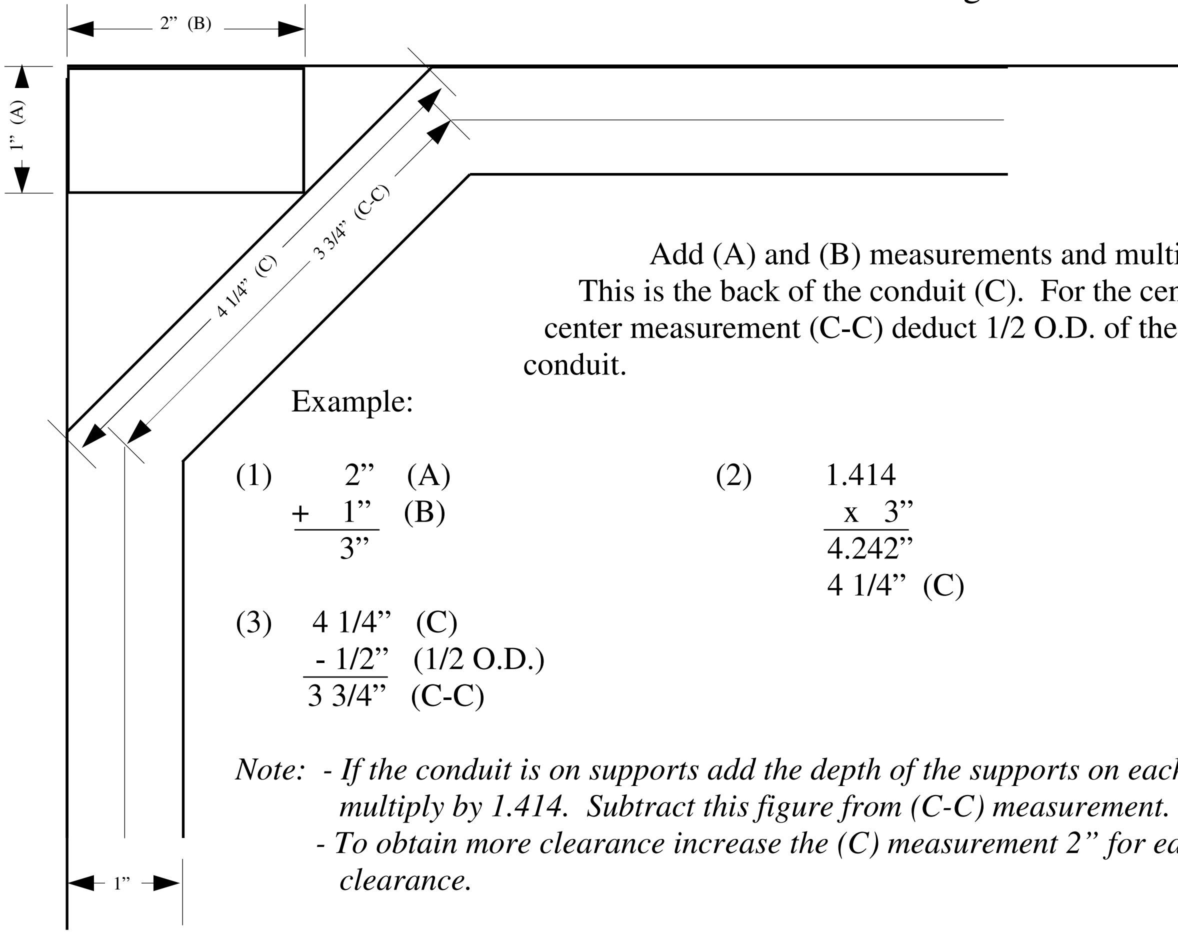
(2) 1.414
x 3"
4.242"
4 1/4" (C)

(3) 4 1/4" (C)
- 1/2" (1/2 O.D.)
3 3/4" (C-C)

Note: - If the conduit is on supports add the depth of the supports on each side and multiply by 1.414. Subtract this figure from (C-C) measurement.

- To obtain more clearance increase the (C) measurement 2" for each 1" of clearance.

To Find Centers of 45° bends with Rectangular Obstruction



Add (A) and (B) measurements and multiply by 1.414 This is the back of the conduit (C). For the center to center measurement (C-C) deduct 1/2 O.D. of the conduit.

Example:

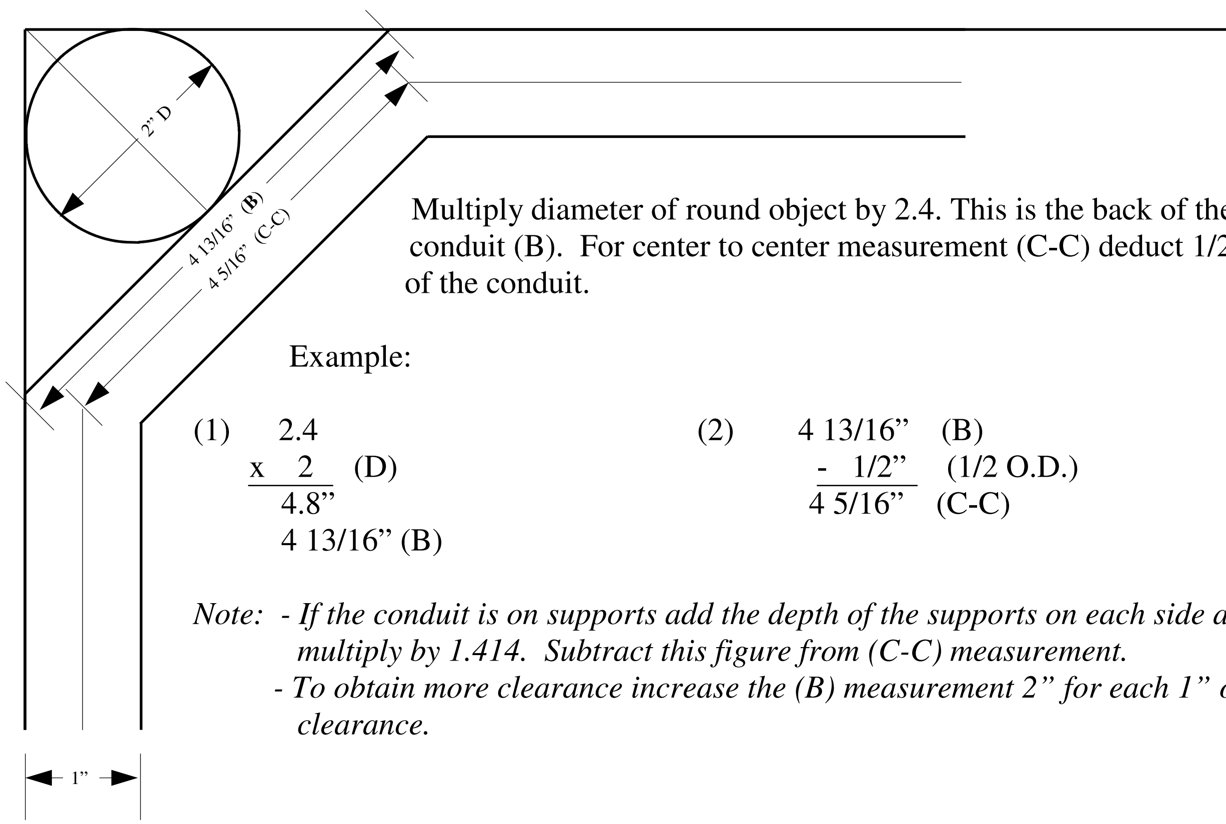
(1)
2" (A)
\+ 1" (B)
3"

(2)
1.414
x 3"
4.242"
4 1/4" (C)

(3)
4 1/4" (C)
\- 1/2" (1/2 O.D.)
3 3/4" (C-C)

Note: - If the conduit is on supports add the depth of the supports on each side and multiply by 1.414. Subtract this figure from (C-C) measurement.
- To obtain more clearance increase the (C) measurement 2" for each 1" of clearance.

To Find Centers of 45° bends with a Round Obstruction



Multiply diameter of round object by 2.4. This is the back of the conduit (B). For center to center measurement (C-C) deduct 1/2 O.D. of the conduit.

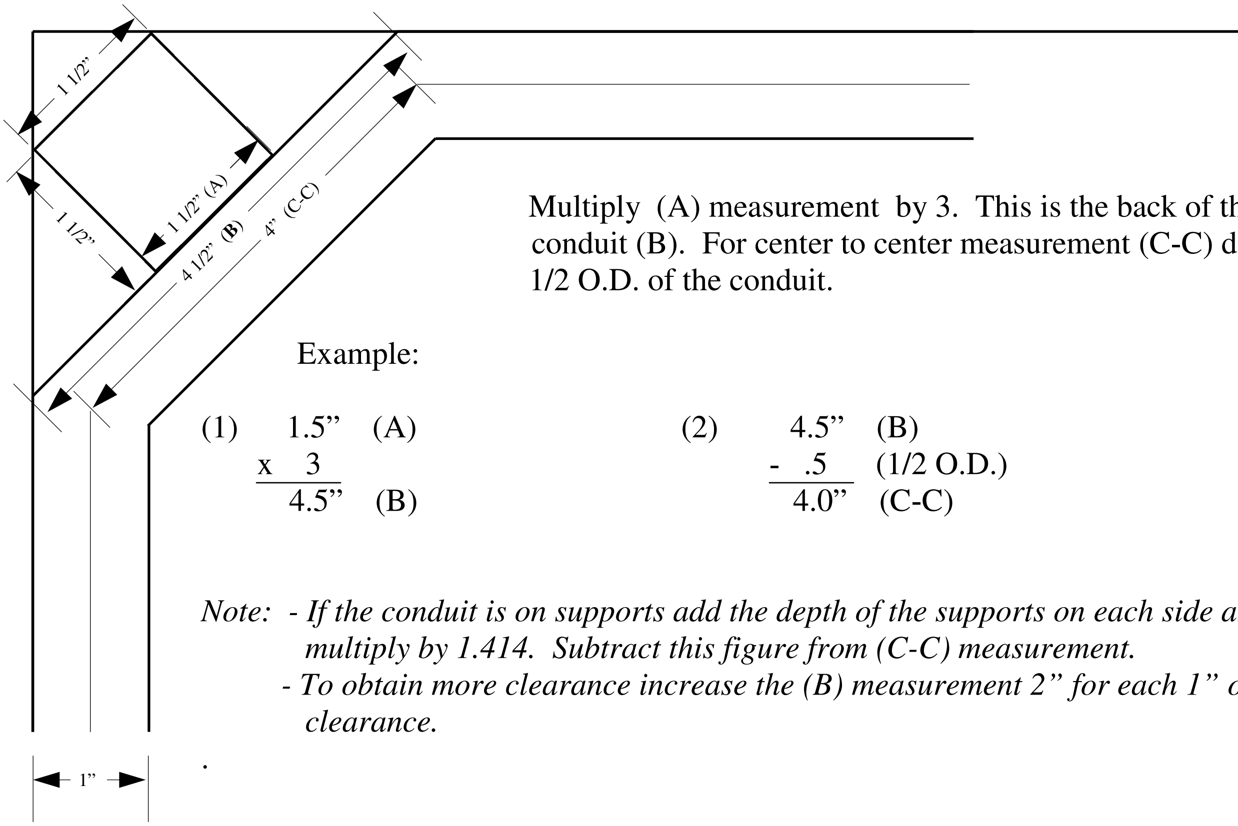
Example:

(1)
2.4
x 2 (D)
4.8"
4 13/16" (B)

(2)
4 13/16" (B)
\- 1/2" (1/2 O.D.)
4 5/16" (C-C)

Note: - If the conduit is on supports add the depth of the supports on each side and multiply by 1.414. Subtract this figure from (C-C) measurement.
- To obtain more clearance increase the (B) measurement 2" for each 1" of clearance.

To Find Centers of 45° bends with a Square Obstruction



Multiply (A) measurement by 3. This is the back of the conduit (B). For center to center measurement (C-C) deduct 1/2 O.D. of the conduit.

Example:

(1)	1.5”	(A)	(2)	4.5”	(B)
	x 3			- .5	(1/2 O.D.)
	4.5”	(B)		4.0”	(C-C)

Note: - If the conduit is on supports add the depth of the supports on each side and multiply by 1.414. Subtract this figure from (C-C) measurement.

- To obtain more clearance increase the (B) measurement 2” for each 1” of clearance.

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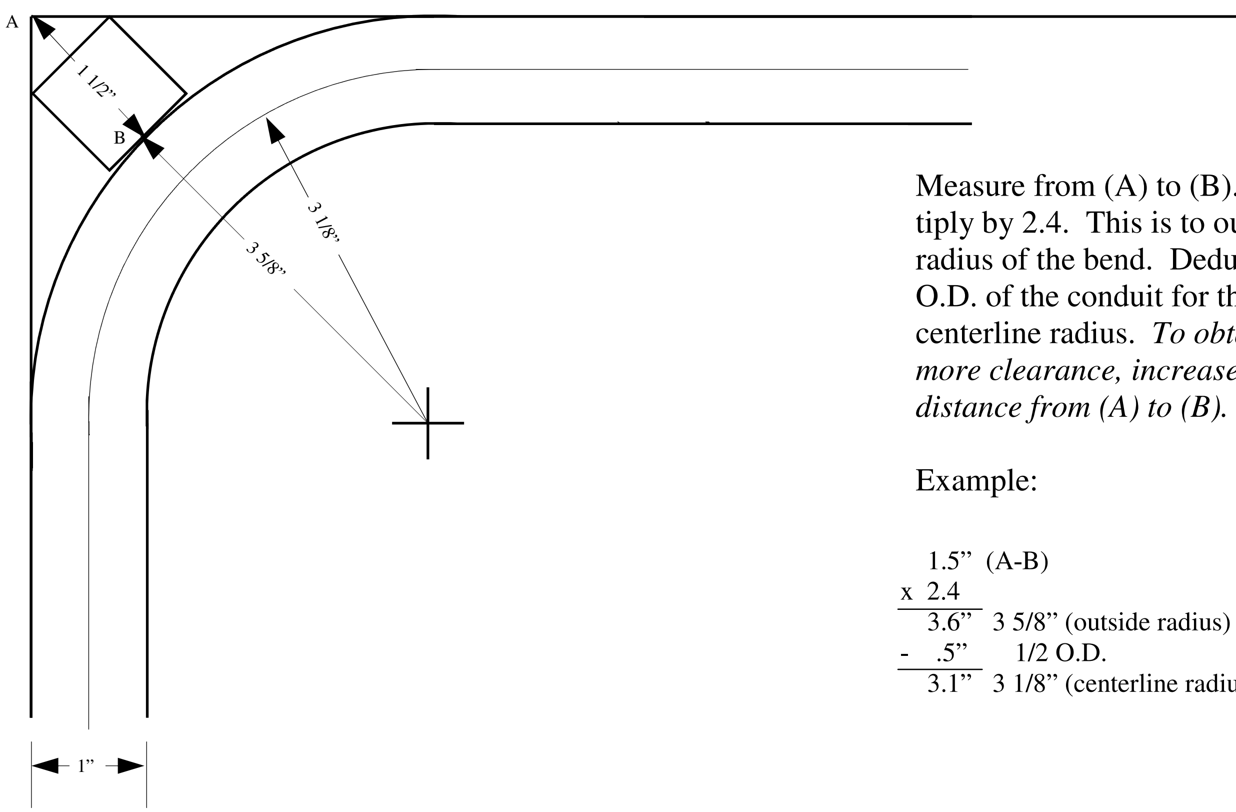
To Find a Radius Required to Clear an Obstruction

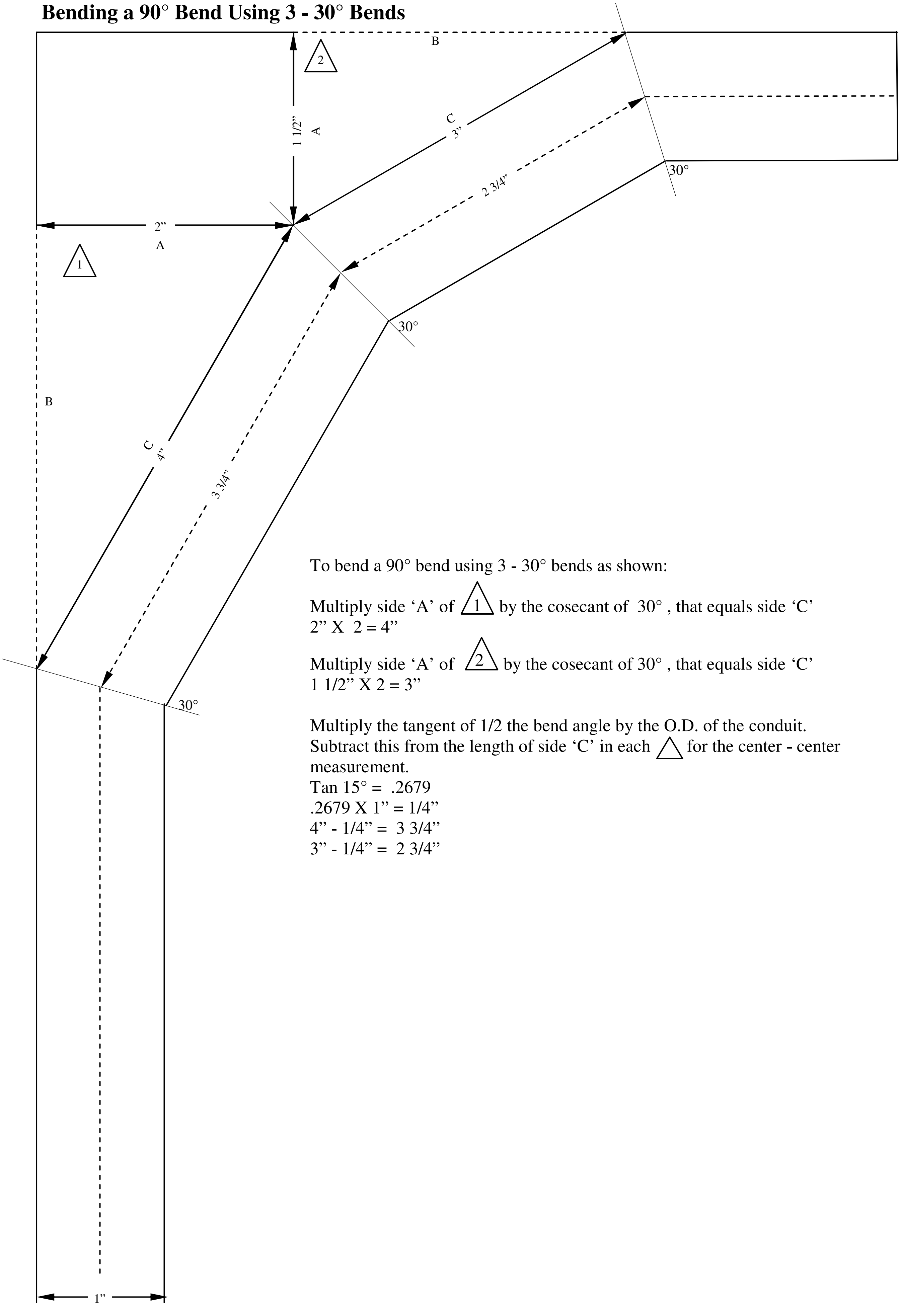


Measure from (A) to (B). Multiply by 2.4. This is to outside radius of the bend. Deduct 1/2 O.D. of the conduit for the centerline radius. *To obtain more clearance, increase the distance from (A) to (B).*

Example:

1.5”	(A-B)
x 2.4	
3.6”	3 5/8” (outside radius)
- .5”	1/2 O.D.
3.1”	3 1/8” (centerline radius)

Bending a 90° Bend Using 3 - 30° Bends



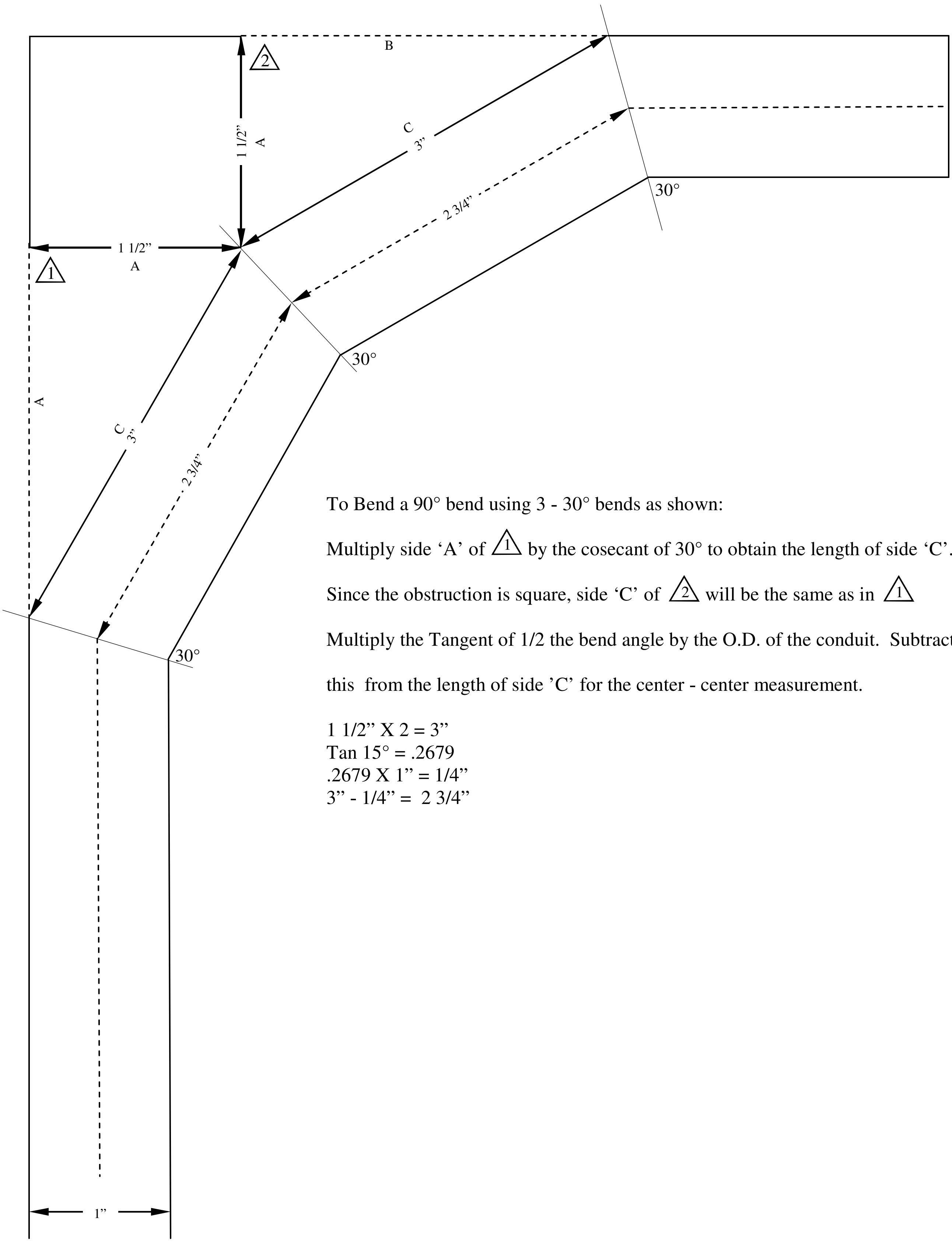
To bend a 90° bend using 3 - 30° bends as shown:

Multiply side ‘A’ of △1 by the cosecant of 30° , that equals side ‘C’
2” X 2 = 4”

Multiply side ‘A’ of △2 by the cosecant of 30° , that equals side ‘C’
1 1/2” X 2 = 3”

Multiply the tangent of 1/2 the bend angle by the O.D. of the conduit.
Subtract this from the length of side ‘C’ in each △ for the center - center measurement.
Tan 15° = .2679
.2679 X 1” = 1/4”
4” - 1/4” = 3 3/4”
3” - 1/4” = 2 3/4”

Bending a 90° Bend Using 3 - 30° Bends



To Bend a 90° bend using 3 - 30° bends as shown:

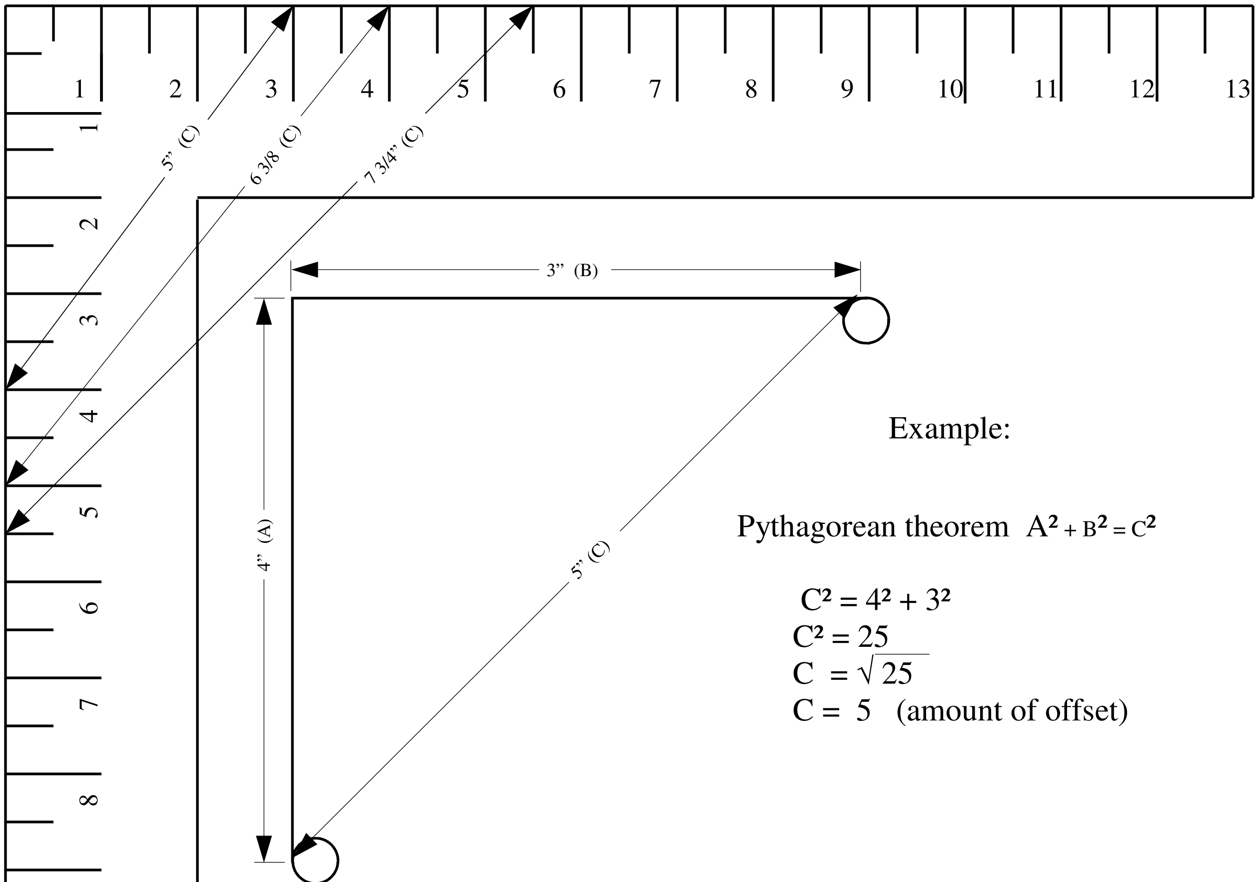
Multiply side 'A' of △1 by the cosecant of 30° to obtain the length of side 'C'.

Since the obstruction is square, side 'C' of △2 will be the same as in △1

Multiply the Tangent of 1/2 the bend angle by the O.D. of the conduit. Subtract this from the length of side 'C' for the center - center measurement.

1 1/2" X 2 = 3"
Tan 15° = .2679
.2679 X 1" = 1/4"
3" - 1/4" = 2 3/4"

To Figure Amount of Offset Needed for A Rolling Offset



Example:

Pythagorean theorem $A^2 + B^2 = C^2$

$C^2 = 4^2 + 3^2$
$C^2 = 25$
$C = \sqrt{25}$
$C = 5$ (amount of offset)

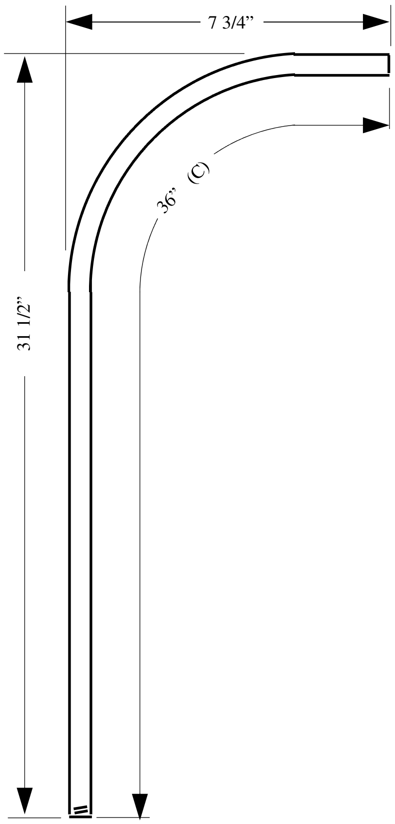
Measure the distance the conduit has to offset up or down and the distance it has to offset right or left. Mark these two figures on any square and measure between them as shown. This will be amount of offset required.

$C^2 = A^2 + B^2$	$C^2 = A^2 + B^2$	$C^2 = A^2 + B^2$
$C^2 = 4^2 + 3^2$	$C^2 = 5^2 + 4^2$	$C^2 = 5.5^2 + 5.5^2$
$C^2 = 25$	$C^2 = 41$	$C^2 = 60.5$
$C = \sqrt{25}$	$C = \sqrt{41}$	$C = \sqrt{60.5}$
$C = 5$	$C = 6.403$ (6 3/8")	$C = 7.778$ (7 3/4")

When laying out a slab to get a square wall use the carpenter's rule called The 3, 4, 5 rule. Just like the triangle above, take any number multiply it by 3, 4, and 5 use these numbers to lay out a square wall.

5' x 3 = 15'	$C^2 = A^2 + B^2$
5' x 4 = 20'	$25^2 = 15^2 + 20^2$
5' x 5 = 25'	$25^2 = 625$
	$25 = \sqrt{625}$
	$25 = 25$

Gain for 90º Bends

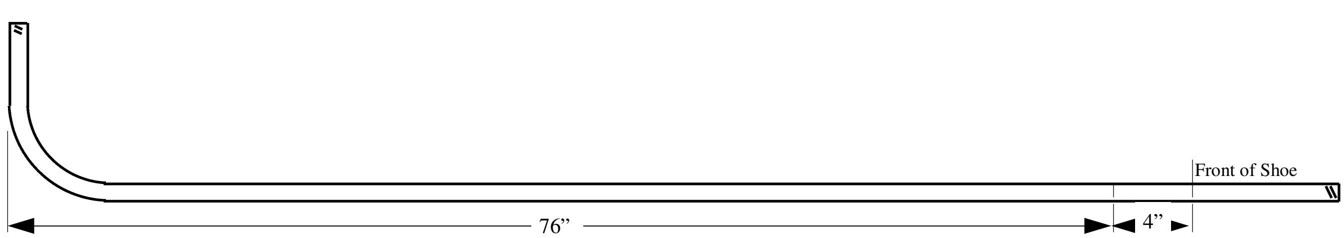


	7 3/4”	
+	31 1/2”	
	39 1/4”	
-	36 ”	(C actual amount of conduit)
	3 1/4”	(amount of gain)

Gain is the difference between the sum of right angle measurements of both legs of the 90º bend and the actual amount of conduit required to make the 90º bend. For standard shoes on Chicago benders the gain is 3 times the outside diameter of the conduit (+ or – a fraction of an inch).

To determine the gain of your bender take a scrap piece of conduit of the size needed. Use 3/4” for the example, and the length is 36”. Put the end of the conduit flush with the front of the shoe and bend a 90º. Measure both legs of the bend very carefully. Say that the two sides measured (7 3/4”) and (31 1/2”), add the two sides (7 3/4” + 31 1/2” = 39 1/4”) Subtract the original length of the conduit form this figure (39 1/4” - 36” = 3 3/4”). This is the gain for a 3/4” 90º.

This is used to cut and thread conduit before bending. Another use is to obtain a figure for back to back 90º bending. If you have back to back 90ºs that are 5 foot, 6 foot, or longer, it is more practical to reverse the conduit in the bender and bend up the short end of the conduit. By putting the original conduit even with the front of the shoe, you now have the stub-up length of the bender (7 3/4”). To obtain back to back figure subtract the gain from the stub up. ((7 3/4” - 3 3/4”) = 4”) Add this figure to the length of the back to back bends.



Bending Conduit Using the Travel Method

To bend conduit using the travel method, place conduit in bender and mark at the back of the rear conduit support. Bend a 90º bend and mark the conduit at the back of the rear conduit support again. Be sure the 90º bend is perfect by checking with a square or a protractor. Measure between the 2 marks. This is the amount of travel for a 90º angle. Divide this figure by 90. This figure is you coefficient number or amount of travel for 1 degree. To find the amount of travel for a specific degree, multiply the coefficient number by the desired degree.

Example:

Travel for 3/4" 90º = 7 1/4"

$$90\overline{)7.25''} = .080''$$ (coefficient #)

15º x .080" = 1.208" =1 3/16" (travel for 15º)

20º x .080" = 1.6" = 1 5/8" (travel for 20º)

30º x .080" = 2.4" =2 3/8" (travel for 30º)

Bend a trial offset in a piece of scrap pipe using the angle you want to bend. You can then adjust you travel figure by pulling a little more or less travel.

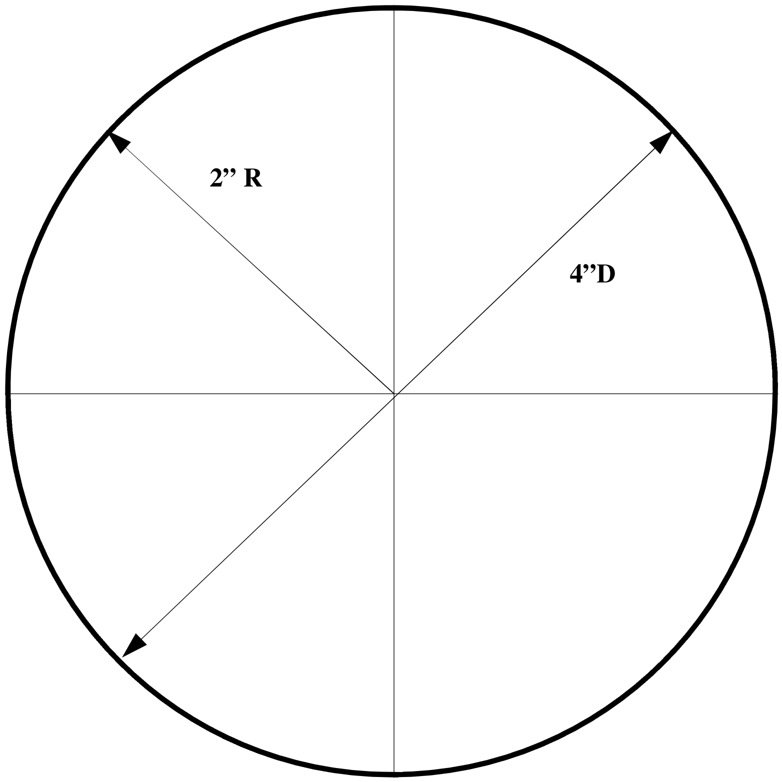
Problem:
To bend a 3 3/4" offset with 20º bends in 3/4 " conduit:

First multiply the amount of offset by the cosecant of the bend angle for the distance between bends (3.75 x 2.92 = 10.95 or 10 15/16"). Place 2 marks 10 15/16" apart on the conduit. Put the 1st mark at the front of the bending shoe and engage the bender. With the weight of the handle on the conduit measure back and mark the conduit 1 5/8" behind the rear conduit support. Pull the conduit through until this mark is at the back of the conduit support. Release and rotate the conduit 180º and place the 2nd mark of your between bends measurement at the front of the bending shoe. Tighten bender to conduit and mark 1 5/8" behind the conduit support. Pull the conduit to this point, and this will give you a 3 3/4" offset bent at 20º.

To match existing offsets:
Measure the amount of offset and the distance between bends. Divide the distance by the amount of offset. This will give you cosecant of the bend angle. Find this cosecant on the chart and the corresponding angle will be the bend angle. You can also use the inverse cosecant on your calculator.

Example:
Match an existing offset of 3 3/4" with distance between bends of 7 1/2".

$$3.75\overline{)7.50} = 2$$ (csc (30º)) = bend angle



Circumference of a circle (360°) = D π = 2 R π

π = 3.1416

Circumference of 1/4 of a circle (90°) = Developed length

Dev. Length = $\frac{R\ 2\ \pi}{4}$

Dev. Length = $\frac{R\ 2\ (3.1416)}{4}$ = R x 1.57

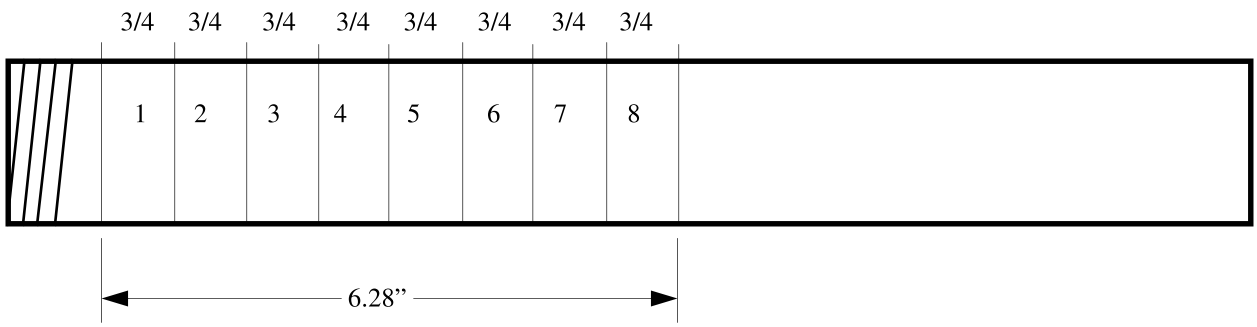
Multiply the radius by 1.57 for the Dev. Length of a 90° bend. This is the amount of straight conduit required to make the bend.

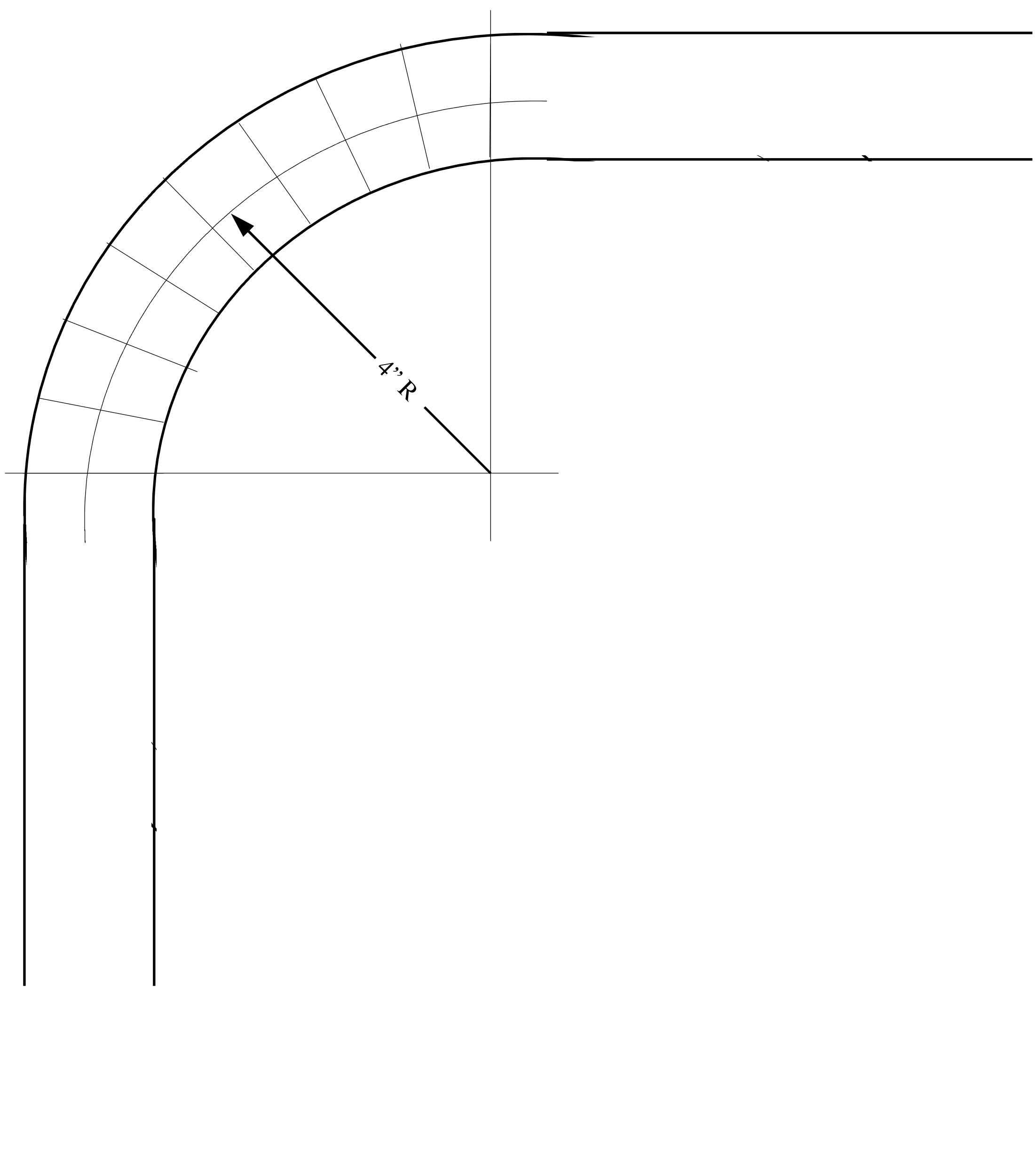
Example:

To make a 90° bend with a 4” center line radius: Multiply the radius (4”) by 1.57 for the Dev. Length (6.28). Divide by one less than the amount of bends, for example 9 – 1 = 8 spaces. Bend 10° at each line.

Dev Length = 1.57 x 4” = 6.28”

.785 or 3/4”
8 spaces /6.28”

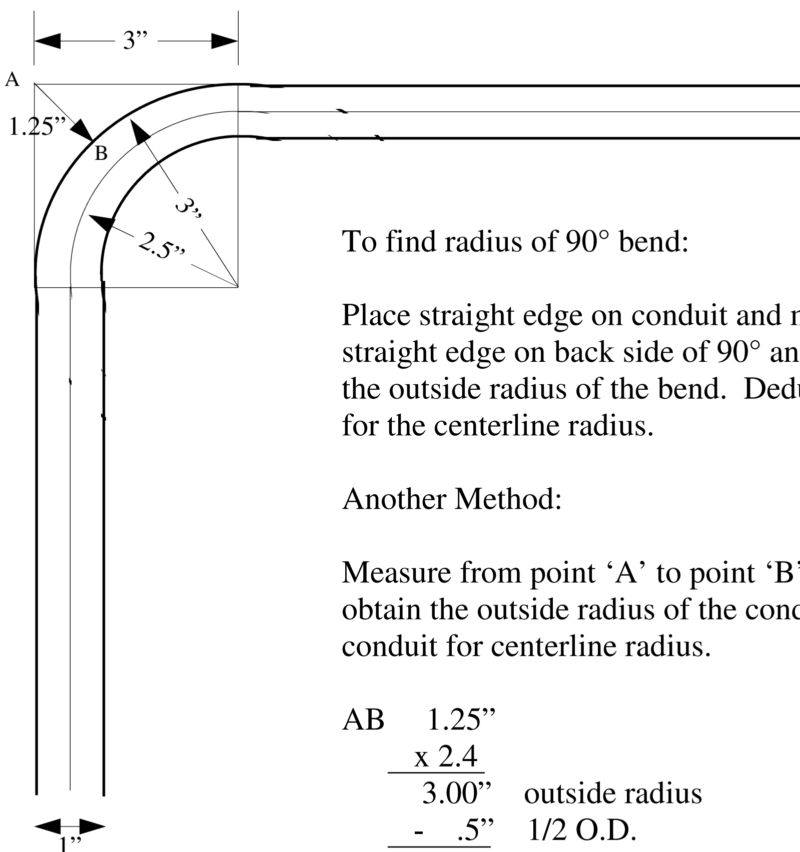




To bend a 90º of any given radius: Determine radius. Code states a minimum of six times the inside diameter of conduit of the inside radius of a 90° bend. Add 1/2 outside diameter of conduit for centerline radius. To determine how many spaces to use and how many degrees to bend use this rule: Length of spaces should not exceed 3” to keep the elbow smooth.

For DL up to 18” - use 8 spaces and bend 10°.
For DL of 19” to 36” - use 17 spaces and bend 5° or 14 spaces and 6°.
For DL over 36” - use 29 spaces and 3º.

You can use any number of spaces. Divide number of spaces +1 into 90° to determine number of degrees to bend.
After you determine how many spaces you will use divide the DL by this number. This will be the length of each space. Mark the conduit and bend the proper number of degrees ant each line.



To find radius of 90° bend:

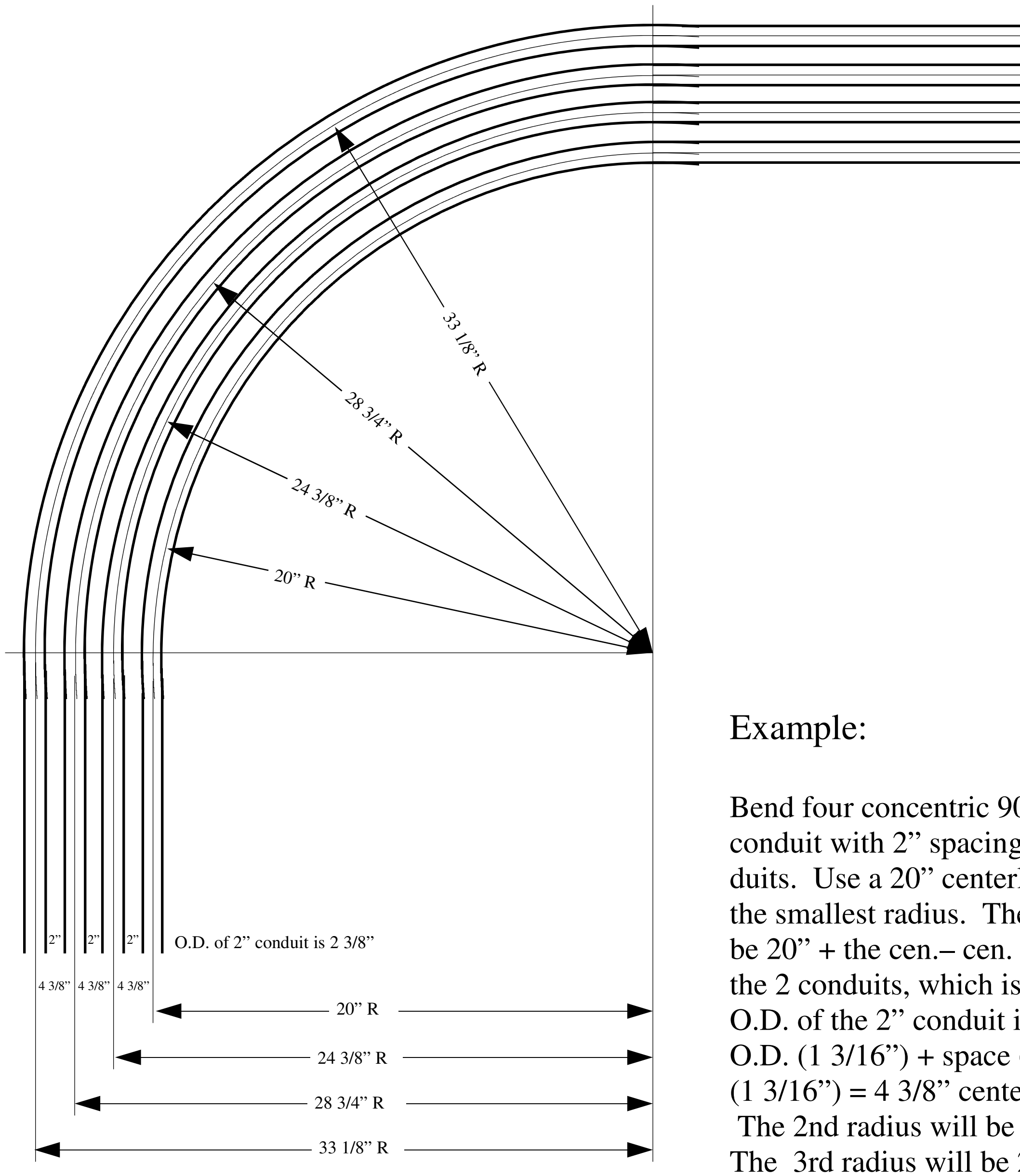
Place straight edge on conduit and mark where bend starts. Place straight edge on back side of 90° and measure to the mark (3”). This is the outside radius of the bend. Deduct 1/2 of the O.D. of the conduit for the centerline radius.

Another Method:

Measure from point ‘A’ to point ‘B’. Multiply this figure by 2.4 to obtain the outside radius of the conduit. Deduct 1/2 of the O.D. of the conduit for centerline radius.

AB	1.25”	
	x 2.4	
	3.00”	outside radius
	- .5”	1/2 O.D.
	2.5”	centerline radius

Concentric Bends



Example:

Bend four concentric 90° bends in 2" conduit with 2" spacing between conduits. Use a 20" centerline radius for the smallest radius. The next radius will be 20" + the cen.– cen. measurement of the 2 conduits, which is 4 3/8". The O.D. of the 2" conduit is 2 3/8" so 1/2 O.D. (1 3/16") + space (2") + 1/2 O.D. (1 3/16") = 4 3/8" center to center.

The 2nd radius will be 24 3/8"
The 3rd radius will be 28 3/4"
The 4th radius will be 33 1/8"

Multiply each radius by 1.57 for Developed length

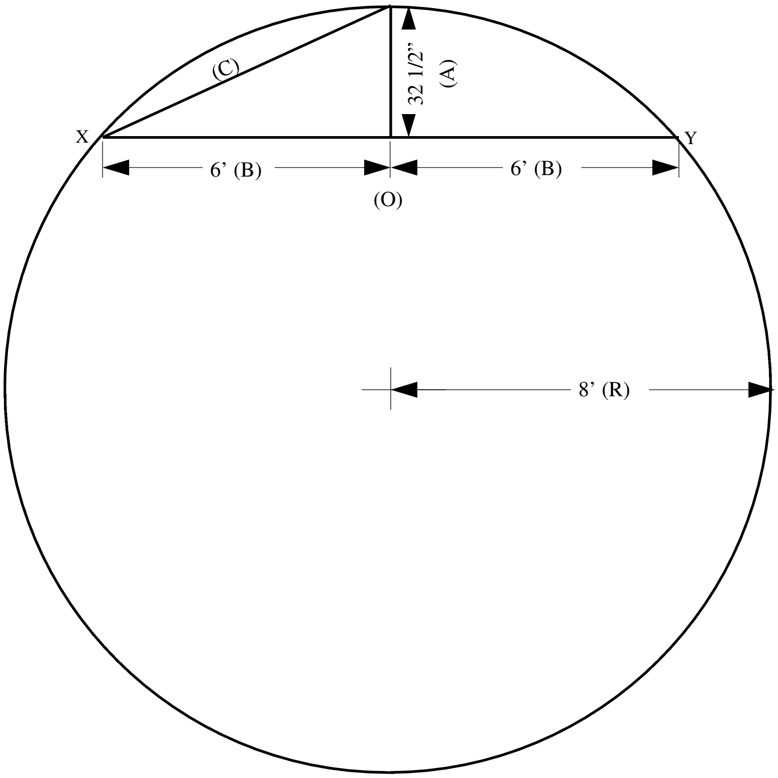
1 20" X 1.57 = 31.40 = 31 3/8"
2 24.375 X 1.57 = 38.269 = 38 1/4"
3 28.75 X 1.57 = 45.138 = 45 1/8"
4 33.125 X 1.57 = 52.006= 52"

Divide each D.L. by 17 (# of spaces)

1 31.40 / 17 = 1.847 = 1 13/16"
2 38.269 / 17 = 2.251 = 2 1/4"
3 45.138 / 17 = 2.655 = 2 5/8"
4 52.00 / 17 = 3.058 = 3 1/ 16"

Mark each conduit from the same starting point 17 spaces 18 marks. Bend 5°at each mark.

To Find Radius of a Tank or Arc



XY — Chord of arc
O — Center of Cord of arc
A — Height of arc
C — Cord of 1/2 the arc
R — radius

The chord is found by laying out 2 points on the circle. These points must be less than the diameter. Make these points (X and Y) an even measurement such as 6’, 8’, 10’ ect. From the center point of XY (O) measure at a right angle to the circle. This figure (A) is the height of the arc. To find the cord of 1/2 the arc use the Pythagorean theorem. To find the radius of the circle use the formula $R = C^2 / 2(A)$.

$A^2 + B^2 = C^2$

$C = \sqrt{A^2 + B^2}$

$C = \sqrt{32.5^{2}” + 72^{2}”}$

$C = \sqrt{6240.25”}$

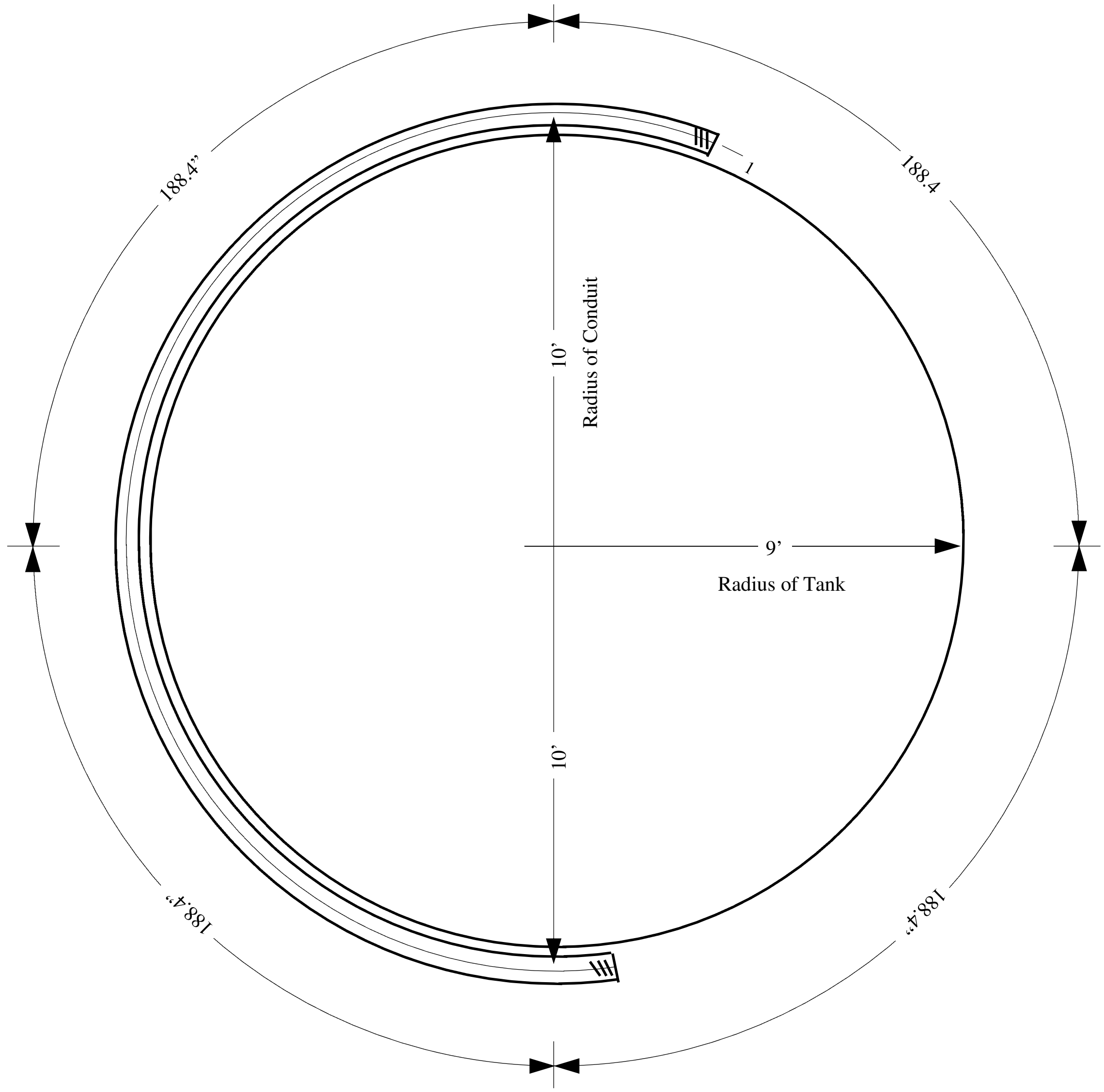
$C = 78.9”$

$R = C^2 / 2(A)$

$R = 6240.25 / 2(32.5)$

$R = 96.0”$ (8’)

To Determine a Radius of Conduit around a Tank



Measure from center of tank to center of conduit. Multiply this figure by 1.57 and convert to inches. This is the developed length for 90° or 1/4 of the circumference of the conduit if it ran completely around the tank. Developed length (188.4“) / spaces (89) = 2.12” or 2 1/8”. Bend 1° at each line. These figures will be the same no matter how far the conduit runs around the tank.
If it is easier to measure around the tank (678.85“) divide this figure by 3.1416 (678.58 / 3.1416 = 216”)
For the diameter of the tank. 1/2 of this figure (108“) is the radius of the tank. Add the distance from the tank to the center of the conduit (12”) for the centerline radius of the conduit (120”)

Example:

(1) 3.1416 ⟌ 678.85” = 216” (tank circumference) (tank diameter)

(2) $\frac{216"}{2}$ = 108” (9’ tank radius)

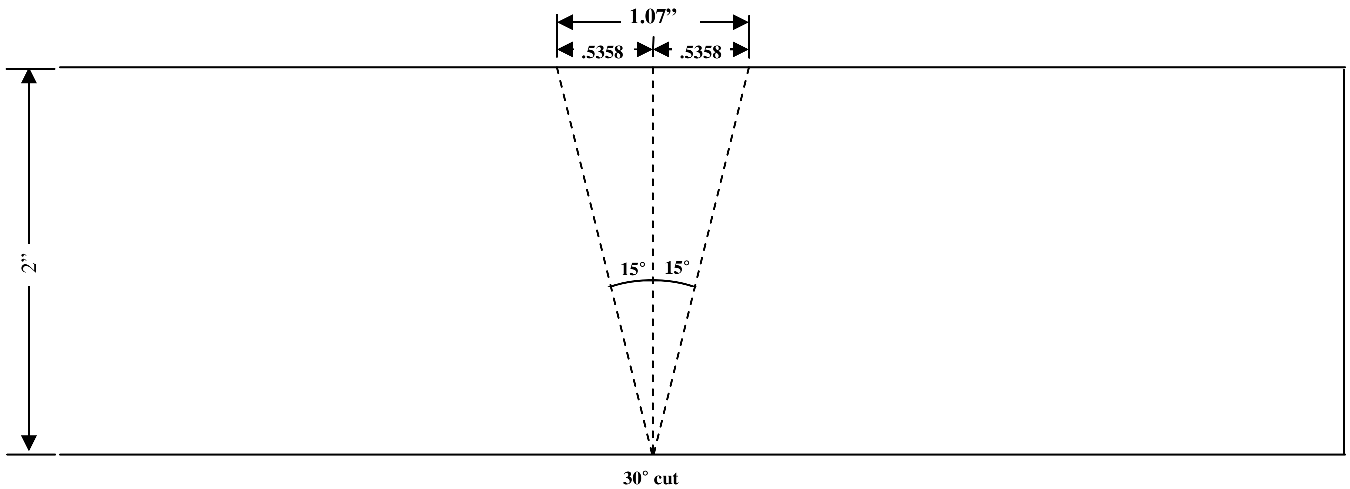
(3) 108” + 12” = 120” (10’ centerline radius)

(4) 120” (centerline radius)
x 1.57
188.4” (Developed length for 90*)

(5) 89 ⟌ 188.4 = 2.12” or 2 1/8 (Length of spaces)

It is almost impossible to bend at one degree. Sometimes it is better to have flat spots between bends and bend at 3° or 5°

Tray Cuts for Any Given Angle



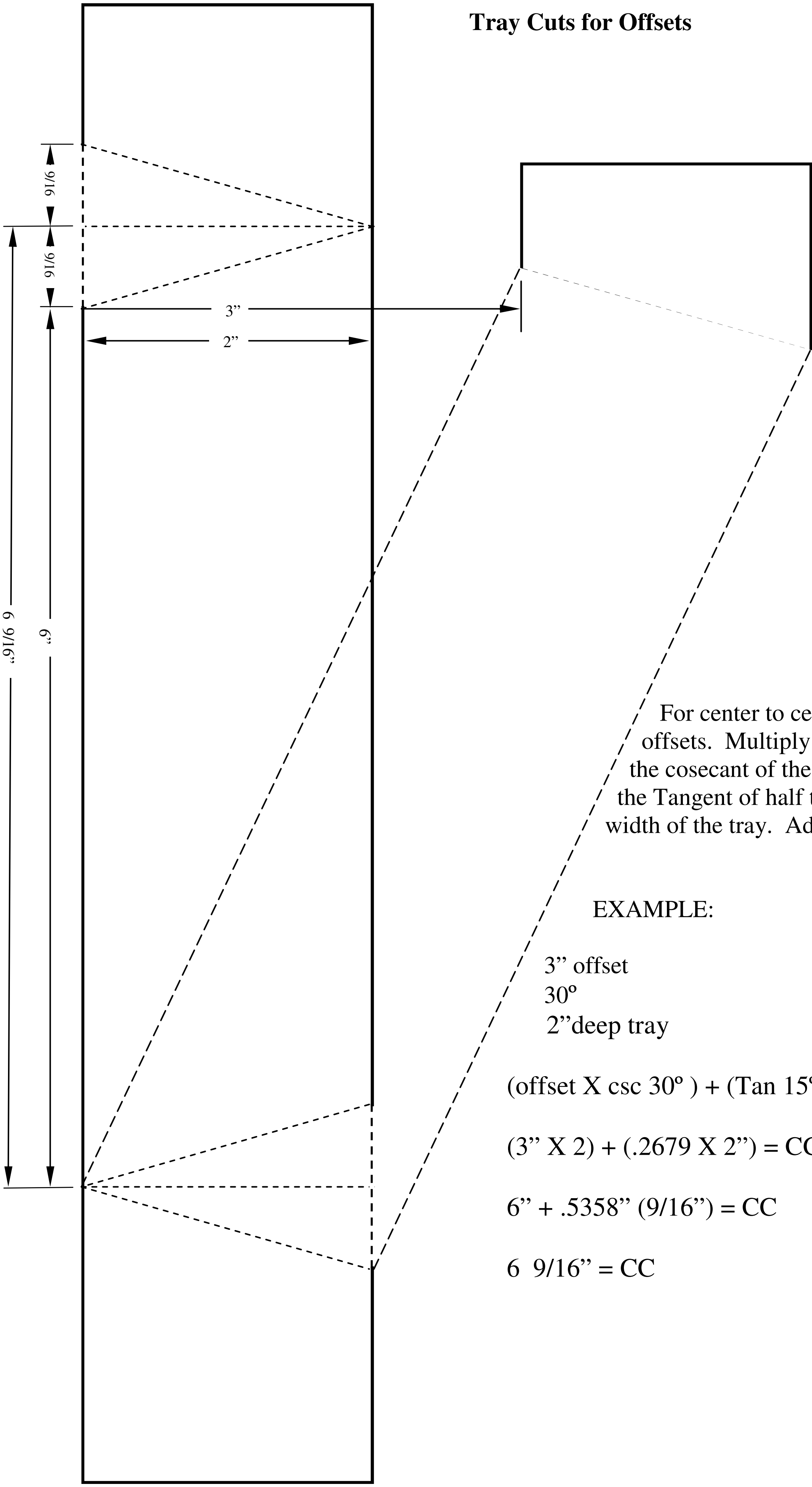
To determine amount to cut from the tray for any given angle: Multiply the depth (or width) of the tray by the tangent of 1/2 the cut angle. Cut this amount from each side of the center line.

$$\text{Tan } 15° = \frac{\text{opp (amount to cut each side of center)}}{\text{adj (depth of width of tray)}}$$

opp = Tan (15°) X adj (2")
opp = .2679 X 2"
opp = .5358" = 17/32"

Cut 17/32" from each side of the center line

Tray Cuts for Offsets



For center to center of cuts on tray offsets. Multiply amount of offset by the cosecant of the angle needed. Multiply the Tangent of half that angle by the depth or width of the tray. Add this to the first figure.

EXAMPLE:

3” offset
30º
2”deep tray

(offset X csc 30º) + (Tan 15º X depth) = CC

(3” X 2) + (.2679 X 2”) = CC

6” + .5358” (9/16”) = CC

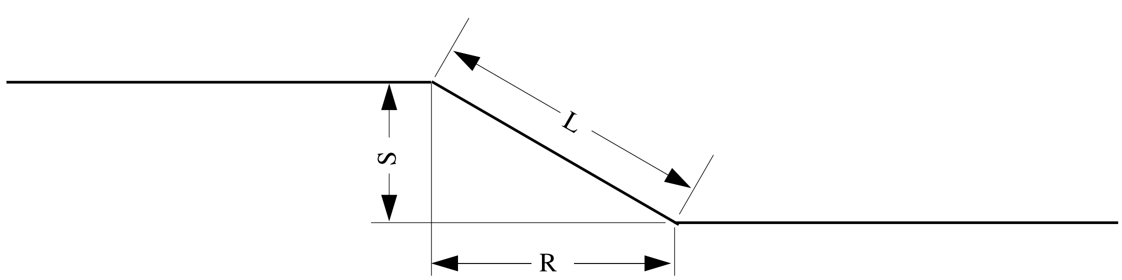
6 9/16” = CC

Conduit	3/4'	1"	1 1/4"	1 1/2"	2"
Travel 15*	1 1/4"	1 1/2"	1 7/8"	2 1/4"	2 1/2"
Travel 20*	1 5/8"	2"	2 1/2"	3"	3 3/8"
Travel 30*	2 3/8"	3"	3 3/4"	4 1/2"	5"
Travel 45*	3 5/8"	4 5/8"	5 5/8"	6 3/4"	7 1/2"
Travel 90*	7 3/8"	9 1/4"	11 1/4"	13 1/2"	15 1/8"
< 2" Offset Hyp.	4 3/4"	5 5/8"	6 7/8"	8 3/4"	13 1/2"

Travel Chart – Figures are approximate and may vary a little with each bender. Cross reference degree of bend and conduit size. This is the amount to pull through for the angle.

Un-known	Known	5°	10°	15°	20°	25°	30°	45°	60°	Trig f(x)
L	S	11.4	5.76	3.86	2.92	2.37	2.00	1.41	1.16	CSC
S	L	.087	.174	.259	.342	.423	.50	.707	.866	SIN
R	S	11.4	5.67	3.73	2.75	2.14	1.76	1.00	5.77	COT
S	R	.087	.176	.268	.364	.466	.577	1.00	1.73	TAN
L	R	1.00	1.02	1.04	1.06	1.10	1.16	1.41	2.00	SEC
R	L	.996	.985	.966	.939	.906	.866	.707	.50	COS

S = amount of offset
L = length between bends
R = center to center of bends after offset is completed



To find unknown: Multiply known figure by the multiplier for desired angle.

Example:
Find (R) if the amount of offset (S) is 2" and the bends are 30°. If (S) is known and (R) is the unknown, that would be line 3 of the chart. Under 30° you find the multiplier is 1.73. Multiply 2" (S) by 1.73 and (R) = 3.46" or 3 7/16".

Trigonometry Functions

sinΘ = $\frac{opp}{hyp}$

cosΘ = $\frac{adj}{hyp}$

tanΘ = $\frac{opp}{hyp}$

cotΘ = $\frac{adj}{opp}$

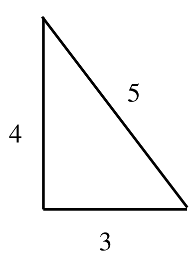
secΘ = $\frac{hyp}{adj}$

cscΘ = $\frac{hyp}{opp}$

Pythagorean Theorem

$A^2 + B^2 = C^2$

3,4,5 rule (right angle rule)



Circumference of a circle

C = R x 2 x π

Angle					Angle				
Degree	Radian	Sine	Cosine	Tangent	Degree	Radian	Sine	Cosine	Tangent
0°	0.000	0.000	1.000	0.000					
1°	0.017	0.017	1.000	0.017	46°	0.803	0.719	0.695	1.036
2°	0.035	0.035	0.999	0.035	47°	0.820	0.731	0.682	1.072
3°	0.052	0.052	0.999	0.052	48°	0.838	0.743	0.669	1.111
4°	0.070	0.070	0.998	0.070	49°	0.855	0.755	0.656	1.150
5°	0.087	0.087	0.996	0.087	50°	0.873	0.766	0.643	1.192
6°	0.105	0.105	0.995	0.105	51°	0.890	0.777	0.629	1.235
7°	0.122	0.122	0.993	0.123	52°	0.908	0.788	0.616	1.280
8°	0.140	0.139	0.990	0.141	53°	0.925	0.799	0.602	1.327
9°	0.157	0.156	0.988	0.158	54°	0.942	0.809	0.588	1.376
10°	0.175	0.174	0.985	0.176	55°	0.960	0.819	0.574	1.428
11°	0.192	0.191	0.982	0.194	56°	0.977	0.829	0.559	1.483
12°	0.209	0.208	0.978	0.213	57°	0.995	0.839	0.545	1.540
13°	0.227	0.225	0.974	0.231	58°	1.012	0.848	0.530	1.600
14°	0.244	0.242	0.970	0.249	59°	1.030	0.857	0.515	1.664
15°	0.262	0.259	0.966	0.268	60°	1.047	0.866	0.500	1.732
16°	0.279	0.276	0.961	0.287	61°	1.065	0.875	0.485	1.804
17°	0.297	0.292	0.956	0.306	62°	1.082	0.883	0.469	1.881
18°	0.314	0.309	0.951	0.325	63°	1.100	0.891	0.454	1.963
19°	0.332	0.326	0.946	0.344	64°	1.117	0.899	0.438	2.050
20°	0.349	0.342	0.940	0.364	65°	1.134	0.906	0.423	2.145
21°	0.367	0.358	0.934	0.384	66°	1.152	0.914	0.407	2.246
22°	0.384	0.375	0.927	0.404	67°	1.169	0.921	0.391	2.356
23°	0.401	0.391	0.921	0.424	68°	1.187	0.927	0.375	2.475
24°	0.419	0.407	0.914	0.445	69°	1.204	0.934	0.358	2.605
25°	0.436	0.423	0.906	0.466	70°	1.222	0.940	0.342	2.748
26°	0.454	0.438	0.899	0.488	71°	1.239	0.946	0.326	2.904
27°	0.471	0.454	0.891	0.510	72°	1.257	0.951	0.309	3.078
28°	0.489	0.469	0.883	0.532	73°	1.274	0.956	0.292	3.271
29°	0.506	0.485	0.875	0.554	74°	1.292	0.961	0.276	3.487
30°	0.524	0.500	0.866	0.577	75°	1.309	0.966	0.259	3.732
31°	0.541	0.515	0.857	0.601	76°	1.326	0.970	0.242	4.011
32°	0.559	0.530	0.848	0.625	77°	1.344	0.974	0.225	4.332
33°	0.576	0.545	0.839	0.649	78°	1.361	0.978	0.208	4.705
34°	0.593	0.559	0.829	0.675	79°	1.379	0.982	0.191	5.145
35°	0.611	0.574	0.819	0.700	80°	1.396	0.985	0.174	5.671
36°	0.628	0.588	0.809	0.727	81°	1.414	0.988	0.156	6.314
37°	0.646	0.602	0.799	0.754	82°	1.431	0.990	0.139	7.115
38°	0.663	0.616	0.788	0.781	83°	1.449	0.993	0.122	8.144
39°	0.681	0.629	0.777	0.810	84°	1.466	0.995	0.105	9.514
40°	0.698	0.643	0.766	0.839	85°	1.484	0.996	0.087	11.43
41°	0.716	0.656	0.755	0.869	86°	1.501	0.998	0.070	14.30
42°	0.733	0.669	0.743	0.900	87°	1.518	0.999	0.052	19.08
43°	0.750	0.682	0.731	0.933	88°	1.536	0.999	0.035	28.64
44°	0.768	0.695	0.719	0.966	89°	1.553	1.000	0.017	57.29
45°	0.785	0.707	0.707	1.000	90°	1.571	1.000	0.000	

Using a Folding Rule to Find Angles

Degrees	Inches	Degrees	Inches	Degrees	Inches
2.36	1/32”	34.31	1 3/4”	65.91	5 7/8”
4.72	1/16”	37.02	2”	68.40	6 3/8”
6.98	1/8”	39.74	2 1/4”	70.82	7”
9.25	3/16”	42.47	2 5/8”	73.25	7 3/8”
12.27	1/4”	45.16	2 15/16”	75.58	7 3/4”
15.30	3/8”	47.85	3 1/4”	77.92	8 1/4”
18.00	1/2”	50.50	3 9/16”	80.18	8 9/16”
20.70	5/8”	53.16	4”	82.45	9”
23.41	3/4”	55.76	4 3/8”	84.61	9 7/16”
26.13	1”	58.37	4 9/16”	86.78	10 1/16”
28.86	1 1/8”	60.90	4 7/8”	88.39	10 3/8”
31.60	1 3/8”	63.43	5 9/16”	90.00	10 3/4”

Use folding rule to check degrees. Fold the rule at 18” joint and again at 36” joint. When the end is at 10 3/4”, a 90 degree bend is formed at the 18” joint. The opposite side of the 18” mark is 54”