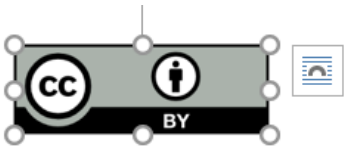


Disclaimer

This workforce product was funded by a grant awarded by the U.S. Department of Labor's Employment and Training Administration. The product was created by the grantee and does not necessarily reflect the official position of the U.S. Department of Labor. The U.S. Department of Labor makes no guarantees, warranties, or assurances of any kind, express or implied, with respect to such information, including any information on linked sites and including, but not limited to, accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability, or ownership.

MFGT 140
Fabrication Methods 2

Book 1 of 2

Manufacturing Processes, Equations & Equipment Operation

This book should come to every Fabrication class you have. Every day!

Reference materials for calculating weights, flat patterns, bending, cutting, drilling, manufacturing parts and running equipment.

Written by:
Jay Schimelfenig
Associate Professor
NDSCS Manufacturing Dept.

Revised 5/4/2017

NSCS®

Project Book
MANUFACTURING TECHNOLOGIES

THE SCIENCE OF SUCCESS

INCH/METRIC TAP DRILL SIZES & DECIMAL EQUIVALENTS

Drill Size	Decimal Equivalent	Tap Size
80	.0135	
79	.0145	
1/64	.0156	
78	.0160	
77	.0180	
76	.0200	
75	.0210	
74	.0225	
73	.0240	
72	.0250	
71	.0260	
70	.0280	
69	.0292	
68	.0310	
1/32	.0312	
67	.0320	
66	.0330	
65	.0350	
64	.0360	
63	.0370	
62	.0380	
61	.0390	
60	.0400	
59	.0410	
58	.0420	
57	.0430	
56	.0465	
3/64	.0469	0 - 80
55	.0520	
54	.0550	
53	.0595	1 - 64, 72
1/16	.0625	
52	.0635	
51	.0670	
50	.0700	2 - 56, 64
49	.0730	
48	.0760	
5/64	.0781	
47	.0785	3 - 48
46	.0810	
45	.0820	3 - 56
44	.0860	
43	.0890	4 - 40
42	.0935	4 - 48
3/32	.0938	
41	.0960	
40	.0980	
39	.0995	
38	.1015	5 - 40
37	.1040	5 - 44
36	.1065	6 - 32
7/64	.1094	
35	.1100	
34	.1110	
33	.1130	6 - 40
32	.1160	
31	.1200	
1/8	.1250	
30	.1285	
29	.1360	8 - 32, 36
28	.1405	
9/64	.1406	
27	.1440	
26	.1470	
25	.1495	10 - 24
24	.1520	
23	.1540	
5/32	.1562	
22	.1570	
21	.1590	10 - 32
20	.1610	
19	.1660	
18	.1695	
11/64	.1719	
17	.1730	
16	.1770	12 - 24
15	.1800	
14	.1820	12 - 28
13	.1850	
3/16	.1875	
12	.1890	
11	.1910	

Drill Size	Decimal Equivalent	Tap Size
10	.1935	
9	.1960	
8	.1990	
7	.2010	1/4 - 20
13/64	.2031	
6	.2040	
5	.2055	
4	.2090	
3	.2130	1/4 - 28
7/32	.2188	
2	.2210	
1	.2280	
A	.2340	
15/64	.2344	
B	.2380	
C	.2420	
D	.2460	
1/4	.2500	
E	.2500	
F	.2570	5/16 - 18
G	.2610	
17/64	.2656	
H	.2660	
I	.2720	5/16 - 24
J	.2770	
K	.2810	
9/32	.2812	
L	.2900	
M	.2950	
19/64	.2969	
N	.3020	
5/16	.3125	3/8 - 16
O	.3160	
P	.3230	
21/64	.3281	
Q	.3320	3/8 - 24
R	.3390	
11/32	.3438	
S	.3480	
T	.3580	
23/64	.3594	
U	.3680	7/16 - 14
3/8	.3750	
V	.3770	
W	.3860	
25/64	.3906	7/16 - 20
X	.3970	
Y	.4040	
13/32	.4062	
Z	.4130	
27/64	.4219	1/2 - 13
7/16	.4375	
29/64	.4531	1/2 - 20
15/32	.4688	
31/64	.4844	9/16 - 12
1/2	.5000	
33/64	.5156	9/16 - 18
17/32	.5312	5/8 - 11
35/64	.5469	
9/16	.5625	
37/64	.5781	5/8 - 18
19/32	.5938	
39/64	.6094	
5/8	.6250	
41/64	.6406	
21/32	.6562	3/4 - 10
43/64	.6719	
11/16	.6875	3/4 - 16
45/64	.7031	
23/32	.7188	
47/64	.7344	
3/4	.7500	
49/64	.7656	7/8 - 9
25/32	.7812	
51/64	.7969	
13/16	.8125	7/8 - 14
53/64	.8281	
27/32	.8438	
55/64	.8594	
7/8	.8750	1 - 8
57/64	.8906	
29/32	.9062	

Drill Size	Decimal Equivalent	Tap Size
59/64	.9219	1 - 12
15/16	.9375	1 - 14
61/64	.9531	
31/32	.9688	
63/64	.9844	1 1/8 - 7
1	1.0000	
1 3/64	1.0469	1 1/8 - 12
1 7/64	1.1094	1 1/4 - 7
1 1/8	1.1250	
1 11/64	1.1719	1 1/4 - 12
1 7/32	1.2188	1 3/8 - 6
1 1/4	1.2500	
1 19/64	1.2969	1 3/8 - 12
1 11/32	1.3438	1 1/2 - 6
1 3/8	1.3750	
1 27/64	1.4219	1 1/2 - 12
1 1/2	1.5000	

METRIC TAP DRILL SIZES

Metric Tap	Tap Drill (mm)	Decimal (inch)
M1.6 x 0.35	1.25	.0492
M1.8 x 0.35	1.45	.0571
M2 x 0.4	1.60	.0630
M2.2 x 0.45	1.75	.0689
M2.5 x 0.45	2.05	.0807
M3 x 0.5	2.50	.0984
M3.5 x 0.6	2.90	.1142
M4 x 0.7	3.30	.1299
M4.5 x 0.75	3.70	.1457
M5 x 0.8	4.20	.1654
M6 x 1	5.00	.1968
M7 x 1	6.00	.2362
M8 x 1.25	6.70	.2638
M8 x 1	7.00	.2756
M10 x 1.5	8.50	.3346
M10 x 1.25	8.70	.3425
M12 x 1.75	10.20	.4016
M12 x 1.25	10.80	.4252
M14 x 2	12.00	.4724
M14 x 1.5	12.50	.4921
M16 x 2	14.00	.5512
M16 x 1.5	14.50	.5709
M18 x 2.5	15.50	.6102
M18 x 1.5	16.50	.6496
M20 x 2.5	17.50	.6890
M20 x 1.5	18.50	.7283
M22 x 2.5	19.50	.7677
M22 x 1.5	20.50	.8071
M24 x 3	21.00	.8268
M24 x 2	22.00	.8661
M27 x 3	24.00	.9449
M27 x 2	25.00	.9843
M30 x 3.5	26.50	1.0433
M30 x 2	28.00	1.1024
M33 x 3.5	29.50	1.1614
M33 x 2	31.00	1.2205
M36 x 4	32.00	1.2598
M36 x 3	33.00	1.2992
M39 x 4	35.00	1.3780
M39 x 3	36.00	1.4173

Pipe Thread Sizes (NPSC)

Thread	Drill	Thread	Drill
1/8 – 27	11/32	1 1/2 – 11 1/2	1 3/4
1/4 – 18	7/16	2 – 11 1/2	2 7/32
3/8 – 18	37/64	2 1/2 – 8	2 21/32
1/2 – 14	23/32	3 – 8	3 1/4
3/4 – 14	59/64	3 1/2 – 8	3 3/4
1 – 11 1/2	1 5/32	4 – 8	4 1/4
1 1/4 – 11 1/2	1 1/2		

PRECISION MACHINE TOOLING & WELDING TECHNOLOGIES

MILLIMETER - INCH CONVERSION CHART

mm	decimal	inch
	0.015	1/64
	0.031	1/32
1	0.0394	
	0.062	1/16
2	0.0787	
	0.093	3/32
3	0.1181	
	0.125	1/8
	0.156	5/32
4	0.1575	
	0.187	3/16
5	0.1969	
	0.218	7/32
6	0.2362	
	0.250	1/4
7	0.2756	
	0.281	9/32
	0.312	5/16
8	0.3150	
	0.343	11/32
9	0.3543	
	0.375	3/8
10	0.3937	
	0.406	13/32
11	0.4331	
	0.437	7/16
	0.468	15/32
12	0.4724	
	0.500	1/2
13	0.5118	
	0.531	17/32
14	0.5512	
	0.562	9.16
15	0.5906	
	0.593	19/32
	0.625	5/8
16	0.6299	
	0.656	21/32
17	0.6693	
	0.687	11/16
18	0.7087	
	0.718	23/32
19	0.7480	
	0.750	3/4
	0.781	25/32
20	0.7874	
	0.812	13/16
21	0.8268	
	0.843	27/32
22	0.8661	
	0.875	7/8
23	0.9055	
	0.906	29/32
	0.937	15/16
24	0.9449	
	0.968	31/32
25	0.9843	
	1.000	1
26	1.0236	
	1.0310	1-1/32
	1.0620	1-1/16
27	1.0630	
	1.0930	1-3/32
28	1.1024	
	1.125	1-1/8
29	1.1417	
	1.156	1-5/32
30	1.1811	
	1.187	1-3/16
	1.218	1-7/32
31	1.2205	
	1.250	1-1/4
32	1.2598	
	1.281	1-9/32

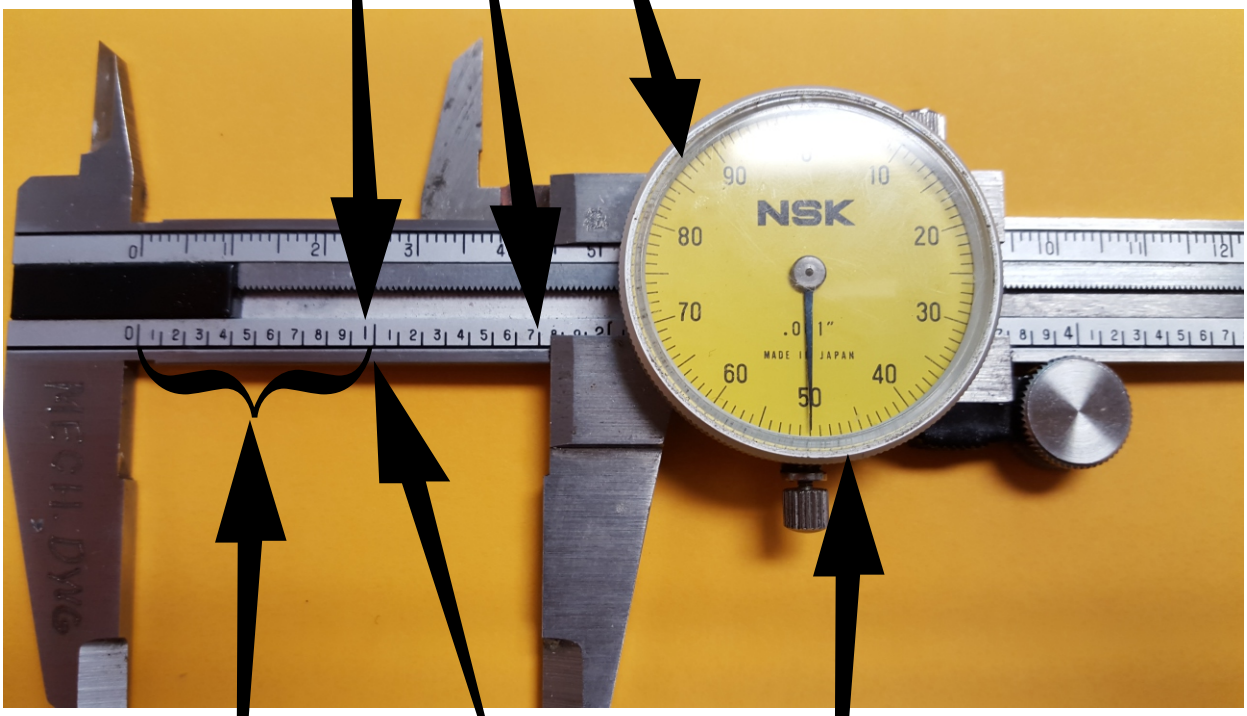
mm	decimal	inch
33	1.2992	
	1.312	1-5/16
34	1.3386	
	1.343	1-11/32
	1.375	1-3/8
35	1.3780	
	1.406	1-13/32
36	1.4173	
	1.437	1-7/16
37	1.4567	
	1.468	1-15/32
38	1.4961	
	1.500	1-1/2
	1.531	1-17/32
39	1.5354	
	1.562	1-9/16
40	1.5748	
	1.593	1-19/32
41	1.6142	
	1.625	1-5/8
42	1.6535	
	1.656	1-21/32
	1.687	1-11/16
43	1.6929	
	1.718	1-23/32
44	1.7323	
	1.750	1-3/4
45	1.7717	
	1.781	1-25/32
46	1.8110	
	1.812	1-13/16
	1.843	1-27/32
47	1.8504	
	1.875	1-7/8
48	1.8898	
	1.906	1-29/32
49	1.9291	
	1.9370	1-15/16
	1.968	1-31/32
50	1.9685	
	2.000	2
51	2.0079	
	2.0310	2-1/32
52	2.0472	
	2.0620	2-1/16
53	2.0866	
	2.0930	2-3/32
	2.125	2-1/8
54	2.1260	
	2.156	2-5/32
55	2.1654	
	2.187	2-3/16
56	2.2047	
	2.218	2-7/32
57	2.2441	
	2.250	2-1/4
	2.281	2-9/32
58	2.2835	
	2.312	2-5/16
59	2.3228	
	2.343	2-11/32
60	2.3622	
	2.375	2-3/8
61	2.4016	
	2.406	2-13/32
	2.437	2-7/16
62	2.4409	
	2.468	2-15/32
63	2.4803	
	2.500	2-1/2
64	2.5197	
	2.531	2-17/32

mm	decimal	inch
65	2.5591	
	2.562	2-9/16
	2.593	2-19/32
66	2.5984	
	2.625	2-5/8
67	2.6378	
	2.656	2-21/32
68	2.6772	
	2.687	2-11/16
69	2.7165	
	2.718	2-23/32
	2.750	2-3/4
70	2.7559	
	2.781	2-25/32
71	2.7953	
	2.812	2-13/16
72	2.8346	
	2.843	2-27/32
73	2.8740	
	2.875	2-7/8
	2.906	2-29/32
74	2.9134	
	2.9370	2-15/16
75	2.9528	
	2.968	2-31/32
76	2.9921	
	3.000	3
	3.0310	3-1/32
77	3.0315	
	3.0620	3-1/16
78	3.0709	
	3.0930	3-3/32
79	3.1102	
	3.125	3-1/8
80	3.1496	
	3.156	3-5/32
	3.187	3-3/16
81	3.1890	
	3.218	3-7/32
82	3.2283	
	3.250	3-1/4
83	3.2677	
	3.281	3-9/32
84	3.3071	
	3.312	3-5/16
	3.343	3-11/32
85	3.3465	
	3.375	3-3/8
86	3.3858	
	3.406	3-13/32
87	3.4252	
	3.437	3-7/16
88	3.4646	
	3.468	3-15/32
	3.500	3-1/2
89	3.5039	
	3.531	3-17/32
90	3.5433	
	3.562	3-9/16
91	3.5827	
	3.593	3-19/32
92	3.6220	
	3.625	3-5/8
	3.656	3-21/32
93	3.6614	
	3.687	3-11/16
94	3.7008	
	3.718	3-23/32
95	3.7402	
	3.750	3-3/4
96	3.7795	
	3.781	3-25/32
	3.812	3-13/16

mm	decimal	inch
97	3.8189	
	3.843	3-27/32
98	3.8583	
	3.875	3-7/8
99	3.8976	
	3.906	3-29/32
100	3.9370	3-15/16
	3.968	3-31/32
101	3.9764	
	4.000	4
102	4.0157	
	4.0310	4-1/32
103	4.0551	
	4.0620	4-1/16
	4.0930	4-3/32
104	4.0945	
	4.125	4-1/8
105	4.1339	
	4.156	4-5/32
106	4.1732	
	4.187	4-3/16
107	4.2126	
	4.218	4-7/32
	4.250	4-1/4
108	4.2520	
	4.281	4-9/32
109	4.2913	
	4.312	4-5/16
110	4.3307	
	4.343	4-11/32
111	4.3701	
	4.375	4-3/8
	4.406	4-13/32
112	4.4094	
	4.437	4-7/16
113	4.4488	
	4.468	4-15/32
114	4.4882	
	4.500	4-1/2
115	4.5276	
	4.531	4-17/32
	4.562	4-9/16
116	4.5669	
	4.593	4-19/32
117	4.6063	
	4.625	4-5/8
118	4.6457	
	4.656	4-21/32
119	4.6850	
	4.687	4-11/16
	4.718	4-23/32
120	4.7244	
	4.750	4-3/4
121	4.7638	
	4.781	4-25/32
122	4.8031	
	4.812	4-13/16
123	4.8425	
	4.843	4-27/32
	4.875	4-7/8
124	4.8819	
	4.906	4-29/32
125	4.9213	
	4.9370	4-15/16
126	4.9606	
	4.968	4-31/32
127	5.000	5

Dial Caliper Reading

1.750



Tenths
.1, .2, .3,

Inches
1, 2, 3,

Hundreths
.01, .02, .03
Thousandths
.015, .025, .035

Dial Caliper Reading

Dial Caliper Reading

Dial Caliper Reading

The Fine Art of Sheet

http://www.pa-international.com.au/pa/indexbaa2.ht

These pages deleted due to c

Metal Fabrication

ml?option=com_easyblog&view=entry&id=23&Itemid=177

copyrighted information.

The Fine Art of Sheet

http://www.pa-international.com.au/pa/indexbaa2.ht

These pages deleted due to c

Metal Fabrication

ml?option=com_easyblog&view=entry&id=23&Itemid=177

copyrighted information.

The Fine Art of Sheet

http://www.pa-international.com.au/pa/indexbaa2.ht

These pages deleted due to c

Metal Fabrication

ml?option=com_easyblog&view=entry&id=23&Itemid=177

copyrighted information.

The Fine Art of Sheet

http://www.pa-international.com.au/pa/indexbaa2.ht

These pages deleted due to c

Metal Fabrication

ml?option=com_easyblog&view=entry&id=23&Itemid=177

copyrighted information.

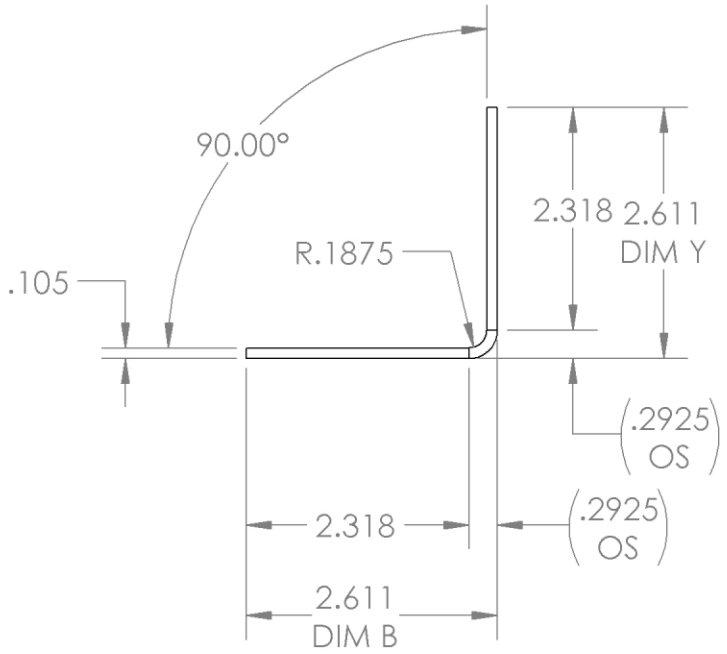
BEND DEDUCTION
DIM Y + DIM B - FLAT LENGTH
2.611 + 2.611 - 5.00 = .222

OUTSIDE SETBACK (OS)
90° BEND:
MT + BEND RADIUS
.105 + .1875 = .2925

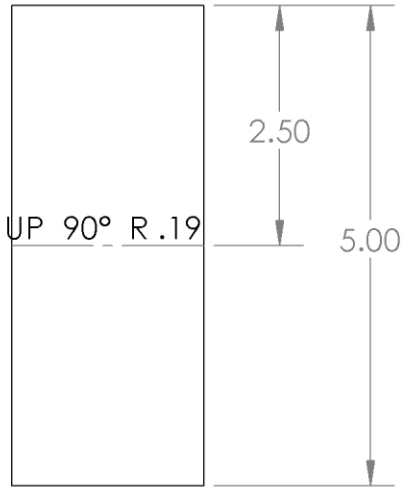
NON 90° BEND:
(TAN(ANGLE/2)) x (MT + RADIUS)
(TAN(90/2)) x (.105 + .1875) = .2925

BEND ALLOWANCE
(2 x OS)- BEND DEDUCTION
(2 x .2925) - .222 = .363

K-FACTOR (IF UNKNOWN)
(-BEND RADIUS + (BEND ALLOWANCE
/(3.1416 x BEND ANGLE/180))) /
MAT'L THICKNESS
(-.1875+(.363/(3.1416x90)/180)))/.104= .419



FORMED PATTERN



FLAT PATTERN

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 12 GA SHEET	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

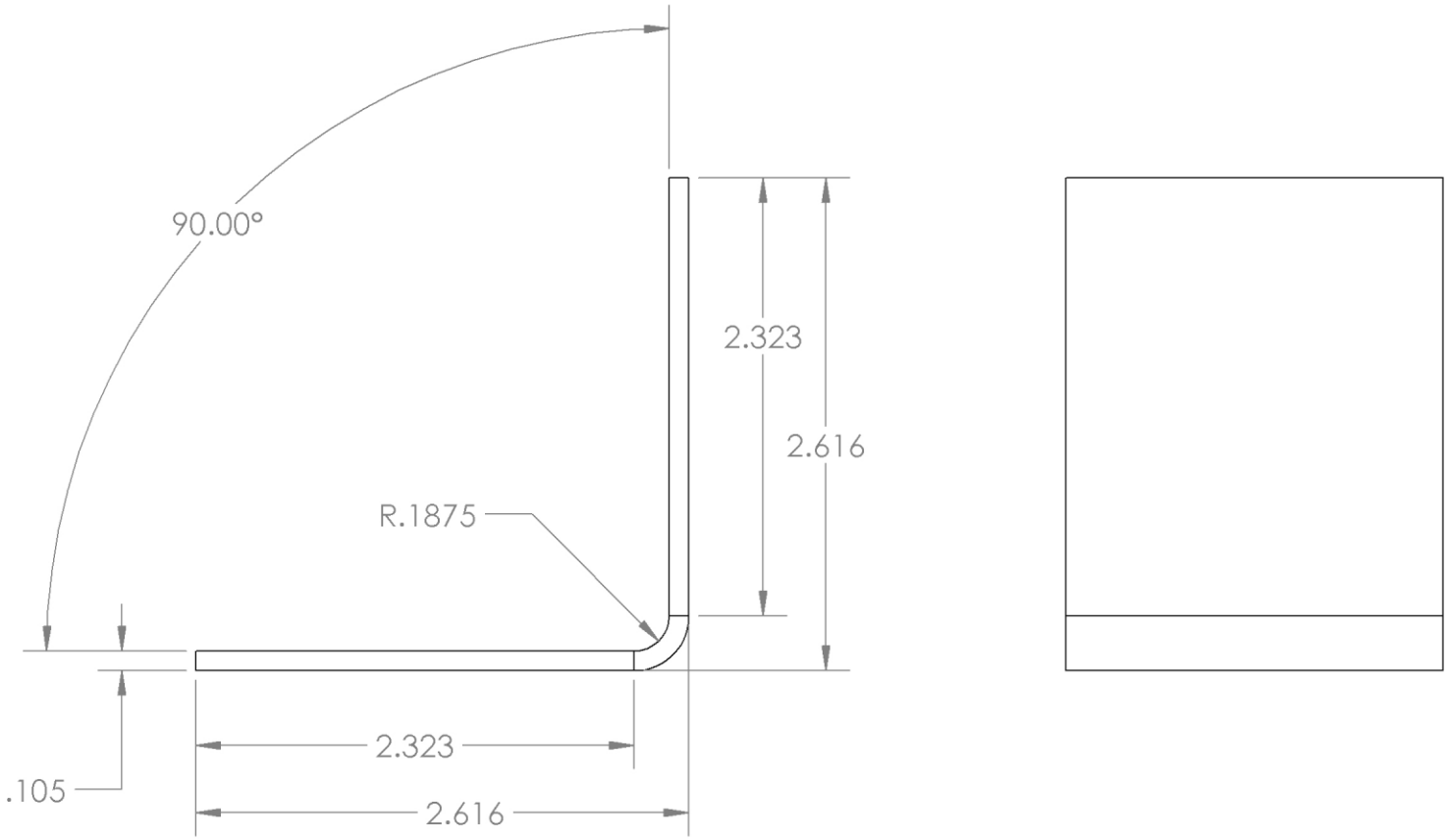
North Dakota State College of Science

TITLE:

K-FACTOR .42

SIZE	DWG. NO.	REV
A	Kfac 42	
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1



		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 12 GA SHEET	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

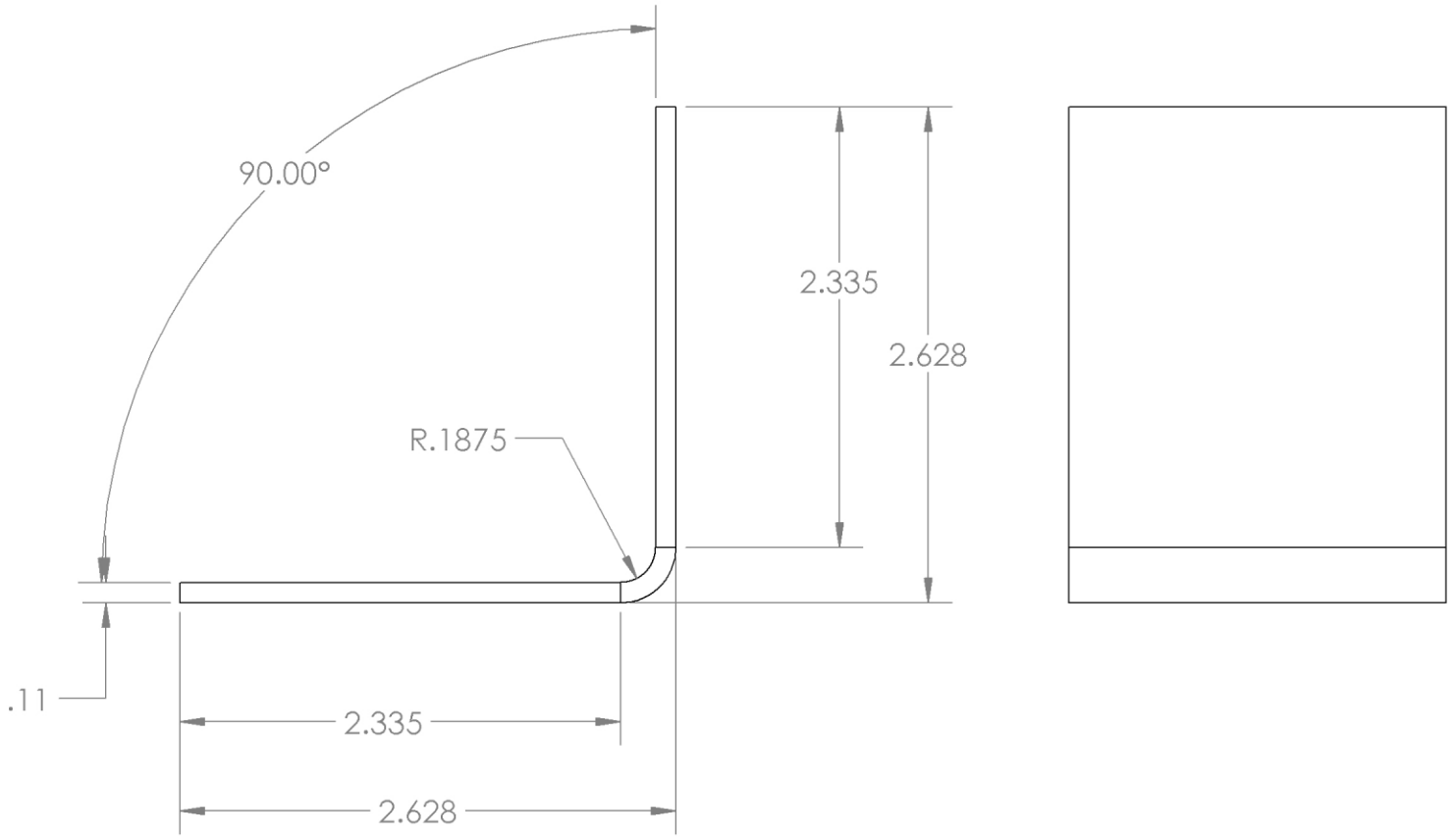
TITLE:

K-FACTOR .36

SIZE	DWG. NO.	REV
A	Kfac 36	

SCALE: 1:1 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1



		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 12 GA SHEET	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

TITLE:

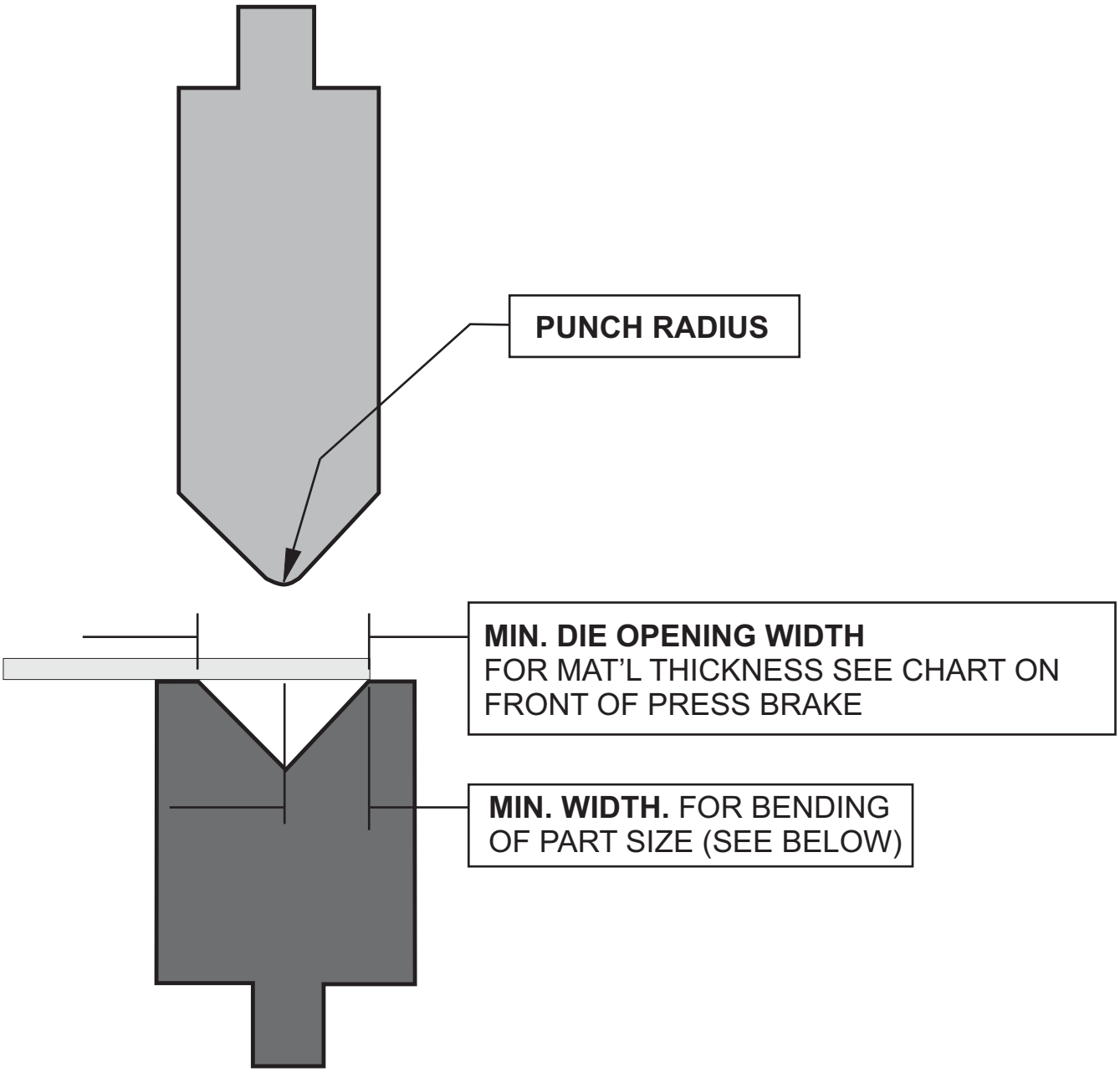
K-FACTOR .21

SIZE	DWG. NO.	REV
A	Kfac 21	

SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

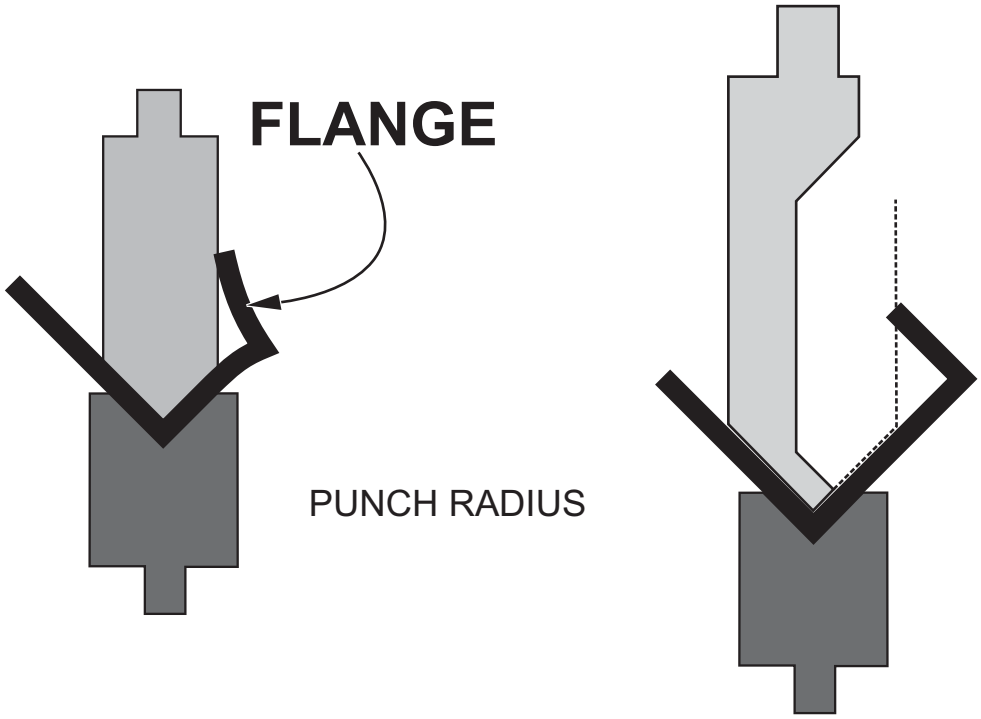
5 4 3 2 1

90° AIR FORMING PUNCHES
THINGS WE HAVE TO KNOW.

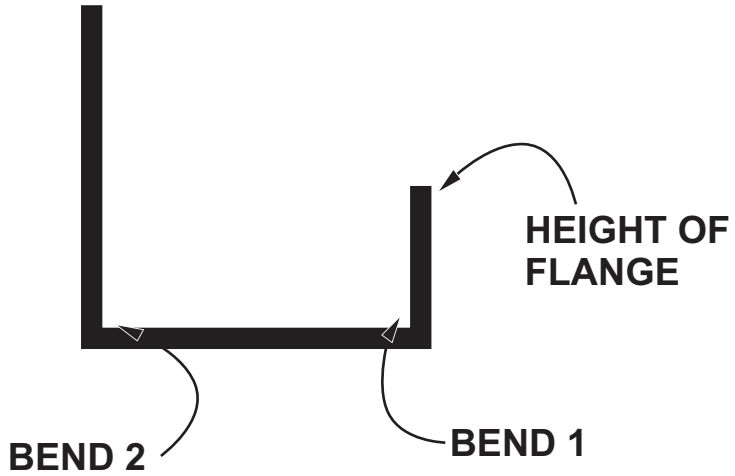


The Flange width and inside radius affect forming of the flange. For mild steel the minimum flange width is 4 times the material thickness plus the inside radius. For softer materials a shorter flange can be used and for harder materials a longer flange is required.

CRASHING THE FLANGE

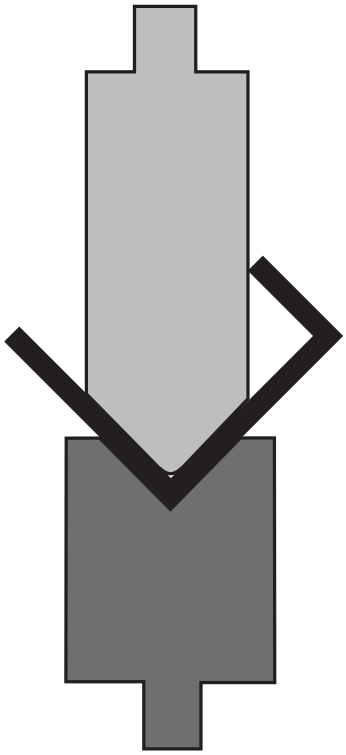


WHAT IS THE ANGLE OF BEND 1 & 2?
WHAT IS THE DISTANCE BETWEEN BEND 1 & 2?
WHAT IS THE HEIGHT OF THE FLANGE?
WHAT IS THE WIDTH OF THE PUNCH?

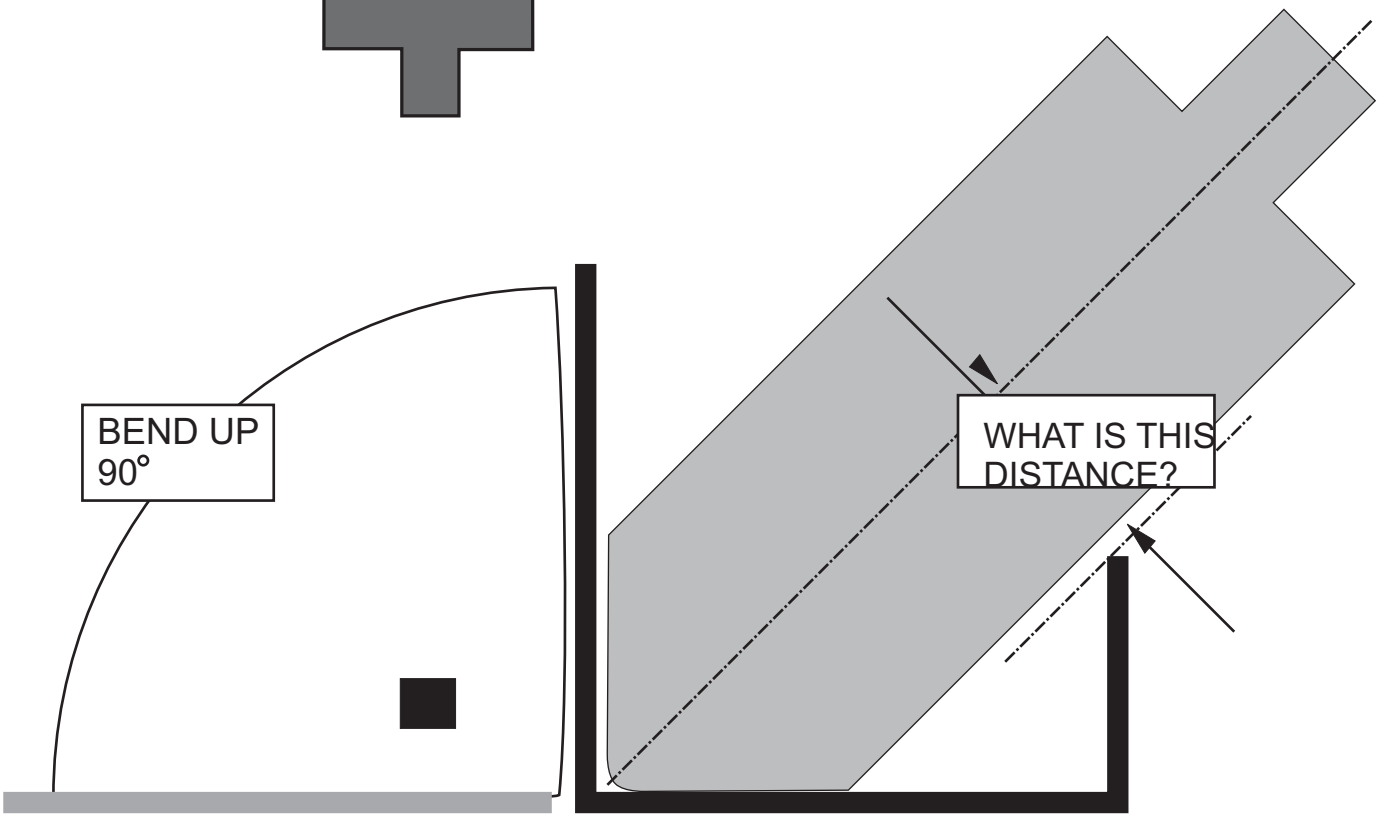


The Flange width and the inside radius affect the forming of the flange. For mild steel the minimum flange width is 4 times the stock thickness plus the inside radius. For softer metals a shorter flange can be used and for harder materials a longer flange is required.

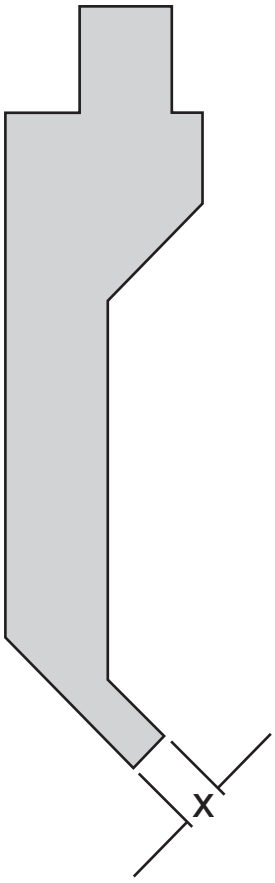
NO CRASH



SKETCH BENT PART AT FULL SCALE.
DRAW IN CENTER LINE OF PUNCH (½ OF BEND ANGLE).
MEASURE DISTANCE.
MEASURE PUNCH WIDTH (½ PUNCH WIDTH).
CHECK FOR CRASH.



Gooseneck Punches



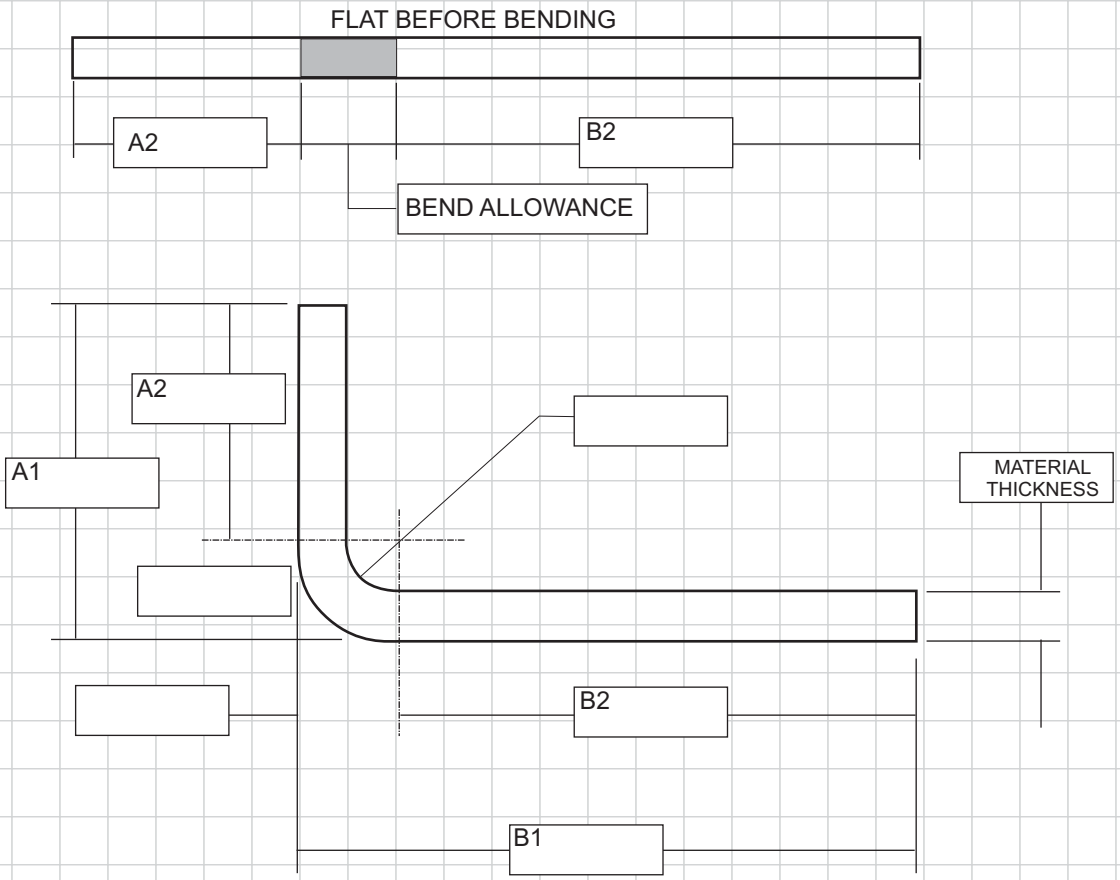
22GA X=.25
18GA X=.375
14GA X=.50
10GA X=.75
9GA X=1.00
7GA X=1.25

Gooseneck punches offer the benefit of clearance for a return flange as in a two stroke channel forming operation.

90° BENDS

BEND ALLOWANCE (BA)=
3.1416 x (R + (K-FACTOR x MAT'L THICKNESS)) x (ANGLE/180)

3.1416 x (R +(_____ x _____)) x .5



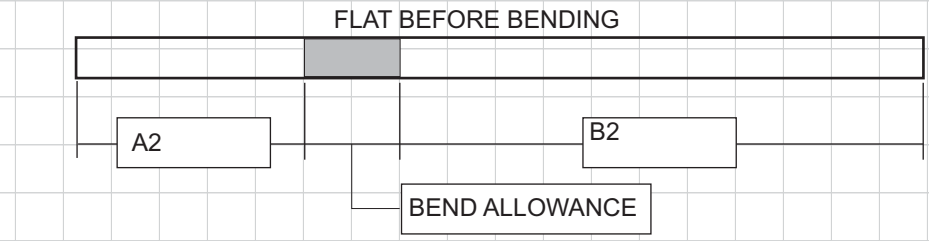
How do we find A2(Outside Setback)= A1- Mat'l Thickness - Radius
How do we find B2(Outside Setback)= B1- Mat'l Thickness - Radius
WHERE DO WE SET THE BACK GAUGE?

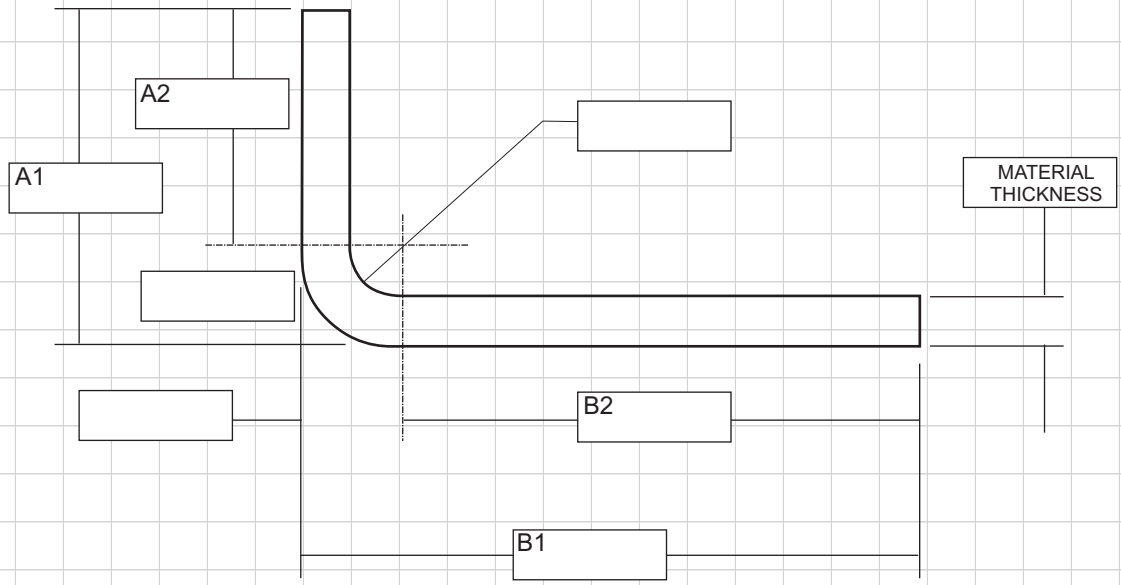
BACK GAUGE SETTING = A2 + (BA/2)

90° BENDS

BEND ALLOWANCE (BA)=
3.1416 x (R + (K-FACTOR x MAT'L THICKNESS)) x (ANGLE/180)

3.1416 x (R +(_____ x _____)) x .5





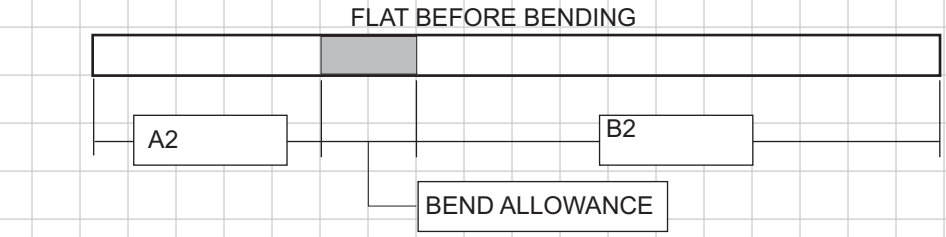
How do we find A2(Outside Setback)= A1- Mat'l Thickness - Radius
How do we find B2(Outside Setback)= B1- Mat'l Thickness - Radius
WHERE DO WE SET THE BACK GAUGE?

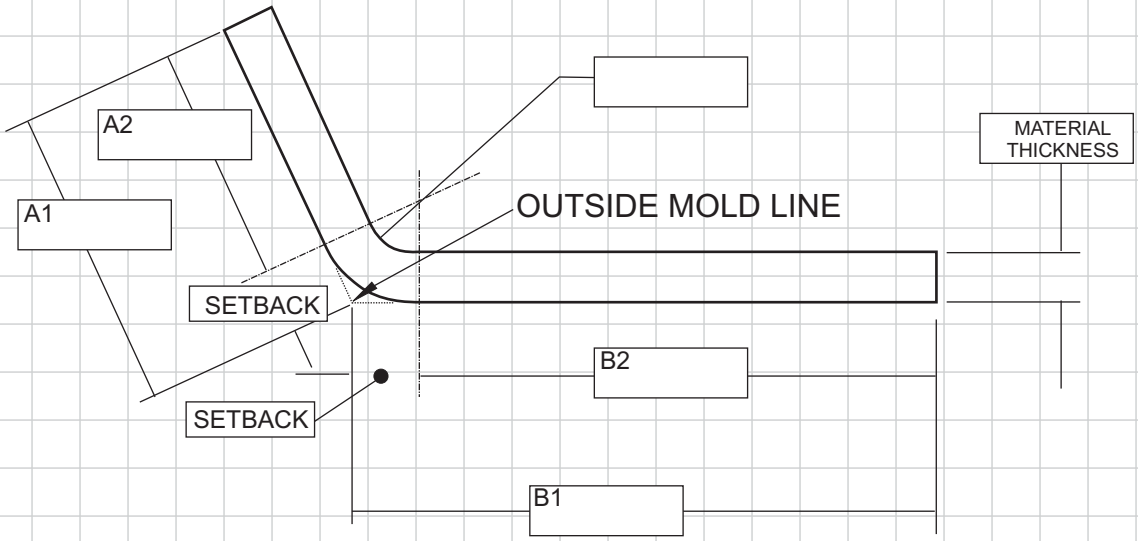
BACK GAUGE SETTING = A2 + (BA/2)

ANGLES BETWEEN 1°-179°, EXCLUDING 90°

BEND ALLOWANCE (BA)=
3.1416 x (R + (K-FACTOR x MAT'L THICKNESS)) x (ANGLE/180)

3.1416 x (R +(_____ x _____)) x (_____/180)



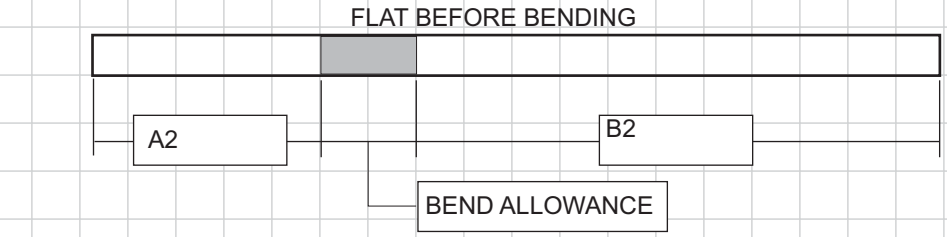


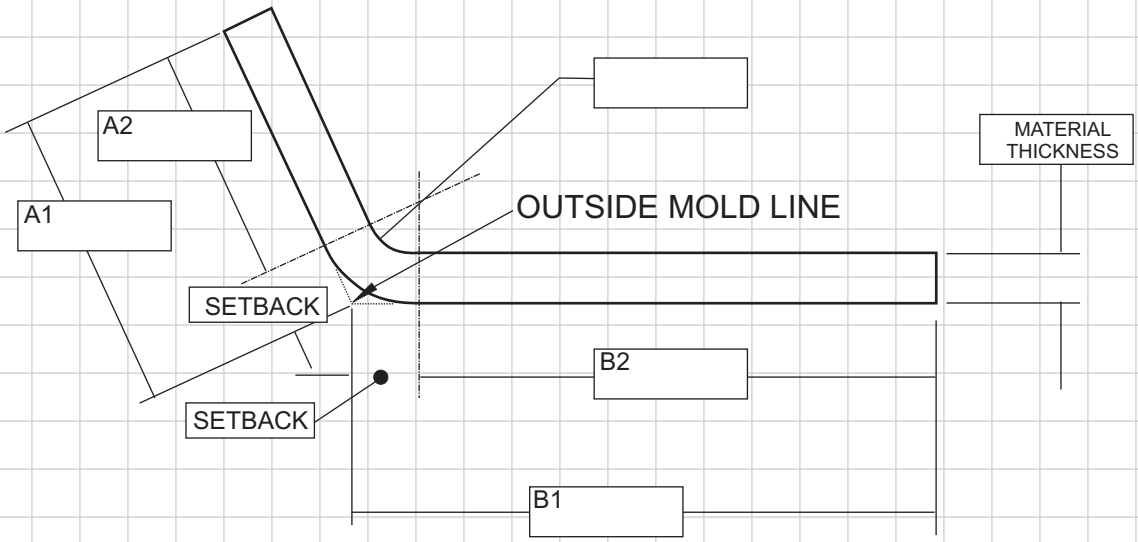
SETBACK WILL NEED TO BE DRAWN OUT TO FIGURE EXACT DISTANCE
BACK GAUGE SETTING = A2 + (BA/2)

ANGLES BETWEEN 1°-179°, EXCLUDING 90°

BEND ALLOWANCE (BA)=
3.1416 x (R + (K-FACTOR x MAT'L THICKNESS)) x (ANGLE/180)

3.1416 x (R +(_____ x _____)) x (_____/180)



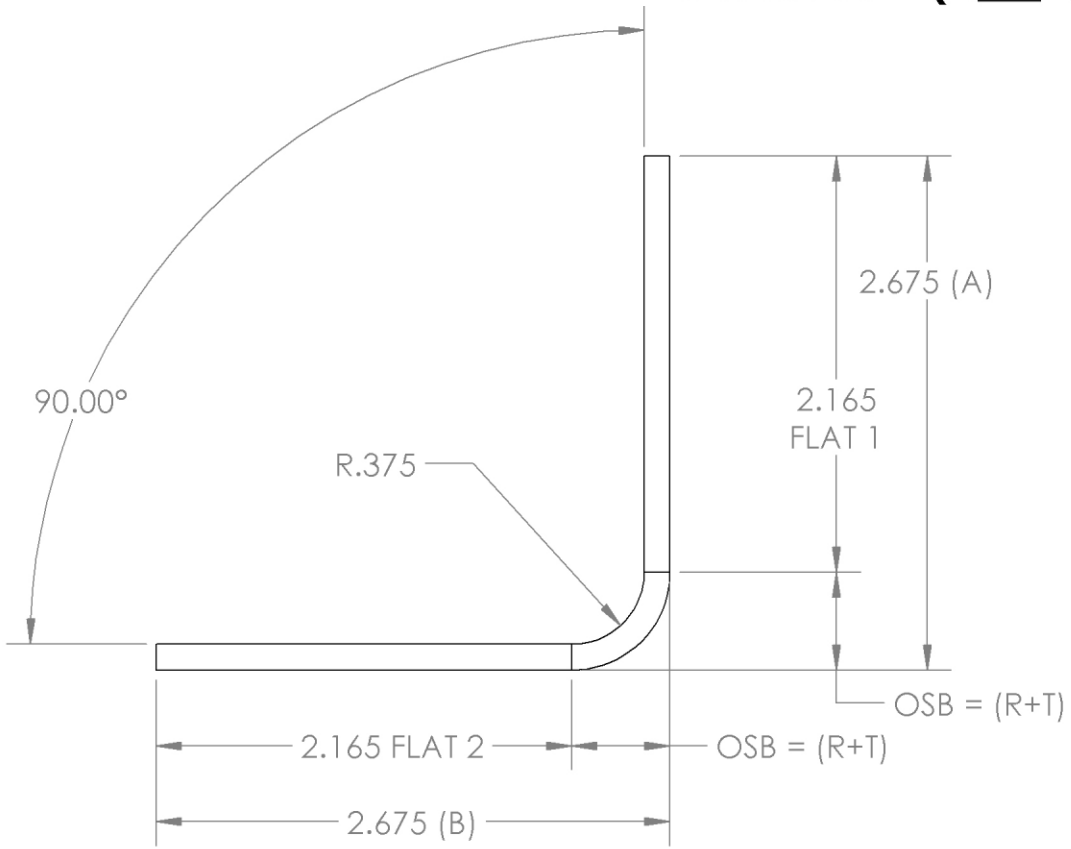


SETBACK WILL NEED TO BE DRAWN OUT TO FIGURE EXACT DISTANCE
BACK GAUGE SETTING = A2 + (BA/2)

NOTE: WHEN FIGURING OUT A K-FACTOR IN THE SHOP WITH A PIECE OF MATERIAL THE BEND ALLOWANCE FORMULA USED IS: BLANK LENGTH-(FLAT 1 + FLAT 2)

K FACTOR = (-R + (BA/(3.1416xANGLE/180)))/T

K FACTOR = (-.___+(._____/(3.1416x90/180)))/._____



NOTE:
FLAT 1= DIM A + OSB
FLAT 2 = DIM B + OSB

MATERIAL _____
BLANK LENGTH = 5.00
K FACTOR = .____
BEND ALLOWANCE = ._____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 10 GA. SHEET	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

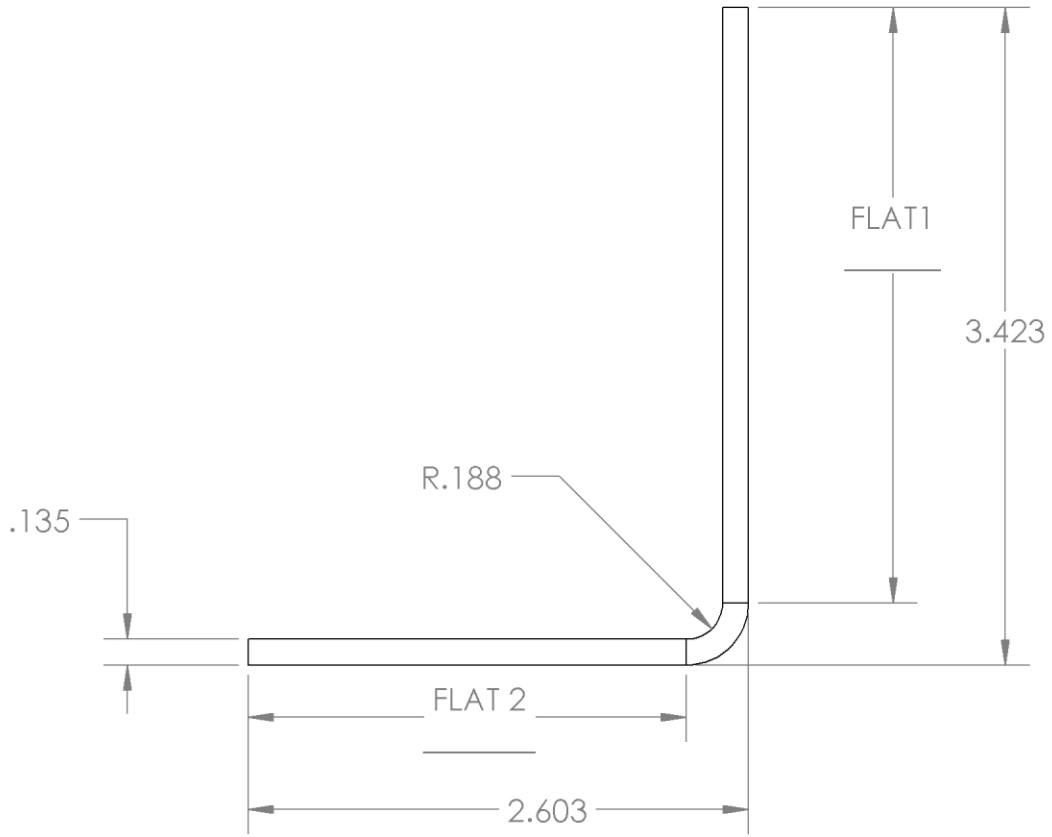
TITLE:
FIGURING K FACTOR FOR OUR SHOP

SIZE	DWG. NO.	REV
A	**kfactor test plate**	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1

K FACTOR = (-R + (BA/(3.1416xANGLE/180)))/T

K FACTOR = (-.___+(._____/(3.1416x90/180)))/._____



NOTE: WHEN FIGURING OUT A K-FACTOR IN THE SHOP WITH A PIECE OF MATERIAL THE BEND ALLOWANCE FORMULA USED IS: BLANK LENGTH-(FLAT 1 + FLAT 2)

MATERIAL _____
BLANK LENGTH = 5.75"
BEND ALLOWANCE = ._____

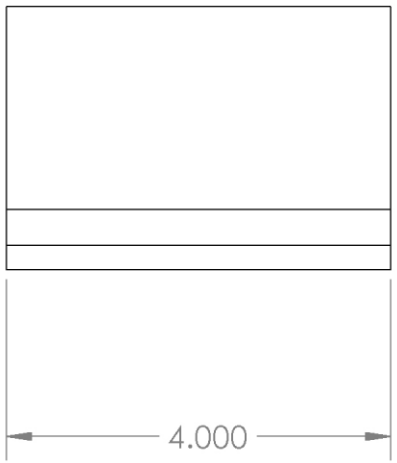
K-FACTOR=_____

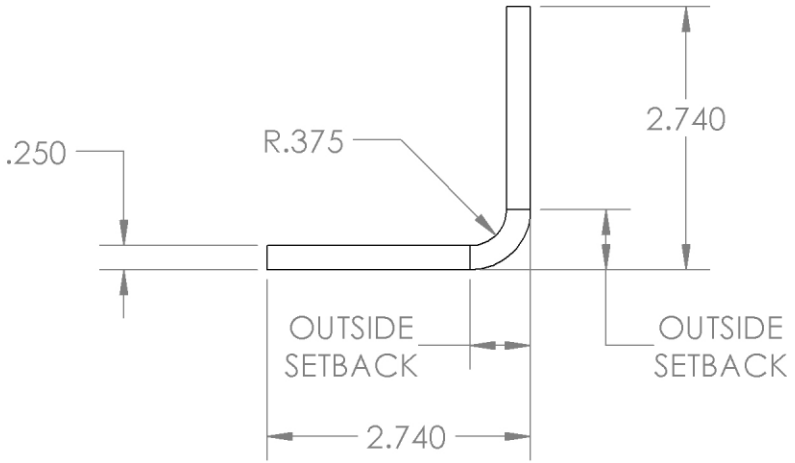
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	North Dakota State College of Science
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN			TITLE:
			CHECKED			
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL	COMMENTS:			SIZE A / DWG. NO. kfactor test plate2 / REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:2 / WEIGHT: / SHEET 1 OF 1

5 4 3 2 1

FLAT IS 5.00" LONG

BEND DEDUCTION: _____
OUTSIDE SETBACK: _____
BEND ALLOWANCE: _____
K-FACTOR: _____





		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

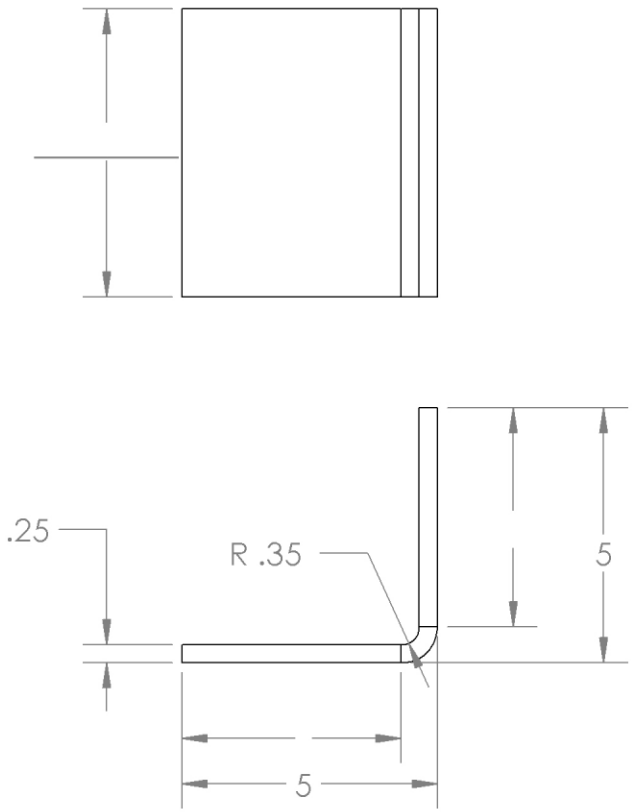
TITLE:

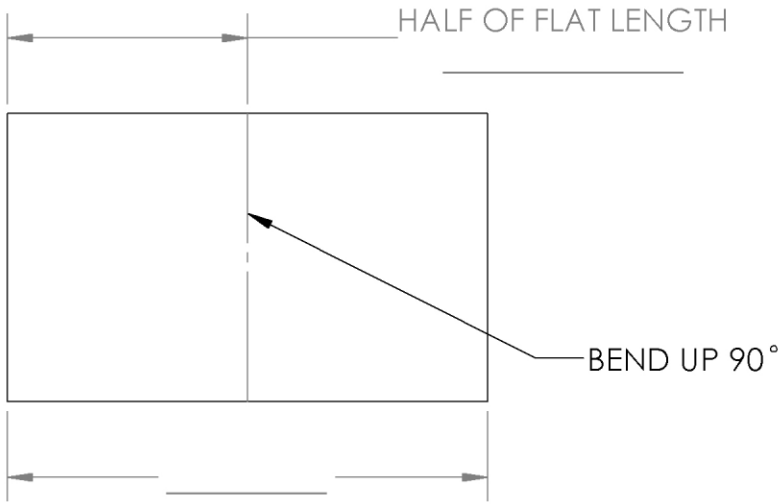
SIZE	DWG. NO.	REV
A	b allow	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1

NAMES: _____

BEND DEDUCTION _____
OUTSIDE SETBACK _____
BEND ALLOWANCE _____
K-FACTOR _.25_____
FLAT LENGTH _____
WHAT DOES IT WEIGH _____





FLAT PATTERN

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

TITLE:

K-FACTOR
LAB FIGURING

SIZE	DWG. NO.	REV
A	BENDPATTERN6	

SCALE: 1:2 | WEIGHT: | SHEET 1 OF 1

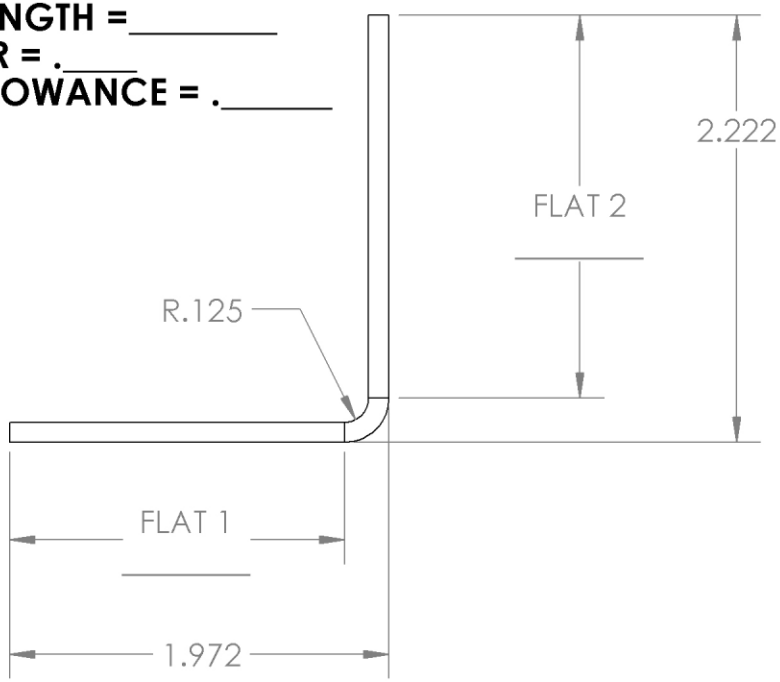
5 4 3 2 1

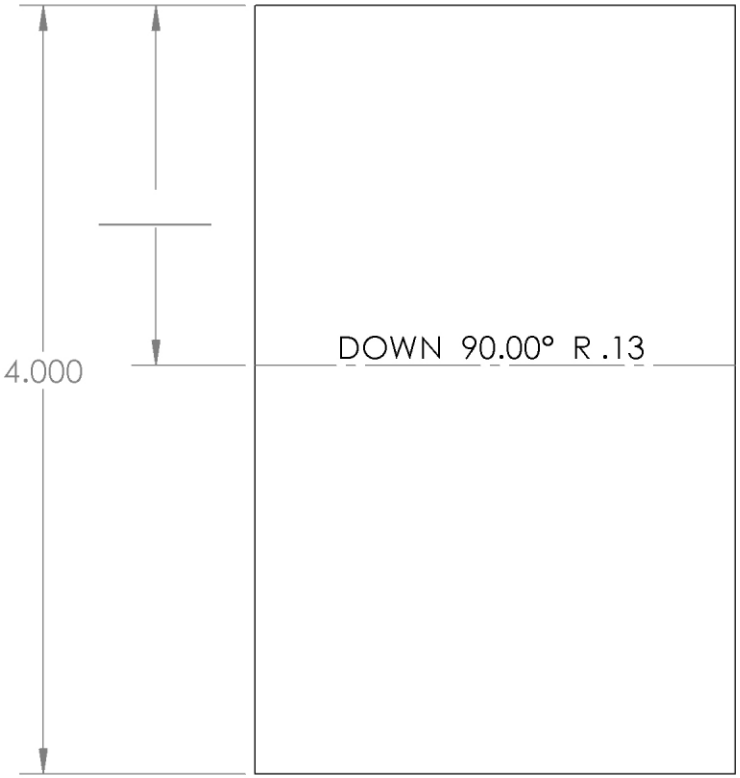
K FACTOR = (-R + (BA/(3.1416xANGLE/180)))/T

K FACTOR = (-.___+(._____/(3.1416x90/180)))/._____

NOTE: WHEN FIGURING OUT K-FACTOR THE BEND ALLOWANCE FORMULA USED IS: BLANK LENGTH-(FLAT 1 + FLAT 2)

MATERIAL _____
BLANK LENGTH =_____
K FACTOR = .____
BEND ALLOWANCE = ._____





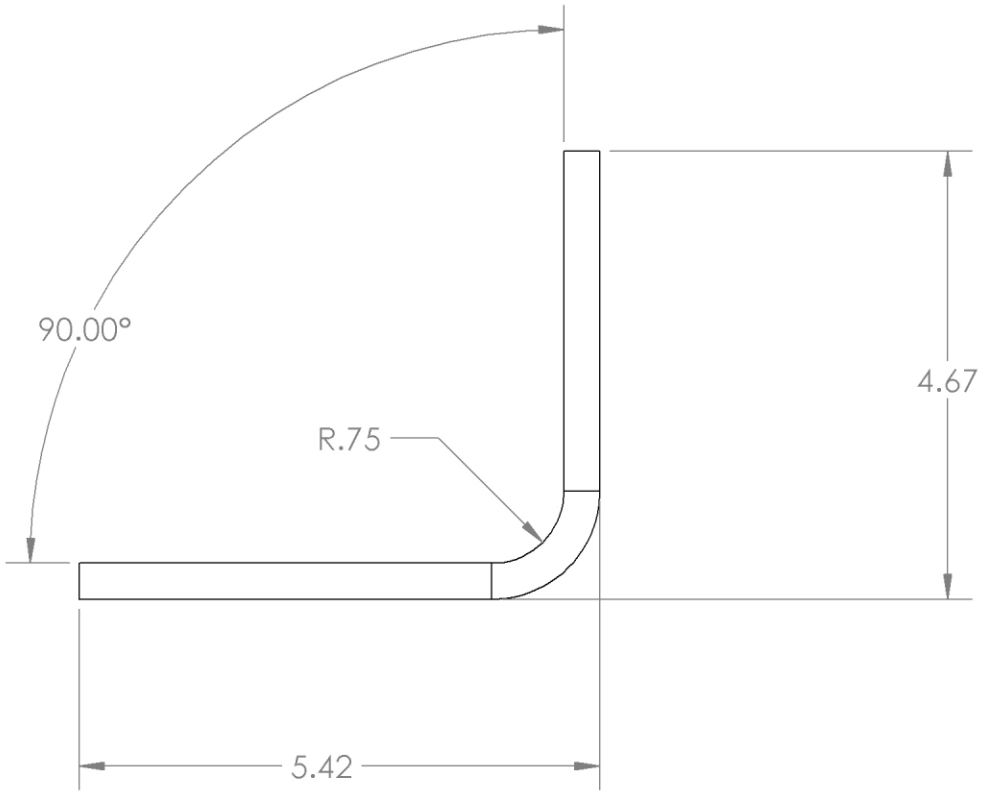
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 12GA SHEET	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

TITLE:

SIZE	DWG. NO.	REV
A	kfactor test plate3	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1



K-FACTOR = .4

WHAT IS BLANK LENGTH _____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
			Q.A.		
		INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
		MATERIAL 3/8 HR SHEET			
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

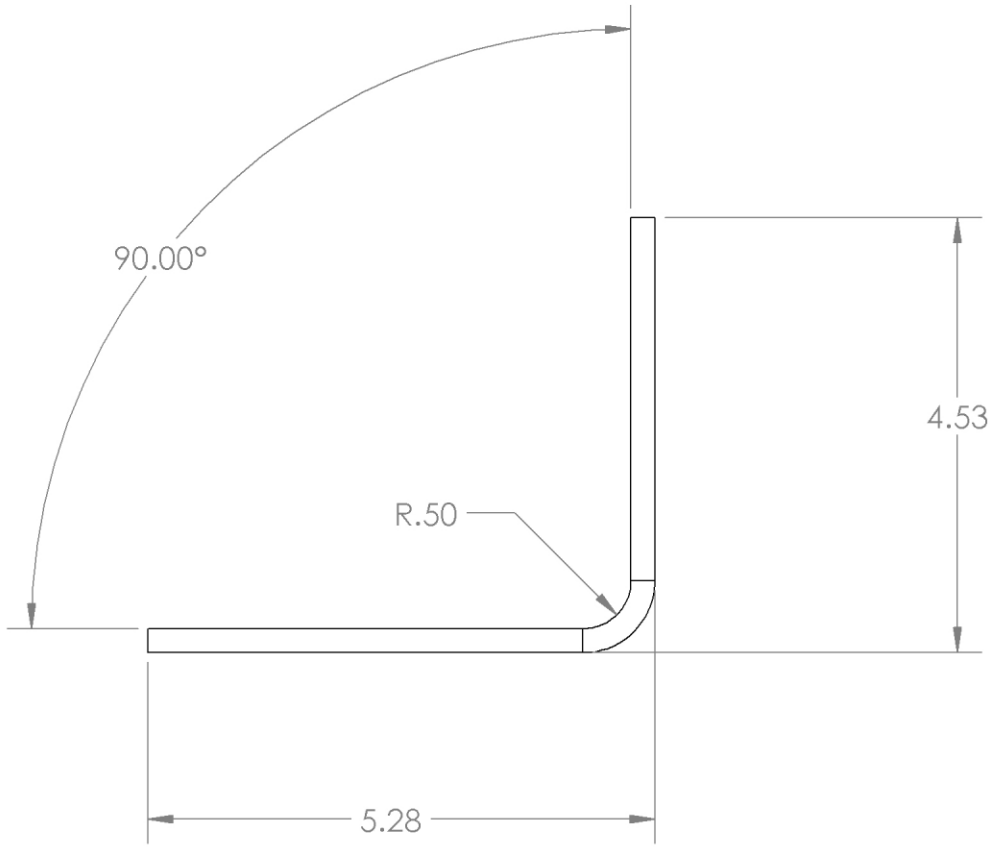
North Dakota State College of Science

TITLE:

SIZE	DWG. NO.	REV
A	BENDPATTERN2	

SCALE: 1:2 | WEIGHT: | SHEET 1 OF 2

5 4 3 2 1



K-FACTOR = .4

WHAT IS BLANK LENGTH _____

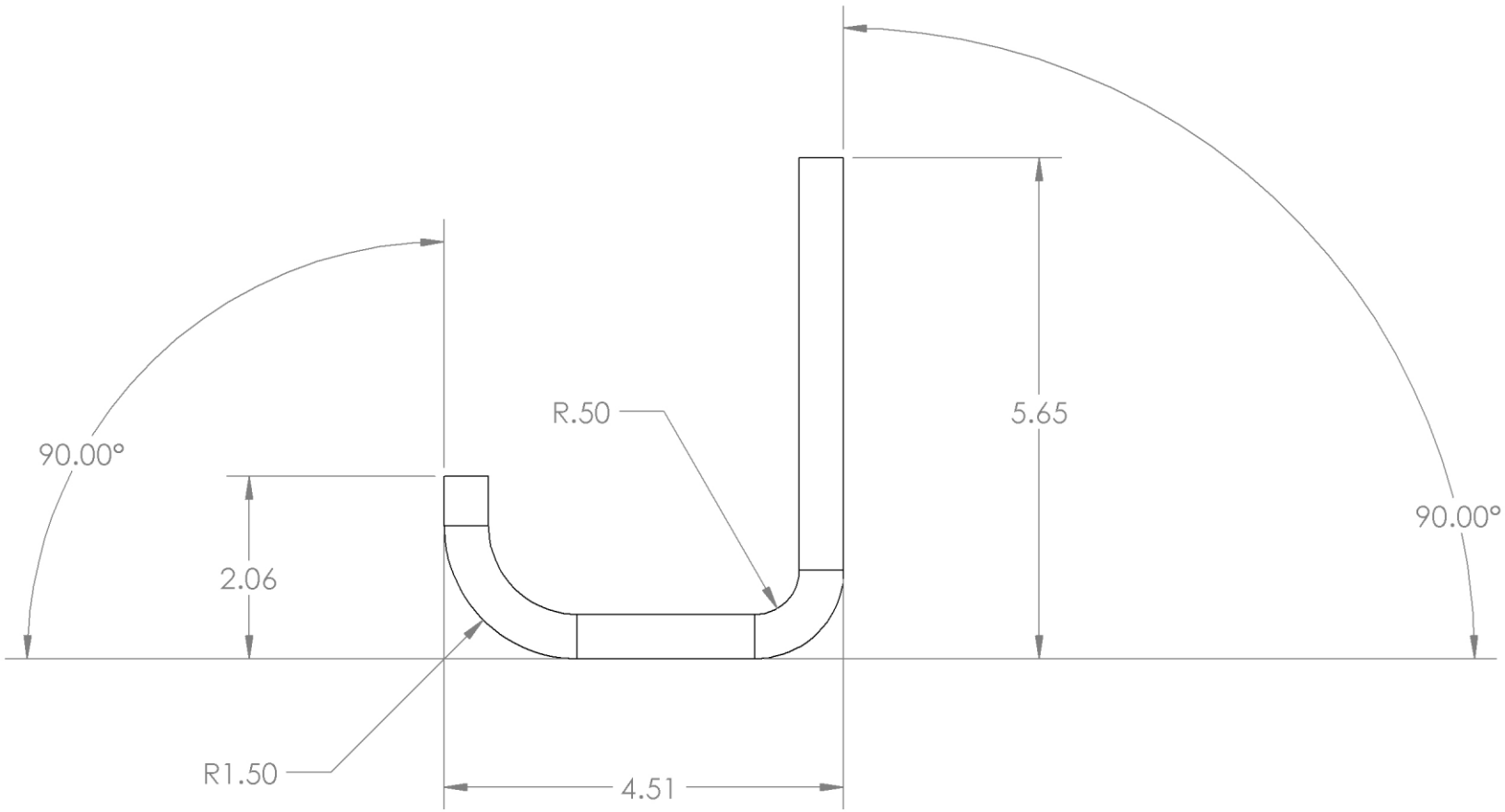
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 1/4 HR SHEET	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

TITLE:

SIZE	DWG. NO.	REV
A	BENDPATTERN3	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1



K-FACTOR = .4

WHAT IS BLANK LENGTH _____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 1/2 CR PLATE	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

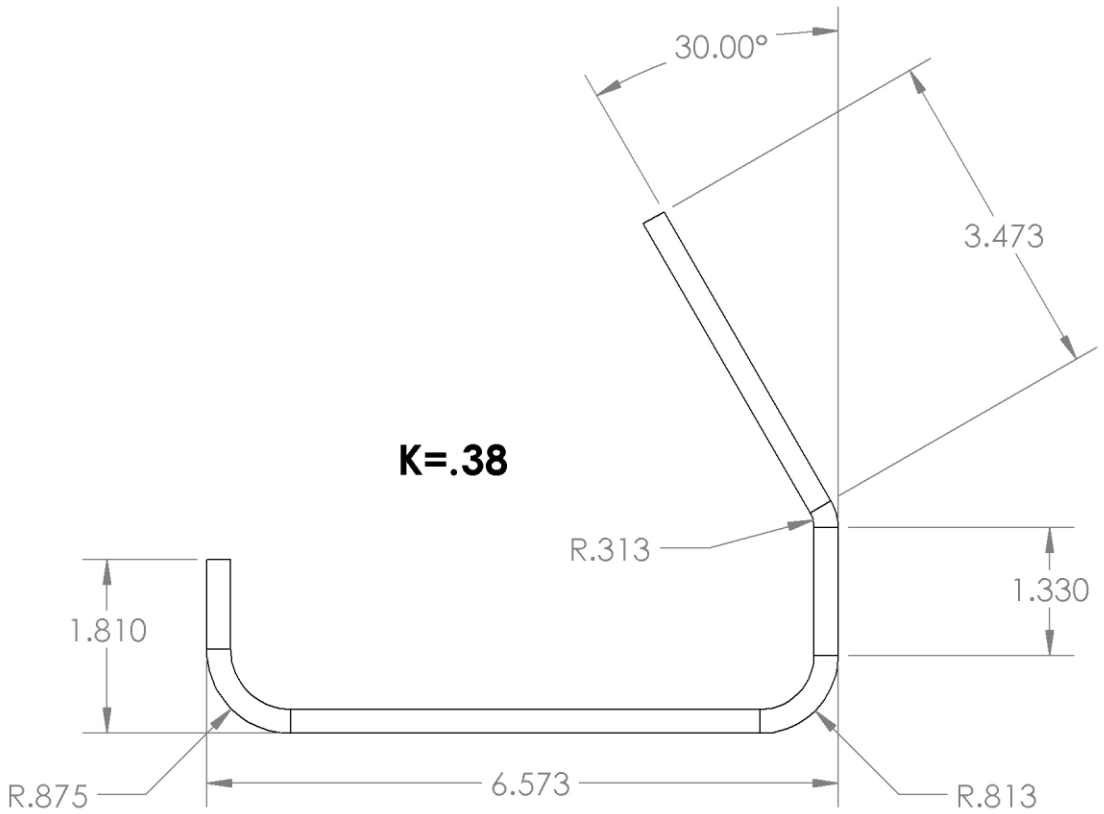
North Dakota State College of Science

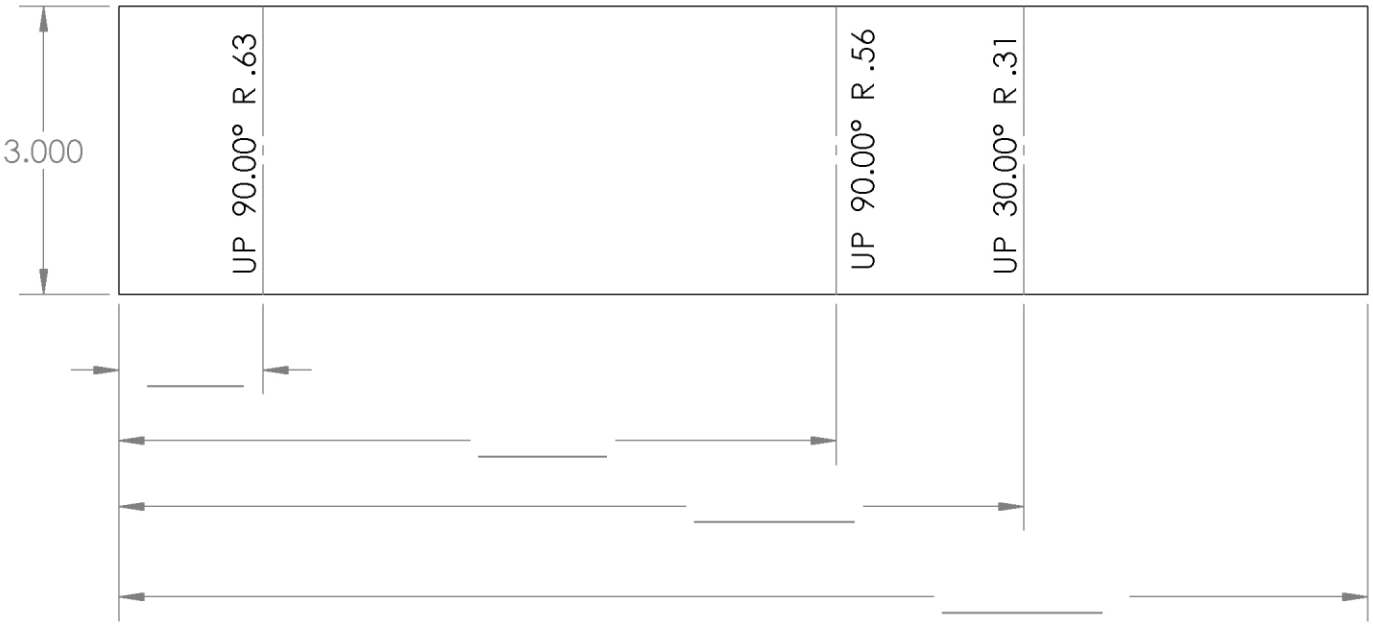
TITLE:

SIZE	DWG. NO.	REV
A	BENDPATTERN4	

SCALE: 1:4 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1





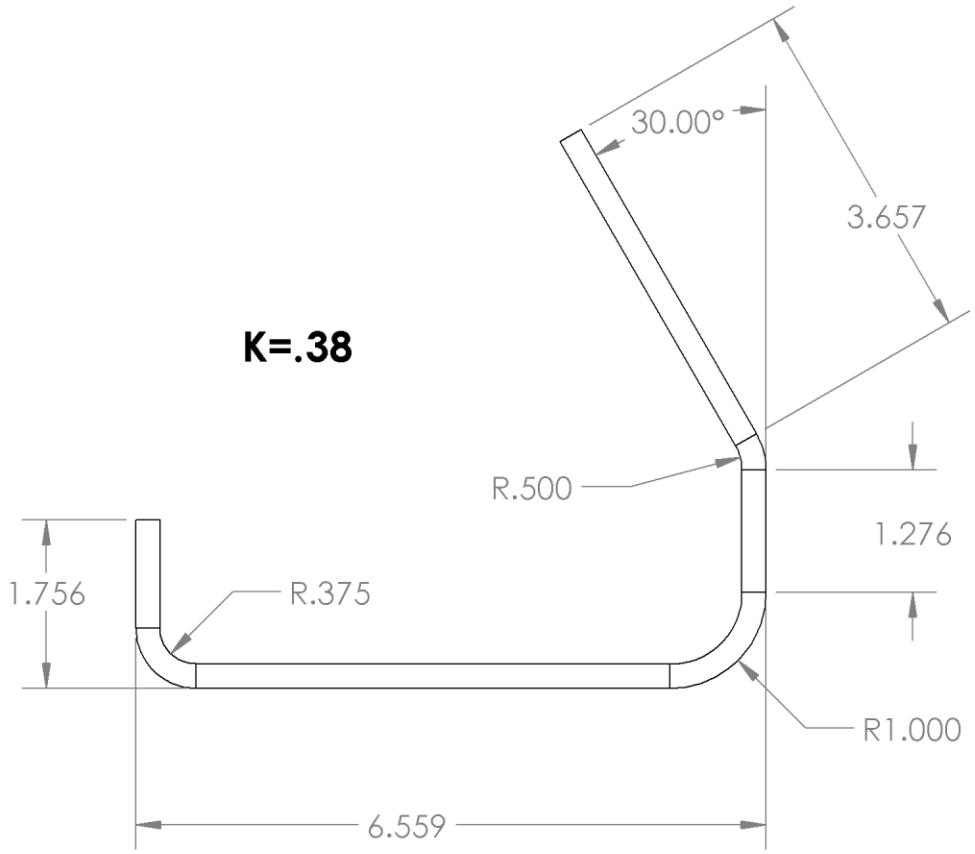
NAME: _____ WEIGHT: _____

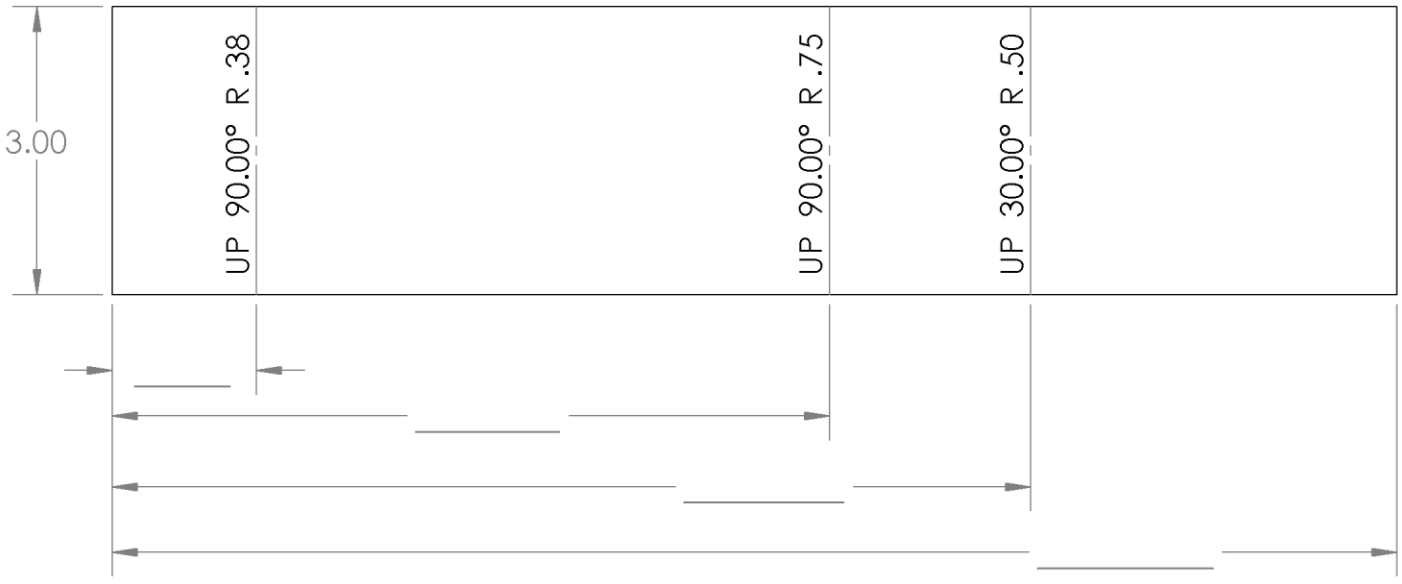
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
			Q.A.		
		MATERIAL 1/4 HR PLATE	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

NDSCS MFGT 140

FLAT PATTERN & WEIGHT

SIZE	DWG. NO.	REV.
A	bendpattern1D-2	
SCALE:1:2	WEIGHT:	SHEET 1 OF 1





NAME: _____ WEIGHT: _____

			NAME	DATE
		DRAWN		
		CHECKED		
		ENG APPR.		
		MFG APPR.		
		Q.A.		
		COMMENTS:		

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

MATERIAL
1/4 HR PLATE

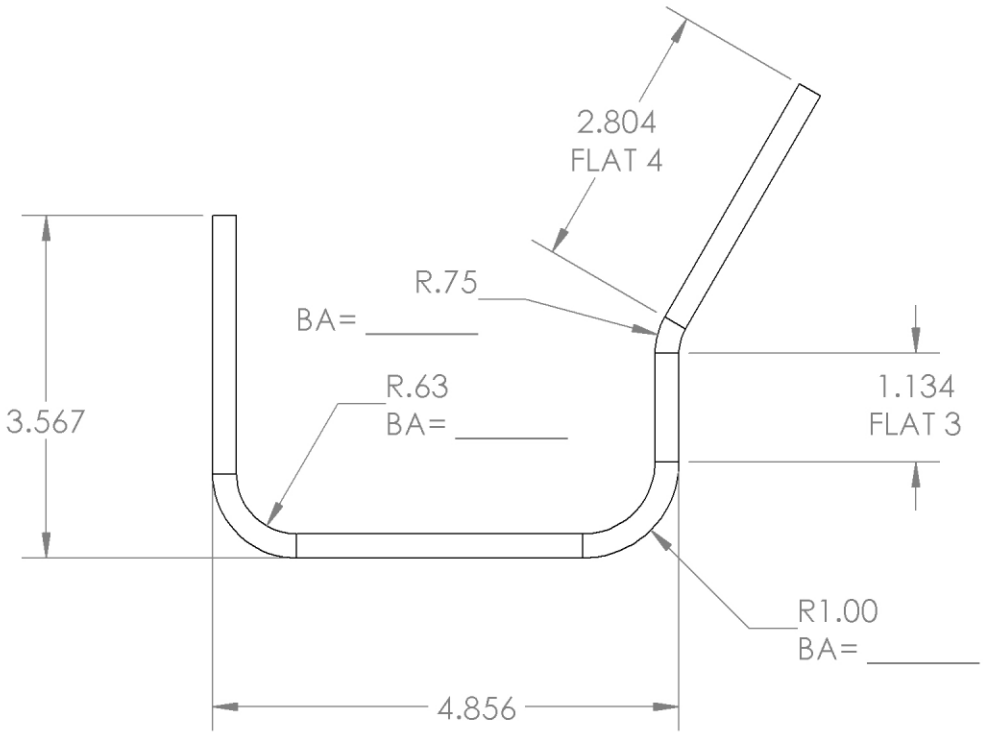
FINISH

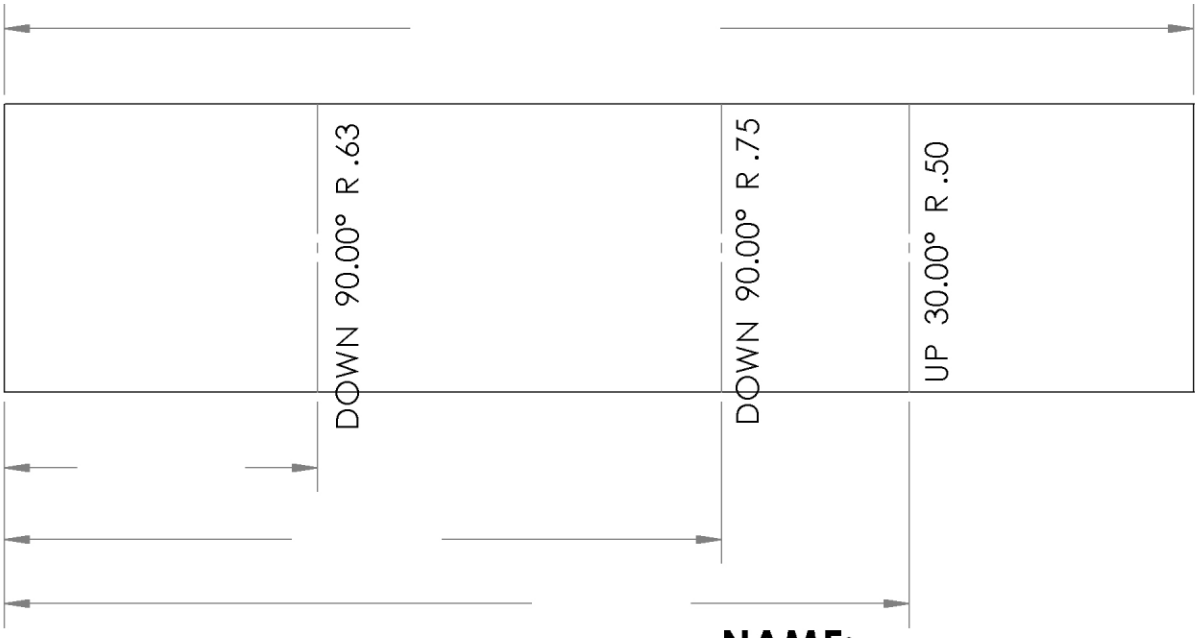
NEXT ASSY	USED ON
APPLICATION	DO NOT SCALE DRAWING

NDSCS MFGT 140

FLAT PATTERN & WEIGHT

SIZE	DWG. NO.	REV.
A	bendpattern1E	
SCALE:1:4	WEIGHT:	SHEET 1 OF 1





NAME: _____

WEIGHT _____

			NAME	DATE
		DRAWN		
		CHECKED		
		ENG APPR.		
		MFG APPR.		
		Q.A.		
		COMMENTS:		

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

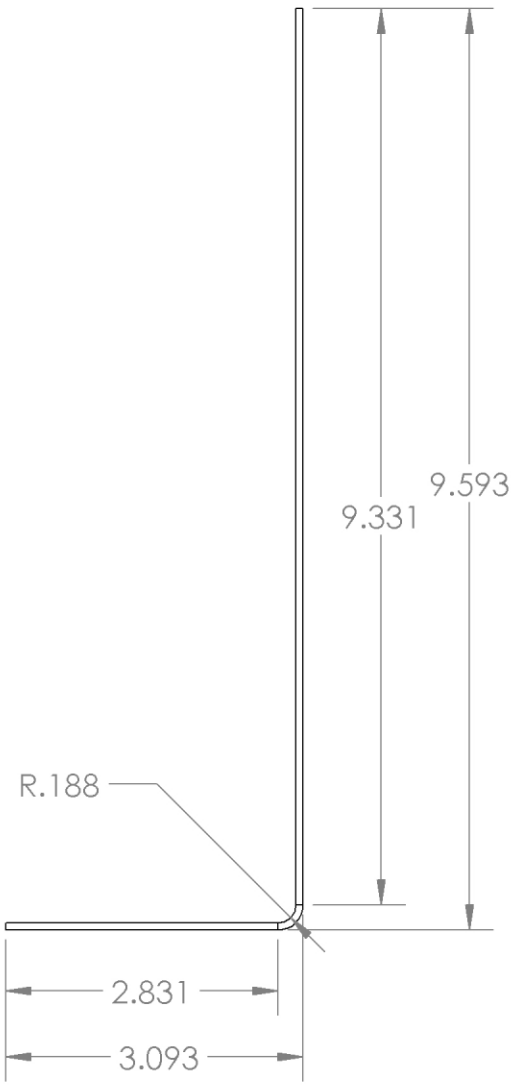
MATERIAL
1/4 STEEL PLATE

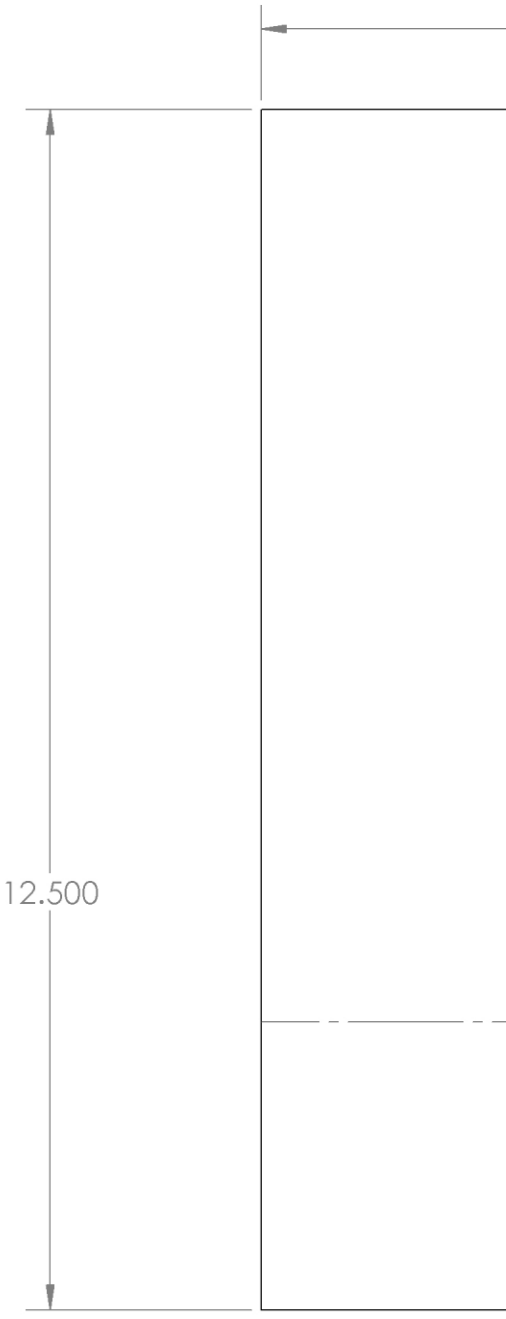
FINISH

NEXT ASSY	USED ON
APPLICATION	DO NOT SCALE DRAWING

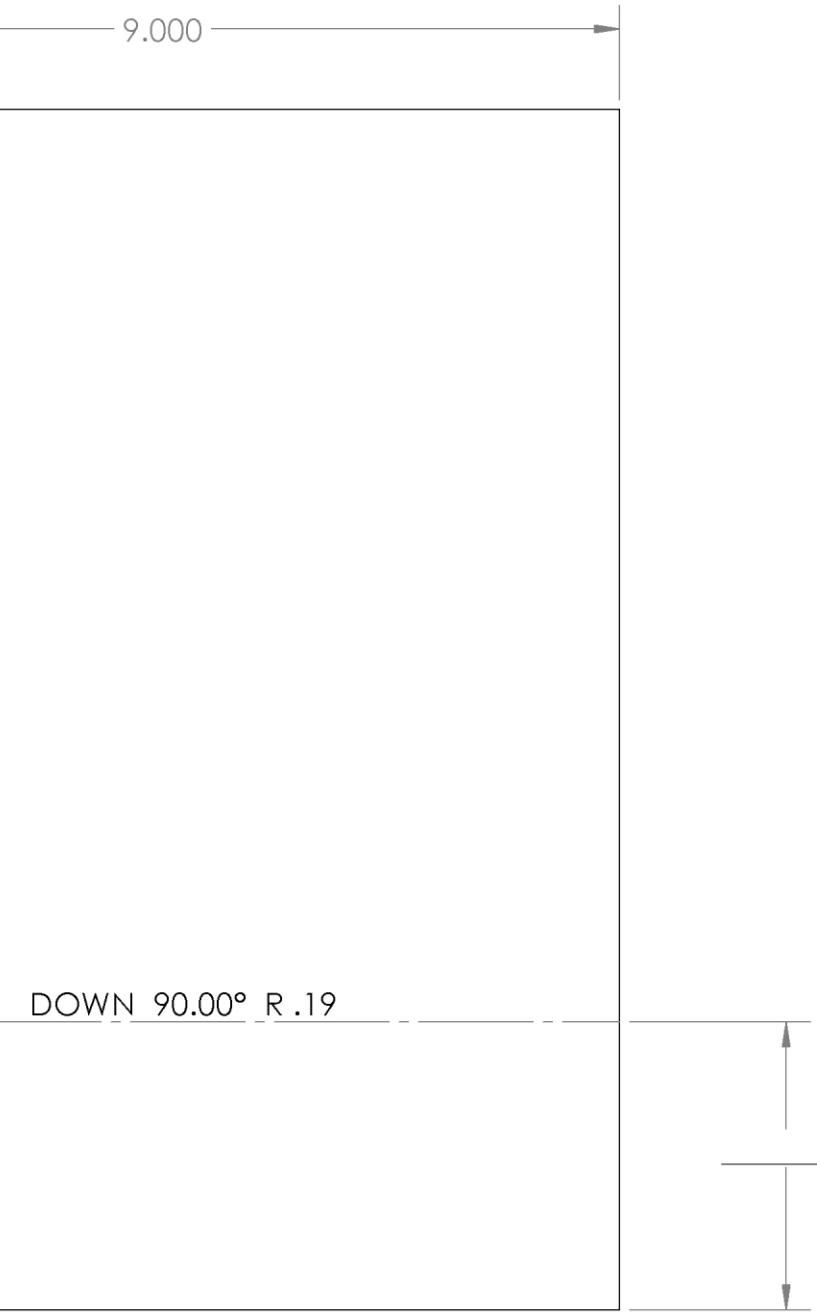
FLAT AND BEND PATTERN

SIZE	DWG. NO.	REV.
A	bendpattern1C	
SCALE:1:2	WEIGHT:	SHEET 1 OF 1





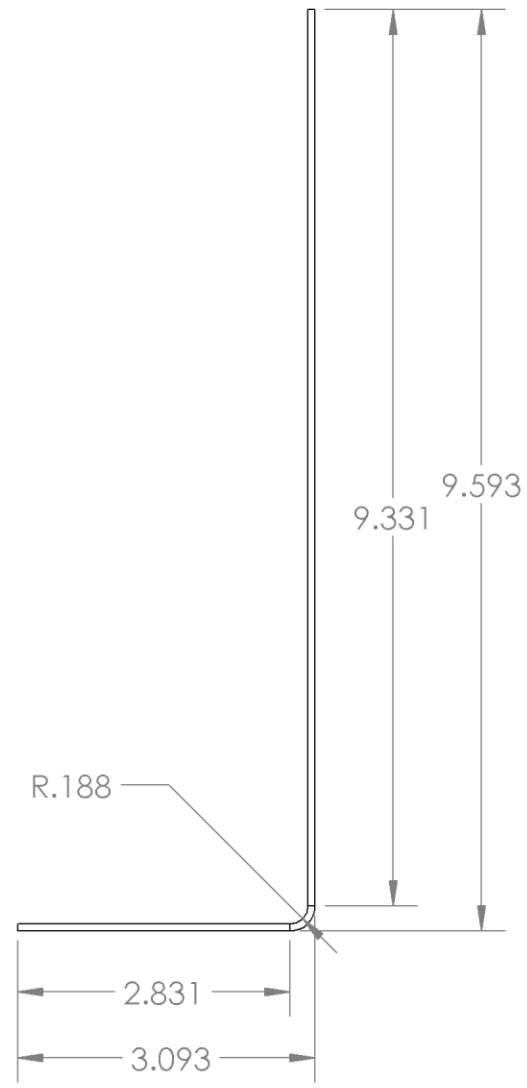
FORMED PATTERN



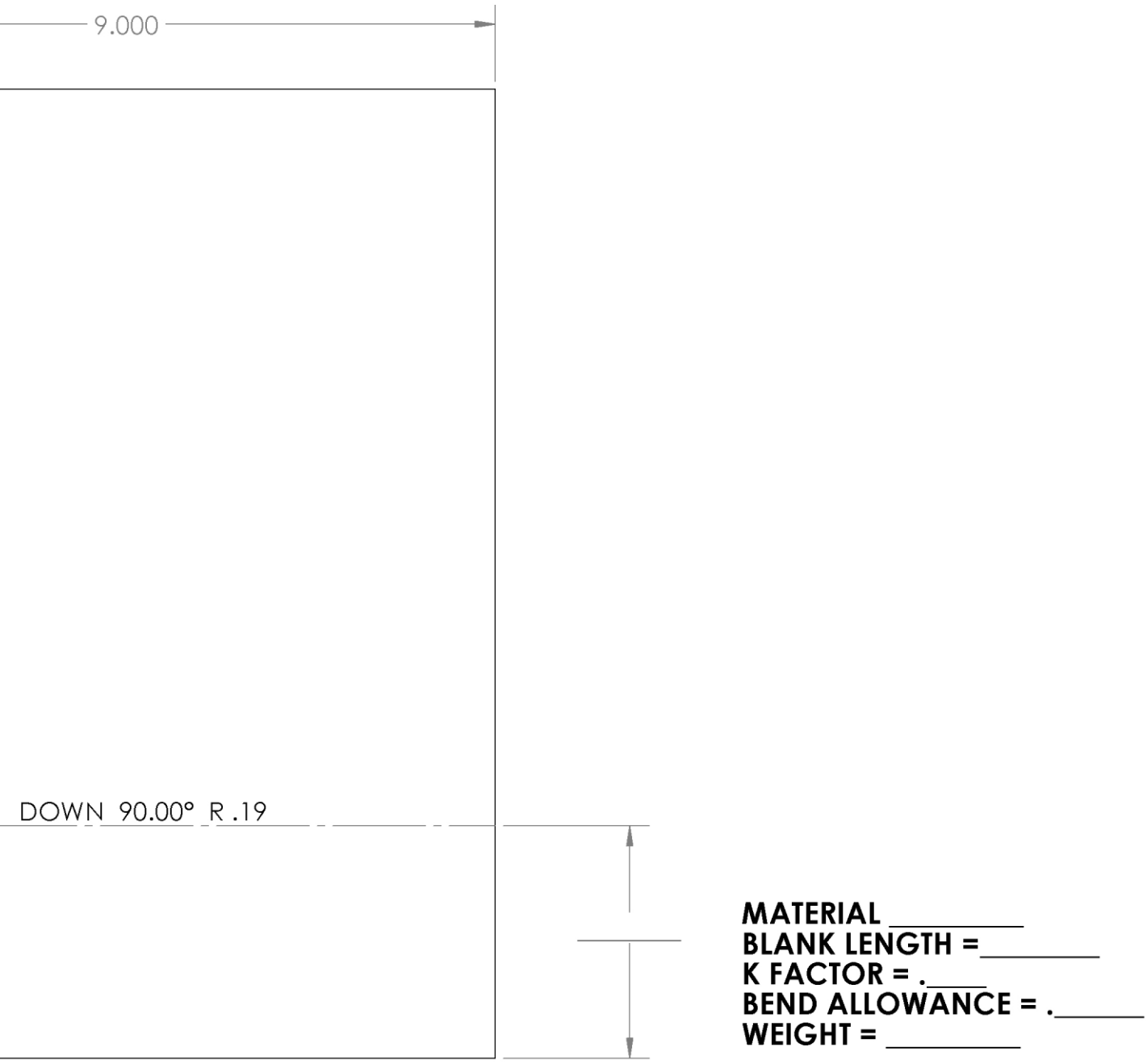
MATERIAL _____
BLANK LENGTH =_____
K FACTOR = .____
BEND ALLOWANCE = ._____
WEIGHT = _____

FLAT PATTERN

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN			
			CHECKED			TITLE:
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL 14 GA SHEET	COMMENTS:			SIZE B / DWG. NO. kfactor test plate 4 / REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:4 / WEIGHT: / SHEET 1 OF 1



FORMED PATTERN

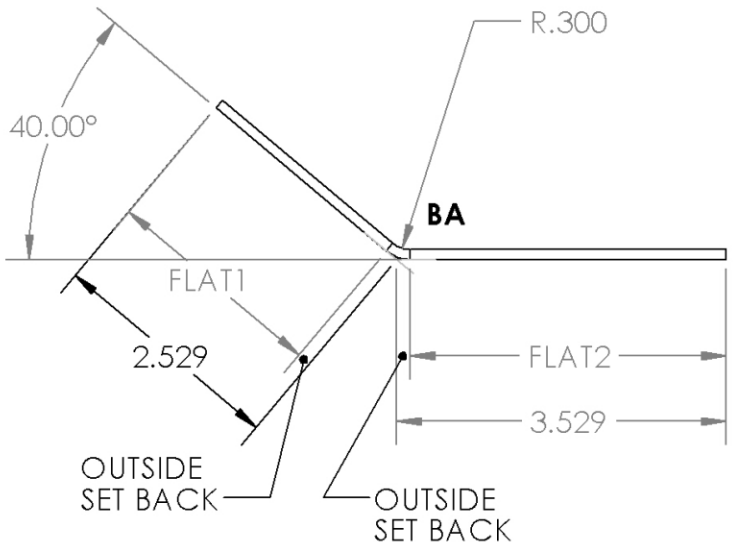


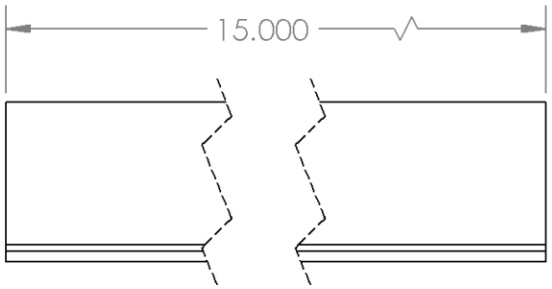
MATERIAL _____
BLANK LENGTH =_____
K FACTOR = .____
BEND ALLOWANCE = ._____
WEIGHT = _____

FLAT PATTERN

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 14 GA SHEET	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

		TITLE:
SIZE B	DWG. NO. kfactor test plate 4	REV
SCALE: 1:4	WEIGHT:	SHEET 1 OF 1





FLAT1 _____
FLAT2 _____
BA _____

TOTAL _____

NAME: _____

WHAT IS THE FLAT WIDTH? _____

WHAT DOES IT WEIGH? _____

SHOW WORK HERE.

OSB=(TAN(ANGLE/2))X(T+R)

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 12 GA STEEL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

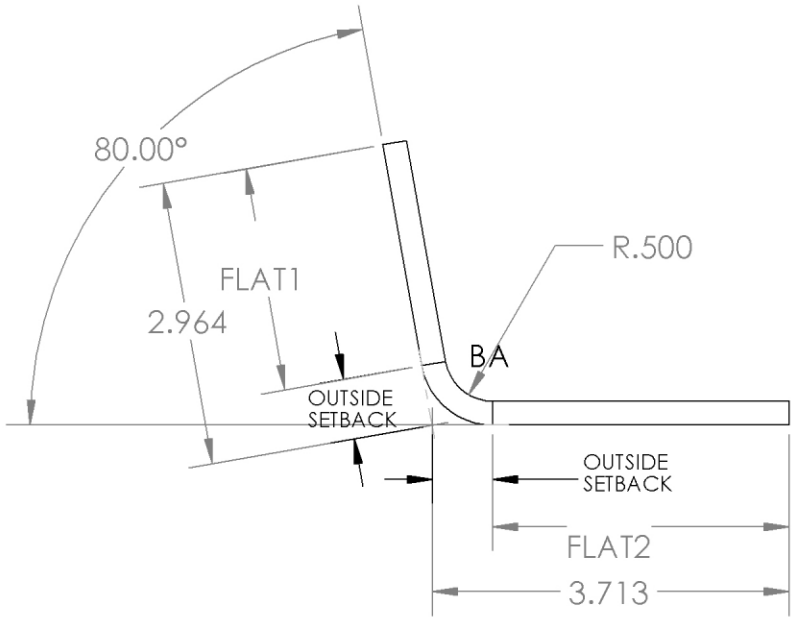
TITLE:

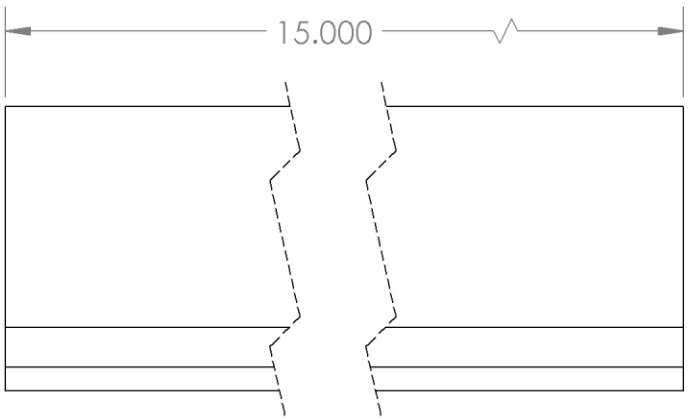
NON 90° BEND FLAT

SIZE	DWG. NO.	REV
A	40 DEGREE	

SCALE: 1:4	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1





SHOW WORK HERE

NAME: _____

WHAT IS FLAT PATTERN? _____

WHAT IS ITS WEIGHT? _____

FLAT1 _____
FLAT2 _____
BA _____

TOTAL _____

NEXT ASSY	USED ON	
APPLICATION		DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES

TOLERANCES:
FRACTIONAL ± 1/16
ANGULAR: MACH ± .5° BEND ±1°
TWO PLACE DECIMAL ±.06
THREE PLACE DECIMAL ±.031

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL
.25 STEEL PLATE

FINISH

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

North Dakota State College of Science

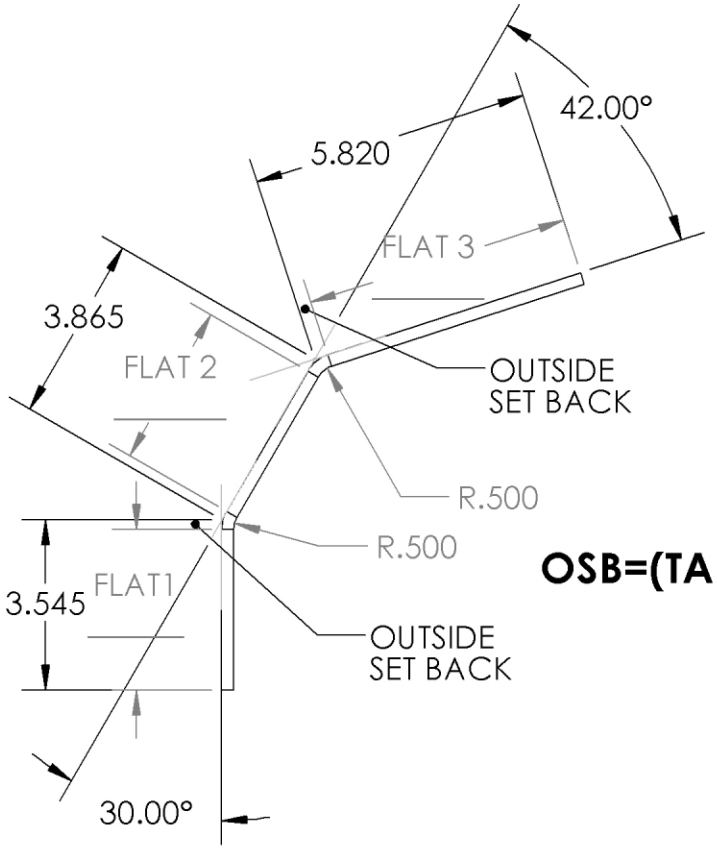
TITLE:

NON 90°FLAT PATTERN

SIZE	DWG. NO.	REV
A	80 DEGREE	

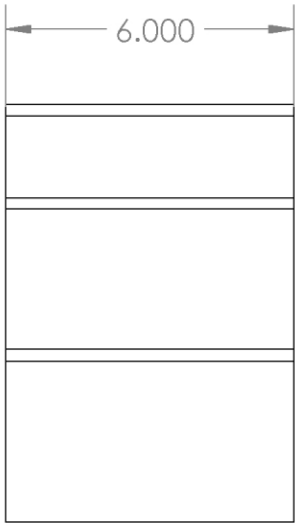
SCALE: 1:4	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1



K=.38

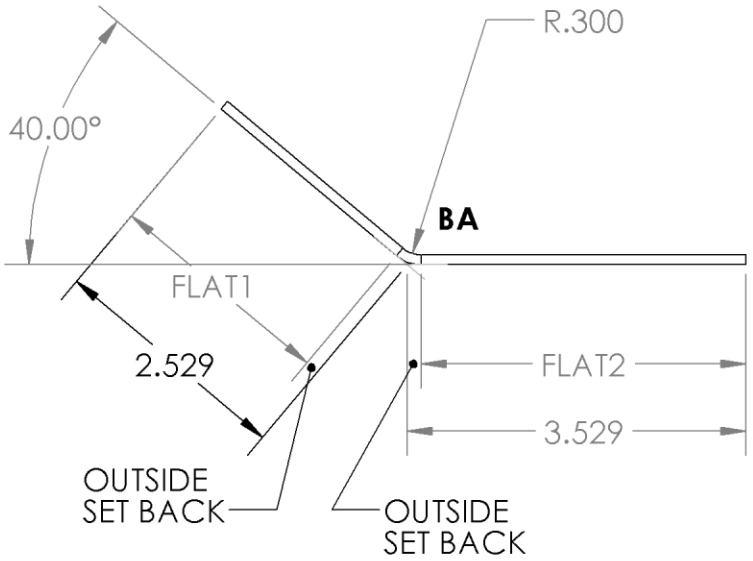
OSB=(TAN(ANGLE/2))X(T+R)

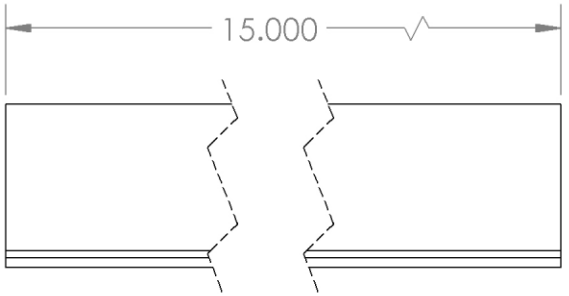


NAME: _____
F1: _____
F2: _____
F3: _____
BA1: _____
BA 2: _____
**---------- **
TOTAL LENGTH _____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	North Dakota State College of Science
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN			TITLE:
			CHECKED			
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL 1/4 HR PLATE	COMMENTS:			SIZE A DWG. NO. ODD BENDS 2 REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:4 WEIGHT: SHEET 1 OF 1

5 4 3 2 1





SHOW WORK HERE.

OSB=(TAN(ANGLE/2))X(T+R)

FLAT1 _____
FLAT2 _____
BA _____

TOTAL _____

NAME: _____

WHAT IS THE FLAT WIDTH? _____

WHAT DOES IT WEIGH? _____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 12 GA STEEL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

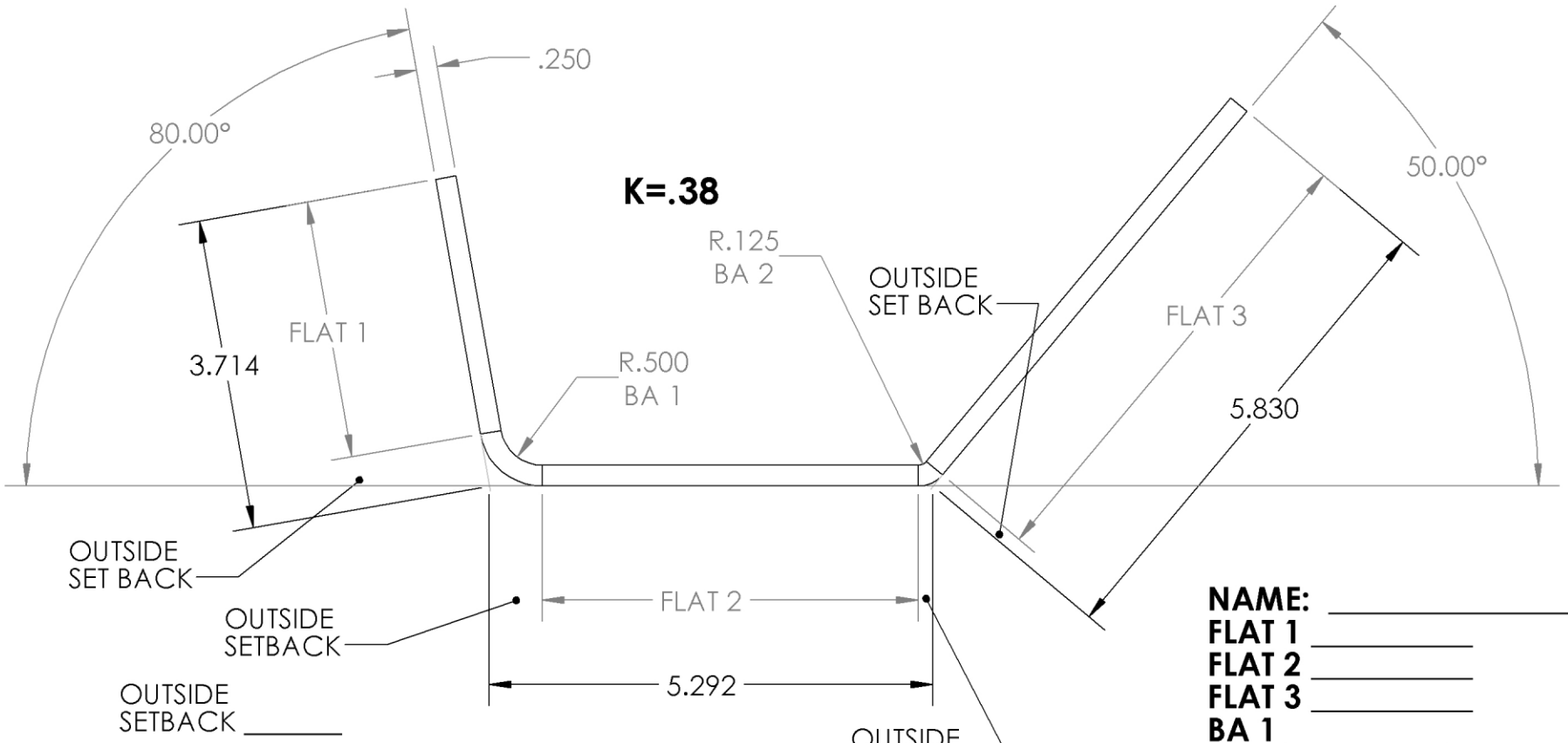
TITLE:

NON 90° BEND FLAT

SIZE	DWG. NO.	REV
A	40 DEGREE-2	

SCALE: 1:4	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1



OSB=(TAN(ANGLE/2))X(T+R)

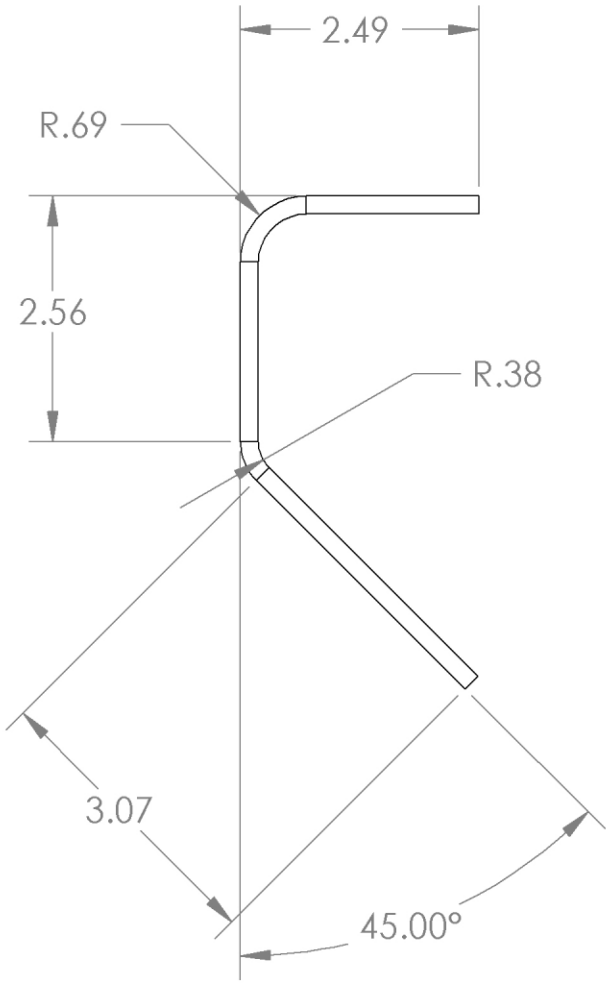
NAME: _____
FLAT 1 _____
FLAT 2 _____
FLAT 3 _____
BA 1 _____
BA 2 _____

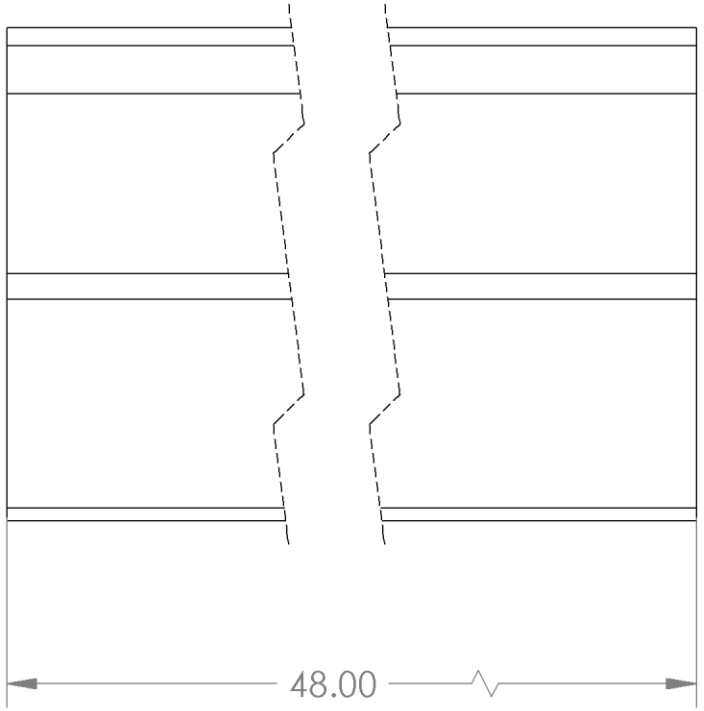
TOTAL _____

48" LONG, WEIGHT? _____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	North Dakota State College of Science
		DIMENSIONS ARE IN INCHES	DRAWN			
		TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	CHECKED			TITLE:
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL	COMMENTS:			SIZE DWG. NO. REV
NEXT ASSY	USED ON	FINISH				A ODD BENDS
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:8 WEIGHT: SHEET 1 OF 1

5 4 3 2 1





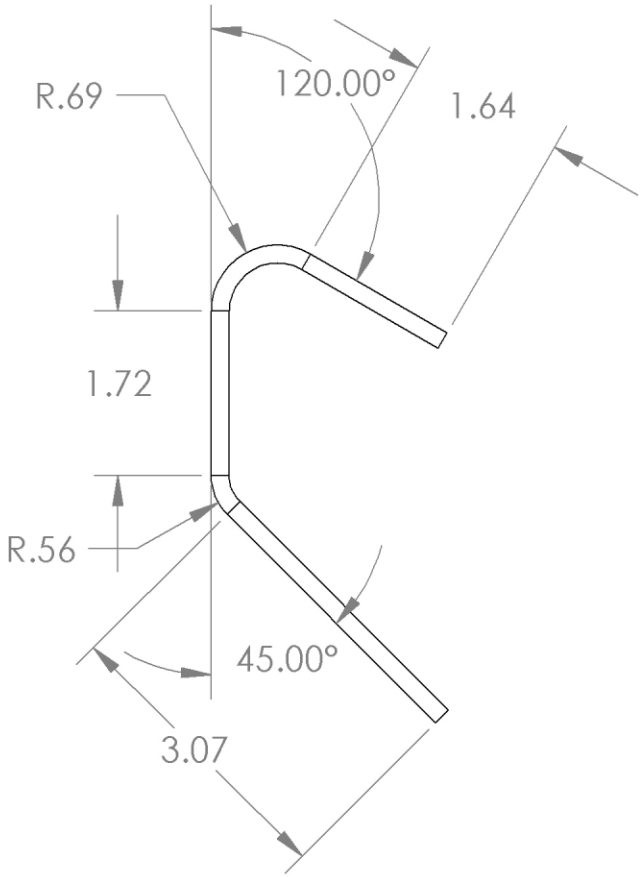
FLAT PATTERN LENGTH_____ WEIGHT _____

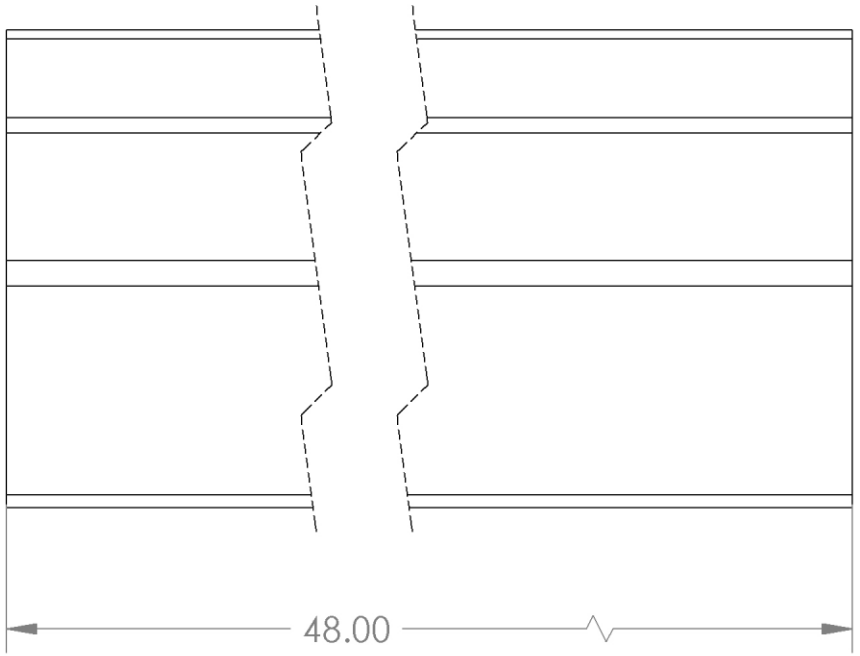
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 3/16 HR PLATE	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

SIZE	DWG. NO.	REV
A	2738	
SCALE: 1:12	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1



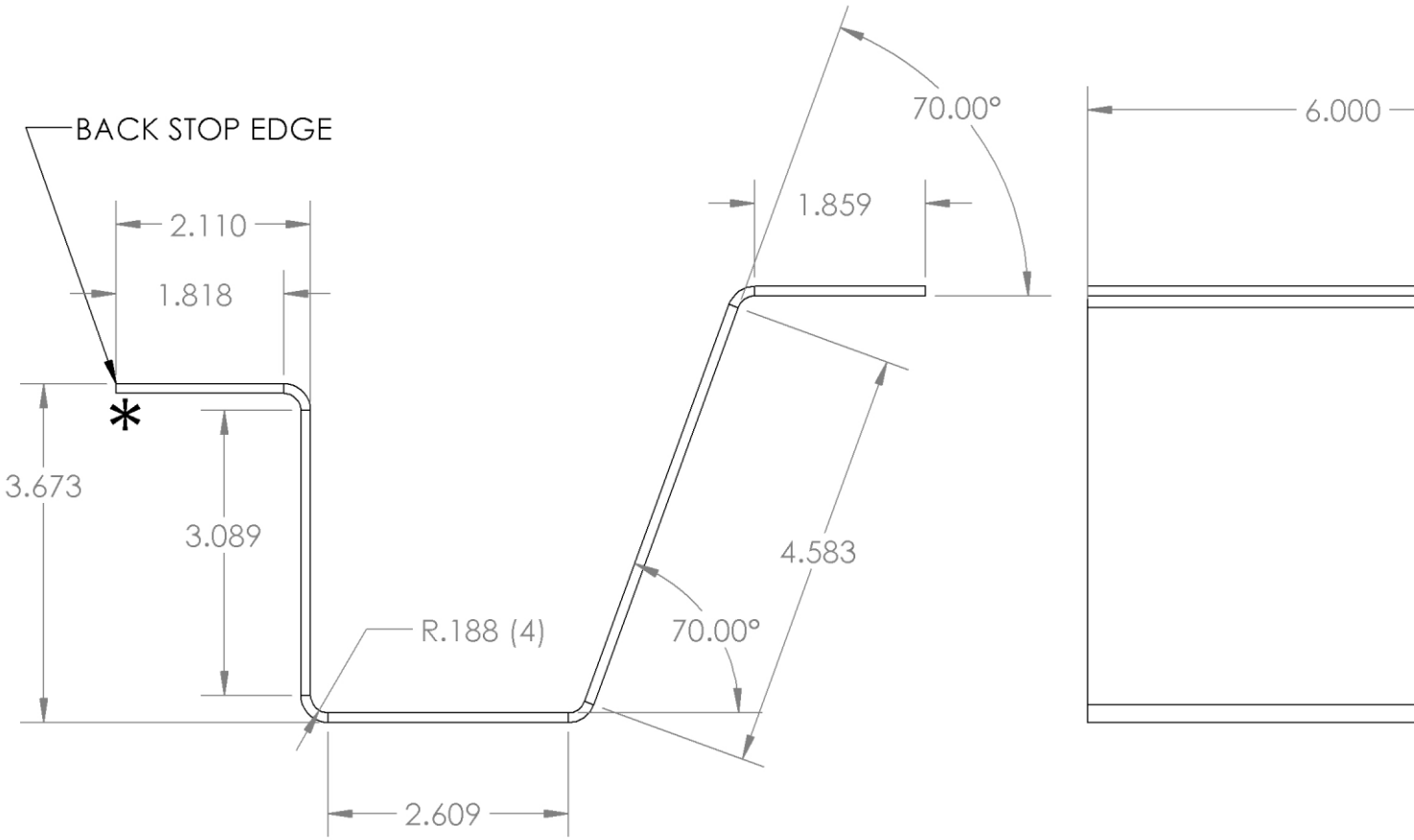


		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 3/8 HR PLATE	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

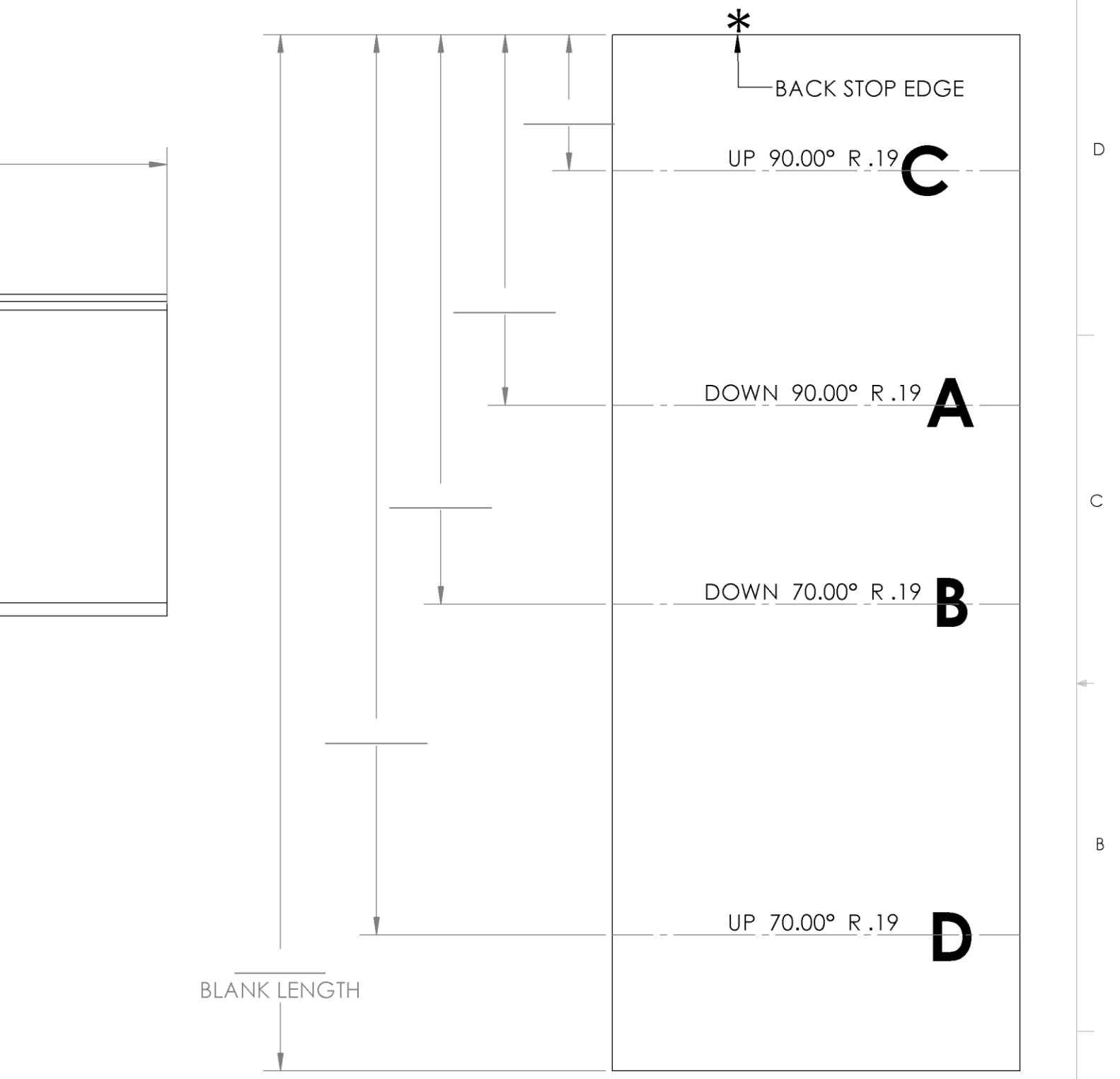
SIZE	DWG. NO.	REV
A	2739	
SCALE: 1:12	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1



NAME: _____
MATERIAL THICKNESS = _____
K FACTOR = .42
90° BEND ALLOWANCE = ._____
70° BEND ALLOWANCE = ._____
WEIGHT = _____

WITH THE FLAT PATTERN DIMENSIONED AS IS
WHAT BEND GETS MADE 1ST? A B C D



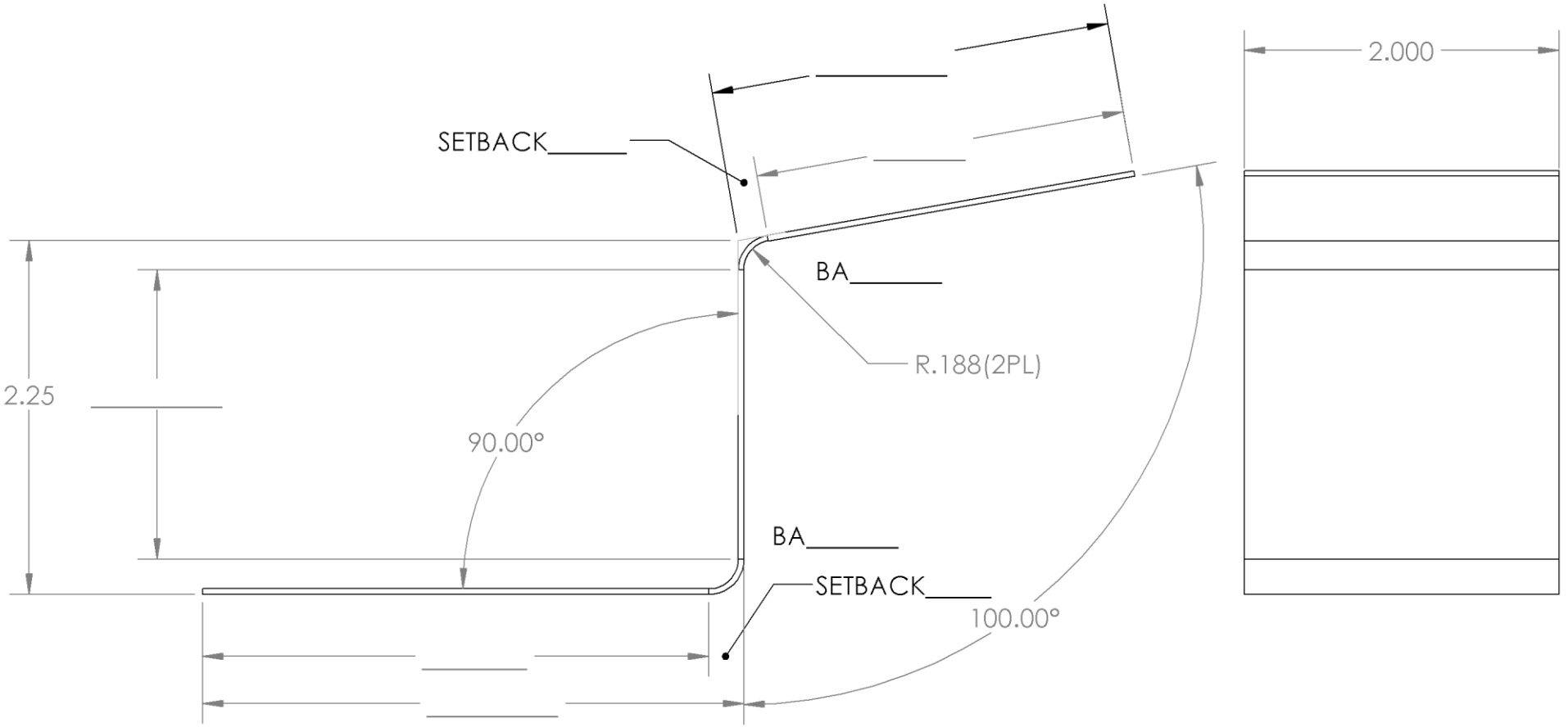
FLAT PATTERN

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH 12 GA. STEEL			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

SIZE	DWG. NO.	REV
B	FINAL BENDING CALC.	

SCALE: 1:4 WEIGHT: SHEET 1 OF 1



NAME _____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

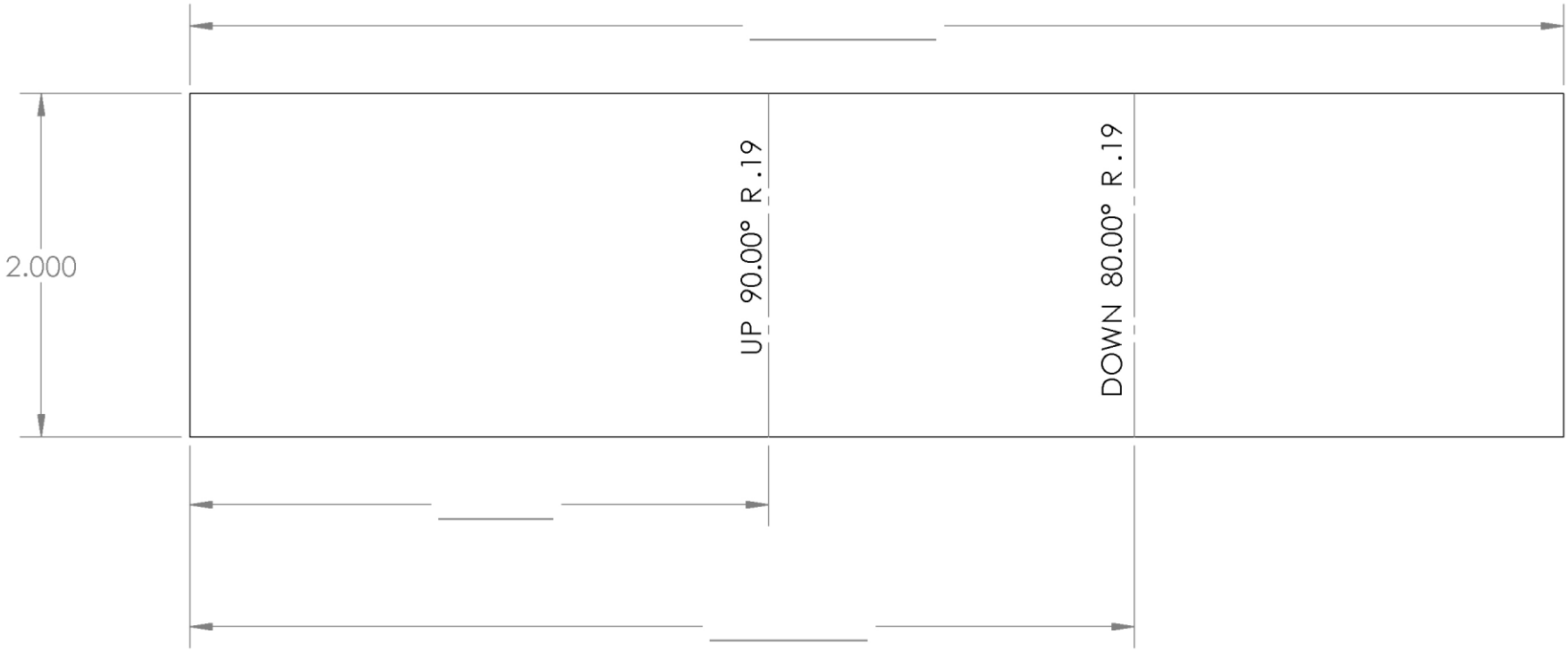
North Dakota State College of Science

TITLE:

SIZE	DWG. NO.	REV
A	BENDPLATE TEST 20GA	

SCALE: 1:2 | WEIGHT: | SHEET 1 OF 4

5 4 3 2 1



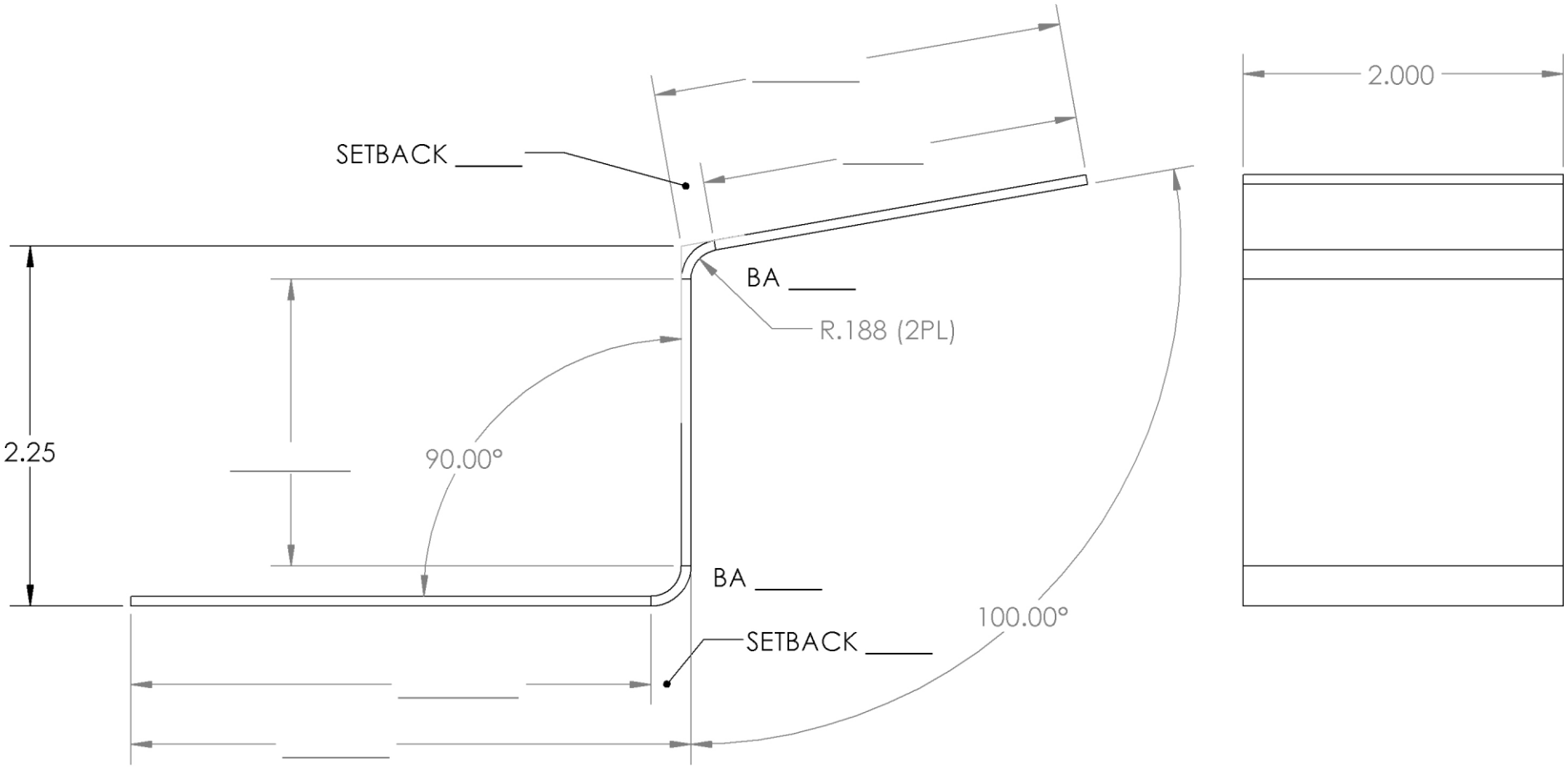
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

SIZE	DWG. NO.	REV
A	BENDPLATE TEST 20GA	

SCALE: 1:2 | WEIGHT: | SHEET 2 OF 4

5 4 3 2 1



NAME: _____

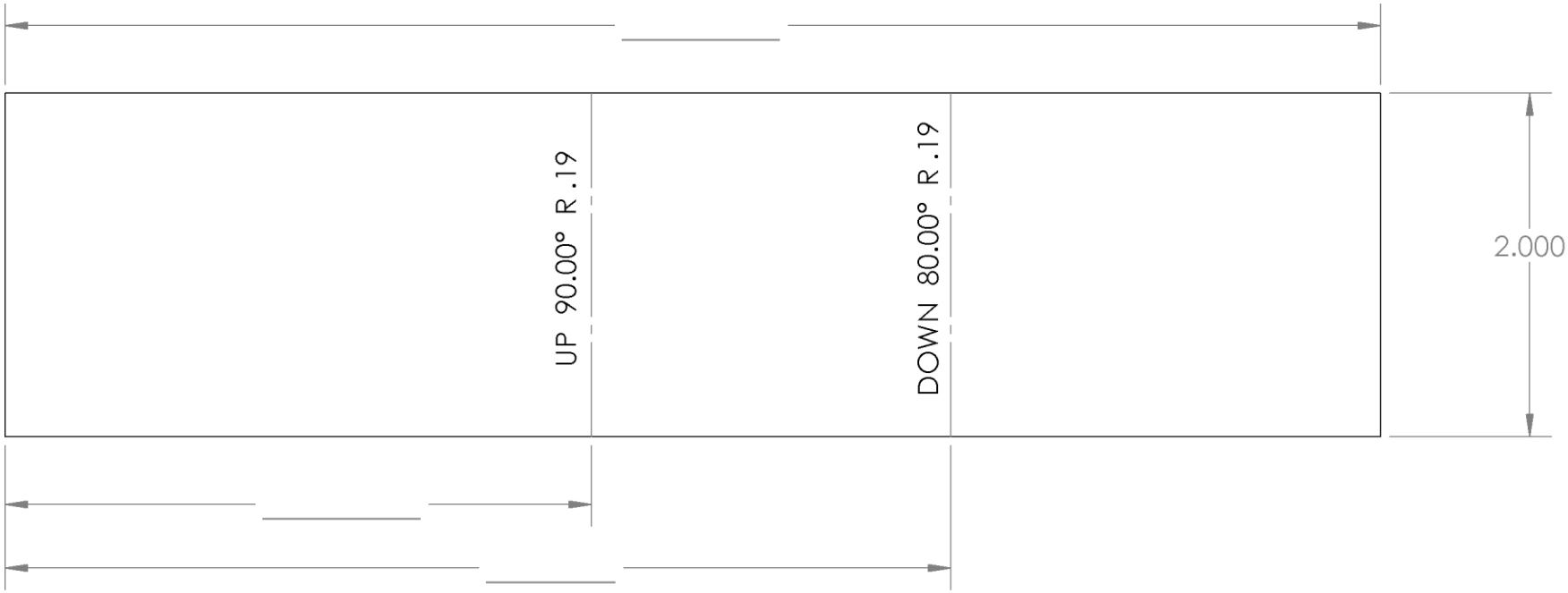
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

TITLE:

SIZE	DWG. NO.	REV
A	BENDPLATE TEST 16GA	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 4

5 4 3 2 1

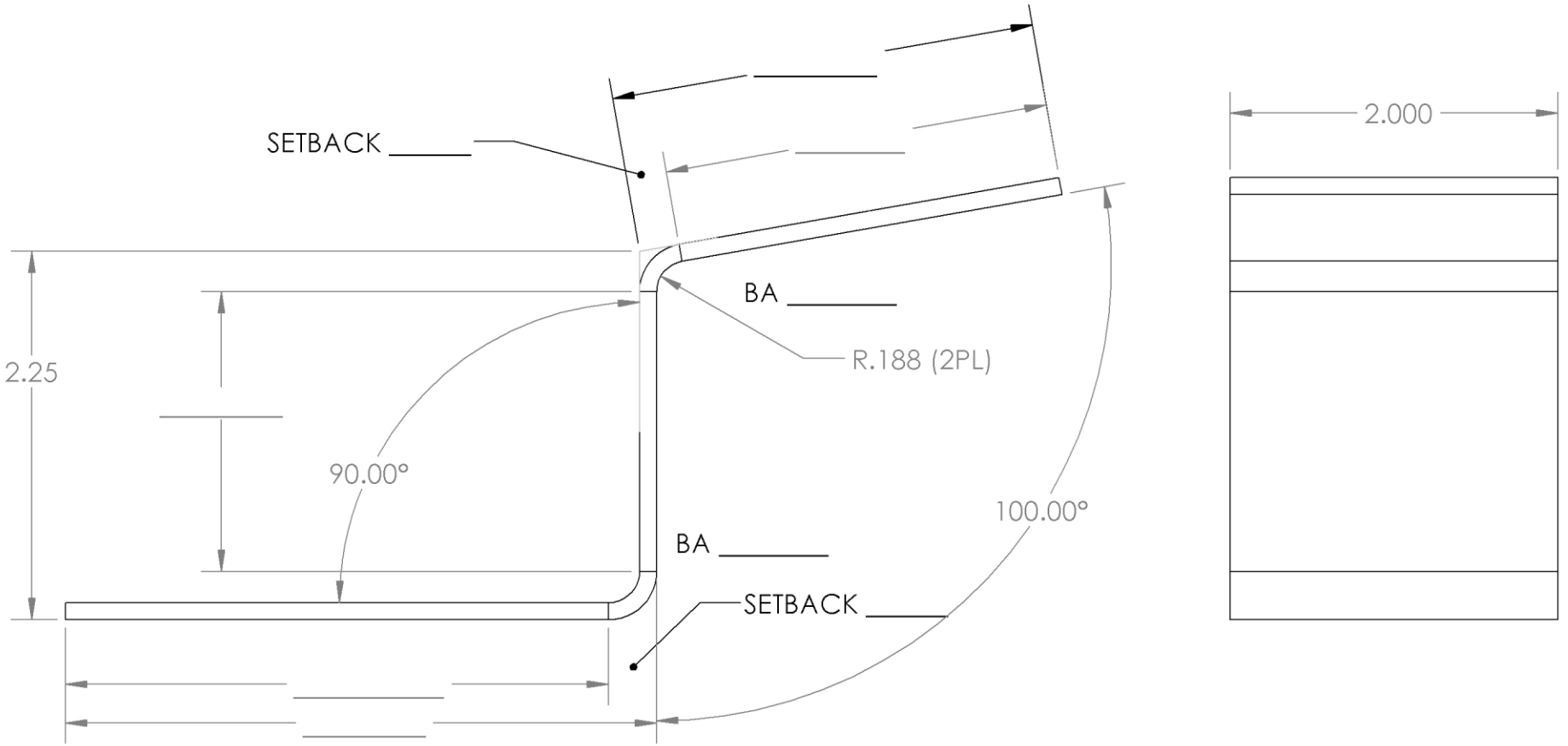


		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

SIZE	DWG. NO.	REV
A	BENDPLATE TEST 16GA	
SCALE: 1:2	WEIGHT:	SHEET 2 OF 4

5 4 3 2 1



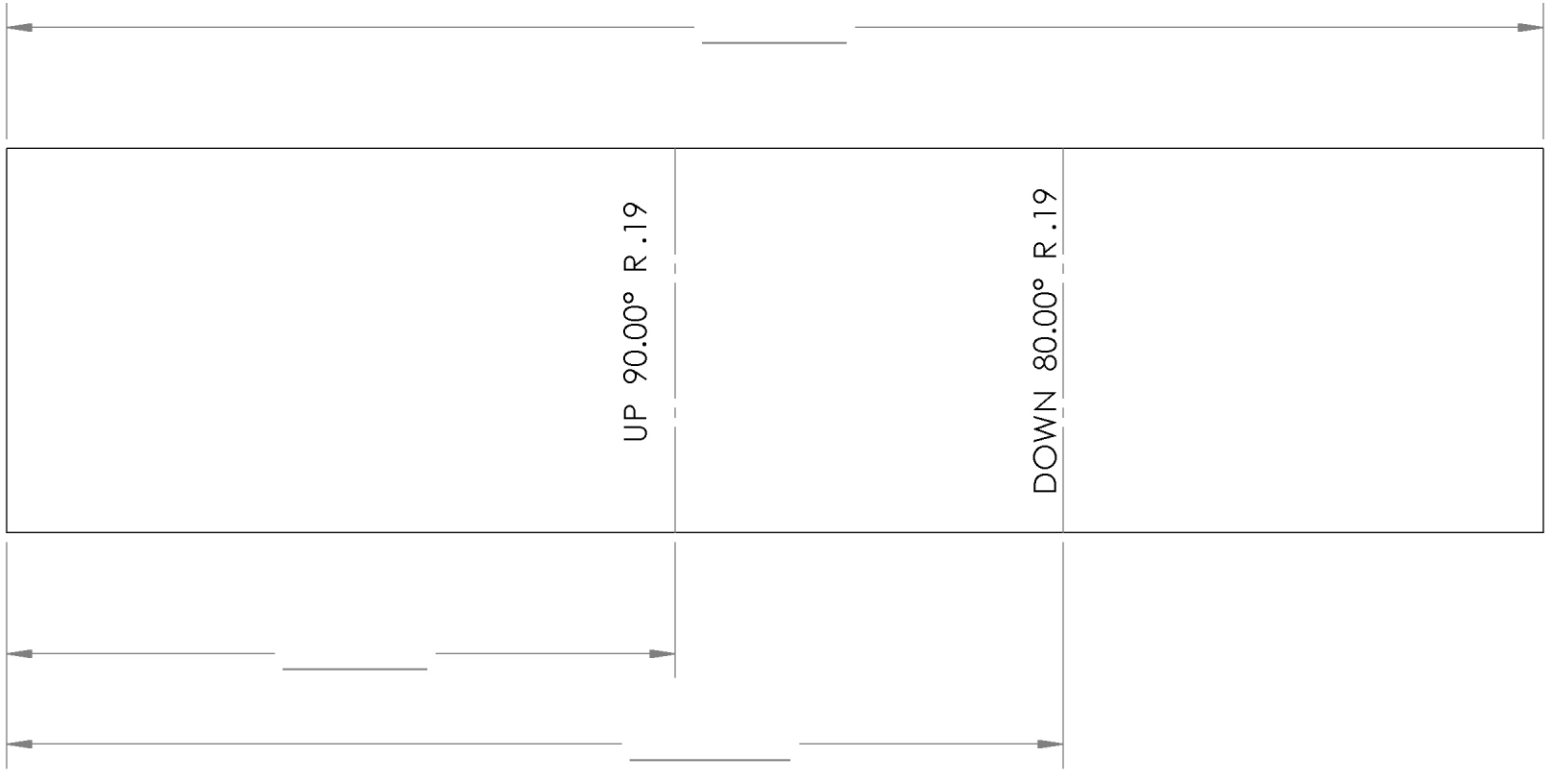
NAME: _____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

SIZE	DWG. NO.	REV
A	BENDPLATE TEST 12GA	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 4

5 4 3 2 1

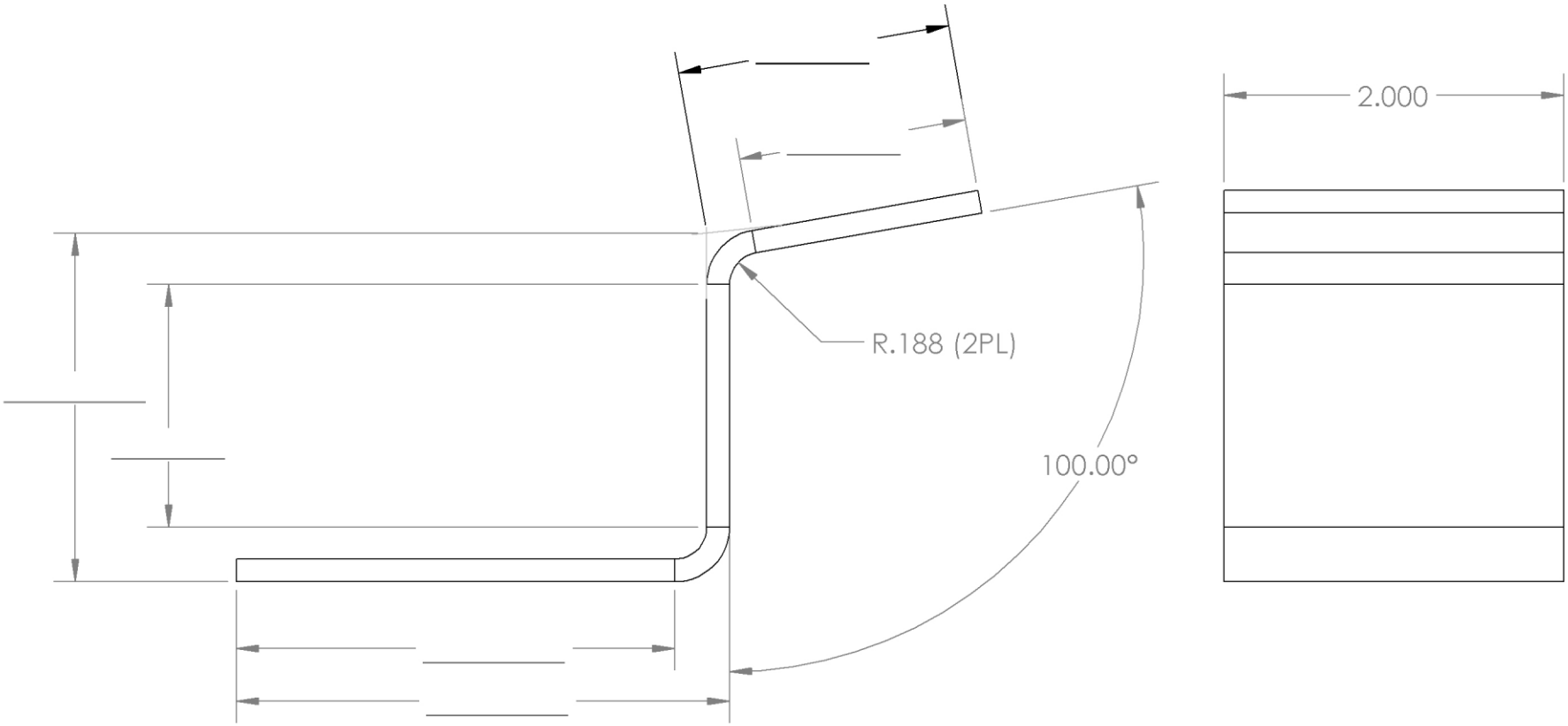


		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

SIZE	DWG. NO.	REV
A	BENDPLATE TEST 12GA	
SCALE: 1:2	WEIGHT:	SHEET 2 OF 4

5 4 3 2 1



NAME: _____

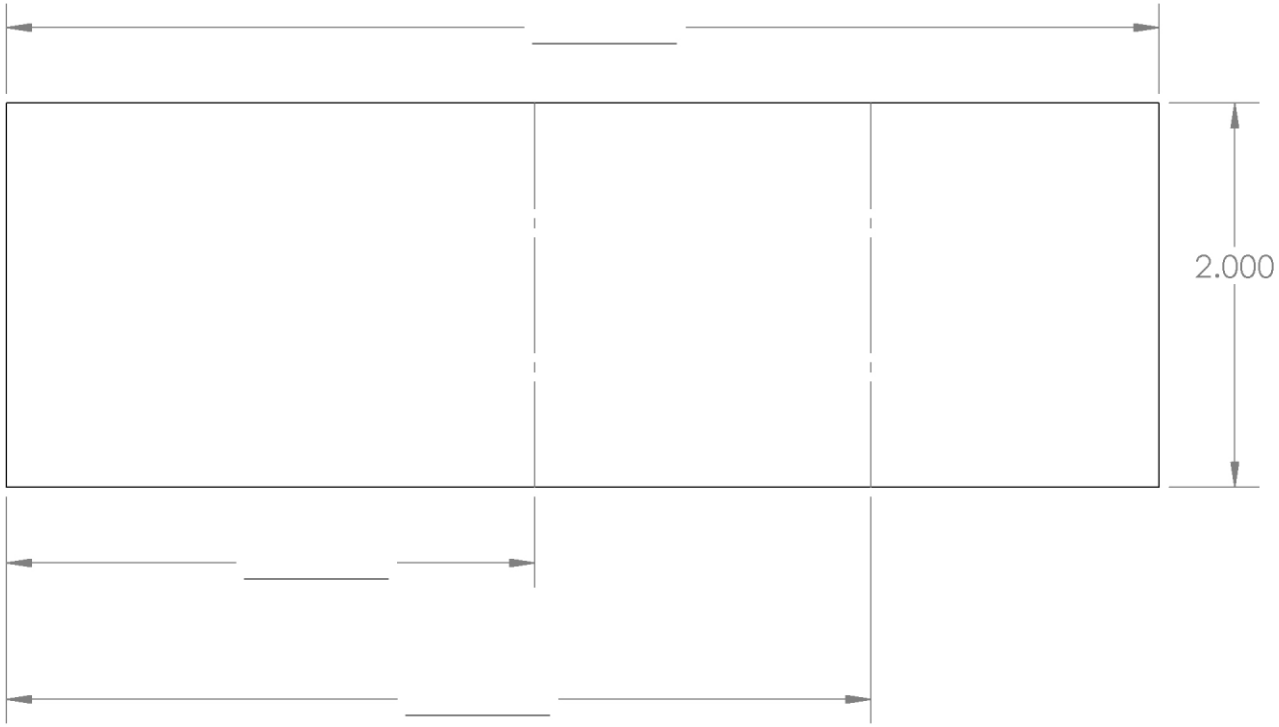
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ±1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.031	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

TITLE:

SIZE	DWG. NO.	REV
A	BENDPLATE TEST 11GA	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 2

5 4 3 2 1



		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

TITLE:

SIZE A | DWG. NO. ENDPLATE TEST 11GA | REV

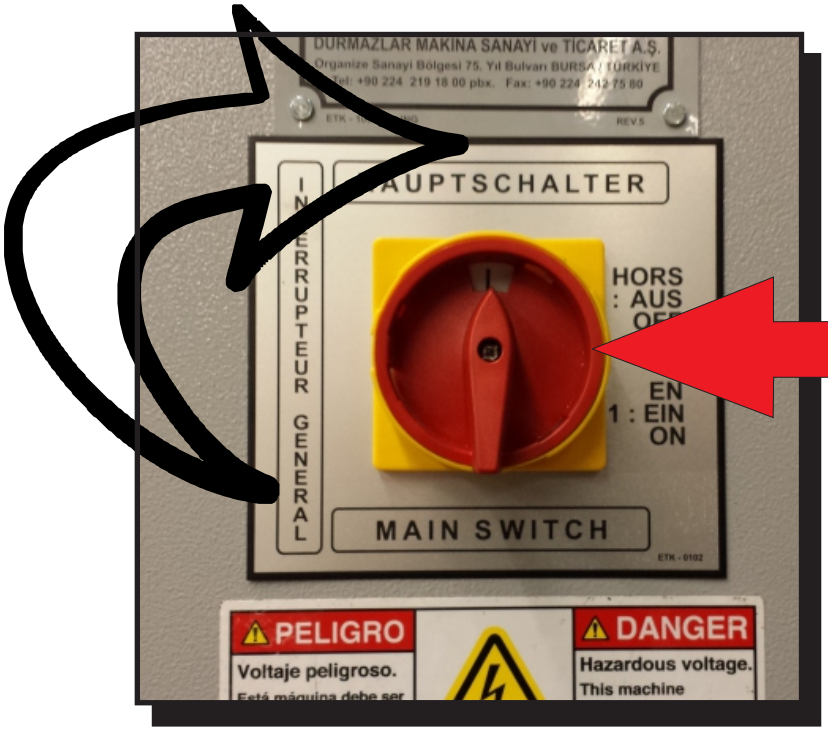
SCALE: 1:2 | WEIGHT: | SHEET 2 OF 2

5 4 3 2 1

Press Brake Basics

NDSCS
Manufacturing Dept.

To Start Press Brake Operation



1

On side of Press Brake, turn main switch clockwise to the ON position.

On control panel

3

Push Green

2

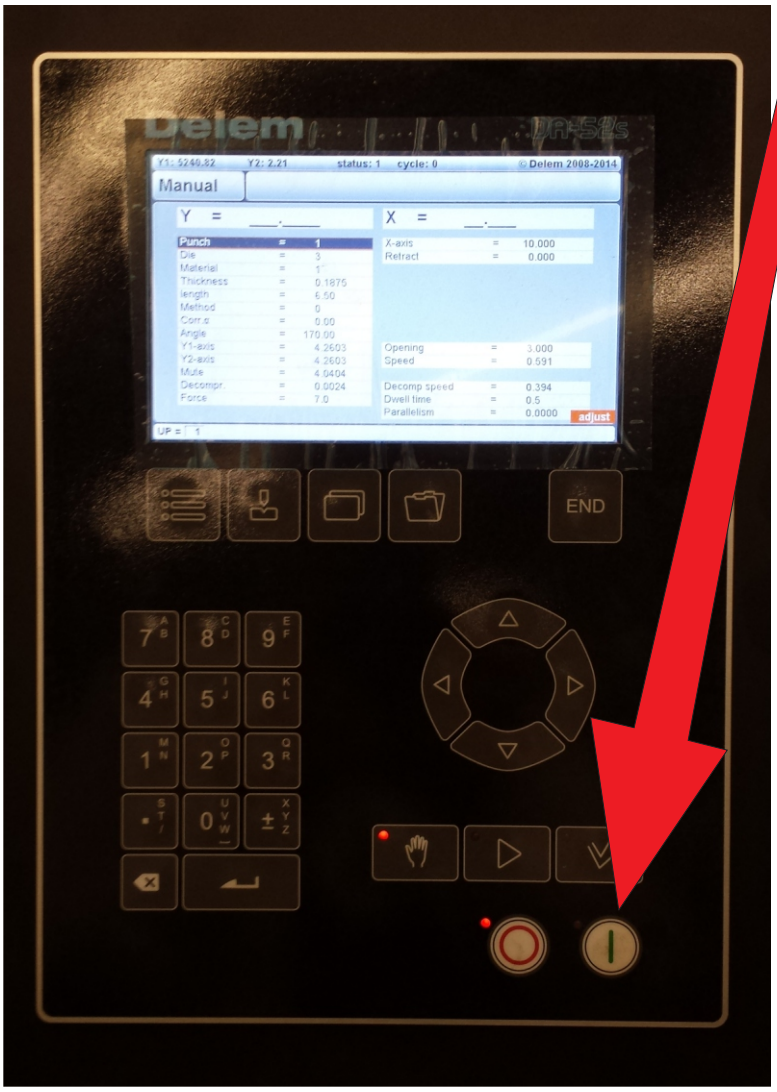
Push Yellow

Activating punch movement

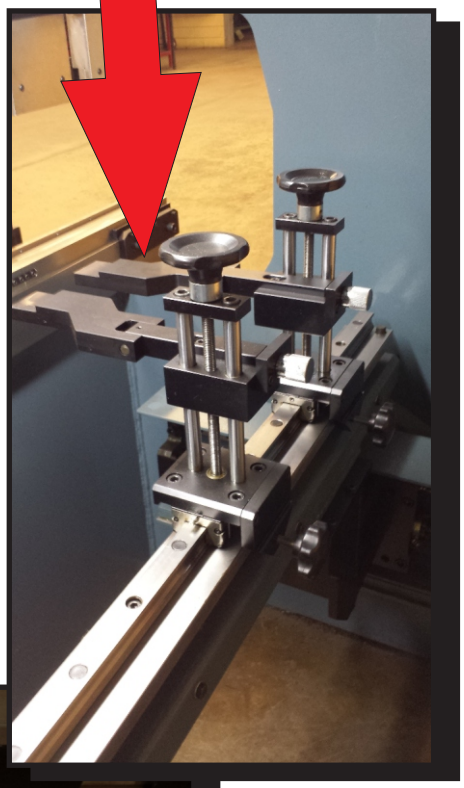
Turn Key on side of control panel

To Hand/Foot

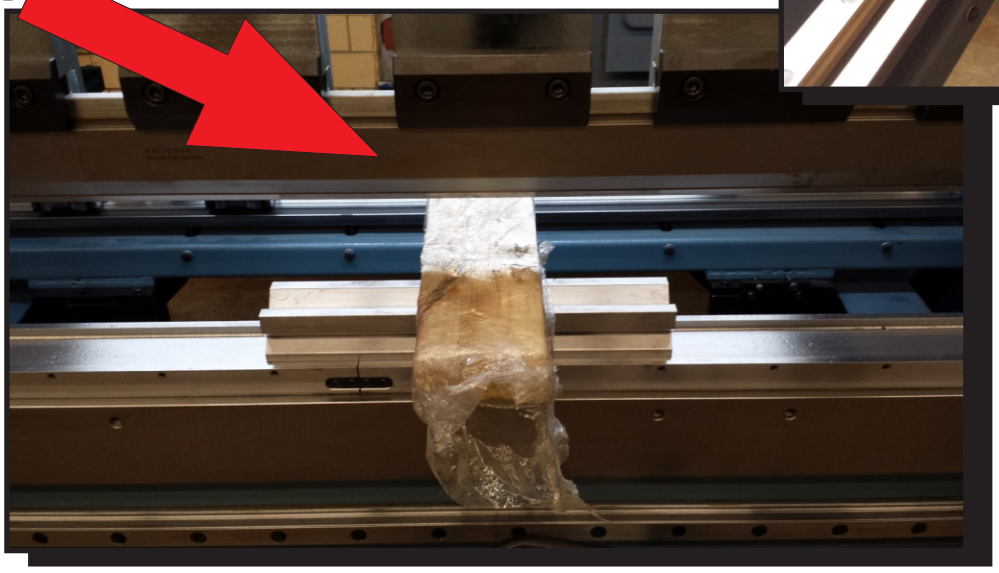
Pushing ⏽ button calibrates back gauge and punch



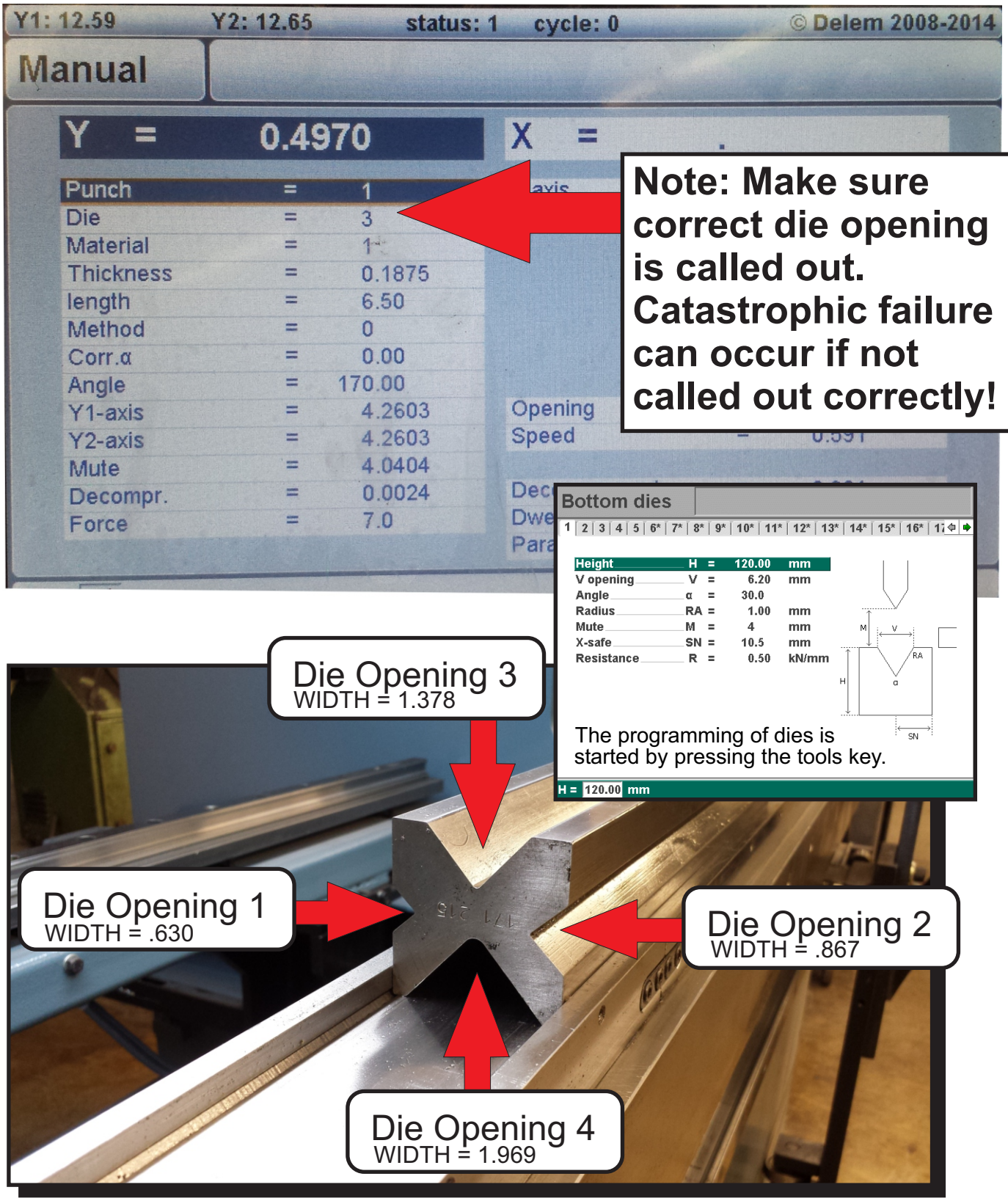
Back Gauge



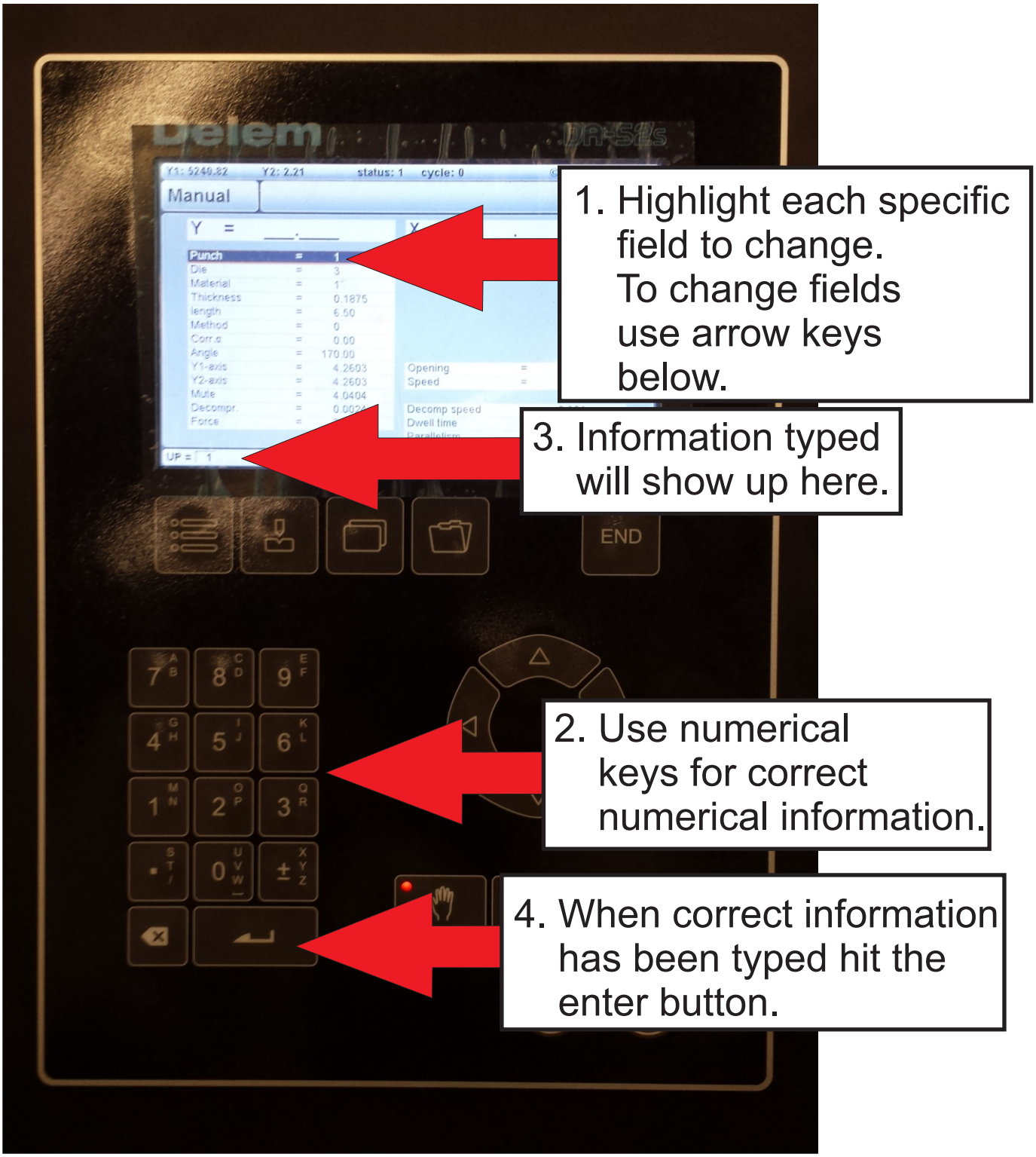
Punch



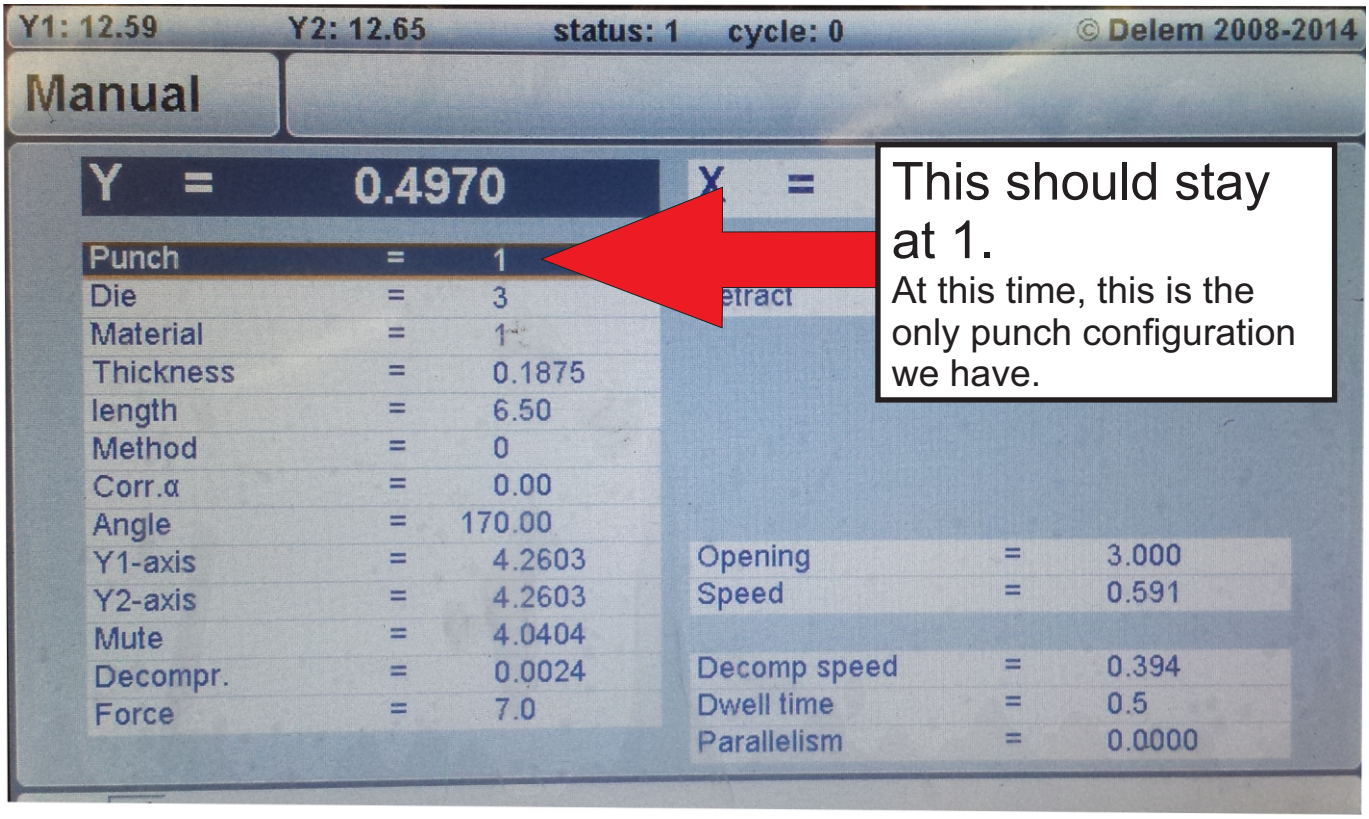
Die Opening

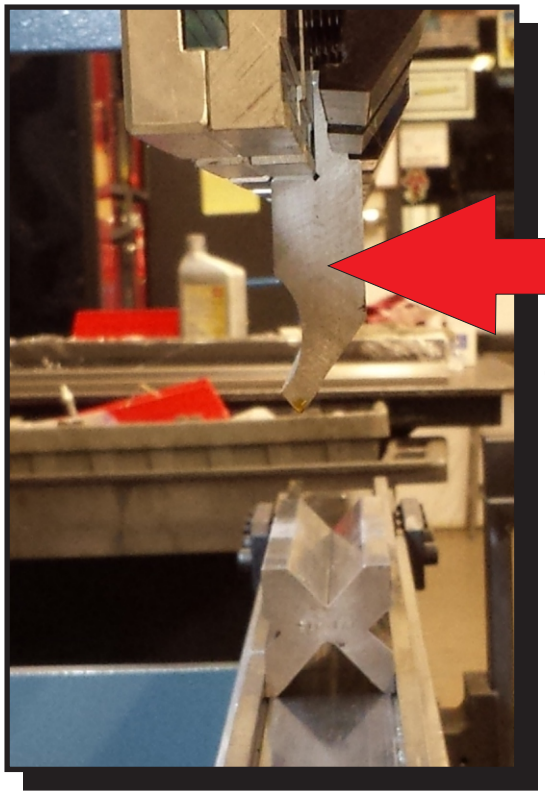

Y1: 12.59
Y2: 12.65
status: 1
cycle: 0
© Delem 2008-2014
Manual
Y = 0.4970
X =
Punch = 1
Die = 3
Material =
Thickness = 0.1875
length = 6.50
Method = 0
Corr.α = 0.00
Angle = 170.00
Y1-axis = 4.2603
Y2-axis = 4.2603
Mute = 4.0404
Decompr. = 0.0024
Force = 7.0
Opening
Speed
Note: Make sure correct die opening is called out. Catastrophic failure can occur if not called out correctly!
Bottom dies
1 | 2 | 3 | 4 | 5 | 6* | 7* | 8* | 9* | 10* | 11* | 12* | 13* | 14* | 15* | 16* | 17
Height H = 120.00 mm
V opening V = 6.20 mm
Angle α = 30.0
Radius RA = 1.00 mm
Mute M = 4 mm
X-safe SN = 10.5 mm
Resistance R = 0.50 kN/mm
The programming of dies is started by pressing the tools key.
H = 120.00 mm
Die Opening 3
WIDTH = 1.378
Die Opening 1
WIDTH = .630
Die Opening 2
WIDTH = .867
Die Opening 4
WIDTH = 1.969

Changing Control Panel Values



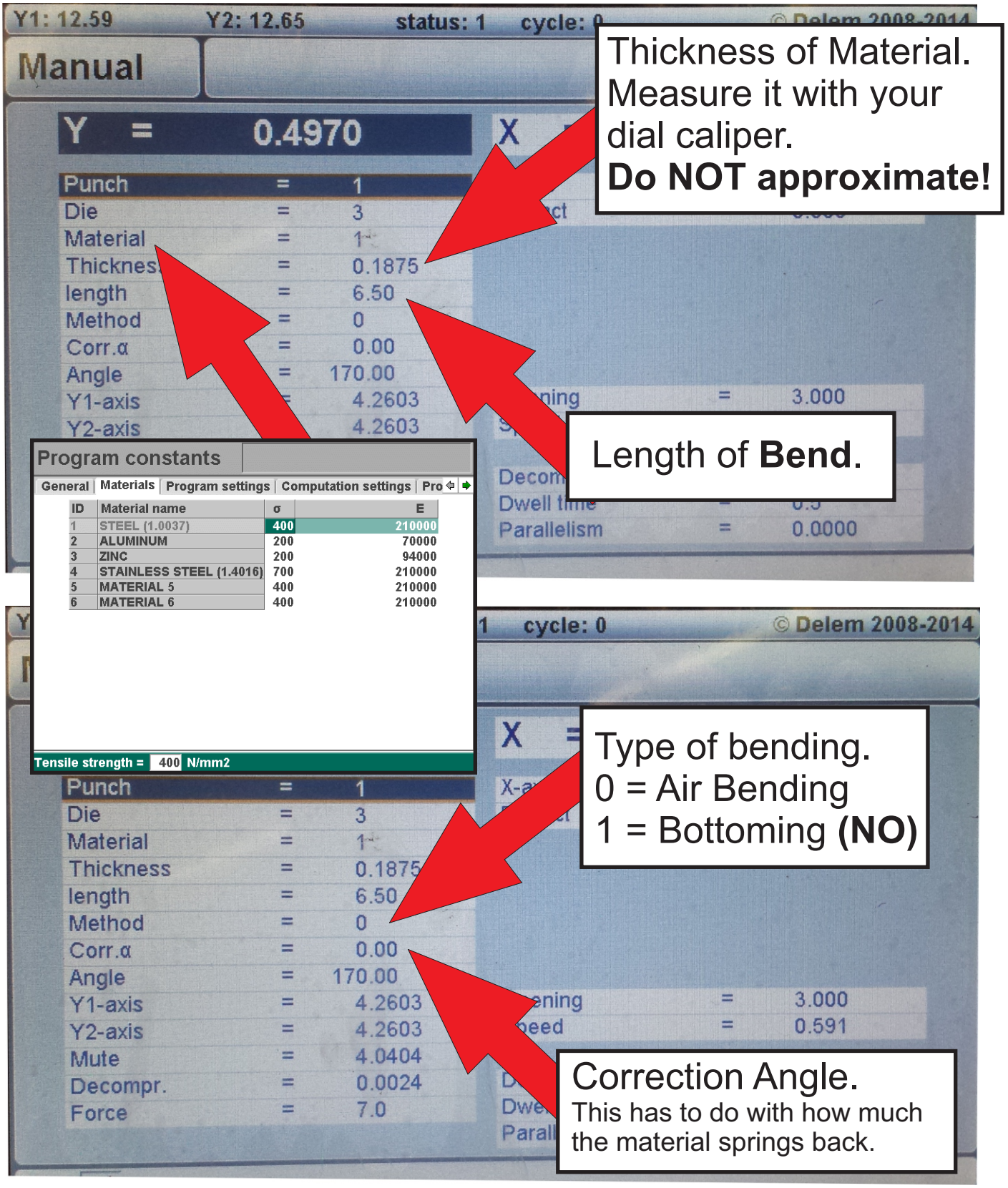
Punch

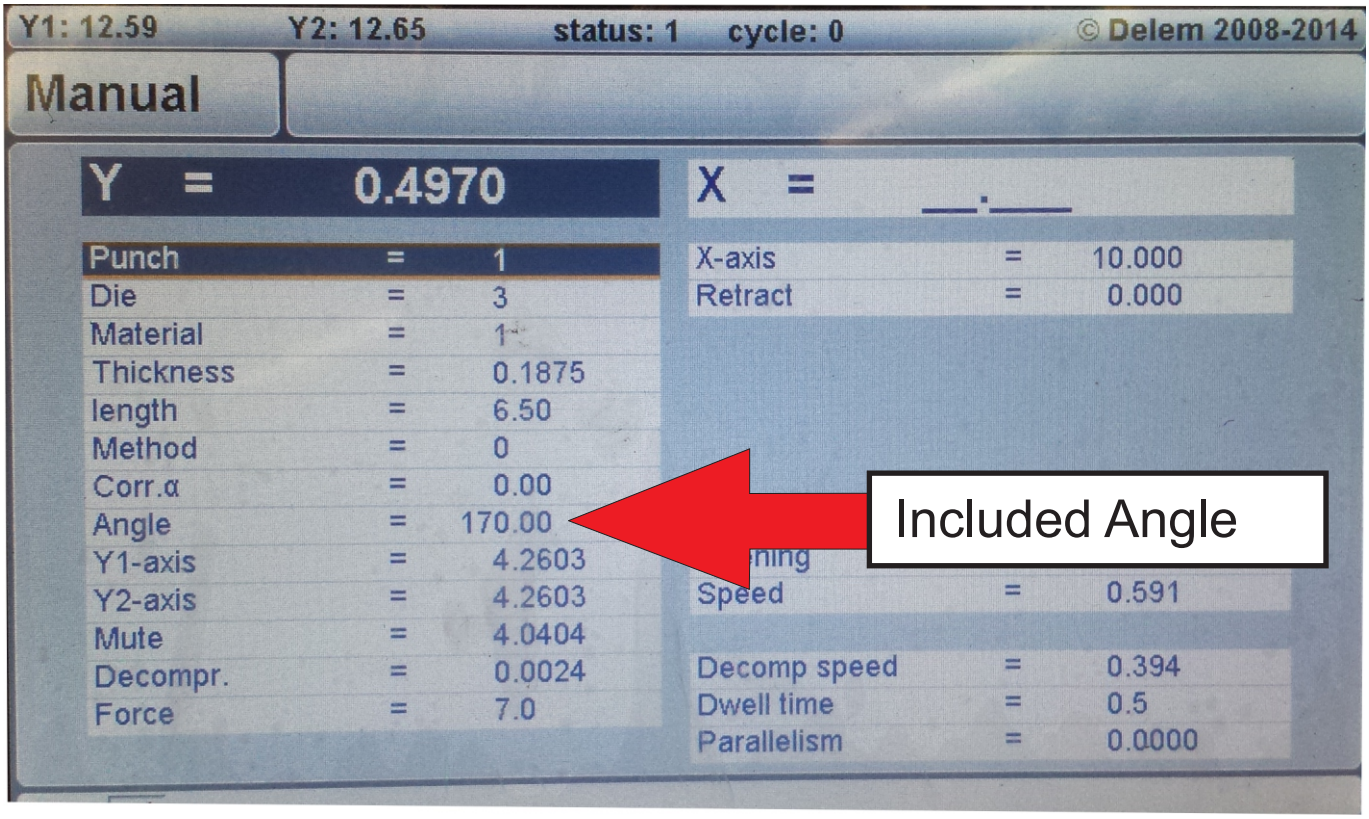


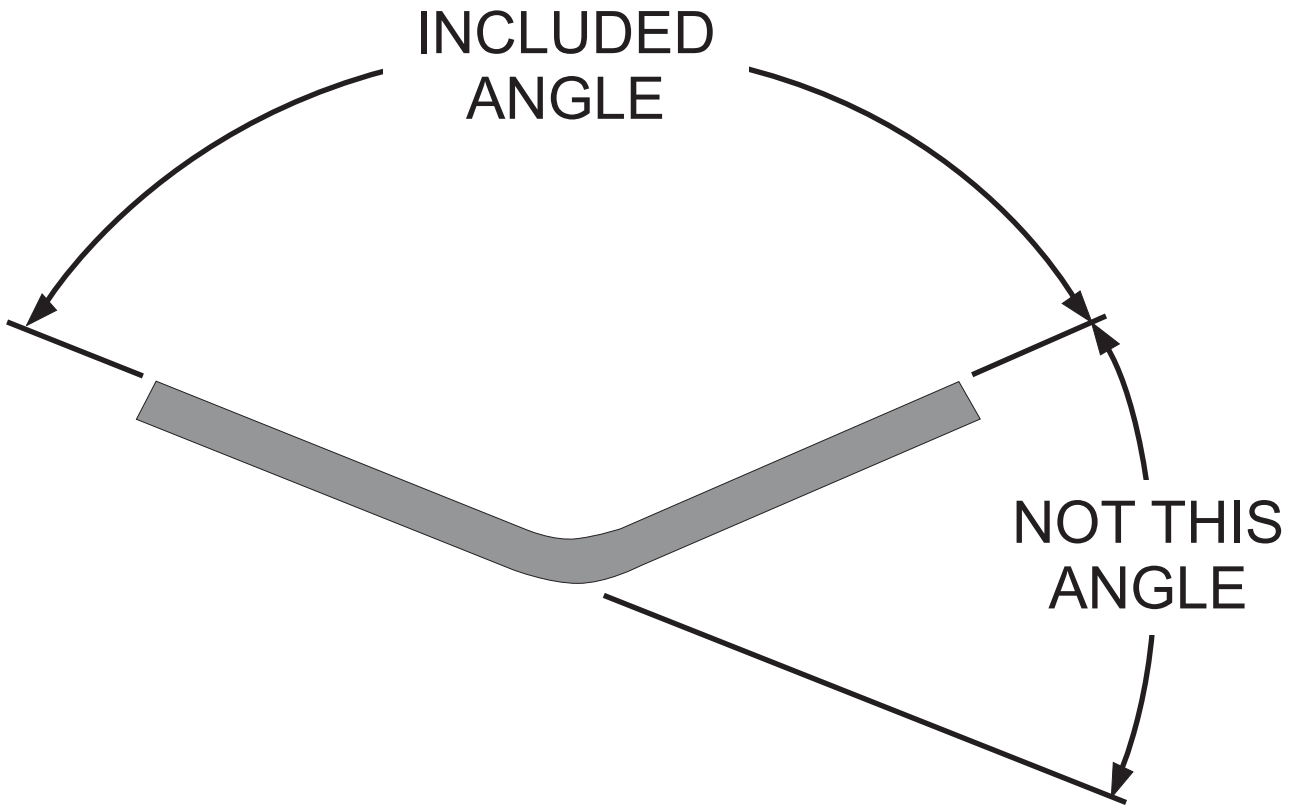


Punch

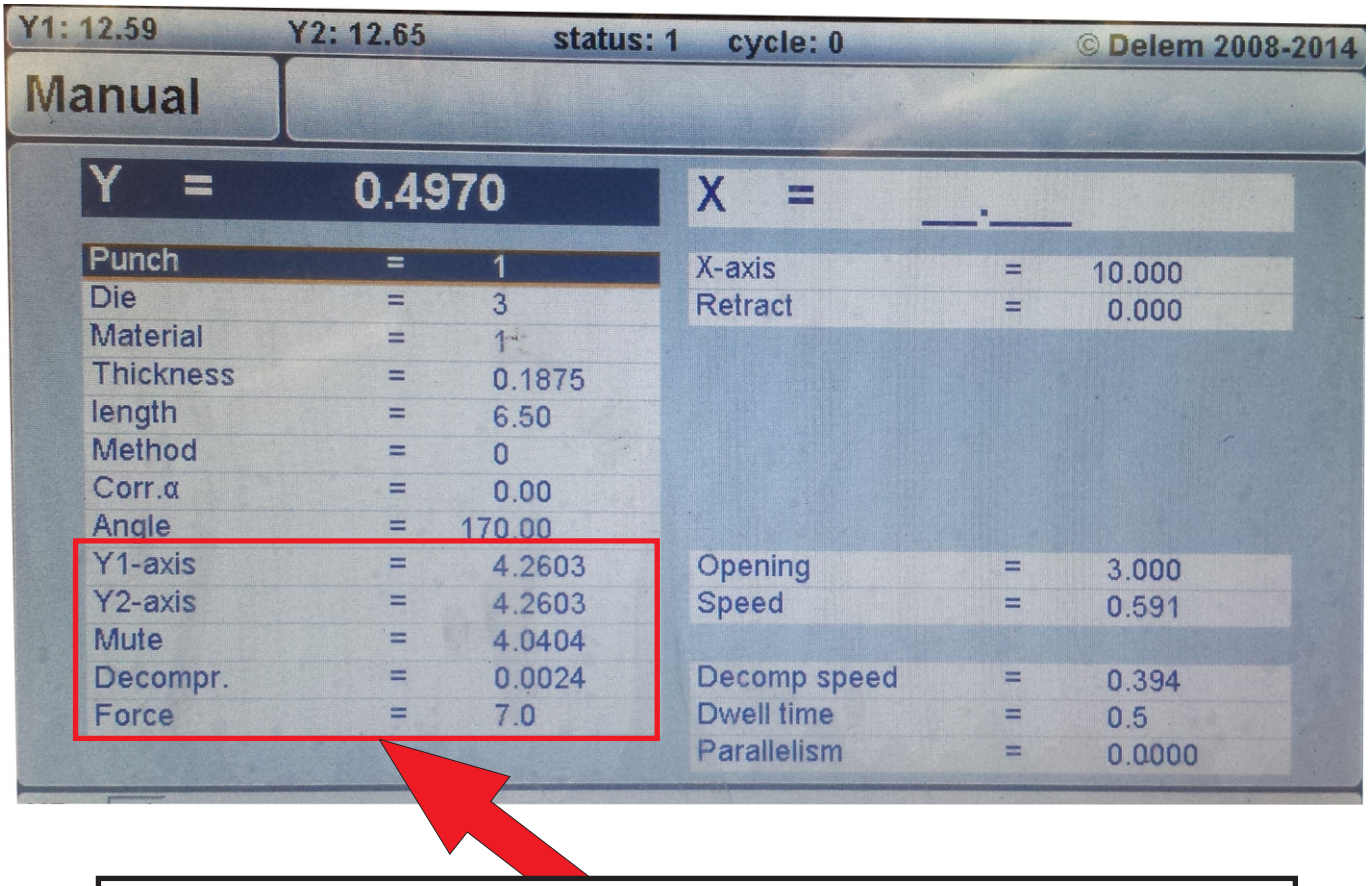
Note: Curved part of punch faces the back of the machine.


Y1: 12.59
Y2: 12.65
status: 1
cycle: 0
Manual
Y = 0.4970
X
Punch = 1
Die = 3
Material = 1
Thickness = 0.1875
length = 6.50
Method = 0
Corr.α = 0.00
Angle = 170.00
Y1-axis = 4.2603
Y2-axis = 4.2603
Parallelism = 3.000
Program constants
General | Materials | Program settings | Computation settings
ID | Material name | σ | E
1 | STEEL (1.0037) | 400 | 210000
2 | ALUMINUM | 200 | 70000
3 | ZINC | 200 | 94000
4 | STAINLESS STEEL (1.4016) | 700 | 210000
5 | MATERIAL 5 | 400 | 210000
6 | MATERIAL 6 | 400 | 210000
Tensile strength = 400 N/mm2
Punch = 1
Die = 3
Material = 1
Thickness = 0.1875
length = 6.50
Method = 0
Corr.α = 0.00
Angle = 170.00
Y1-axis = 4.2603
Y2-axis = 4.2603
Mute = 4.0404
Decompr. = 0.0024
Force = 7.0
Parallelism = 3.000
Speed = 0.591
© Delem 2008-2014
Thickness of Material.
Measure it with your dial caliper.
Do NOT approximate!
Length of Bend.
Type of bending.
0 = Air Bending
1 = Bottoming (NO)
Correction Angle.
This has to do with how much the material springs back.


Y1: 12.59
Y2: 12.65
status: 1
cycle: 0
© Delem 2008-2014
Manual
Y = 0.4970
X = __.____
Punch = 1
Die = 3
Material = 1
Thickness = 0.1875
length = 6.50
Method = 0
Corr.α = 0.00
Angle = 170.00
Y1-axis = 4.2603
Y2-axis = 4.2603
Mute = 4.0404
Decompr. = 0.0024
Force = 7.0
X-axis = 10.000
Retract = 0.000
Speed = 0.591
Decomp speed = 0.394
Dwell time = 0.5
Parallelism = 0.0000
Included Angle

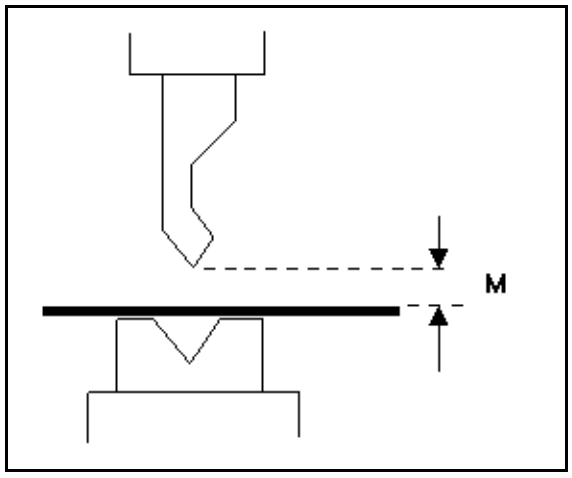

INCLUDED ANGLE
NOT THIS ANGLE

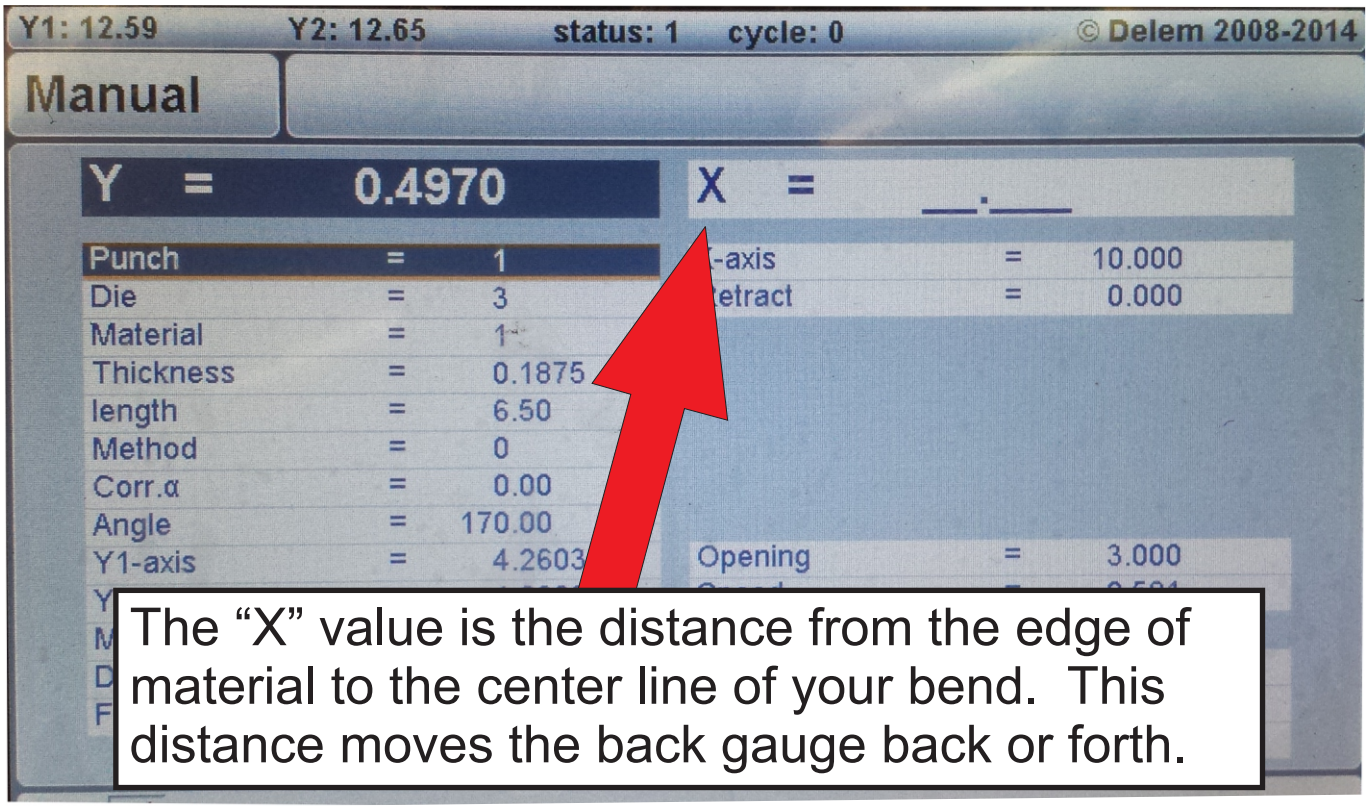
Changing Values

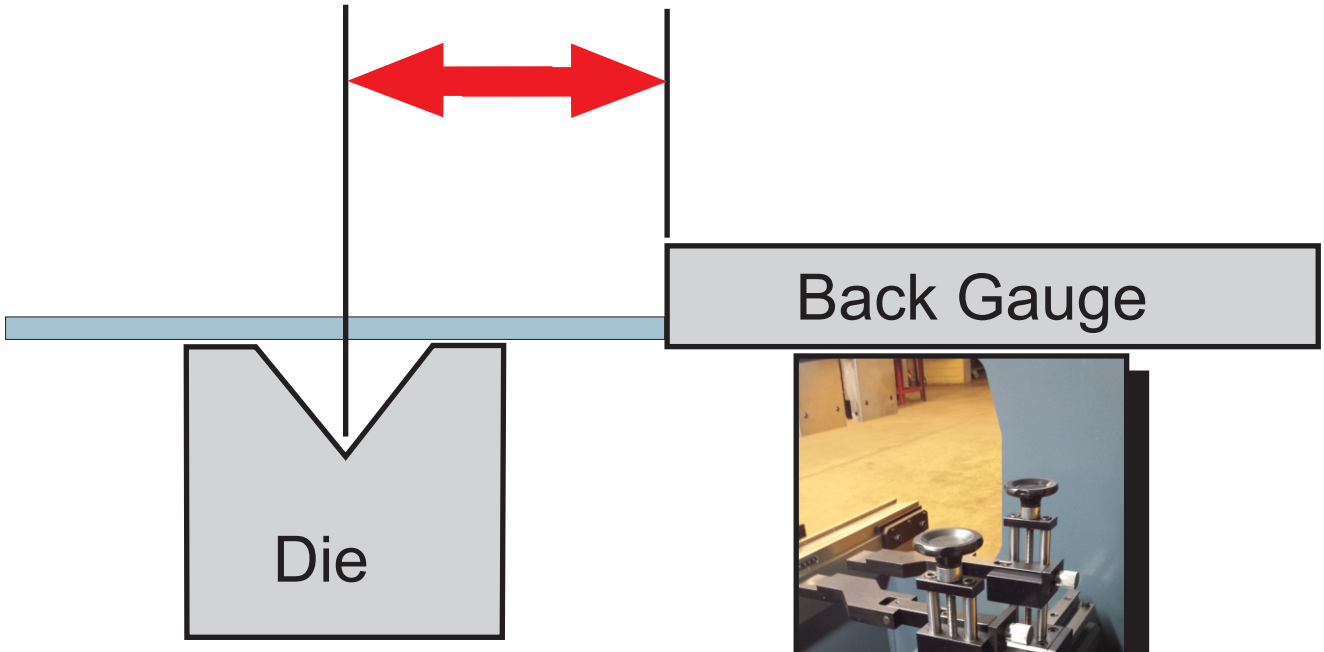


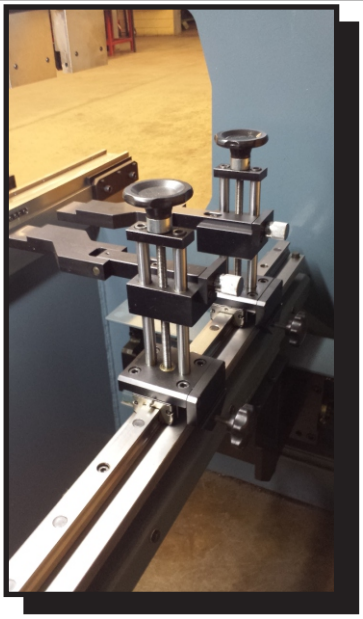
DO NOT CHANGE THESE VALUES. THESE ARE CALCULATED BY THE CONTROL PANEL.

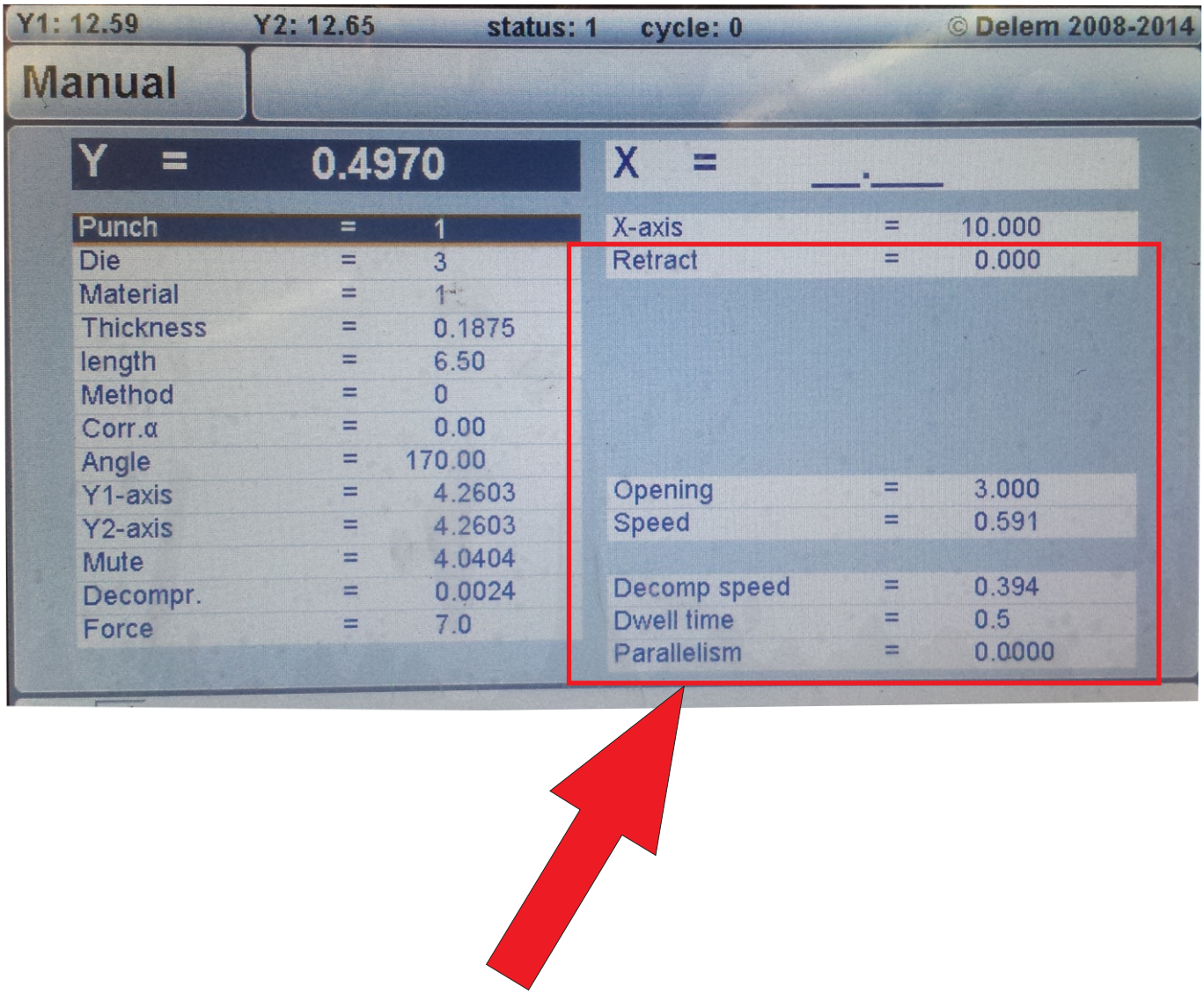
Muting distance. Distance above the sheet at which the speed change takes place.




Y1: 12.59
Y2: 12.65
status: 1
cycle: 0
© Delem 2008-2014
Manual
Y = 0.4970
X = ___.____
Punch = 1
Die = 3
Material =
Thickness = 0.1875
length = 6.50
Method = 0
Corr.α = 0.00
Angle = 170.00
Y1-axis = 4.2603
-axis = 10.000
etract = 0.000
Opening = 3.000
The “X” value is the distance from the edge of material to the center line of your bend. This distance moves the back gauge back or forth.

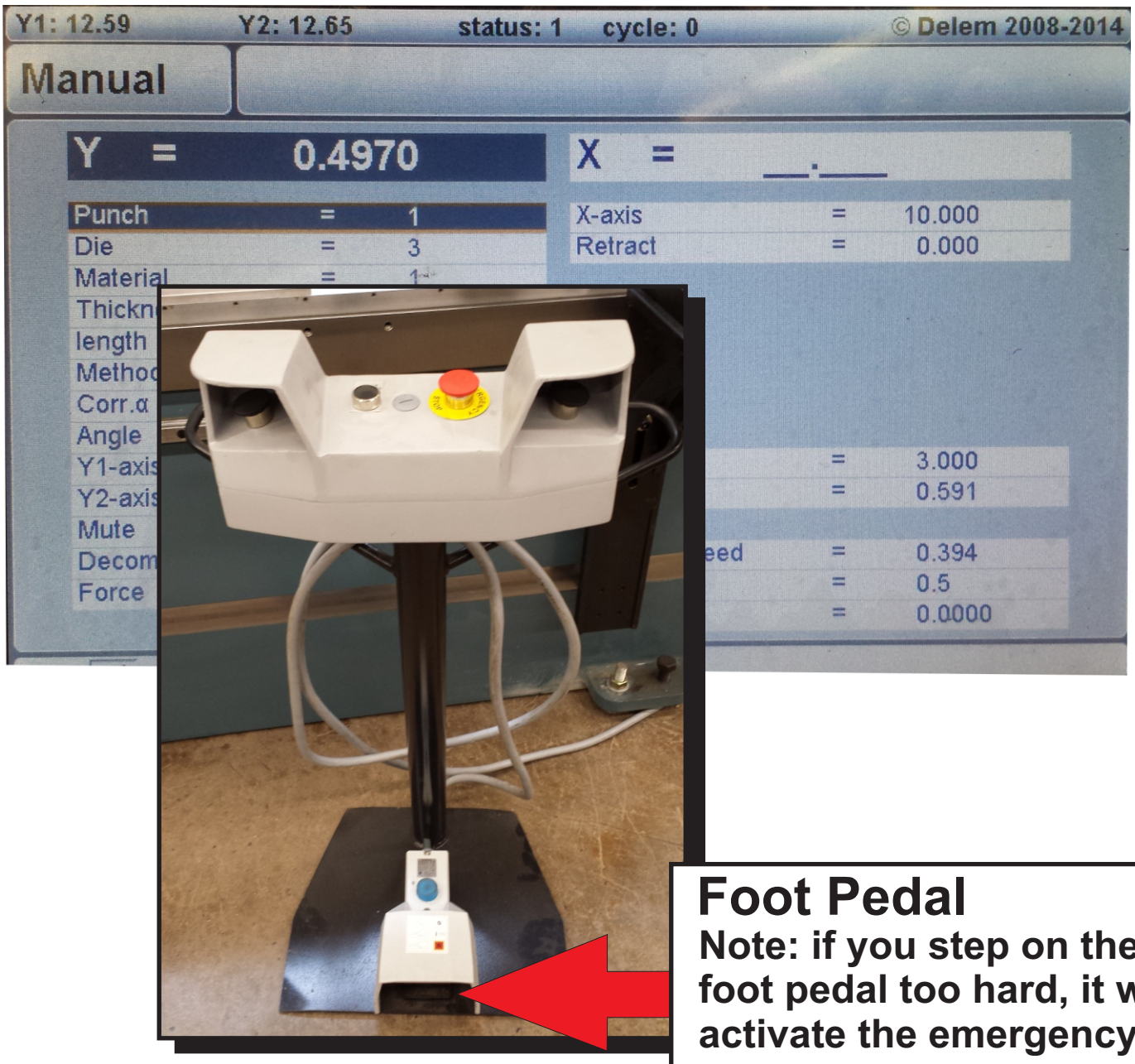

Back Gauge
Die





DO NOT ADJUST THESE SETTINGS

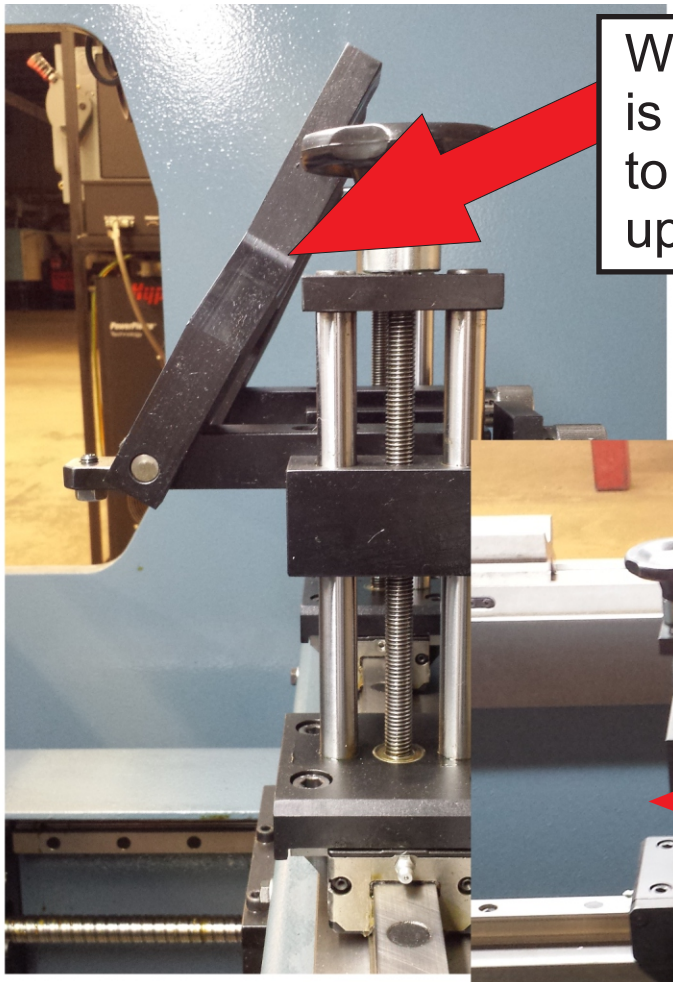
After all values have been entered, cycle through all of your inputs by hitting the enter button (**DO NOT use the arrow keys**) and then step on foot pedal and cycle the punch through a cycle with no material in the die.



Foot Pedal

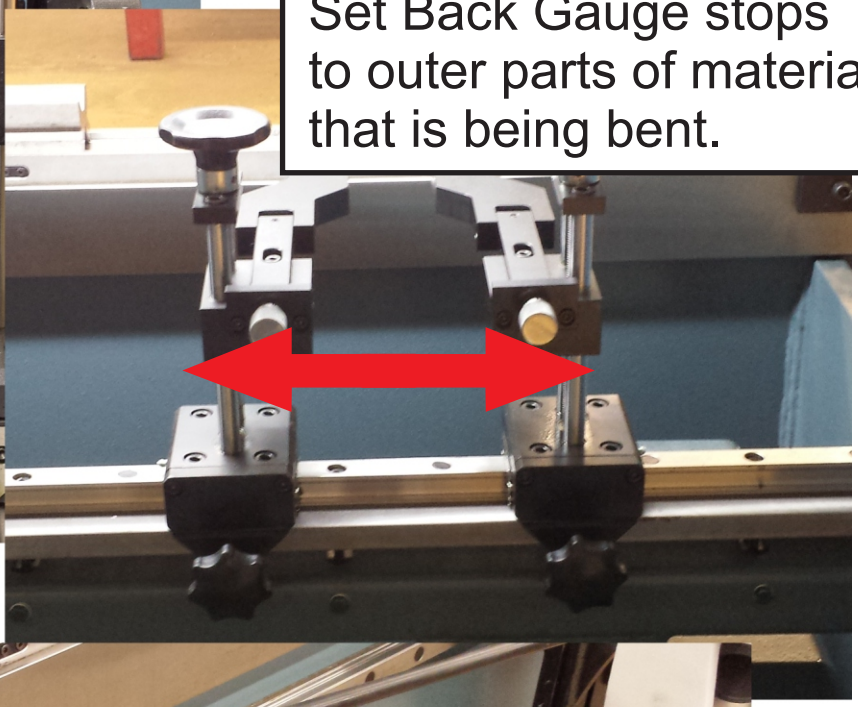
Note: if you step on the foot pedal too hard, it will activate the emergency stop.

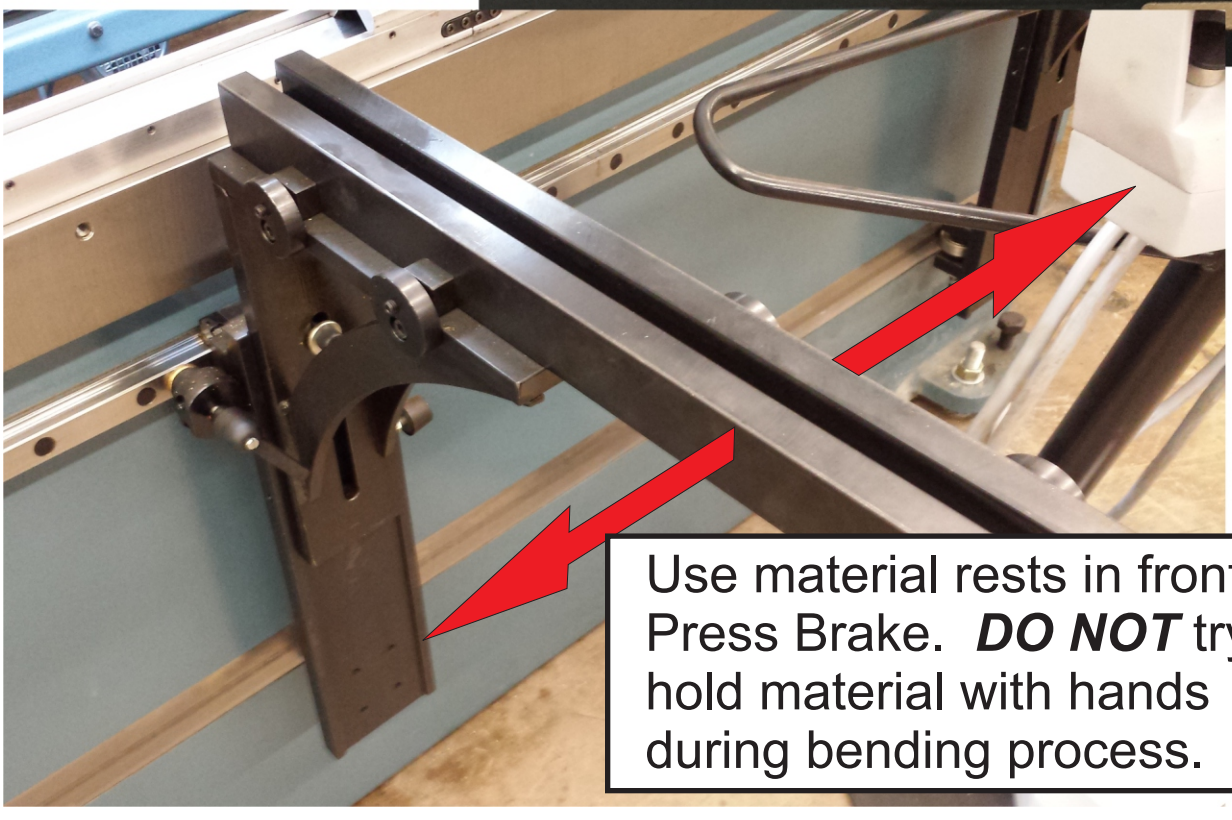
Adjustments



When Back Gauge is set to stop close to the Die, flip stops up before moving.

Set Back Gauge stops to outer parts of material that is being bent.

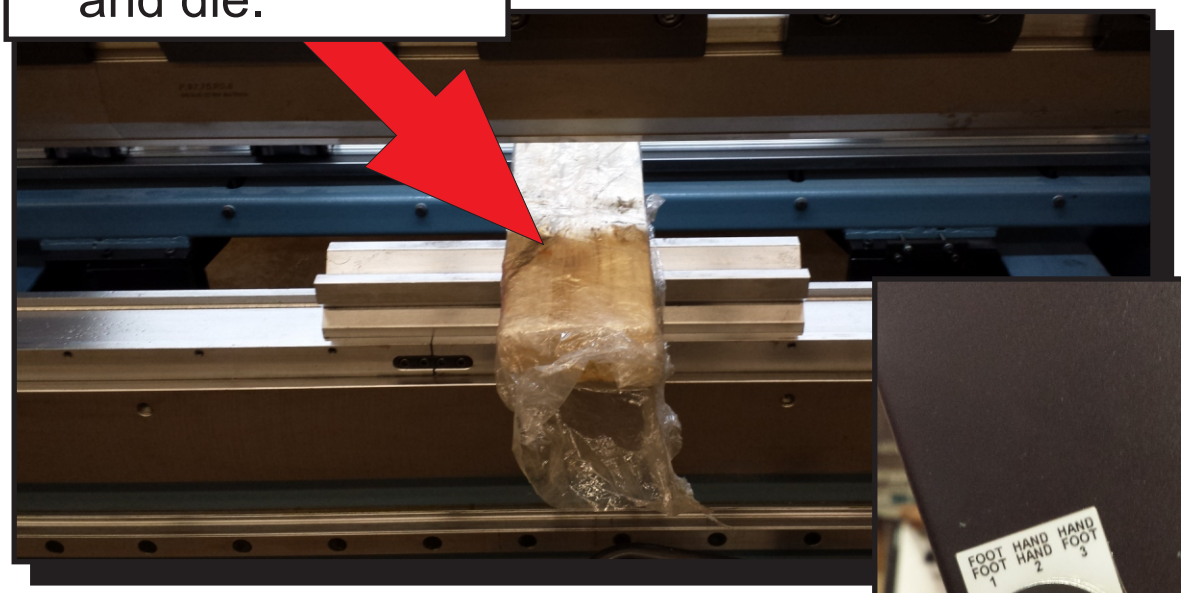




Use material rests in front of Press Brake. ***DO NOT*** try to hold material with hands during bending process.

Shutting down

1. Place wood block between punch and die.

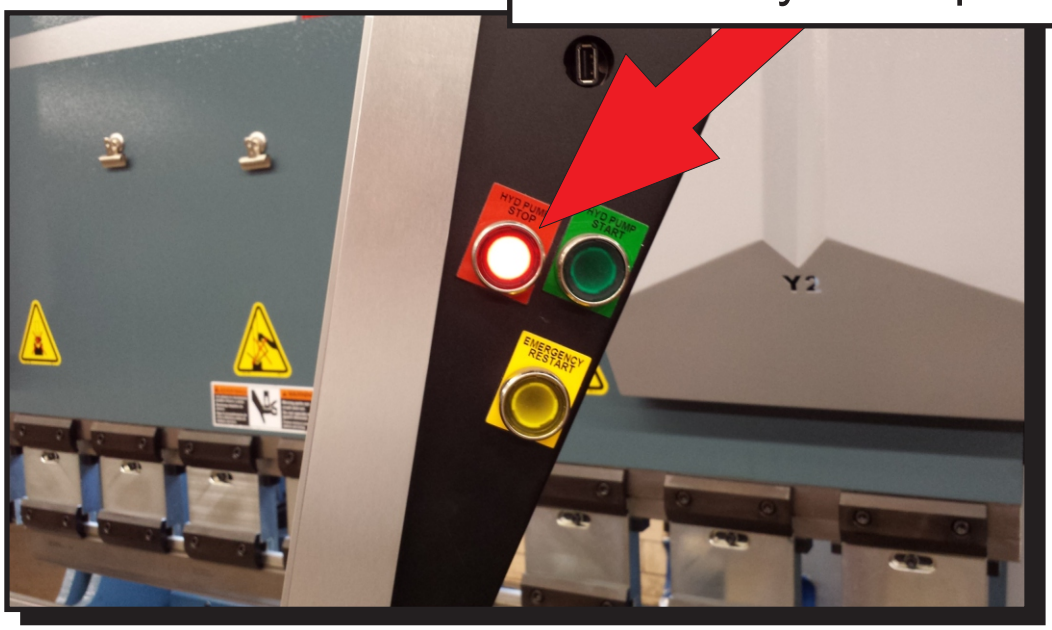


2. Turn key to foot/foot.

3. Step on foot pedal to run punch down to *slightly* touch wood block. **Note: Punch will run in slow motion in foot/foot mode.**

Shutting down

4. Push Hyd Pump STOP



5. Turn Power OFF on side of Press Brake.

BENDING

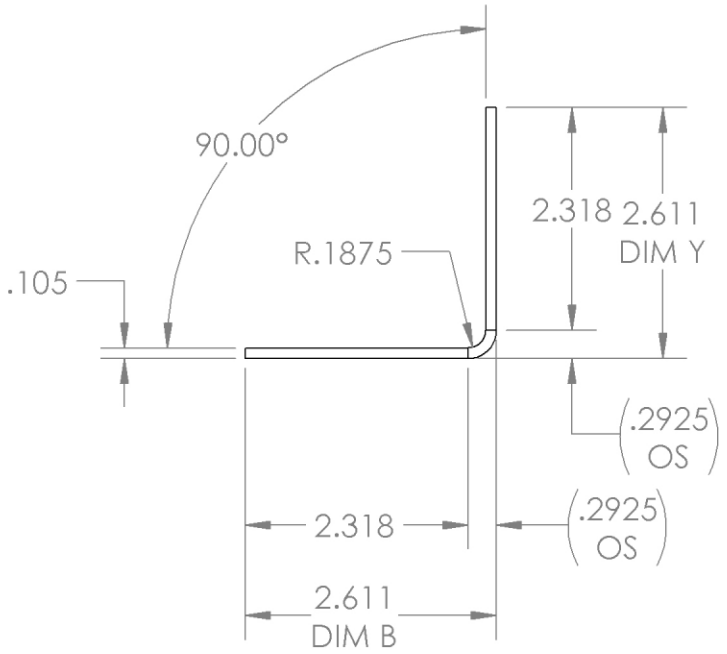
BEND DEDUCTION
DIM Y + DIM B - FLAT LENGTH
2.611 + 2.611 - 5.00 = .222

OUTSIDE SETBACK (OS)
90° BEND:
MT + BEND RADIUS
.105 + .1875 = .2925

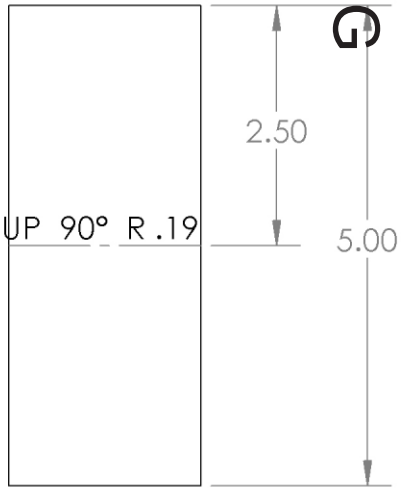
NON 90° BEND:
(TAN(ANGLE/2)) x (MT + RADIUS)
(TAN(90/2)) x (.105 + .1875) = .2925

BEND ALLOWANCE
(2 x OS)- BEND DEDUCTION
(2 x .2925) - .222 = .363

K-FACTOR (IF UNKNOWN)
(-BEND RADIUS + (BEND ALLOWANCE
/(3.1416 x BEND ANGLE/180))) /
MAT'L THICKNESS
(-.1875+(.363/(3.1416x90)/180)))/.104= .419



FORMED PATTERN



FLAT PATTERN

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 12 GA SHEET	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

TITLE:

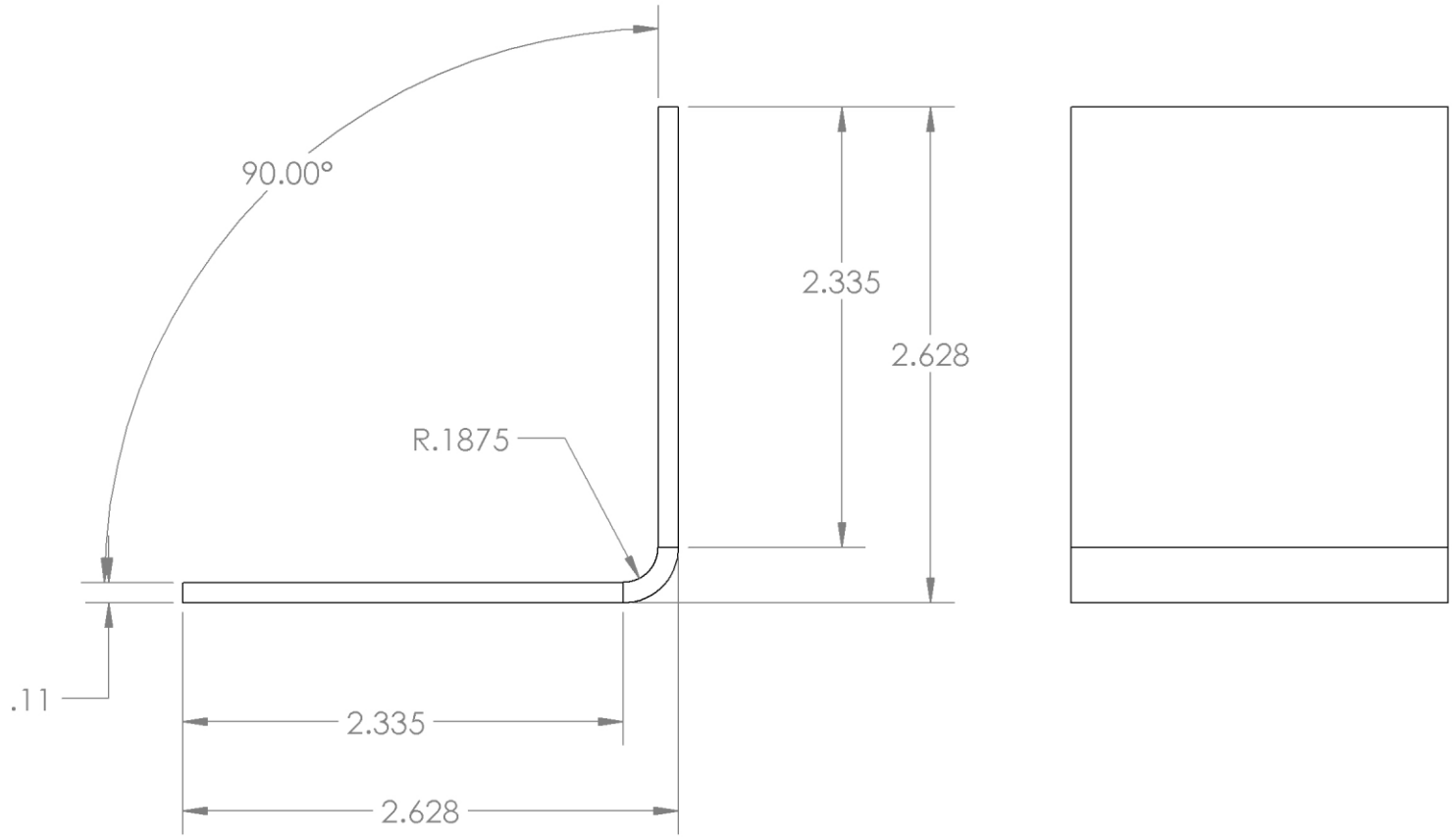
K-FACTOR .42

SIZE	DWG. NO.	REV
A	Kfac 42	

SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1

BENDING



		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 12 GA SHEET	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

TITLE:

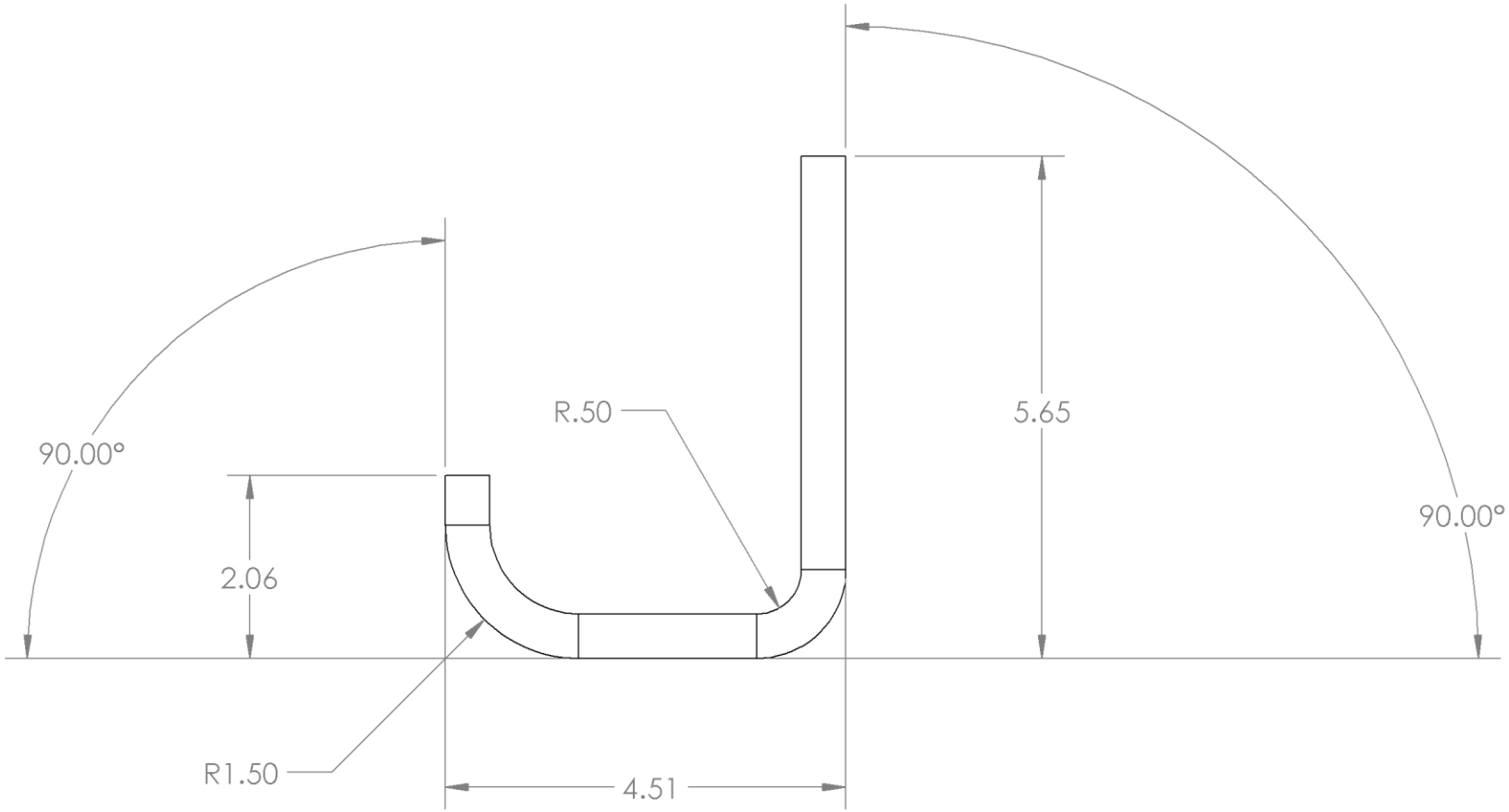
K-FACTOR .21

SIZE	DWG. NO.	REV
A	Kfac 21	

SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1

BENDING



K-FACTOR = .4

WHAT IS BLANK LENGTH _____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 1/2 CR PLATE	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

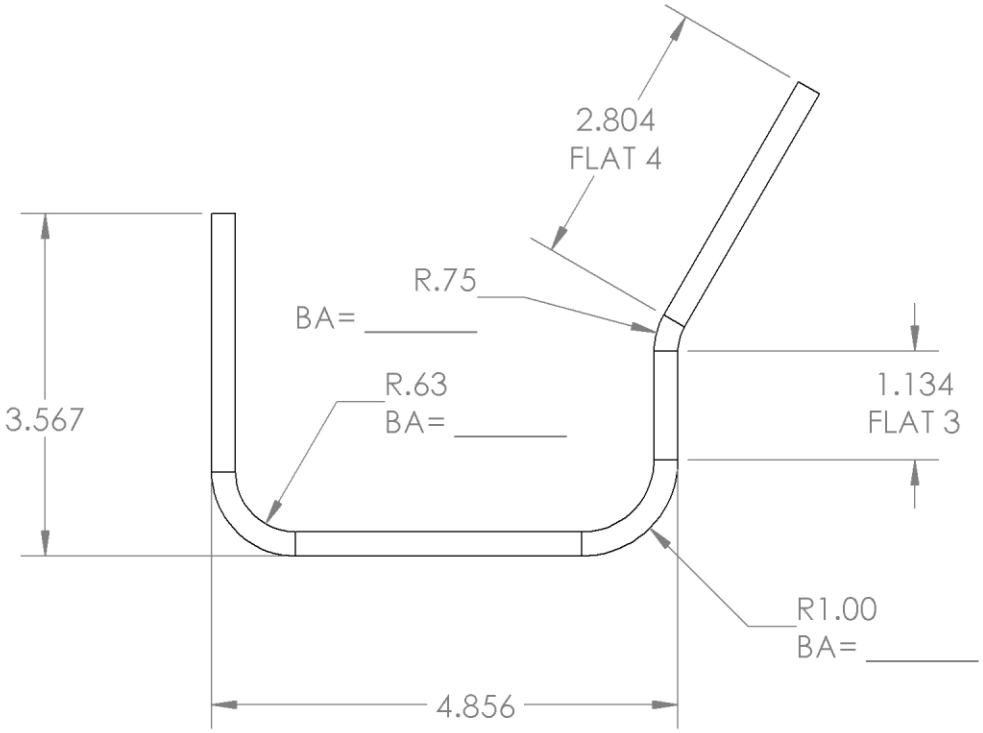
TITLE:

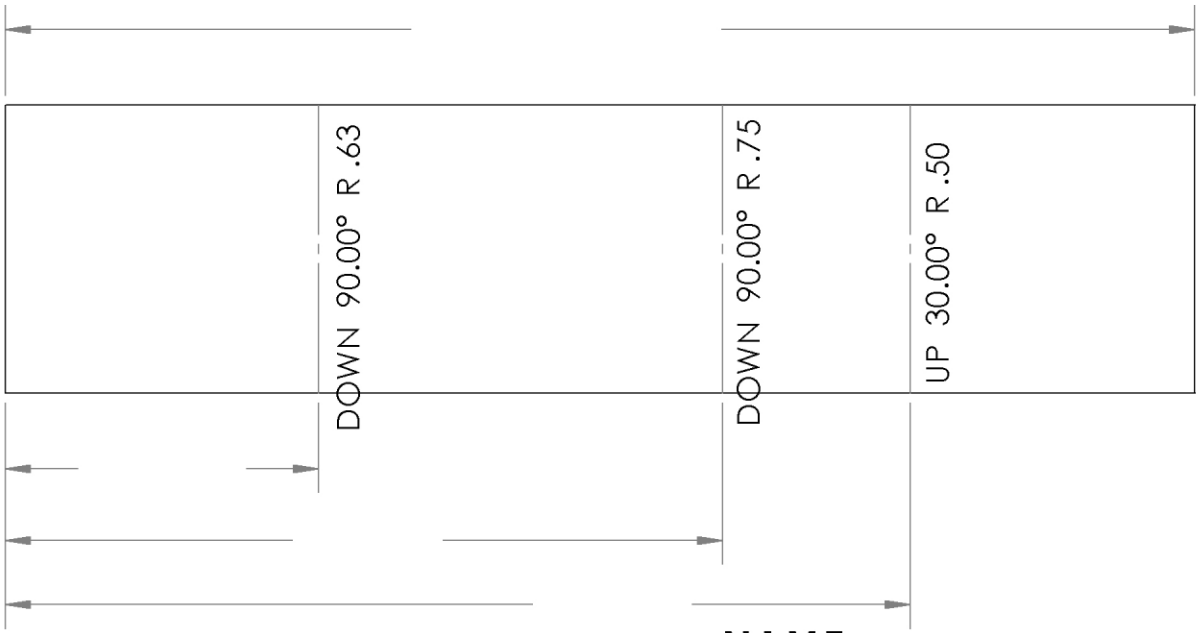
SIZE	DWG. NO.	REV
A	BENDPATTERN4	

SCALE: 1:4 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1

BENDING





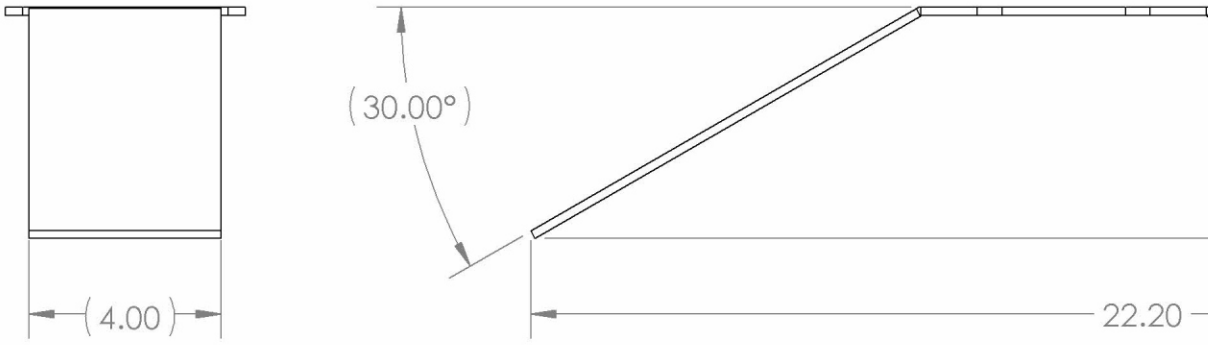
NAME: _____
WEIGHT _____

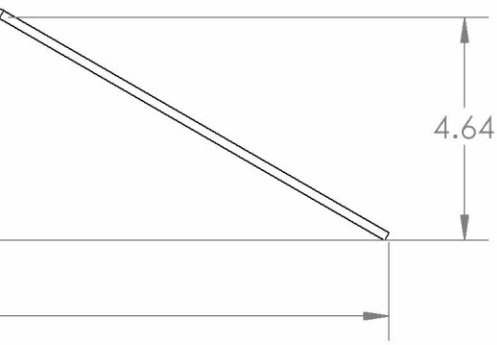
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		NAME	DATE
			DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
			Q.A.		
		MATERIAL 1/4 STEEL PLATE	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

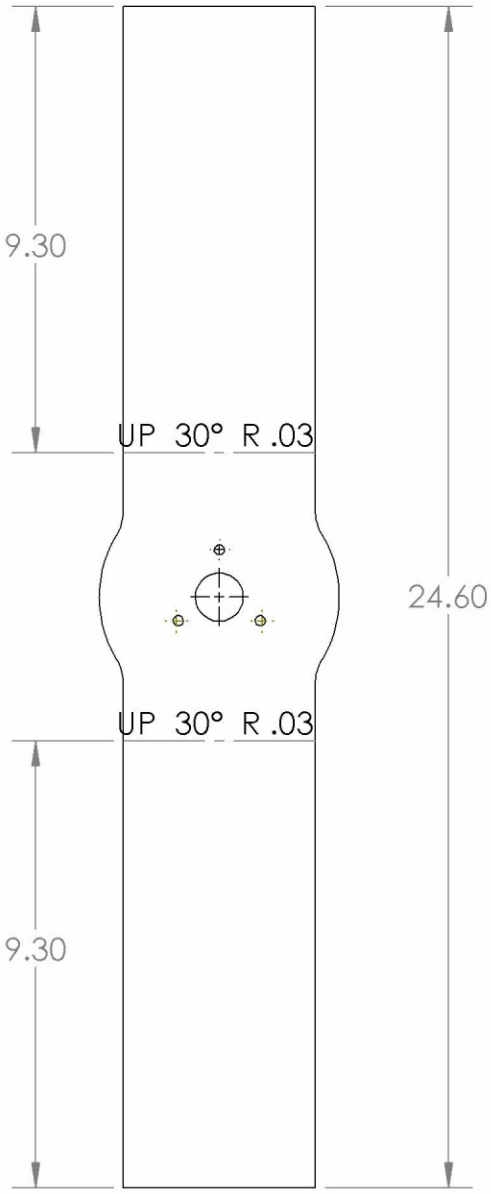
FLAT AND BEND PATTERN

SIZE	DWG. NO.	REV.
A	bendpattern1C	
SCALE:1:2	WEIGHT:	SHEET 1 OF 1

BENDING







B

A

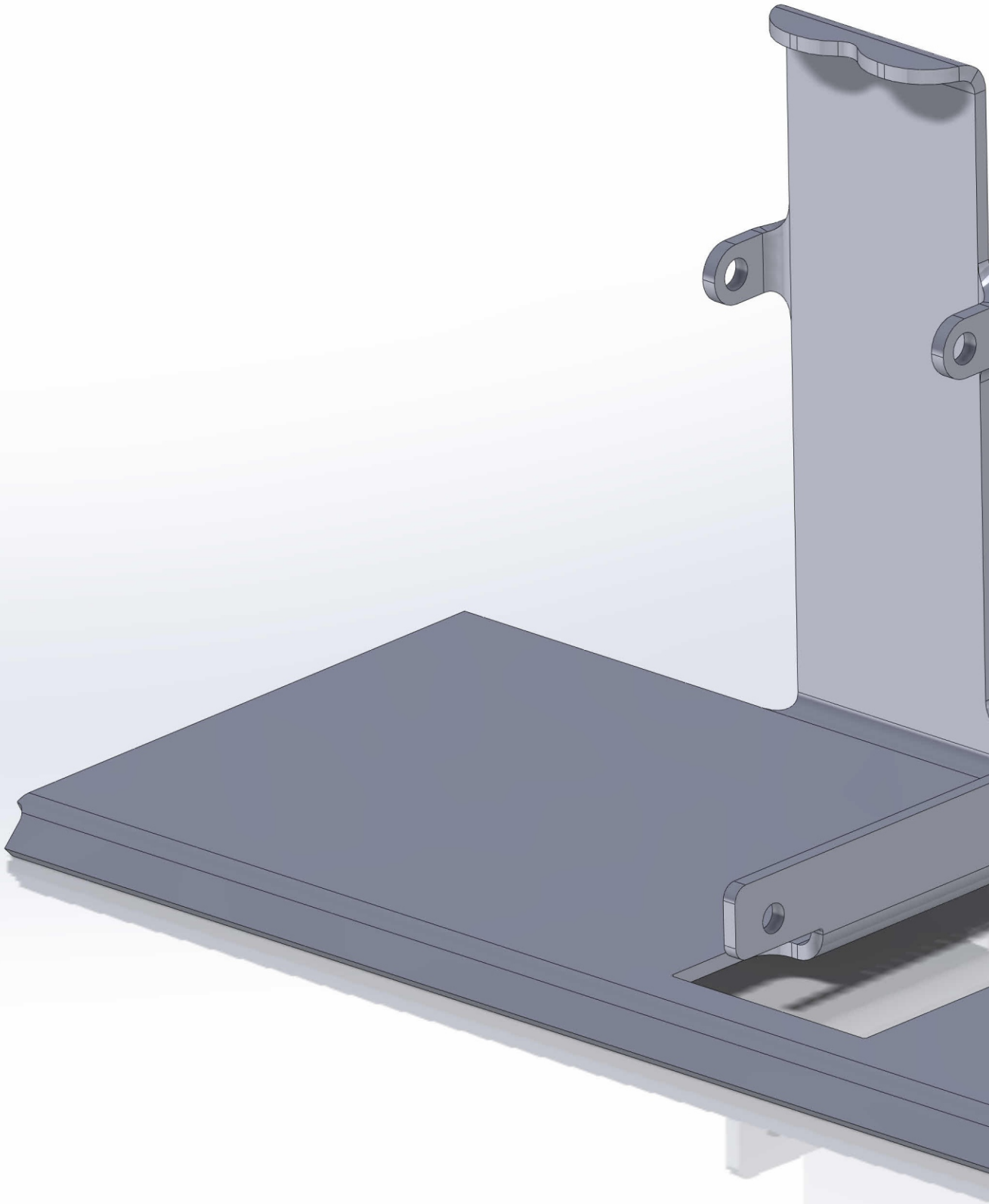
		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 11 GA.MILD STEEL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

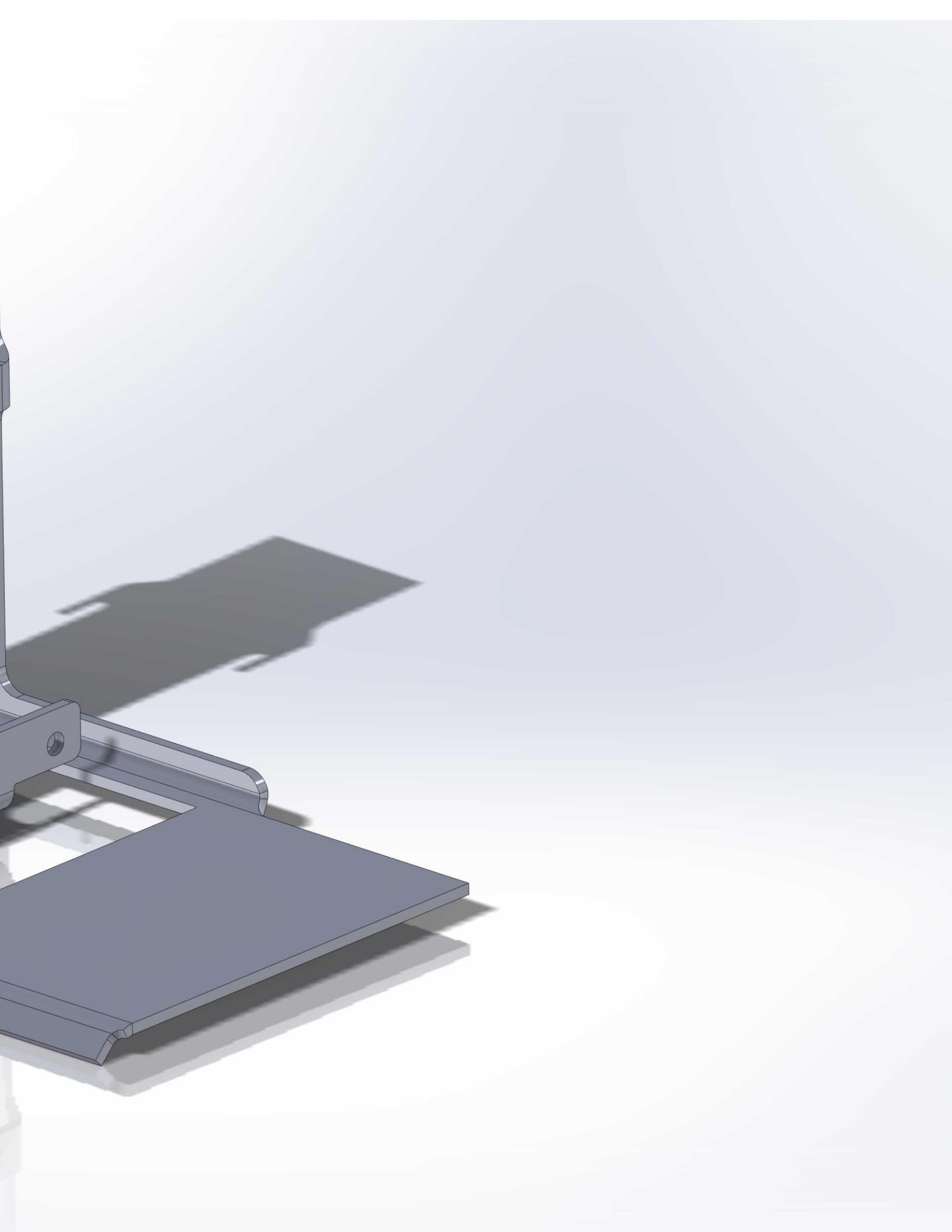
North Dakota State College of Science

TITLE:

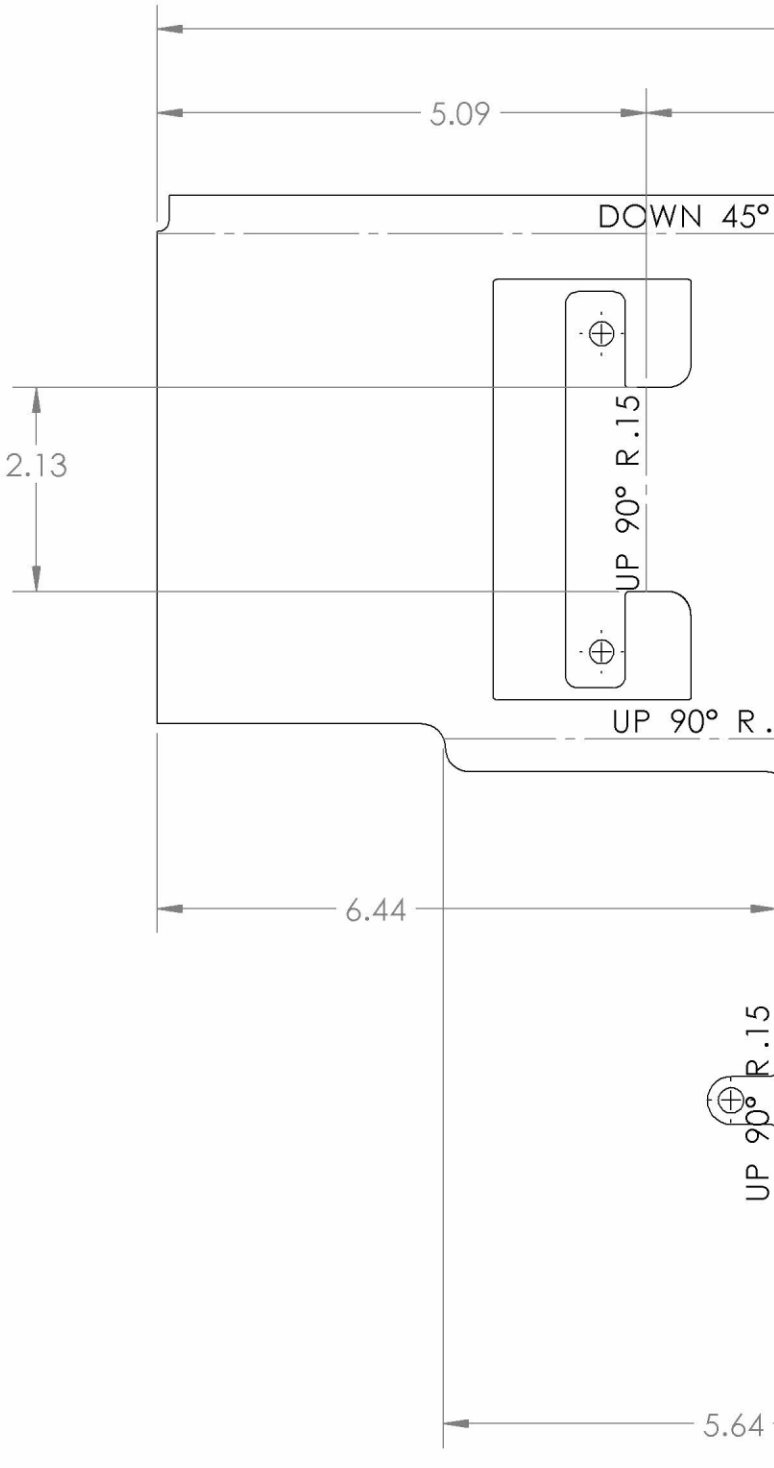
SIZE	DWG. NO.	REV
B	goosex motor mount	
SCALE: 1:2	WEIGHT:	SHEET 1 OF 1

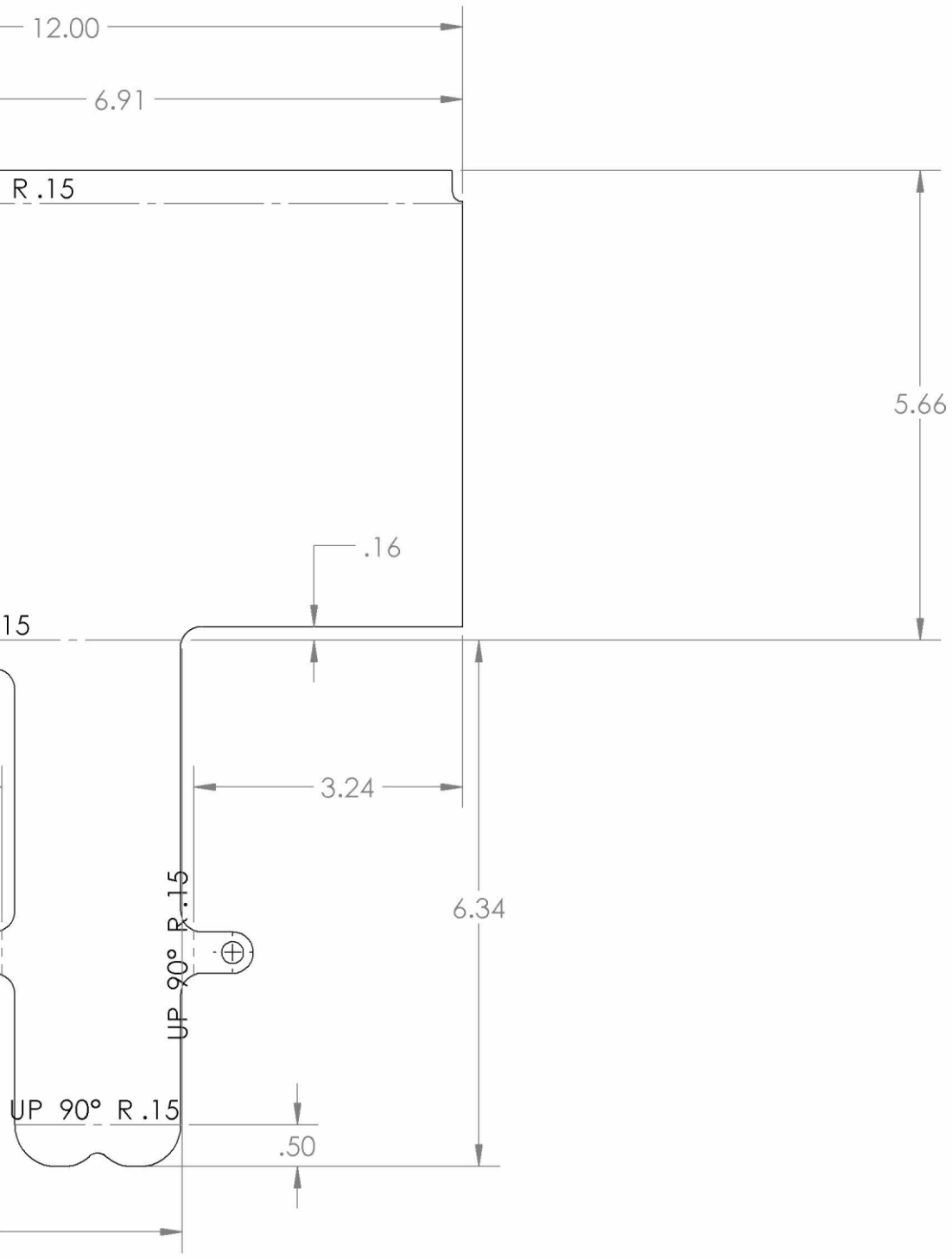
BENDING





BENDING





		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter ± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

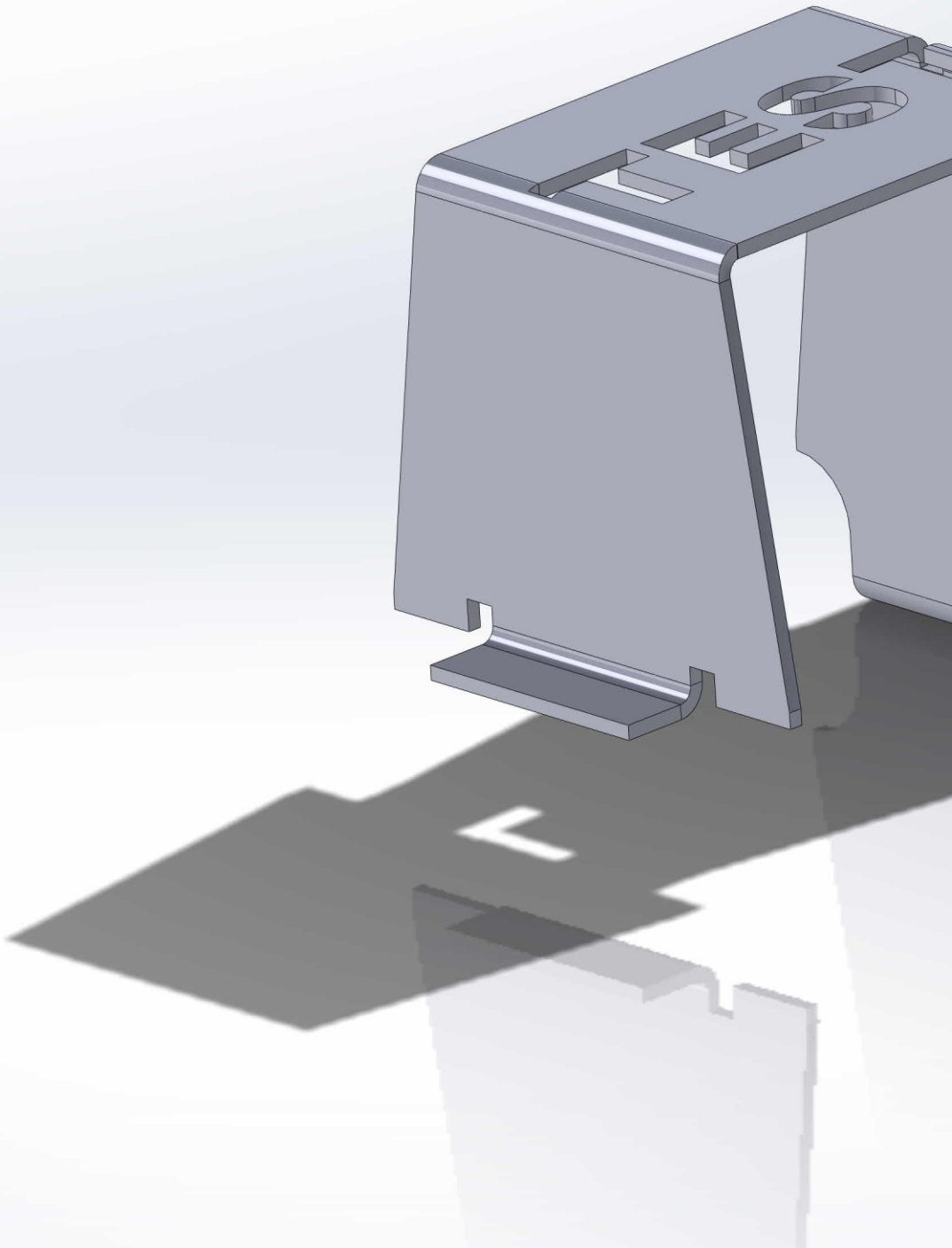
North Dakota State College of Science

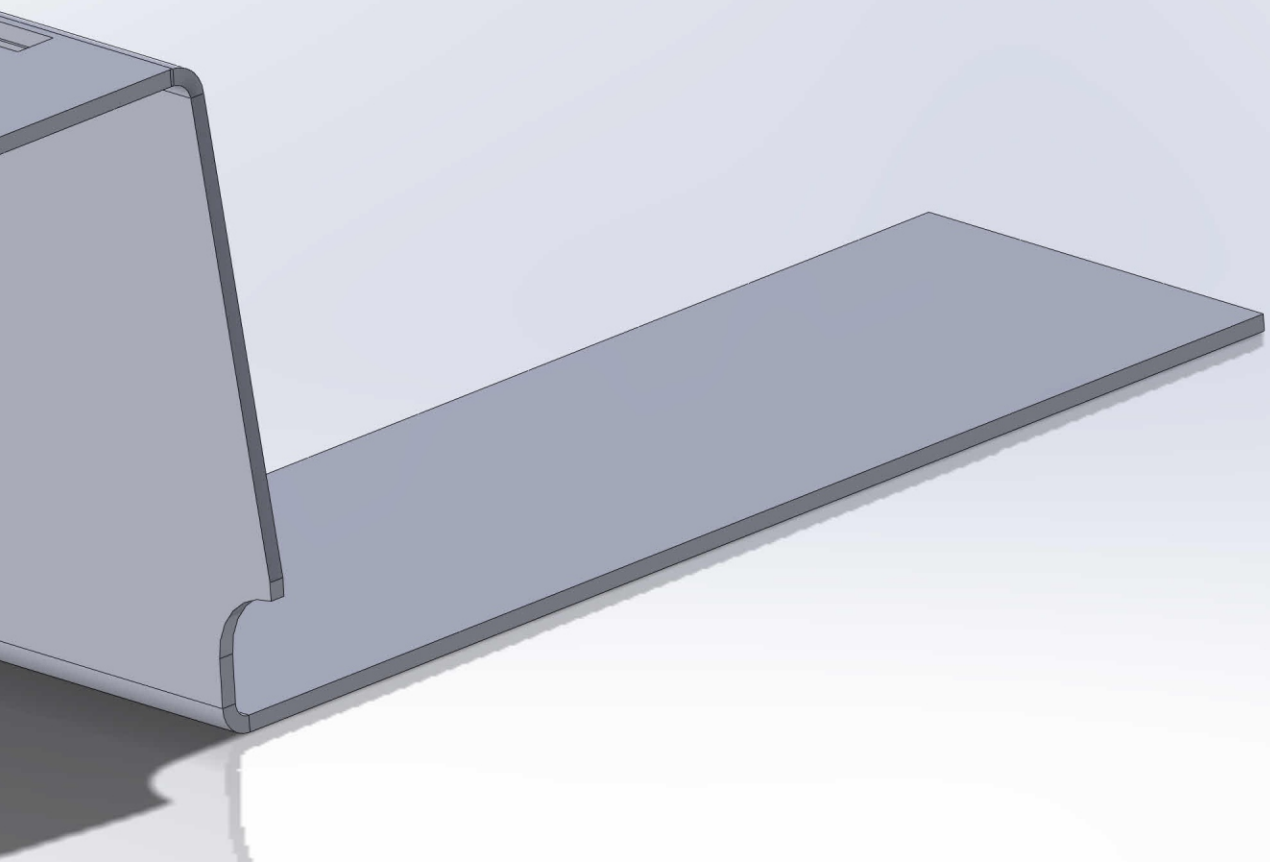
TITLE:

SIZE	DWG. NO.	REV
B	bob base2	

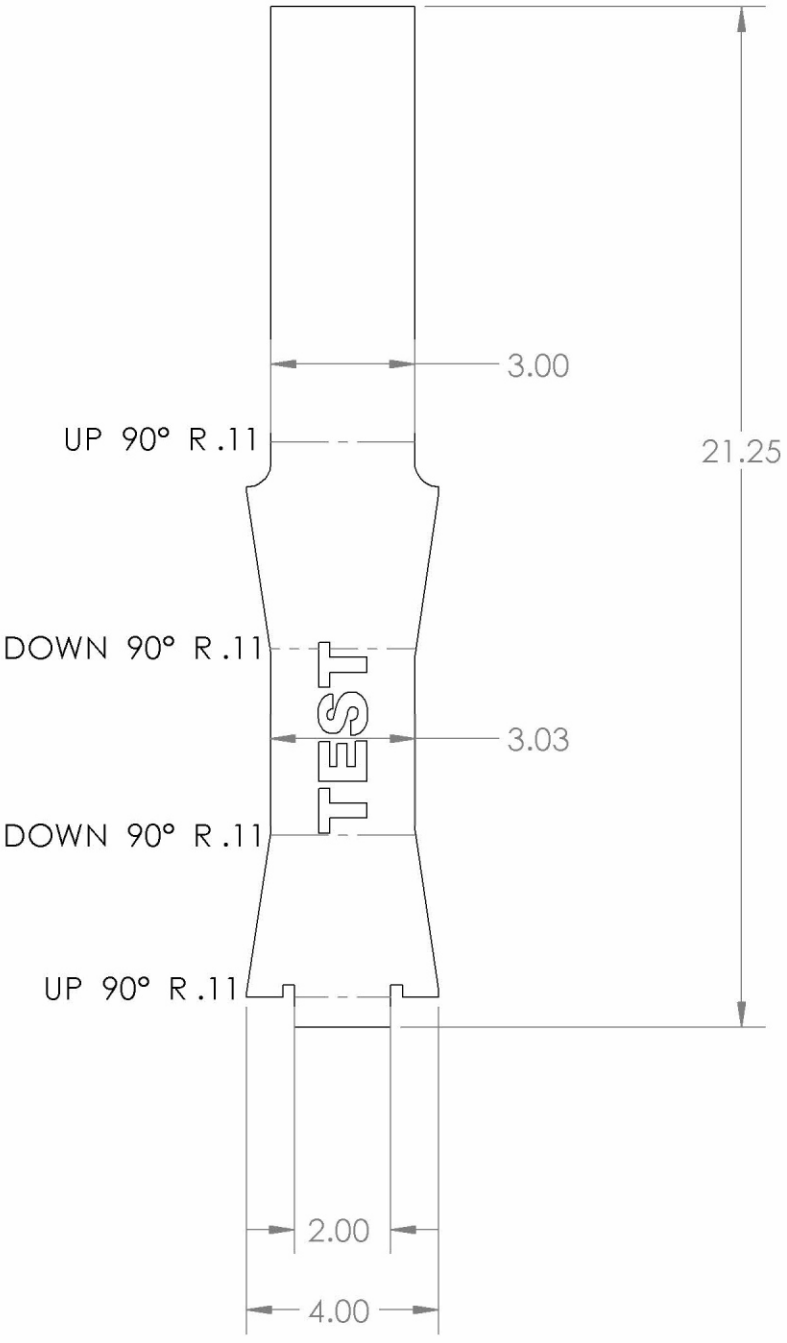
SCALE: 1:4 | WEIGHT: | SHEET 1 OF 1

BENDING



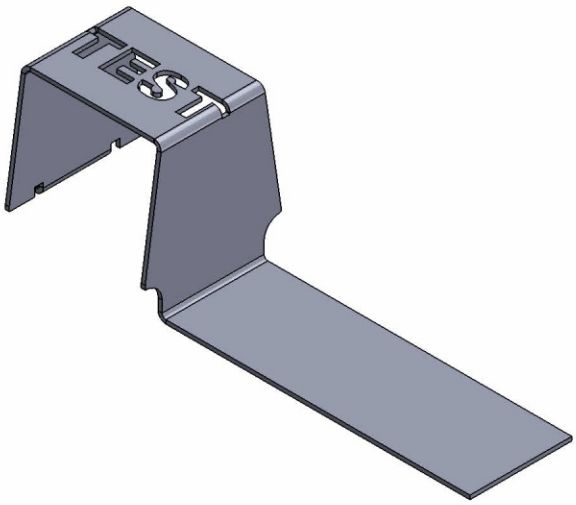


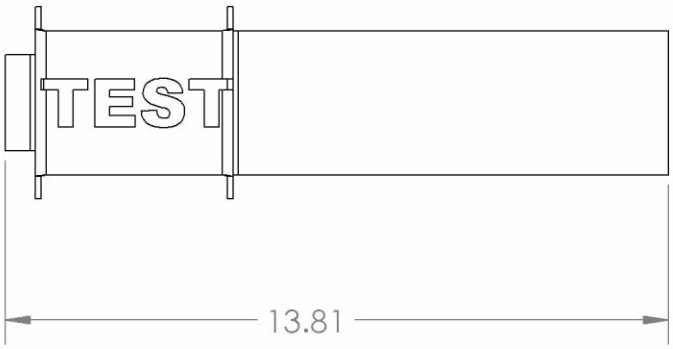
BENDING

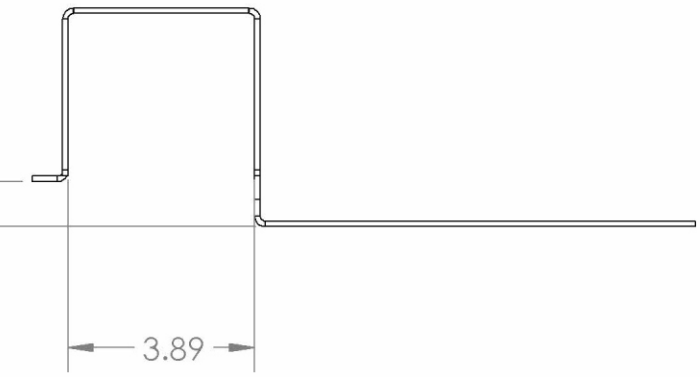


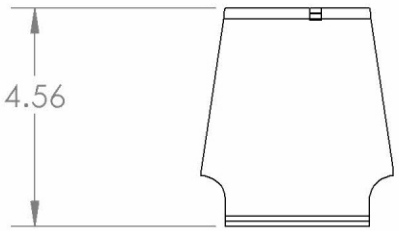
FLAT PATTERN

.94









		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 12 GA. MILD STEEL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

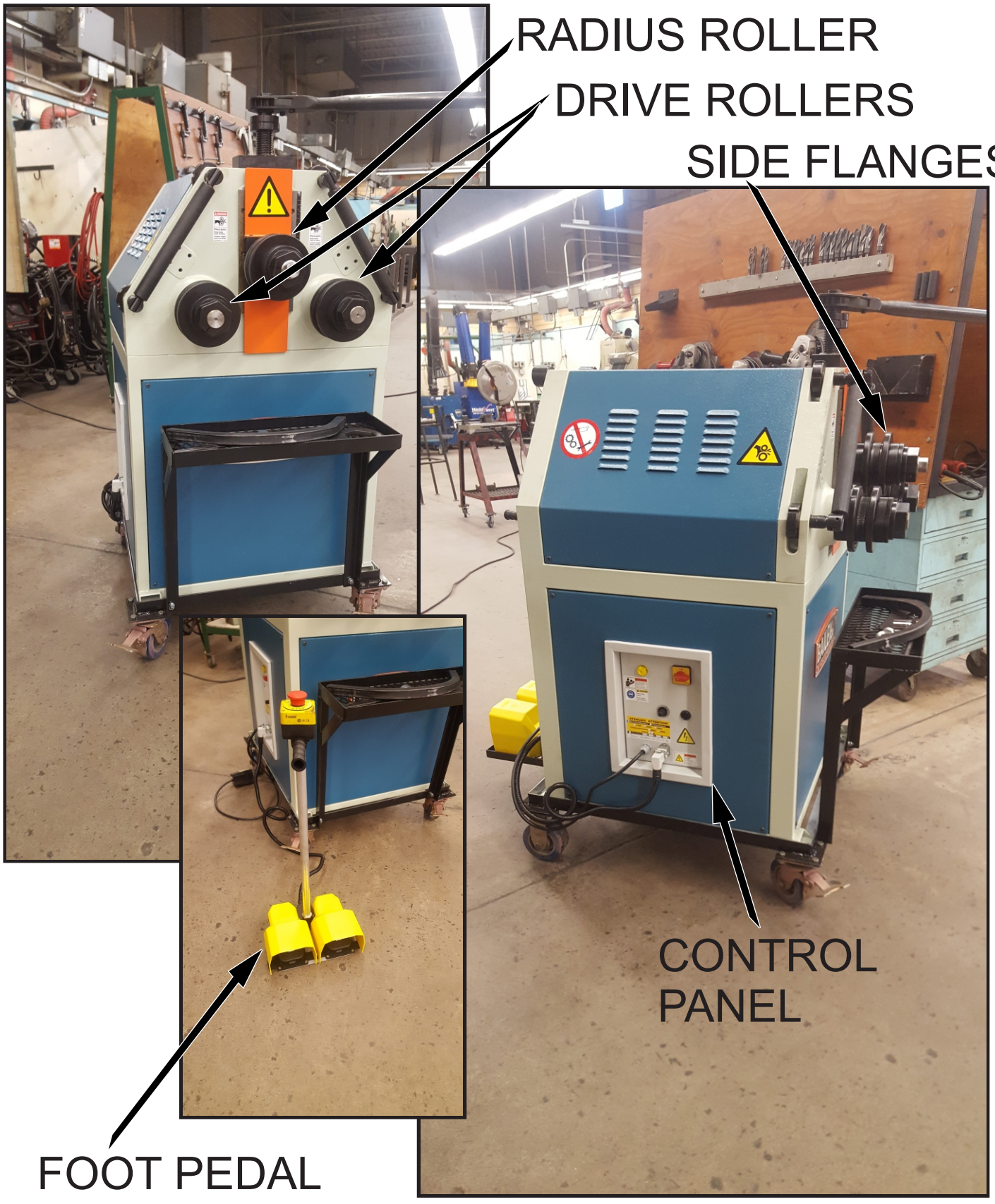
North Dakota State College of Science

TITLE:

SIZE	DWG. NO.	REV
B	TEST BEND PLATE	

SCALE: 1:2 | WEIGHT: | SHEET 1 OF 1

TUBE ROLLING



CONTROL PANEL

ON/OFF

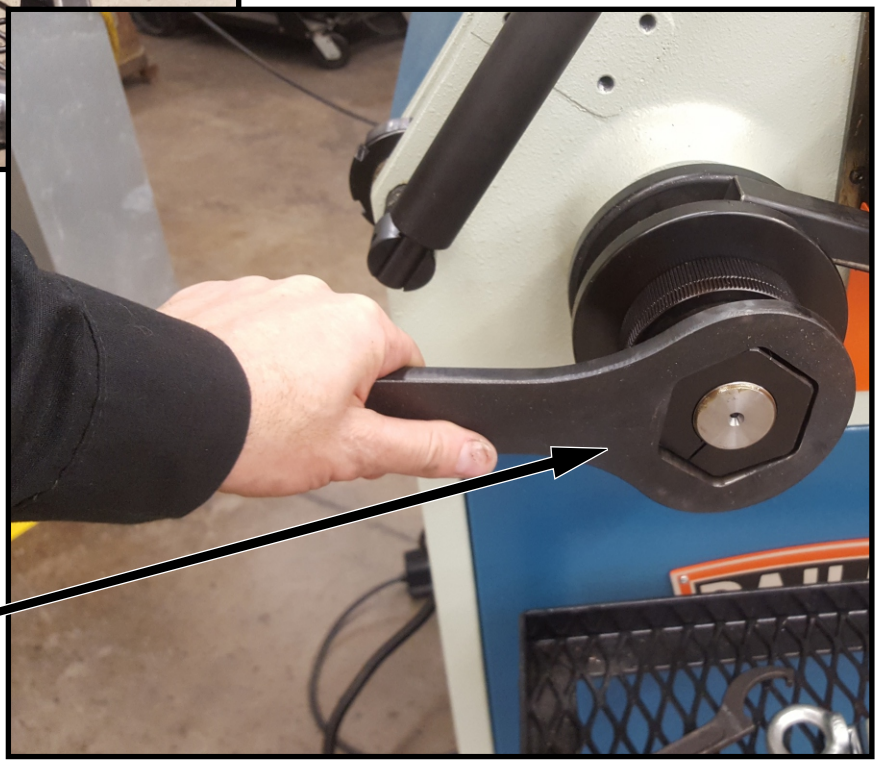
SPEED CONTROL

TUBE ROLLING

ADJUST WIDTH OF SIDE FLANGES BY REMOVING THE NUT OF EACH ASSEMBLY. ADJUST THIS WIDTH FOR THE TUBING SIZE YOU ARE USING.

AFTER NUTS HAVE BEEN REMOVED SLIDE ROLLERS AND FLANGES OFF. REASSEMBLE TO CORRECT WIDTH OF TUBING BE ROLLED.

NOTE: MAKE SURE DRIVE ROLLERS (GROOVED) ARE THE LOWER ROLLERS ON THE MACHINE.

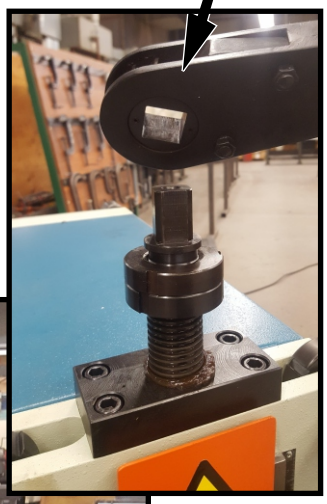


INSERTING TUBE

RAISE THE RADIUS ROLLER HIGH ENOUGH (USING RATCHET) TO INSERT THE TUBE BETWEEN ALL 3 ROLLERS AS SHOWN BELOW.

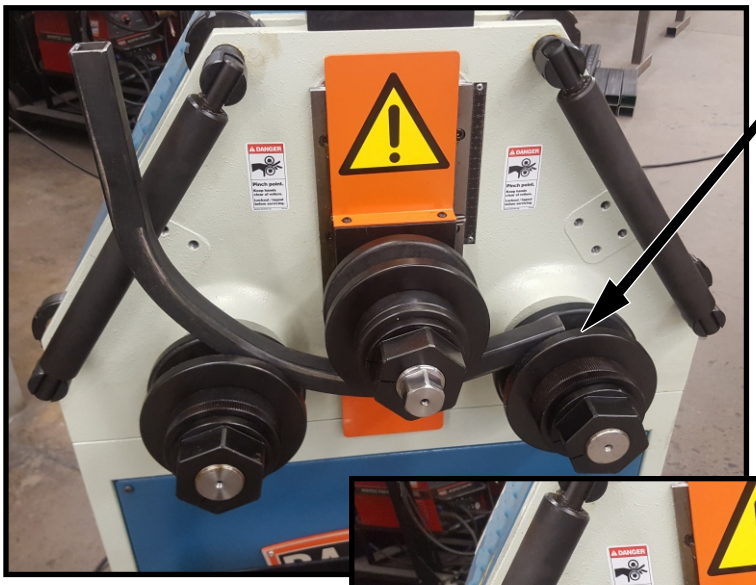
ONCE TUBE IS IN PLACE FLIP RATCHET OVER AND TIGHTEN RADIUS ROLLER DOWN ONTO TUBE. YOU WILL WANT TO TIGHTEN THE RADIUS ROLLER DOWN ON THE TUBE TIGHT ENOUGH TO SIGHTLY BEND THE TUBE.

RATCHET

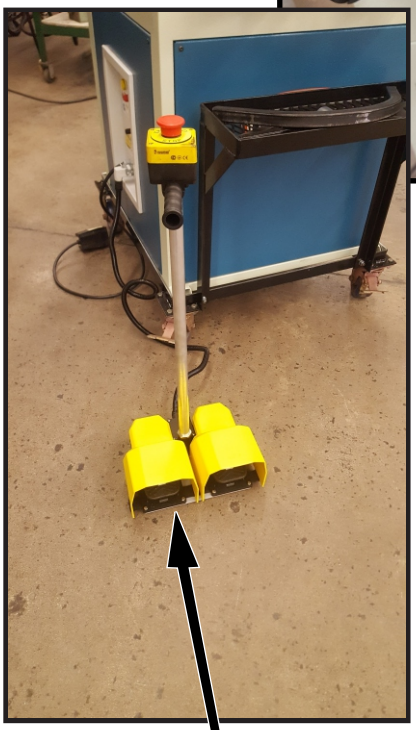


NOTE: RADIUS MARKING CHART
(YOU MAY NEED THIS NUMBER LATER)

TUBE ROLLING



NOTE: NEVER RUN THE TUBE PAST THE CENTERLINE OF THE DRIVE ROLLERS.



DIRECTIONAL CONTROL
RIGHT PEDAL MOVES THE TUBE COUNTERCLOCKWISE
LEFT PEDAL MOVES THE TUBE CLOCKWISE

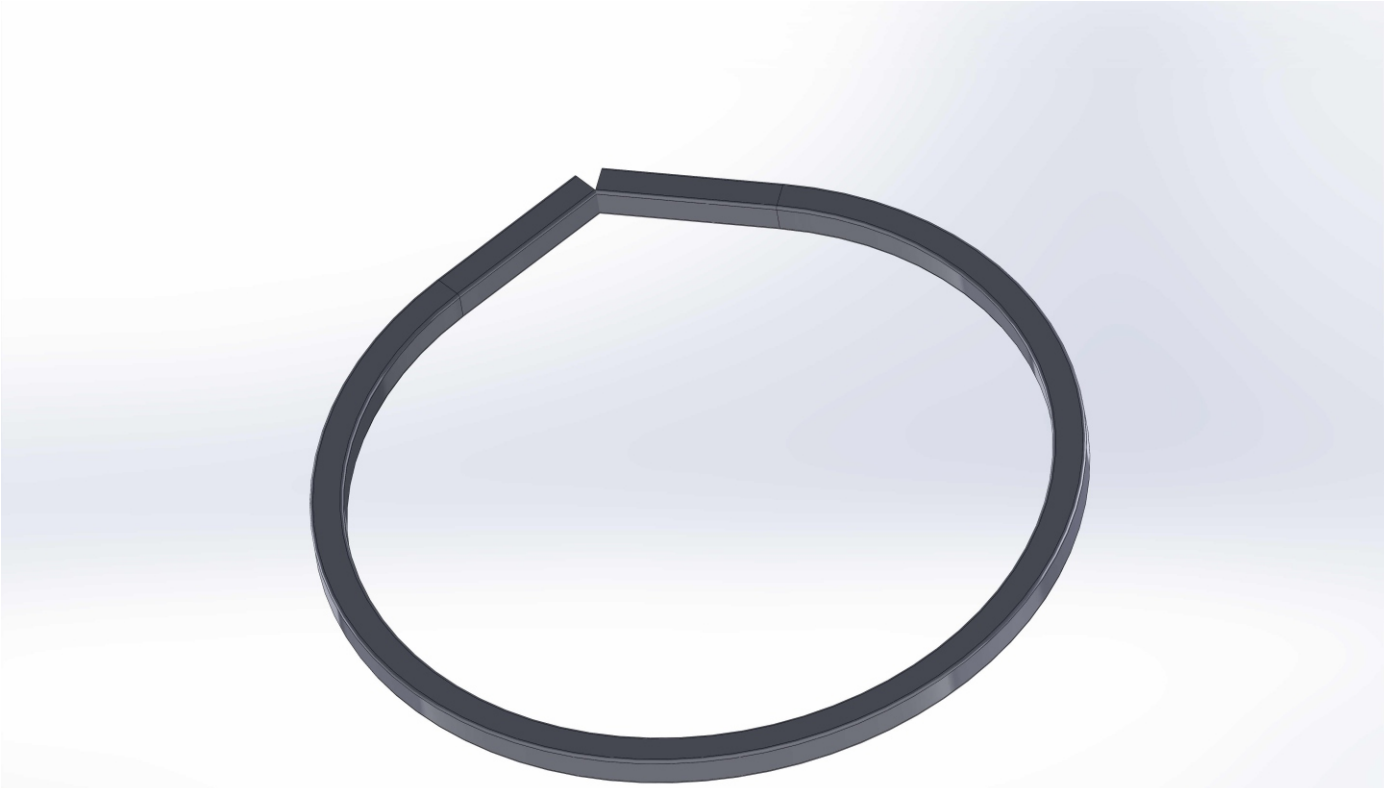
ROLL THE TUBE FROM END TO END ALWAYS STOPPING THE END OF THE TUBE AT THE CENTERLINE OF THE DRIVE ROLLERS.

ONCE YOU HAVE MADE ONE PASS TIGHTEN THE RADIUS ROLLER APPROX. A 1/4 TO 1/2 A TURN AND ROLL AGAIN.

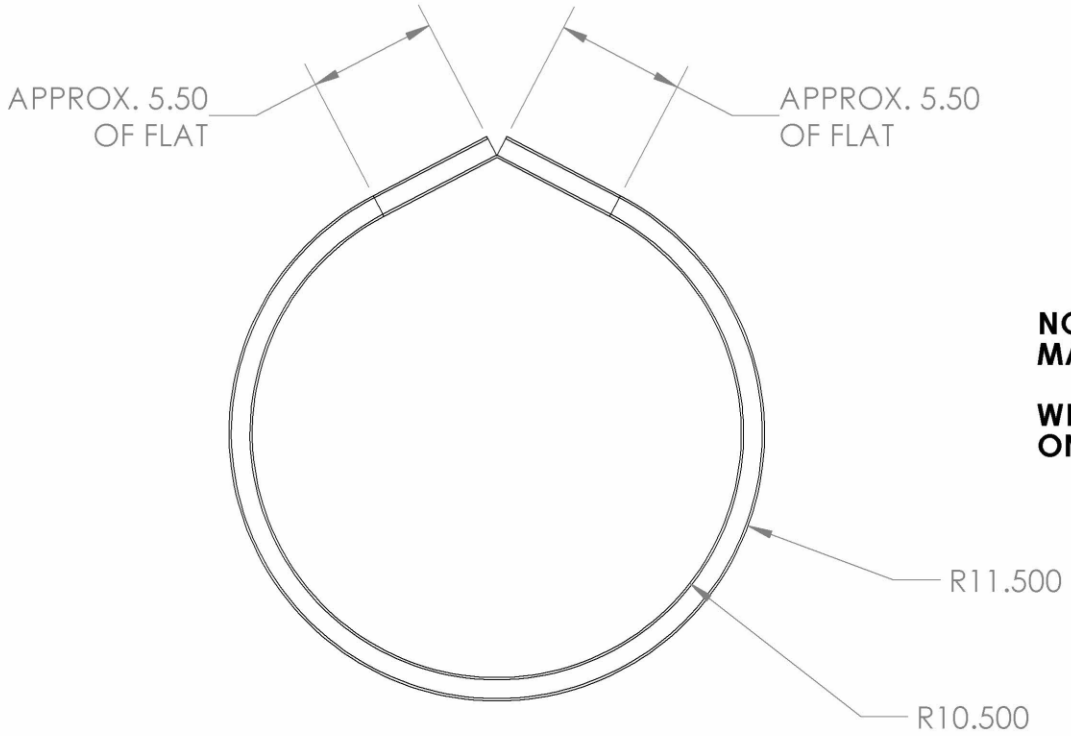
SMALLER ADJUSTMENTS WILL NEED TO BE MADE AS YOU GET CLOSER TO THE DESIRED RADIUS.

NOTE: WHEN ROLLING LONG LENGTHS OF TUBE. WATCH FOR THE TUBE HITTING THE CEILING OR LIGHTING ABOVE!

TUBE ROLLING



NOTE: FLAT TUBE LENGTH IS CALCULATED ON THE OUTSIDE RADIUS OR DIAMETER. THE CIRCUMFERENCE FORMULA IS DIA. x 3.1416 THIS WILL GIVE YOU AN APPROXIMATE LENGTH.
ADJUSTMENTS WILL NEED TO BE MADE.
WRITE DOWN RADIUS ROLLER RULER DIMENSION IF YOU WANT TO MAKE 2 OF THE SAME SIZE RINGS.
SEQUENCE OF BENDS WILL EFFECT RADIUS DIMESIONS TAKEN.



NOTE: APPROX. 72.00 INCHES OF MATERIAL IS USED TO MAKE THIS.

WHAT IS THE RULER DIMENSION ON THE ROLLER? _____

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: Diameter ± .001 ANGULAR: MACH ± .5 TWO PLACE DECIMAL ±.005 THREE PLACE DECIMAL ±.0015	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL 1x1x1/8W MS TUBE	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

North Dakota State College of Science

TITLE:

SIZE	DWG. NO.	REV
A	ROLLED TUBE	

SCALE: 1:8	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1