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# **MFGT 137**

## **Print Reading**

# **Print Reading Basics w/prints**

*This book should  
come to every  
**Print reading**  
class you have.  
**Every day!***

**Reference materials for  
reading a print and  
manufacturing  
parts.**

Written by:  
Jay Schimelfenig  
Associate Professor  
NDSCS Manufacturing Dept.



THE SCIENCE OF SUCCESS

## INCH/METRIC TAP DRILL SIZES & DECIMAL EQUIVALENTS

Drill Size	Decimal Equivalent	Tap Size	Drill Size	Decimal Equivalent	Tap Size	Drill Size	Decimal Equivalent	Tap Size	
1/64	80	0 - 80	13/64	10	1/4 - 20	59	.9219	1 - 12	
	79			9		.1960	64	.9375	1 - 14
	78			8		.1990	61	.9531	
	77			7		.2010	64	.9688	
	76			6		.2031	63	.9844	1 1/8 - 7
	75			5		.2040	64	1.0000	
	74			4		.2055	13/64	1.0469	1 1/8 - 12
	73			3		.2090	17/64	1.1094	1 1/4 - 7
	72			2		.2130	11/64	1.1250	1 1/4 - 12
	71			1		.2188	17/32	1.1719	1 3/8 - 6
	70			A		.2210	119/64	1.2188	1 3/8 - 12
	69					.2280	111/32	1.2500	1 1/2 - 6
	68					.2340	127/64	1.2969	1 1/2 - 12
	68					.2344		1.3438	
	67					.2380		1.3750	
	66					.2420		1.4219	
65		.2460		1.5000					
64		.2500							
63		.2570							
62		.2610							
62		.2656							
61		.2660							
60		.2720							
60		.2770							
59		.2810							
58		.2812							
57		.2812							
56		.2900							
56		.2950							
55		.2969							
54		.3020							
53		.3125							
53		.3160							
52		.3230							
51		.3281							
50		.3320							
49		.3390							
48		.3438							
48		.3480							
47		.3580							
46		.3594							
45		.3680							
44		.3750							
43		.3770							
42		.3860							
42		.3906							
41		.3970							
40		.4040							
39		.4062							
38		.4130							
37		.4219							
36		.4219							
36		.4375							
35		.4531							
34		.4688							
33		.4844							
33		.5000							
32		.5156							
31		.5312							
31		.5469							
30		.5625							
29		.5781							
28		.5938							
28		.6094							
27		.6250							
26		.6406							
25		.6562							
25		.6719							
24		.6875							
23		.7031							
23		.7188							
22		.7344							
21		.7500							
21		.7656							
20		.7812							
19		.7969							
18		.8125							
18		.8281							
17		.8438							
17		.8594							
16		.8750							
16		.8906							
15		.9062							
14									
13									
13									
12									
12									
11									
11									

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		

# MILLIMETER - INCH CONVERSION CHART

mm	decimal	inch	mm	decimal	inch	mm	decimal	inch	mm	decimal	inch
	0.015	1/64	33	1.2992		65	2.5591		97	3.8189	
	0.031	1/32		1.312	1-5/16		2.562	2-9/16		3.843	3-27/32
1	0.0394		34	1.3386			2.593	2-19/32	98	3.8583	
	0.062	1/16		1.343	1-11/32	66	2.5984			3.875	3-7/8
2	0.0787			1.375	1-3/8		2.625	2-5/8	99	3.8976	
	0.093	3/32	35	1.3780		67	2.6378			3.906	3-29/32
3	0.1181			1.406	1-13/32		2.656	2-21/32	100	3.9370	3-15/16
	0.125	1/8	36	1.4173		68	2.6772			3.968	3-31/32
4	0.156	5/32		1.437	1-7/16		2.687	2-11/16	101	3.9764	
	0.1575		37	1.4567		69	2.7165			4.000	4
5	0.187	3/16		1.468	1-15/32		2.718	2-23/32	102	4.0157	
	0.1969		38	1.4961			2.750	2-3/4		4.0310	4-1/32
6	0.218	7/32		1.500	1-1/2	70	2.7559		103	4.0551	
	0.2362			1.531	1-17/32		2.781	2-25/32		4.0620	4-1/16
7	0.250	1/4	39	1.5354		71	2.7953			4.0930	4-3/32
	0.2756			1.562	1-9/16		2.812	2-13/16	104	4.0945	
	0.281	9/32	40	1.5748		72	2.8346			4.125	4-1/8
	0.312	5/16		1.593	1-19/32		2.843	2-27/32	105	4.1339	
8	0.3150		41	1.6142		73	2.8740			4.156	4-5/32
	0.343	11/32		1.625	1-5/8		2.875	2-7/8	106	4.1732	
9	0.3543		42	1.6535			2.906	2-29/32		4.187	4-3/16
	0.375	3/8		1.656	1-21/32	74	2.9134		107	4.2126	
10	0.3937			1.687	1-11/16		2.9370	2-15/16		4.218	4-7/32
	0.406	13/32	43	1.6929		75	2.9528			4.250	4-1/4
11	0.4331			1.718	1-23/32		2.968	2-31/32	108	4.2520	
	0.437	7/16	44	1.7323		76	2.9921			4.281	4-9/32
	0.468	15/32		1.750	1-3/4		3.000	3	109	4.2913	
12	0.4724		45	1.7717			3.0310	3-1/32		4.312	4-5/16
	0.500	1/2		1.781	1-25/32	77	3.0315		110	4.3307	
13	0.5118		46	1.8110			3.0620	3-1/16		4.343	4-11/32
	0.531	17/32		1.812	1-13/16	78	3.0709		111	4.3701	
14	0.5512			1.843	1-27/32		3.0930	3-3/32		4.375	4-3/8
	0.562	9/16	47	1.8504		79	3.1102			4.406	4-13/32
15	0.5906			1.875	1-7/8		3.125	3-1/8	112	4.4094	
	0.593	19/32	48	1.8898		80	3.1496			4.437	4-7/16
	0.625	5/8		1.906	1-29/32		3.156	3-5/32	113	4.4488	
16	0.6299		49	1.9291			3.187	3-3/16		4.468	4-15/32
	0.656	21/32		1.9370	1-15/16	81	3.1890		114	4.4882	
17	0.6693			1.968	1-31/32		3.218	3-7/32		4.500	4-1/2
	0.687	11/16	50	1.9685		82	3.2283		115	4.5276	
18	0.7087			2.000	2		3.250	3-1/4		4.531	4-17/32
	0.718	23/32	51	2.0079		83	3.2677			4.562	4-9/16
19	0.7480			2.0310	2-1/32		3.281	3-9/32	116	4.5669	
	0.750	3/4	52	2.0472		84	3.3071			4.593	4-19/32
	0.781	25/32		2.0620	2-1/16		3.312	3-5/16	117	4.6063	
20	0.7874		53	2.0866			3.343	3-11/32		4.625	4-5/8
	0.812	13/16		2.0930	2-3/32	85	3.3465		118	4.6457	
21	0.8268			2.125	2-1/8		3.375	3-3/8		4.656	4-21/32
	0.843	27/32	54	2.1260		86	3.3858		119	4.6850	
22	0.8661			2.156	2-5/32		3.406	3-13/32		4.687	4-11/16
	0.875	7/8	55	2.1654		87	3.4252			4.718	4-23/32
23	0.9055			2.187	2-3/16		3.437	3-7/16	120	4.7244	
	0.906	29/32	56	2.2047		88	3.4646			4.750	4-3/4
	0.937	15/16		2.218	2-7/32		3.468	3-15/32	121	4.7638	
24	0.9449		57	2.2441			3.500	3-1/2		4.781	4-25/32
	0.968	31/32		2.250	2-1/4	89	3.5039		122	4.8031	
25	0.9843			2.281	2-9/32		3.531	3-17/32		4.812	4-13/16
	1.000	1	58	2.2835		90	3.5433		123	4.8425	
26	1.0236			2.312	2-5/16		3.562	3-9/16		4.843	4-27/32
	1.0310	1-1/32	59	2.3228		91	3.5827			4.875	4-7/8
	1.0620	1-1/16		2.343	2-11/32		3.593	3-19/32	124	4.8819	
27	1.0630		60	2.3622		92	3.6220			4.906	4-29/32
	1.0930	1-3/32		2.375	2-3/8		3.625	3-5/8	125	4.9213	
28	1.1024		61	2.4016			3.656	3-21/32		4.9370	4-15/16
	1.125	1-1/8		2.406	2-13/32	93	3.6614		126	4.9606	
29	1.1417			2.437	2-7/16		3.687	3-11/16		4.968	4-31/32
	1.156	1-5/32	62	2.4409		94	3.7008		127	5.000	5
30	1.1811			2.468	2-15/32		3.718	3-23/32			
	1.187	1-3/16	63	2.4803		95	3.7402				
	1.218	1-7/32		2.500	2-1/2		3.750	3-3/4			
31	1.2205		64	2.5197		96	3.7795				
	1.250	1-1/4		2.531	2-17/32		3.781	3-25/32			
32	1.2598						3.812	3-13/16			
	1.281	1-9/32									

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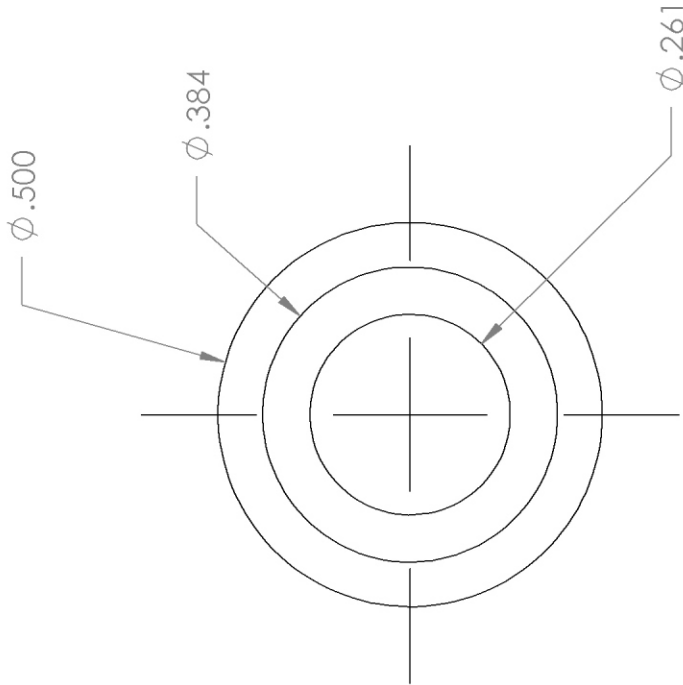
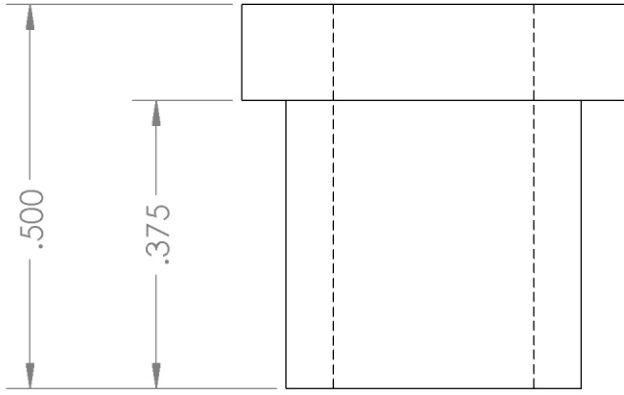
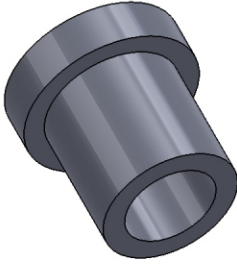
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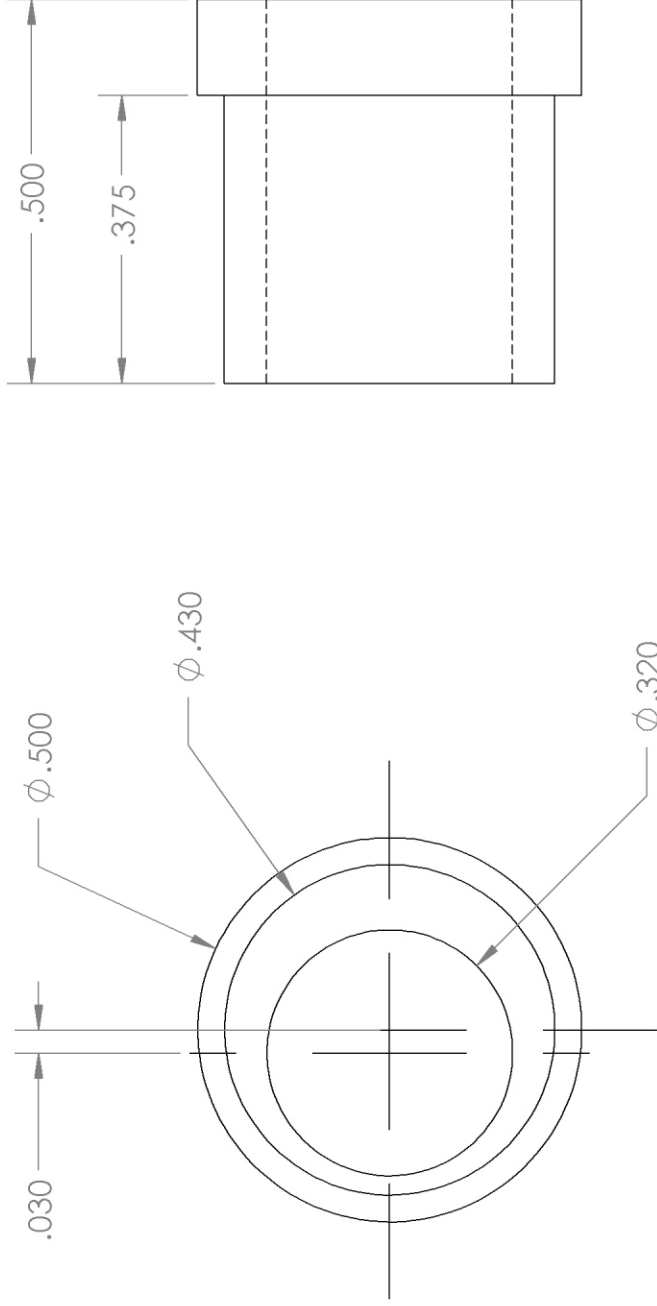
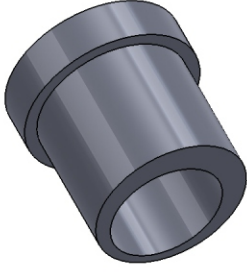
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# Orthographic Drawings



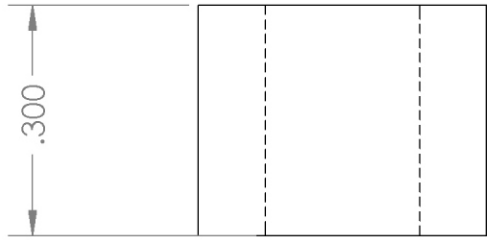
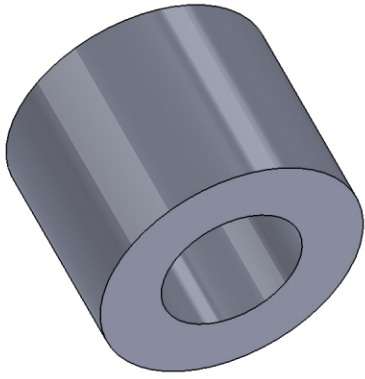
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UNLESS OTHERWISE SPECIFIED:		NAME	DATE	North Dakota State College of Science	
DIMENSIONS ARE IN INCHES		JS	4/28/17	TITLE:	
TOLERANCES:		DRAWN		ACME PLUG CAP	
Diameter $\pm .001$		CHECKED		SIZE	DWG. NO.
ANGULAR: MACH $\pm .5$		ENG APPR.		<b>A</b>	<b>195822</b>
TWO PLACE DECIMAL $\pm .005$		MFG APPR.		SCALE: 4:1	WEIGHT:
THREE PLACE DECIMAL $\pm .0015$		Q.A.			SHEET 1 OF 1
INTERPRET GEOMETRIC TOLERANCING PER:		COMMENTS:			
MATERIAL		MILD STEEL			
FINISH		USED ON			
DO NOT SCALE DRAWING		APPLICATION			
		NEXT ASSY			
		USED ON			

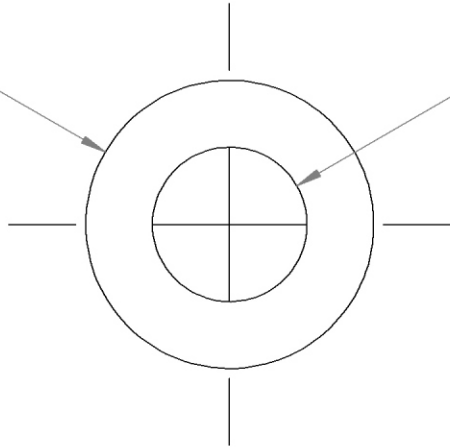


UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: Diameter $\pm .001$ ANGULAR: MACH $\pm .5$ TWO PLACE DECIMAL $\pm .005$ THREE PLACE DECIMAL $\pm .0015$		DRAWN	NAME	DATE	North Dakota State College of Science
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	CHECKED	JS	4/28/17	TITLE:
MATERIAL	MILD STEEL	ENG APPR.			<b>CAM PLUG CAP</b>
FINISH	USED ON	MFG APPR.			
DO NOT SCALE DRAWING	APPLICATION	COMMENTS:			SIZE DWG. NO. <b>A 199985</b>
NEXT ASSY					SCALE: 4:1 WEIGHT: SHEET 1 OF 1

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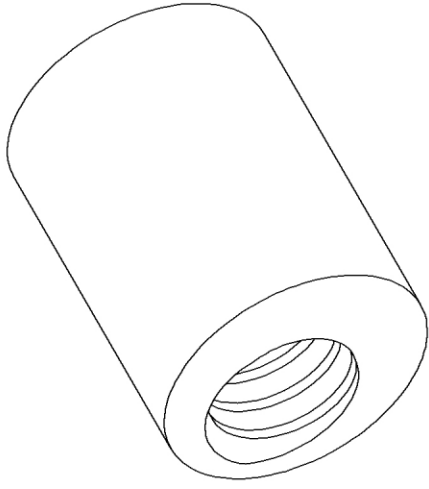
$\phi .375$



$\phi .201$  (#7 DRILL)  
1/4 -20 UNC THRU

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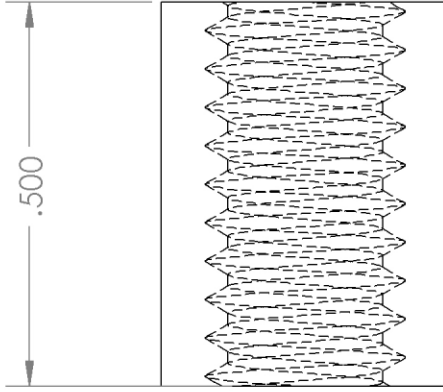
UNLESS OTHERWISE SPECIFIED:		NAME	DATE	North Dakota State College of Science	
DIMENSIONS ARE IN INCHES		JS	4/28/17	TITLE:	
TOLERANCES:		DRAWN		ROD NUT	
Diameter $\pm .001$		CHECKED		SIZE	DWG. NO.
ANGULAR: MACH $\pm .5$		ENG APPR.		<b>A</b>	<b>199763</b>
TWO PLACE DECIMAL $\pm .005$		MFG APPR.		SCALE: 4:1	WEIGHT:
THREE PLACE DECIMAL $\pm .0015$		Q.A.		SHEET 1 OF 1	
INTERPRET GEOMETRIC TOLERANCING PER:		COMMENTS:			
MATERIAL		MILD STEEL			
FINISH		USED ON			
NEXT ASSY		APPLICATION			
DO NOT SCALE DRAWING					



$\phi .201$   
5/16-18 unc

$\phi .375$

.030



North Dakota State College of Science

TITLE:

**THREADED CAM NUT**

SIZE DWG. NO. **A 199642** REV

SCALE: 4:1 WEIGHT: SHEET 1 OF 1

UNLESS OTHERWISE SPECIFIED:	DRAWN	CHECKED	ENG APPR.	MFG APPR.	Q.A.	COMMENTS:	NAME	DATE
DIMENSIONS ARE IN INCHES							JS	4/28/17
TOLERANCES:								
Diameter $\pm .001$								
ANGULAR: MACH $\pm .5$								
TWO PLACE DECIMAL $\pm .005$								
THREE PLACE DECIMAL $\pm .0015$								
INTERPRET GEOMETRIC TOLERANCING PER:								
MATERIAL								
<b>MILD STEEL</b>								
FINISH								
USED ON								
APPLICATION								
DO NOT SCALE DRAWING								

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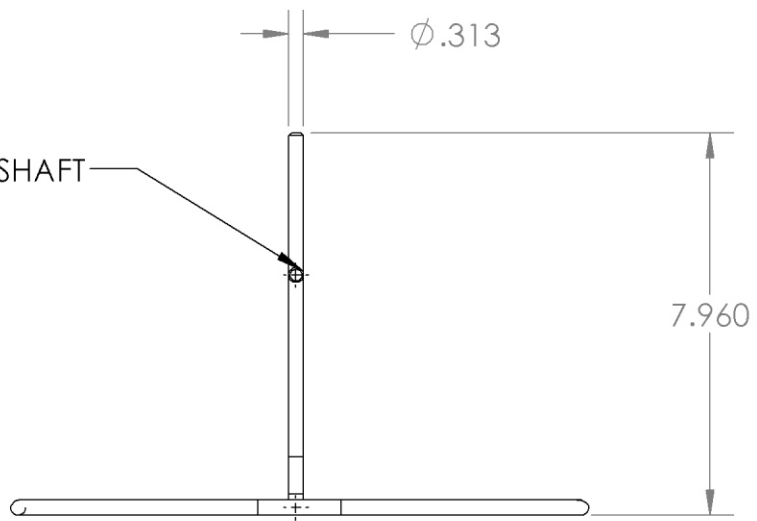
4

3

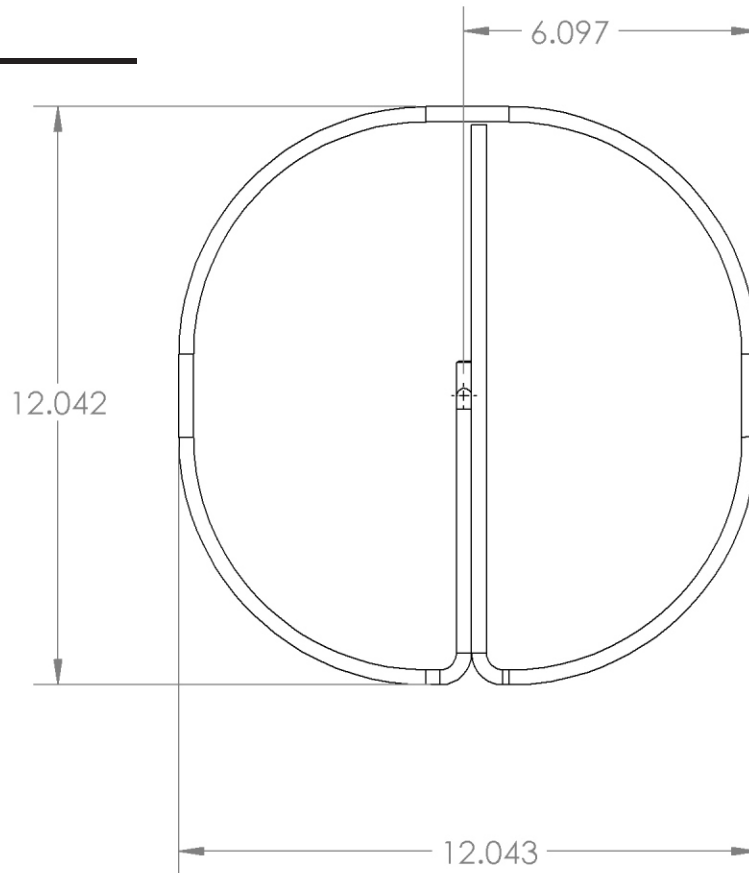
B

**Front** \_\_\_\_\_  
**Right** \_\_\_\_\_  
**Left** \_\_\_\_\_  
**Top** \_\_\_\_\_  
**Bottom** \_\_\_\_\_  
**Back** \_\_\_\_\_  
**Pictorial** \_\_\_\_\_

TAB CENTERED ON SHAFT



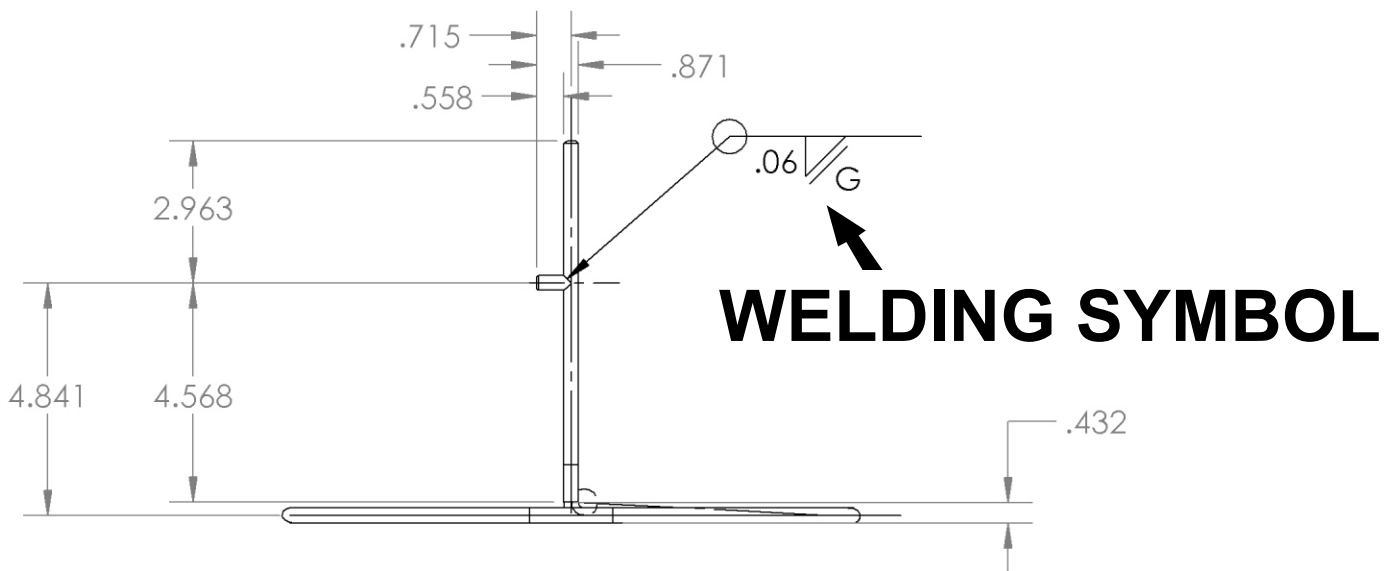
A



4

3

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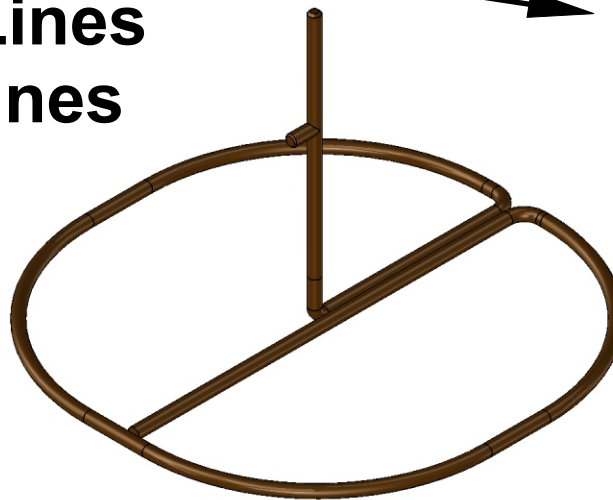
**Hidden Lines** - - - - -

**Object Lines** —————

**Leader Lines** ————▶

**Dimension Lines**

**Extension Lines**



**Title Block information.**

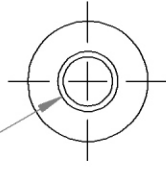
		UNLESS OTHERWISE SPECIFIED:	NAME	DATE	<b>DAKOTA DECOY CO.</b>	
		DIMENSIONS ARE IN INCHES	DRAWN SCHIMELFENIG	10/14	TITLE:	
		TOLERANCES:	CHECKED		<b>SLIDER BASE</b>	
		FRACTIONAL ±	ENG APPR.		SIZE DWG. NO. REV	
		ANGULAR: MACH ± BEND ±	MFG APPR.		<b>B 33586</b>	
		TWO PLACE DECIMAL ±	Q.A.		SCALE: 1:4 WEIGHT: SHEET 1 OF 1	
		THREE PLACE DECIMAL ±	COMMENTS:			
		INTERPRET GEOMETRIC TOLERANCING PER:				
		MATERIAL				
		<b>.312 STEEL SHAFT</b>				
		FINISH				
NEXT ASSY	USED ON	DO NOT SCALE DRAWING				
APPLICATION						

B

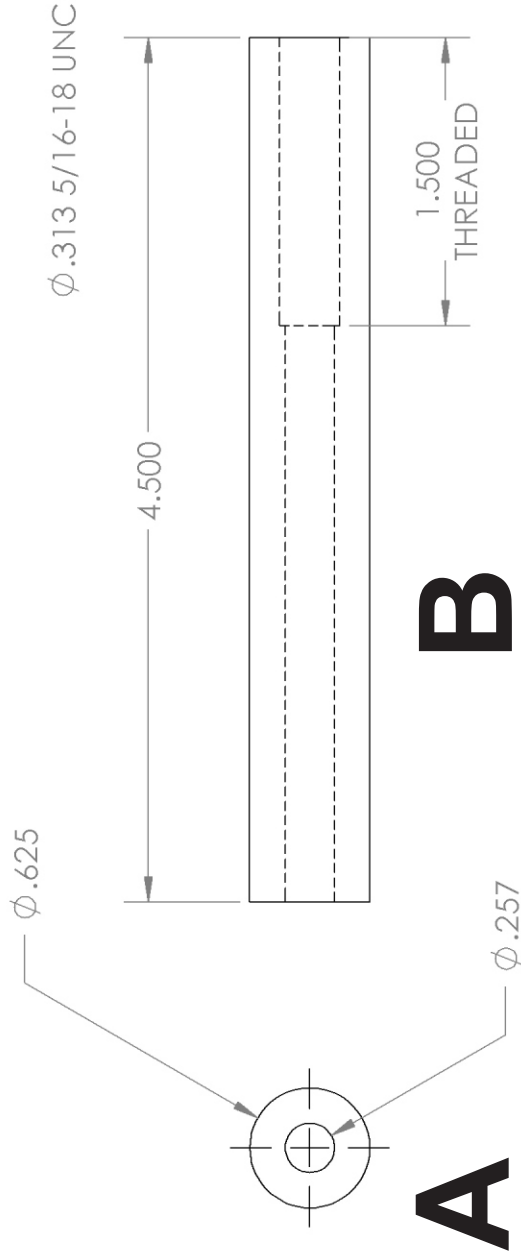
A



**D**



**C**



UNLESS OTHERWISE SPECIFIED:		DRAWN	NAME	DATE	<b>North Dakota State College of Science</b> TITLE: <b>GSX SPINNER ARM</b>	
DIMENSIONS ARE IN INCHES		CHECKED	JS	4/28/17		
TOLERANCES:		ENG APPR.				
Diameter $\pm .001$		MFG APPR.				
ANGULAR: MACH $\pm .5$		Q.A.				
TWO PLACE DECIMAL $\pm .005$		COMMENTS:		SIZE	DWG. NO.	REV
THREE PLACE DECIMAL $\pm .0015$		INTERPRET GEOMETRIC TOLERANCING PER:		<b>A</b>	<b>25632</b>	
MATERIAL		DO NOT SCALE DRAWING		SCALE: 1:2	WEIGHT:	SHEET 1 OF 1
DELFIN FINISH		APPLICATION				
NEXT ASSY		USED ON				


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Front \_\_\_\_\_  
Right \_\_\_\_\_  
Left \_\_\_\_\_  
Top \_\_\_\_\_  
Bottom \_\_\_\_\_  
Back \_\_\_\_\_  
Pictorial \_\_\_\_\_

**Ø = Diameter** (Distance across circle thru the center)

**Hidden Lines** - - - - -

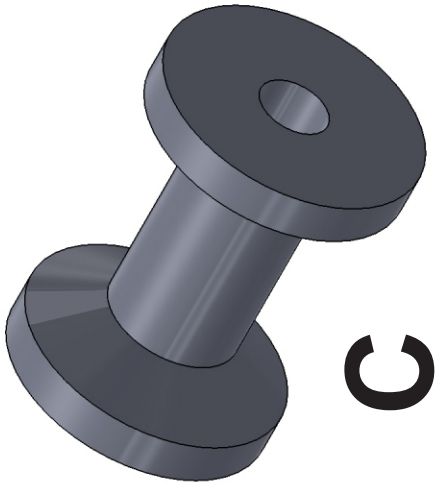
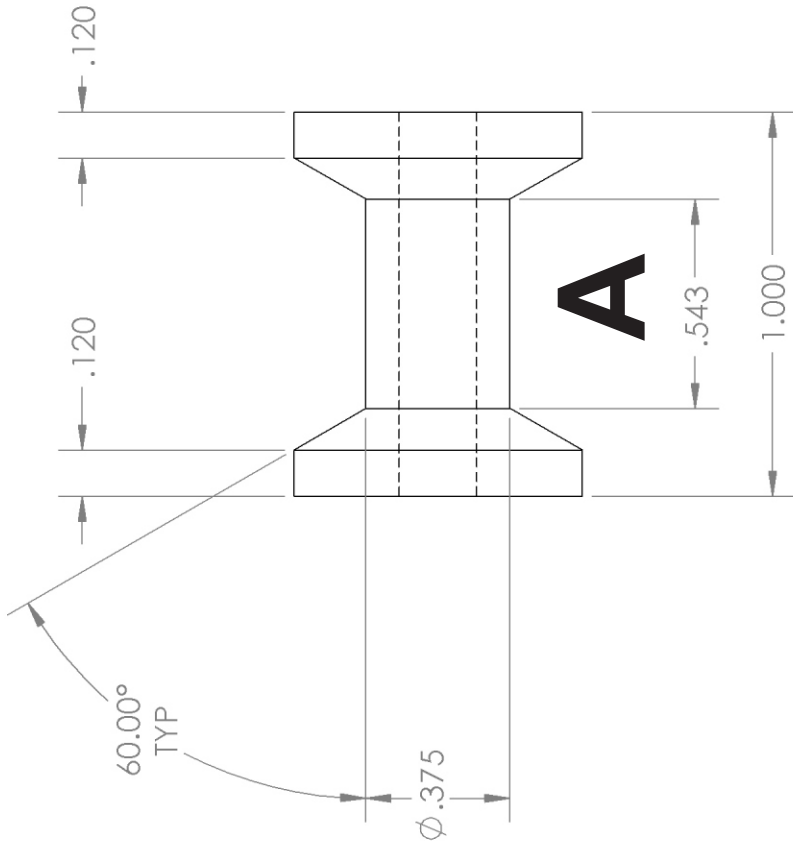
**Object Lines** \_\_\_\_\_

**Leader Lines** \_\_\_\_\_ 

**Dimension Lines**

**Extension Lines**

**Title Block information.**



**C**

$\phi$ .201 TAP DRILL  
1/4-20 UNC THRU

$\phi$ .750

**B**

**A**

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UNLESS OTHERWISE SPECIFIED:		NAME	DATE	North Dakota State College of Science	
DIMENSIONS ARE IN INCHES		JS	4/28/17	TITLE:	
TOLERANCES:		DRAWN		CAM POST	
Diameter $\pm$ .001		CHECKED		SIZE	DWG. NO.
ANGULAR: MACH $\pm$ .5		ENG APPR.		<b>A</b>	<b>27443</b>
TWO PLACE DECIMAL $\pm$ .005		MFG APPR.		SCALE: 2:1	WEIGHT:
THREE PLACE DECIMAL $\pm$ .0015		Q.A.		SHEET 1 OF 1	
INTERPRET GEOMETRIC TOLERANCING PER:		COMMENTS:			
MATERIAL		MILD STEEL			
FINISH		USED ON			
APPLICATION		NEXT ASSY			
DO NOT SCALE DRAWING					

Front \_\_\_\_\_  
Right \_\_\_\_\_  
Left \_\_\_\_\_  
Top \_\_\_\_\_  
Bottom \_\_\_\_\_  
Back \_\_\_\_\_  
Pictorial \_\_\_\_\_

$\emptyset$  = Diameter (Distance across circle thru the center)

Hidden Lines - - - - -

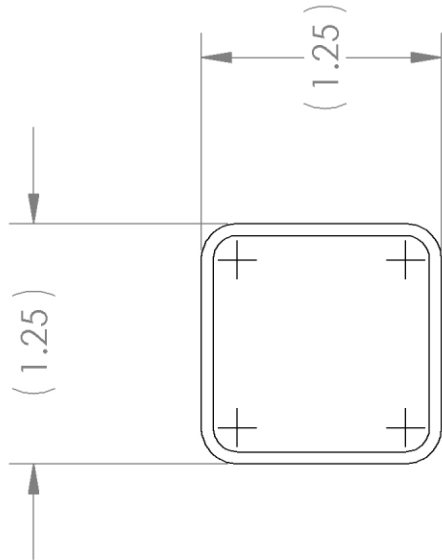
Object Lines \_\_\_\_\_

Leader Lines \_\_\_\_\_  


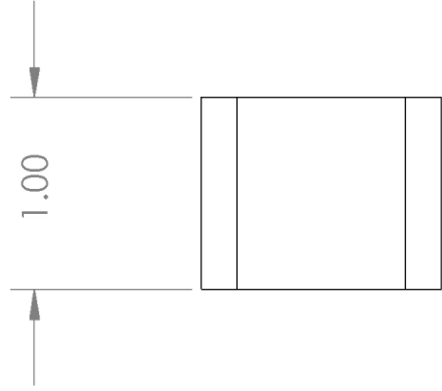
Dimension Lines

Extension Lines

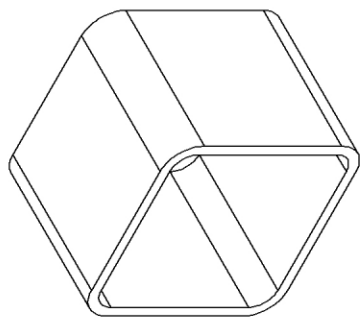
Title Block information.



**A**



**C**



**B**

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UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES		DRAWN	NAME	DATE	NORTH DAKOTA STATE COLLEGE OF SCIENCE
TOLERANCES: FRACTIONAL ±1/16					
ANGULAR: MACHINING ±0.25 BEND ±1.5		ENG APPR.			TITLE: SQ TUBE
TWO PLACE DECIMAL ±.03		MFG APPR.			SIZE DWG. NO. <b>A 27467</b>
THREE PLACE DECIMAL ±.004		Q.A.			SCALE: 2:1 WEIGHT: SHEET 1 OF 1
INTERPRET GEOMETRIC TOLERANCING PER:		COMMENTS:			
MATERIAL		1-1/4 X 16 GA SQ TUBE			
NEXT ASSY		USED ON			
APPLICATION		DO NOT SCALE DRAWING			

Front \_\_\_\_\_  
Right \_\_\_\_\_  
Left \_\_\_\_\_  
Top \_\_\_\_\_  
Bottom \_\_\_\_\_  
Back \_\_\_\_\_  
Pictorial \_\_\_\_\_

**∅ = Diameter** (Distance across circle thru the center)

**Hidden Lines** - - - - -

**Object Lines** \_\_\_\_\_

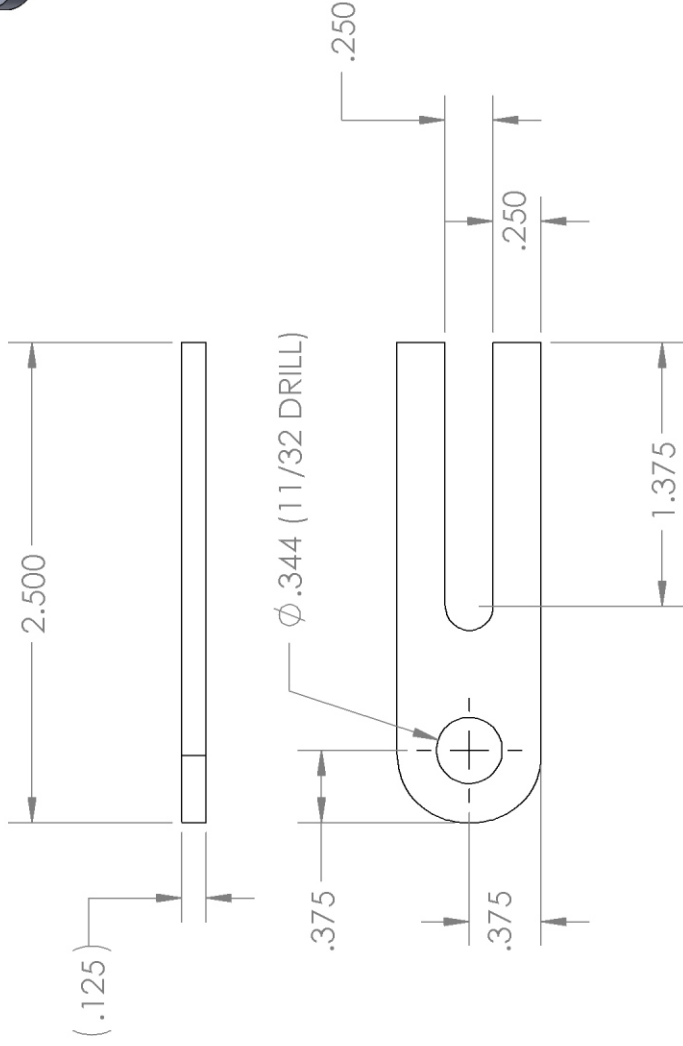
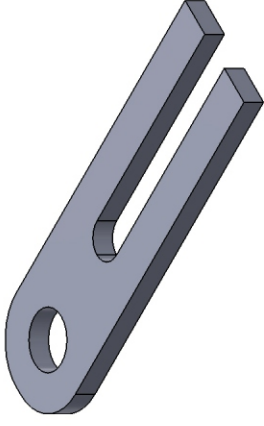
**Leader Lines** \_\_\_\_\_  


**Dimension Lines**

**Extension Lines**

**Title Block information.**





UNLESS OTHERWISE SPECIFIED:		DRAWN	NAME	DATE	North Dakota State College of Science
DIMENSIONS ARE IN INCHES		CHECKED	JS	4/28/17	
TOLERANCES:		ENG APPR.			TITLE:
Diameter ± .001		MFG APPR.			
ANGULAR: MACH ± .5		Q.A.			CAM HOOK
TWO PLACE DECIMAL ± .005		COMMENTS:			
THREE PLACE DECIMAL ± .0015					SIZE DWG. NO.
INTERPRET GEOMETRIC TOLERANCING PER:					<b>A</b> <b>32455</b>
MATERIAL					SCALE: 1:1
.12x.75 STRIP MILD STEEL					WEIGHT:
FINISH					SHEET 1 OF 1
USED ON					
APPLICATION					
DO NOT SCALE DRAWING					

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## Title Block Information

Title \_\_\_\_\_  
Part Number \_\_\_\_\_  
Material \_\_\_\_\_  
Tolerance \_\_\_\_\_  
Scale \_\_\_\_\_  
Drawing Size \_\_\_\_\_

∅ = Diameter (Distance across circle thru the center)

Hidden Lines - - - - -

Object Lines \_\_\_\_\_

Leader Lines 

Dimension Lines

Extension Lines

8

7

6

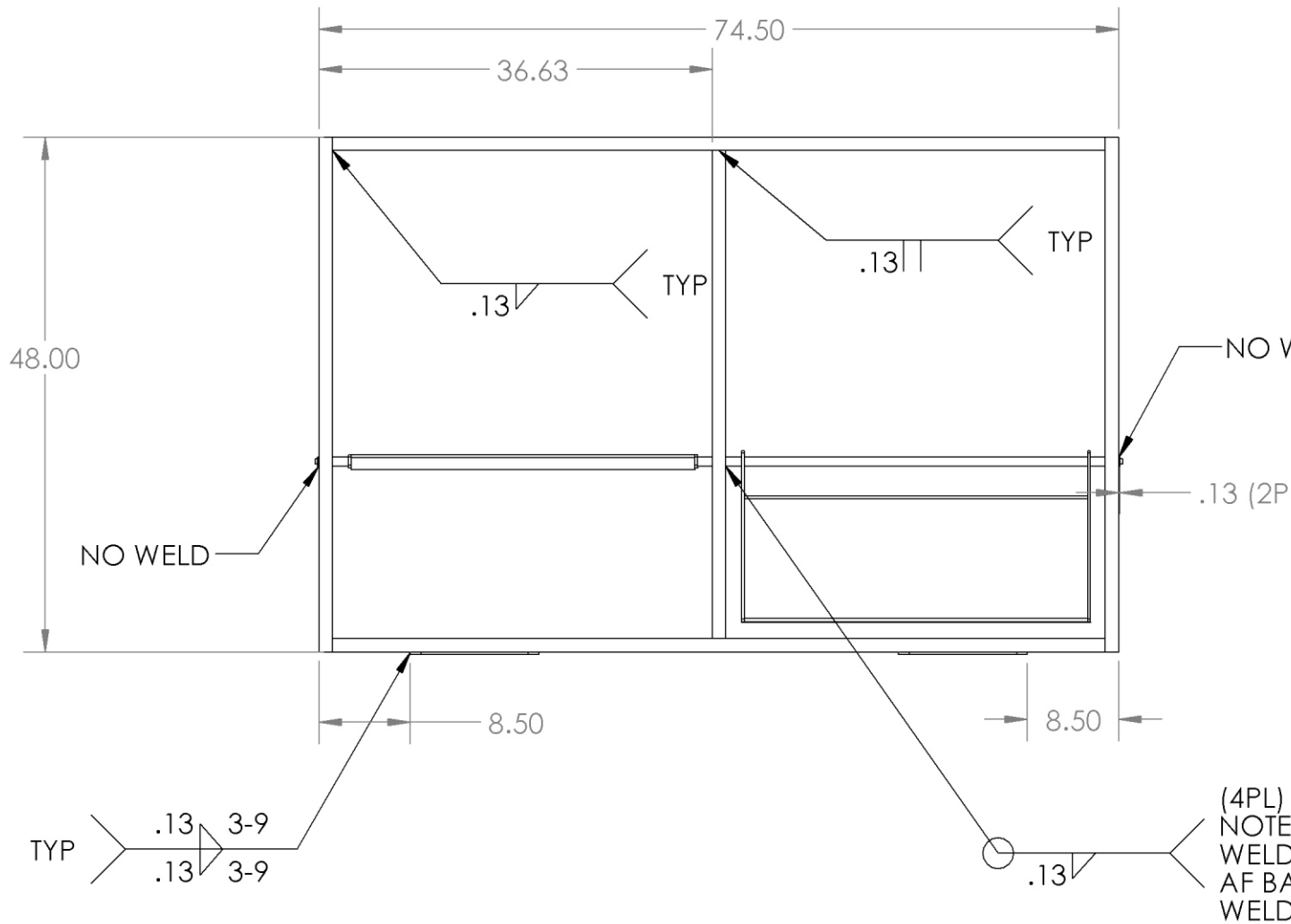
5

D

C

B

A



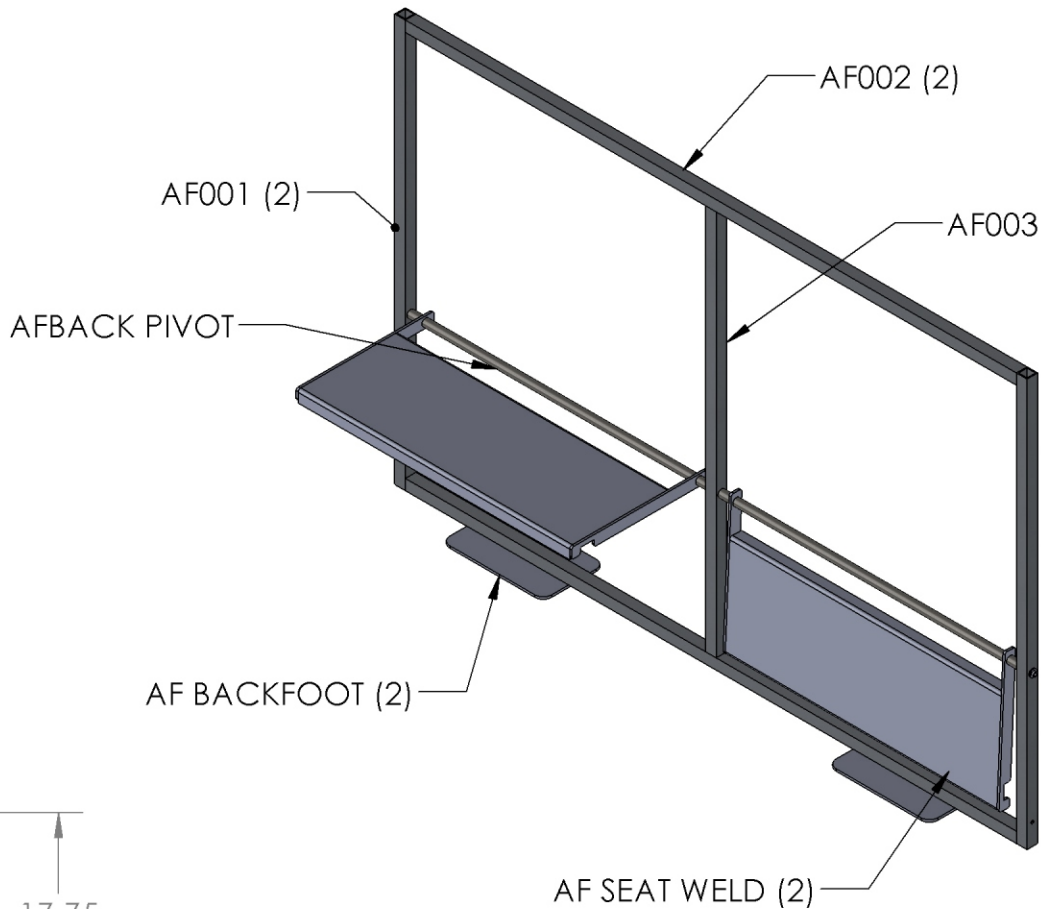
**PROPRIETARY AND CONFIDENTIAL**  
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8

7

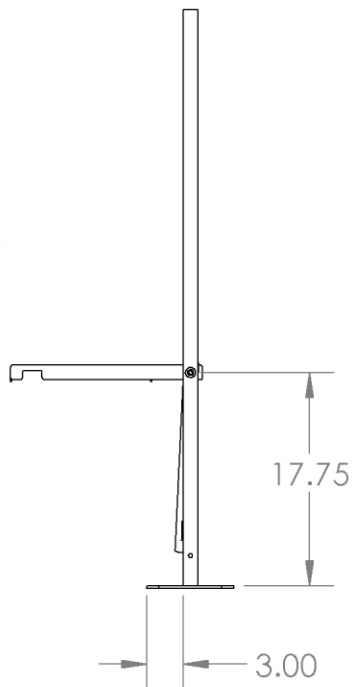
6

5



WELD

L)



: SLIDE AF SEAT  
 (2) ONTO  
 BACK PIVOT BEFORE  
 WELDING

# LOCATING DIMENSIONS:

AFBACKFOOT \_\_\_\_\_, \_\_\_\_\_

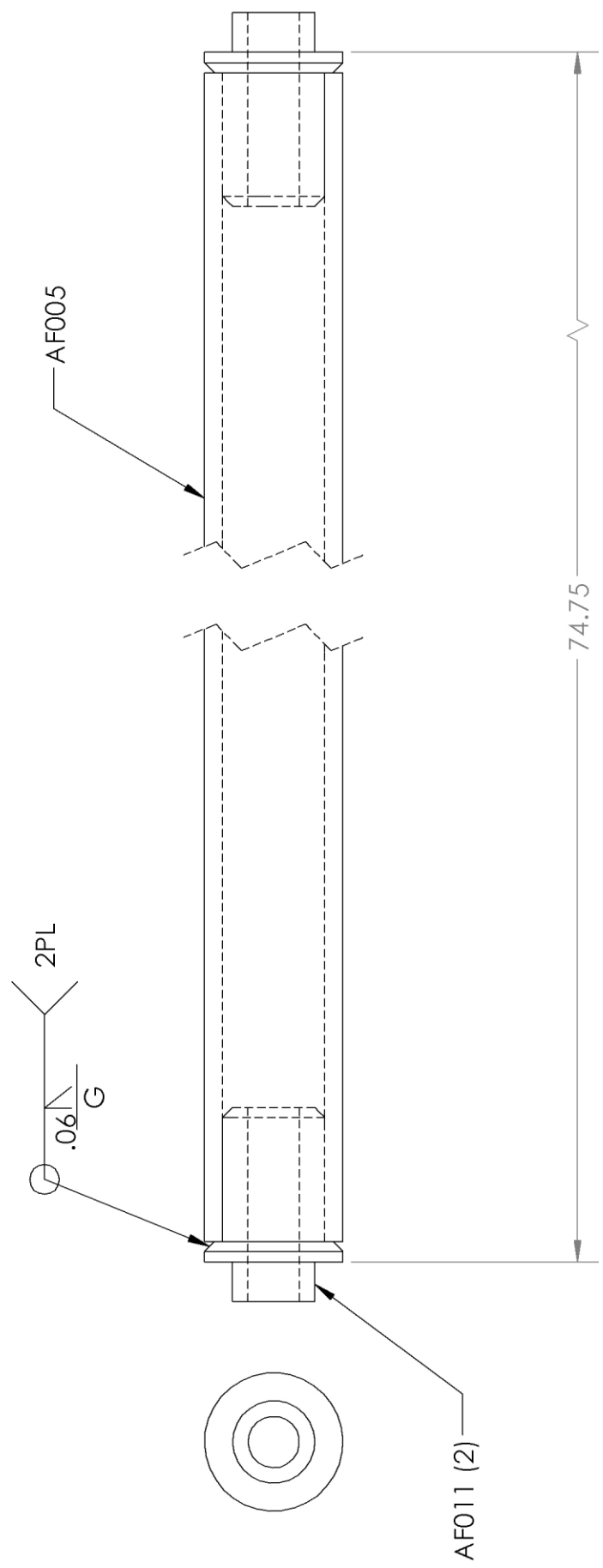
AF003 \_\_\_\_\_, \_\_\_\_\_

# WELDING

		UNLESS OTHERWISE SPECIFIED:	NAME	DATE		
		DIMENSIONS ARE IN INCHES	DRAWN		TITLE:	
		TOLERANCES:	CHECKED			
		FRACTIONAL ±	ENG APPR.			
		ANGULAR: MACH ± BEND ±	MFG APPR.			
		TWO PLACE DECIMAL ±	Q.A.		SIZE	DWG. NO.
		THREE PLACE DECIMAL ±	COMMENTS:		<b>B Af wall back</b>	
		INTERPRET GEOMETRIC TOLERANCING PER:	1 REQUIRED		REV	
		MATERIAL			SCALE: 1:16	WEIGHT:
NEXT ASSY	USED ON	FINISH			SHEET 1 OF 1	
APPLICATION		DO NOT SCALE DRAWING				

1

2



B

B

**LOCATING DIMENSIONS:  
AF011 \_\_\_\_\_', \_\_\_\_\_  
WELDING**

A

A

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

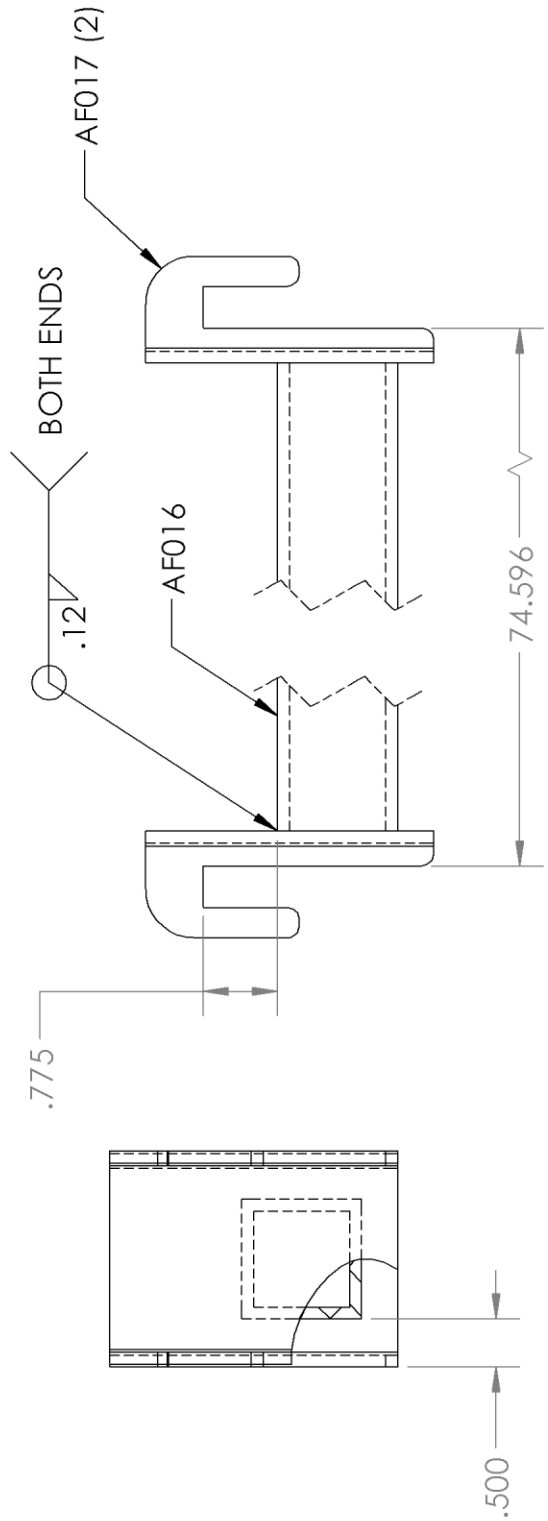
TITLE:

**PROPRIETARY AND CONFIDENTIAL**  
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SIZE DWG. NO. REV  
**A** AF BACKPIVOT  
 SCALE: 1:16 WEIGHT: SHEET 1 OF 1

1

2

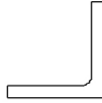
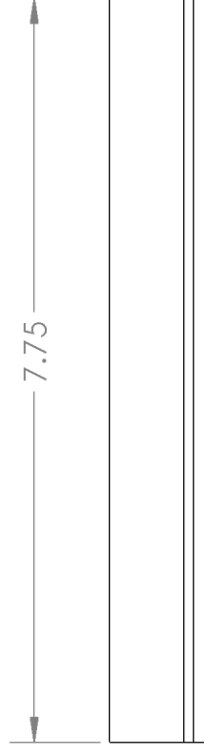
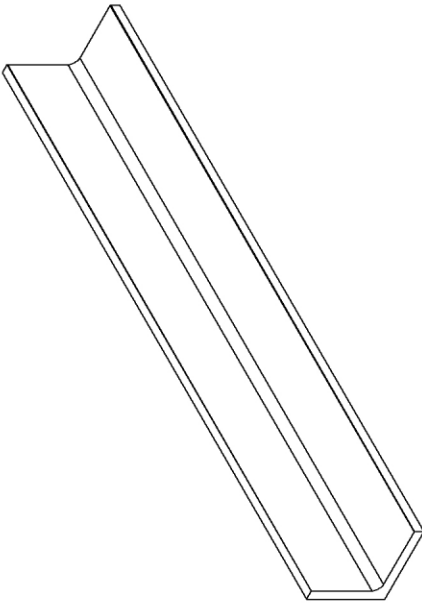


# LOCATING DIMENSIONS: AF017 \_\_\_\_\_, WELDING

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

SIZE **A** DWG. NO. af seat brace REV  
 SCALE: 1:24 WEIGHT: SHEET 1 OF 1



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UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES		DRAWN	NAME	DATE	<b>North Dakota State College of Science</b>  TITLE:  <b>RAIL</b>
TOLERANCES: FRACTIONAL: 1/16 ANGULAR: MACH ± .5° BEND ± 1° TWO PLACE DECIMAL ± .06 THREE PLACE DECIMAL ± .031		CHECKED	JS	4/28/17	
INTERPRET GEOMETRIC TOLERANCING PER:		ENG APPR.			
MATERIAL <b>1X1.125 ANGLE</b> FINISH		MFG APPR.			
DO NOT SCALE DRAWING		Q.A.			
NEXT ASSY	USED ON	COMMENTS:			SIZE DWG. NO. <b>A 2791</b> SCALE: 1:2 WEIGHT: SHEET 1 OF 1

## **Title Block Information**

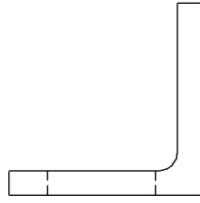
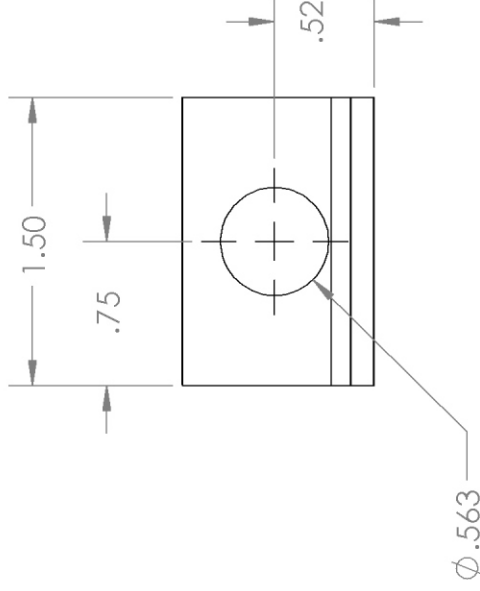
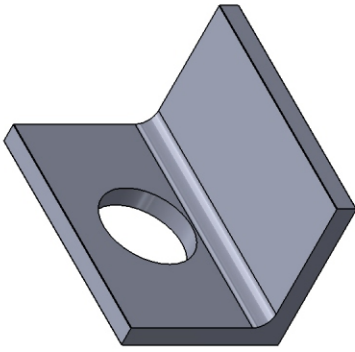
**Title** \_\_\_\_\_  
**Part Number** \_\_\_\_\_  
**Material** \_\_\_\_\_  
**Tolerance** \_\_\_\_\_  
**Scale** \_\_\_\_\_  
**Drawing Size** \_\_\_\_\_

## **Drawing information**

**What are we going to do?**

**How are we going to make it?**





UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES		DRAWN	NAME	DATE	North Dakota State College of Science <b>FRONT SCREW HOLDER</b> TITLE:
TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ± 1° TWO PLACE DECIMAL ± .06 THREE PLACE DECIMAL ± .031		CHECKED	JS	4/28/17	
INTERPRET GEOMETRIC TOLERANCING PER:		ENG APPR.			
MATERIAL 1x1x.125 ANGLE FINISH		MFG APPR.			
DO NOT SCALE DRAWING		G.A.			
APPLICATION		COMMENTS:			SCALE: 1:1
NEXT ASSY	USED ON	SIZE DWG. NO.			WEIGHT:
		A 2789			SHEET 1 OF 1

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## **Title Block Information**

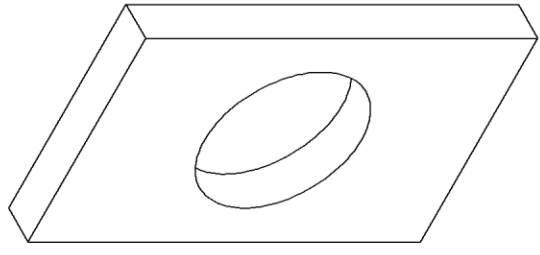
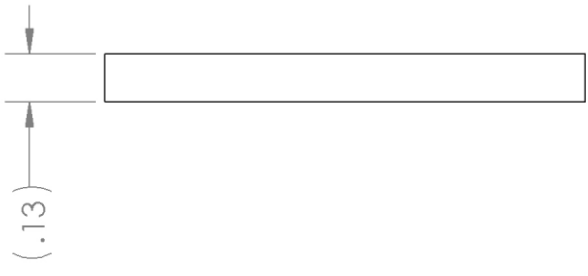
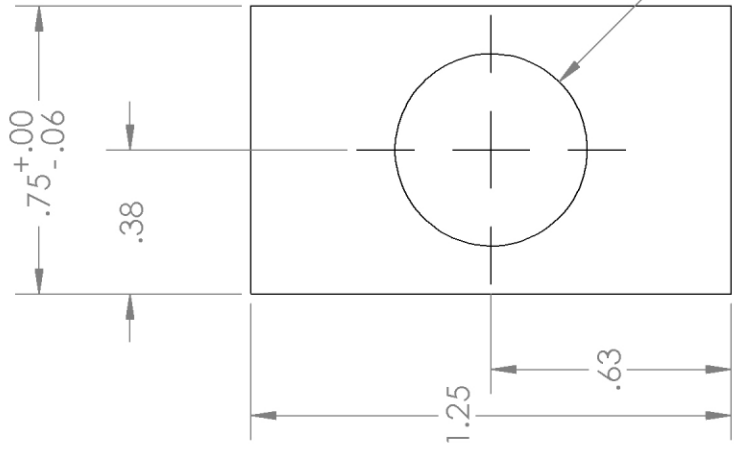
**Title** \_\_\_\_\_  
**Part Number** \_\_\_\_\_  
**Material** \_\_\_\_\_  
**Tolerance** \_\_\_\_\_  
**Scale** \_\_\_\_\_  
**Drawing Size** \_\_\_\_\_

## **Drawing information**

**What are we going to do?**

**How are we going to make it?**

**What is  $\varnothing$  .563?**



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES		DRAWN	NAME	DATE	<b>North Dakota State College of Science</b>  <b>TITLE:</b>  <b>SLIDE</b>  SIZE <b>A</b> DWG. NO. <b>2793</b> REV SCALE: 2:1 WEIGHT: SHEET 1 OF 1
TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: MACH ± .5° BEND ± 1° TWO PLACE DECIMAL ± .06 THREE PLACE DECIMAL ± .031		CHECKED	JS	4/28/17	
INTERPRET GEOMETRIC TOLERANCING PER:		ENG APPR.			
MATERIAL <b>.125x.75 STRIP</b>		MFG APPR.			
FINISH		Q.A.			
NEXT ASSY		COMMENTS:			
APPLICATION		DO NOT SCALE DRAWING			

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## **Title Block Information**

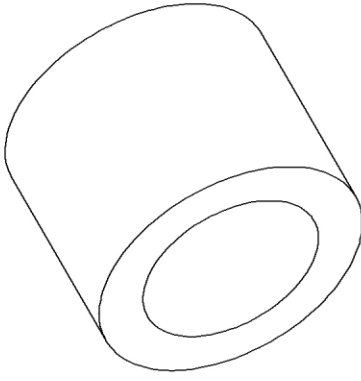
**Title** \_\_\_\_\_  
**Part Number** \_\_\_\_\_  
**Material** \_\_\_\_\_  
**Tolerance** \_\_\_\_\_  
**Scale** \_\_\_\_\_  
**Drawing Size** \_\_\_\_\_

## **Drawing information**

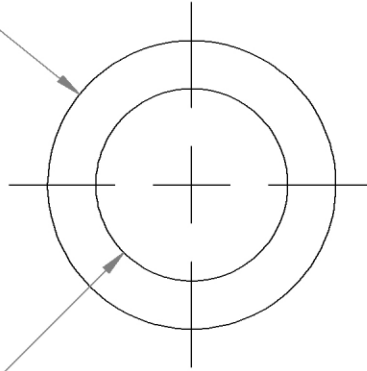
**What are we going to do?**

**How are we going to make it?**

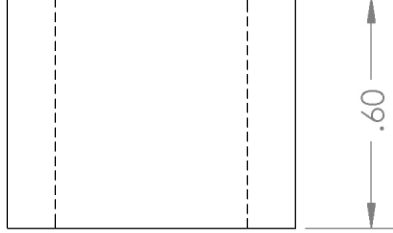
**What is  $\varnothing$  ?**



$\phi .750$



$\phi .500$



.60

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UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES		DRAWN	NAME	DATE	North Dakota State College of Science
TOLERANCES: FRACTIONAL $\pm 1/16$ ANGULAR: MACH $\pm .5^\circ$ BEND $\pm 1^\circ$ TWO PLACE DECIMAL $\pm .06$ THREE PLACE DECIMAL $\pm .031$		CHECKED	JS	4/28/17	
INTERPRET GEOMETRIC TOLERANCING PER:		ENG APPR.			TITLE:
MATERIAL		MFG APPR.			<b>VICE SCREW CAP</b>
.75 OD X.12W TUBE FINISH		Q.A.			
USED ON		COMMENTS:			SIZE
APPLICATION					<b>A</b>
NEXT ASSY					DWG. NO.
					<b>2795</b>
					REV
					SCALE: 2:1
					WEIGHT:
					SHEET 1 OF 1

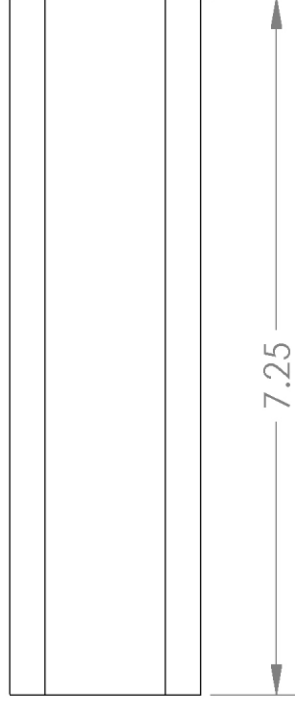
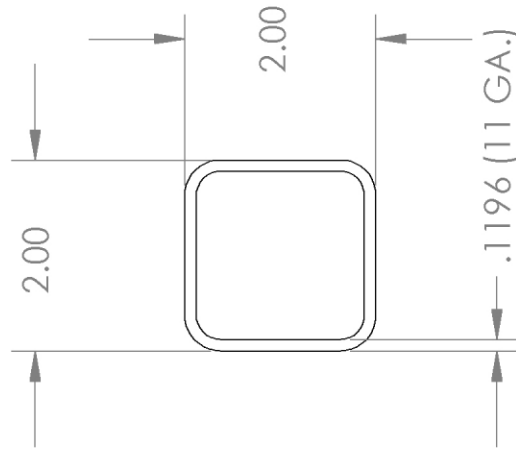
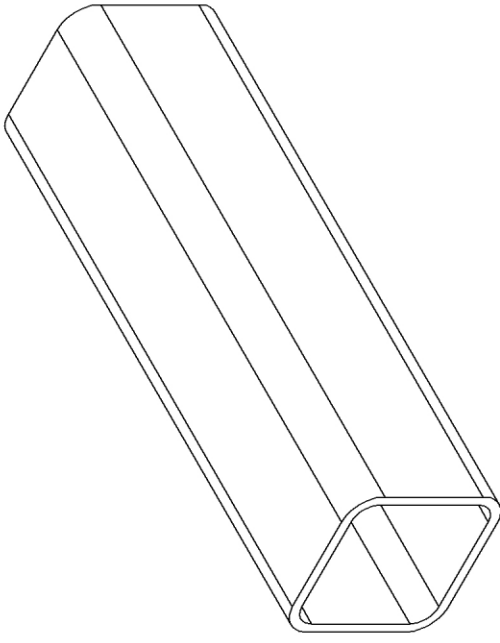
## **Title Block Information**

**Title** \_\_\_\_\_  
**Part Number** \_\_\_\_\_  
**Material** \_\_\_\_\_  
**Tolerance** \_\_\_\_\_  
**Scale** \_\_\_\_\_  
**Drawing Size** \_\_\_\_\_

## **Drawing information**

**What are we going to do?**

**How are we going to make it?**



UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES		JS	4/28/17
TOLERANCES:		DRAWN	
FRACTIONAL ±		CHECKED	
ANGULAR: MACH ± BEND ±		ENG APPR.	
TWO PLACE DECIMAL ±		MFG APPR.	
THREE PLACE DECIMAL ±		Q.A.	
INTERPRET GEOMETRIC TOLERANCING PER:		COMMENTS:	
MATERIAL		MILD STEEL	
FINISH		USED ON	
NEXT ASSY		APPLICATION	
DO NOT SCALE DRAWING			

TITLE:

GSX TUBE

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SIZE **A** DWG. NO. **2743** REV

SCALE: 1:2 WEIGHT: SHEET 1 OF 1

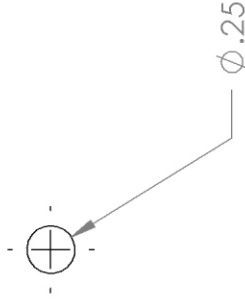
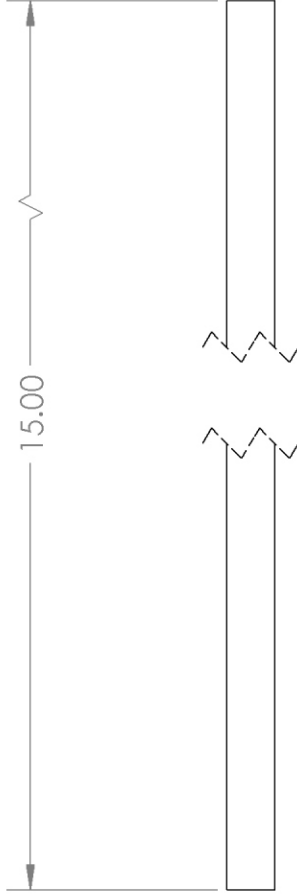
**Title Block Information**

**Title** \_\_\_\_\_  
**Part Number** \_\_\_\_\_  
**Material** \_\_\_\_\_  
**Tolerance** \_\_\_\_\_  
**Scale** \_\_\_\_\_  
**Drawing Size** \_\_\_\_\_

**Drawing information**

**What are we going to do?**  
**How are we going to make it?**





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UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: Diameter ± .06 ANGULAR: ± 1° TWO PLACE DECIMAL ±.06 THREE PLACE DECIMAL ±.005		NAME JS	DATE 4/28/17	North Dakota State College of Science	
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.	DRAWN	CHECKED	TITLE: <b>GSX ROD</b>	
MATERIAL <b>1/4 MS SHAFT</b> FINISH	COMMENTS:	ENG APPR.	MFG APPR.	SIZE <b>A</b>	DWG. NO. <b>26875</b>
NEXT ASSY	USED ON	DO NOT SCALE DRAWING		SCALE: 1:4	WEIGHT:
APPLICATION	4	3	2	1	SHEET 1 OF 1

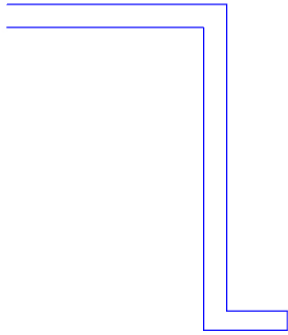
**What do we do?**

4

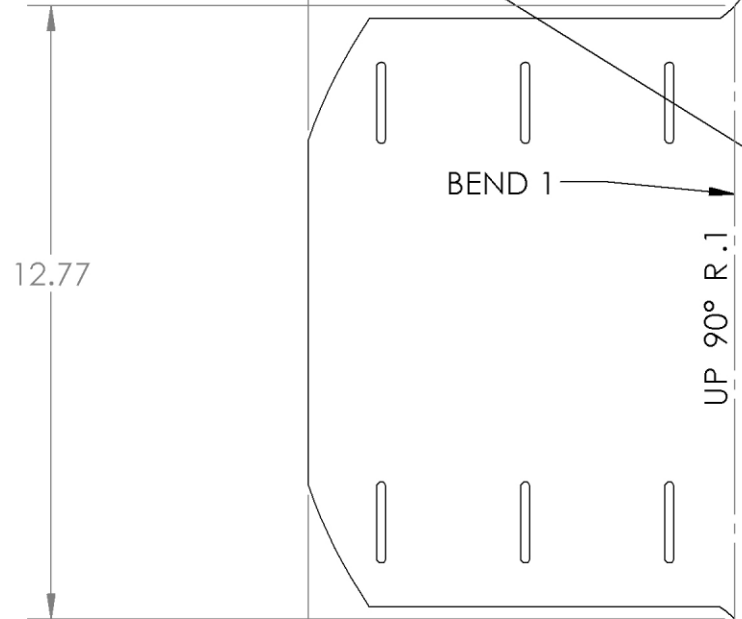
3

BEND 4 IS MEASURED FROM BEND 3 AFTER IT'S BENT 4.18

**NOTE: NO BOTTOM DIE IN THIS AREA WHEN BENDING BEND 3 & 4**



B



BEND

BEND 1

UP 90° R.1

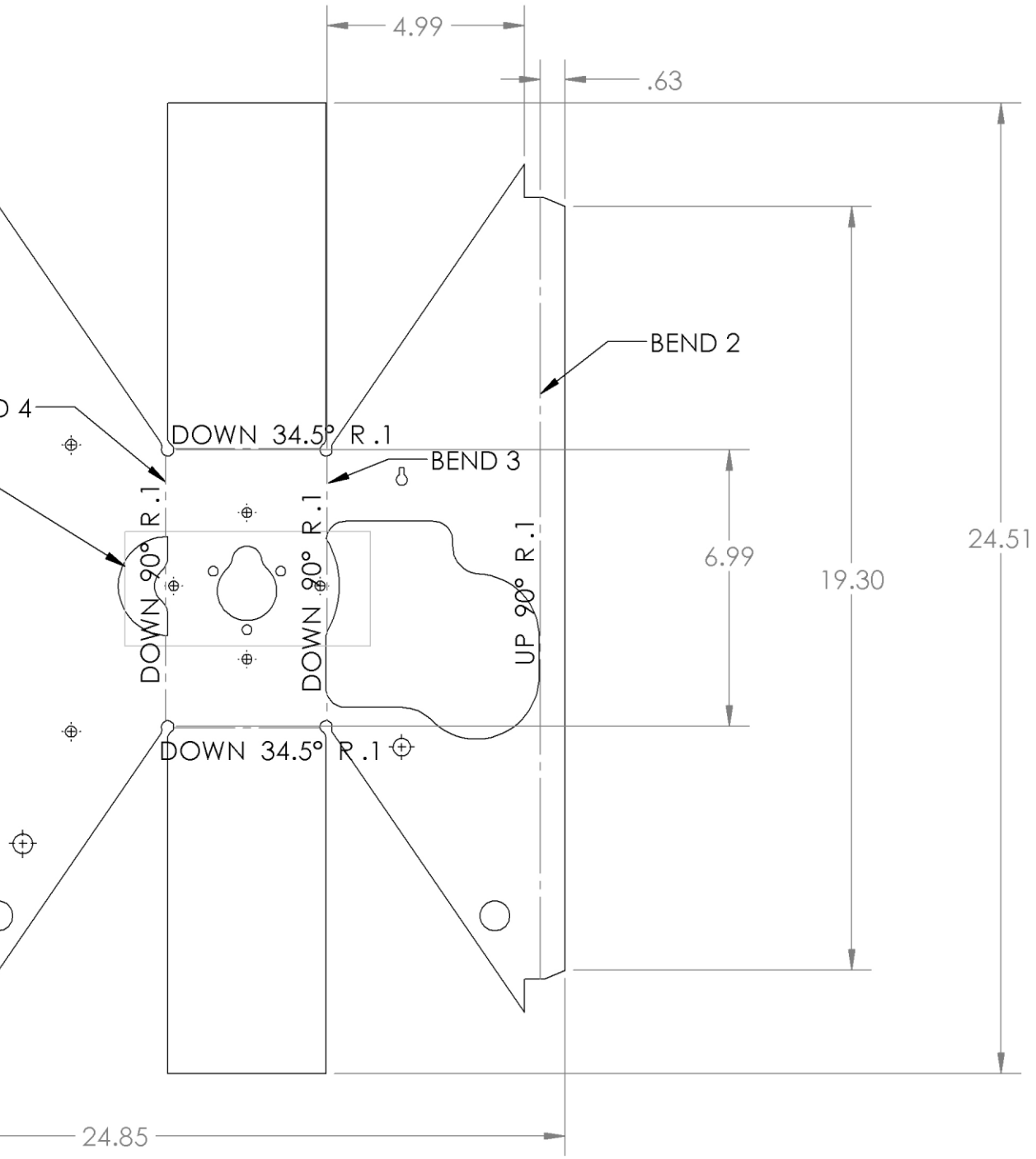
A

4

3

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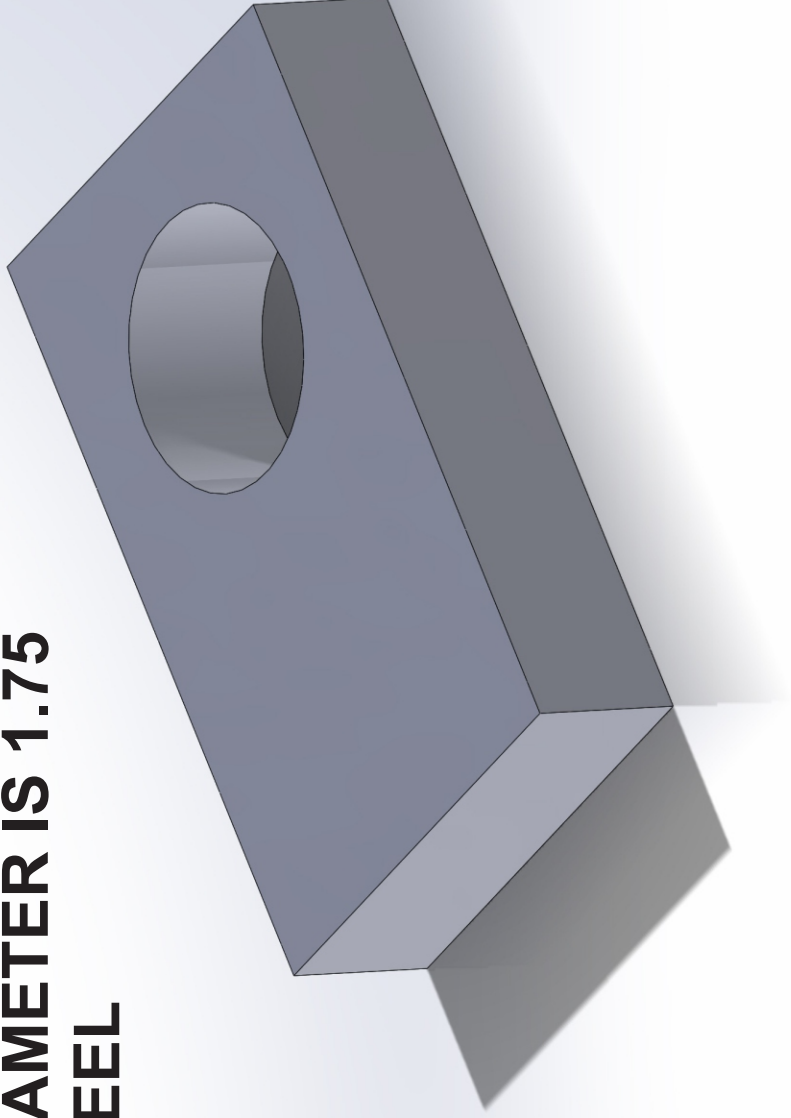


B

A

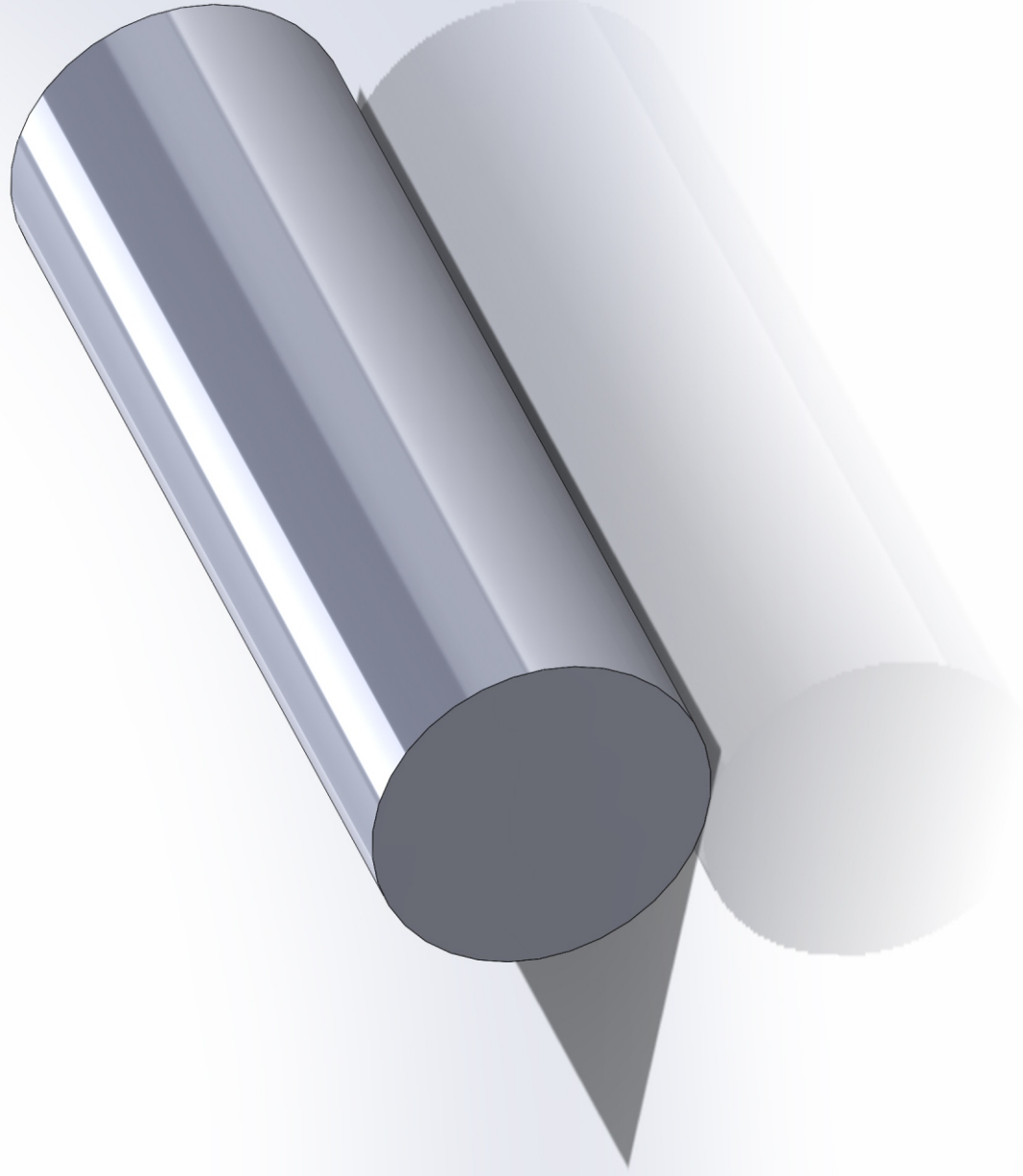
		UNLESS OTHERWISE SPECIFIED:	NAME	DATE	North Dakota State College of Science	
		DIMENSIONS ARE IN INCHES	DRAWN	JS	4/28/17	TITLE:  <b>GSX MAIN PAN</b>
		TOLERANCES: Diameter ± .06	CHECKED			
		ANGULAR: ± 1°	ENG APPR.			
		TWO PLACE DECIMAL ±.06	MFG APPR.			
		THREE PLACE DECIMAL ±.005	Q.A.			SIZE DWG. NO. REV <b>B 42721</b>
		INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:			
		MATERIAL 12 GA. MS				SCALE: 1:8 WEIGHT: SHEET 1 OF 1
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				

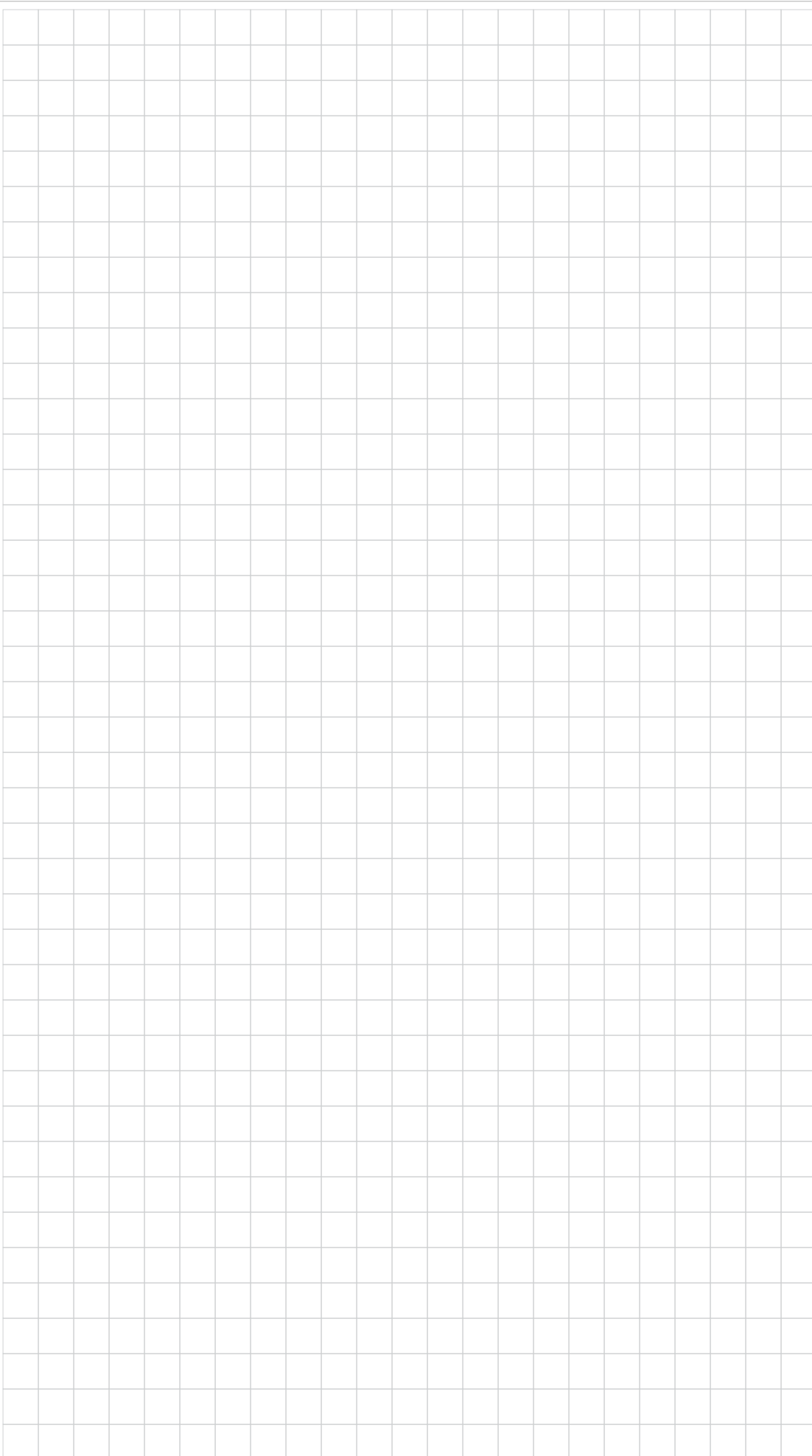
**THIS PART 3.00 x 5.00 x 1.00 THICK  
HOLE IS 3.50 FROM ONE END AND 1.50 FROM THE OTHER.  
HOLE DIAMETER IS 1.75  
MILD STEEL**





**THIS PART 1.50 DIAMETER x 5.00 LONG  
ALUMINUM**

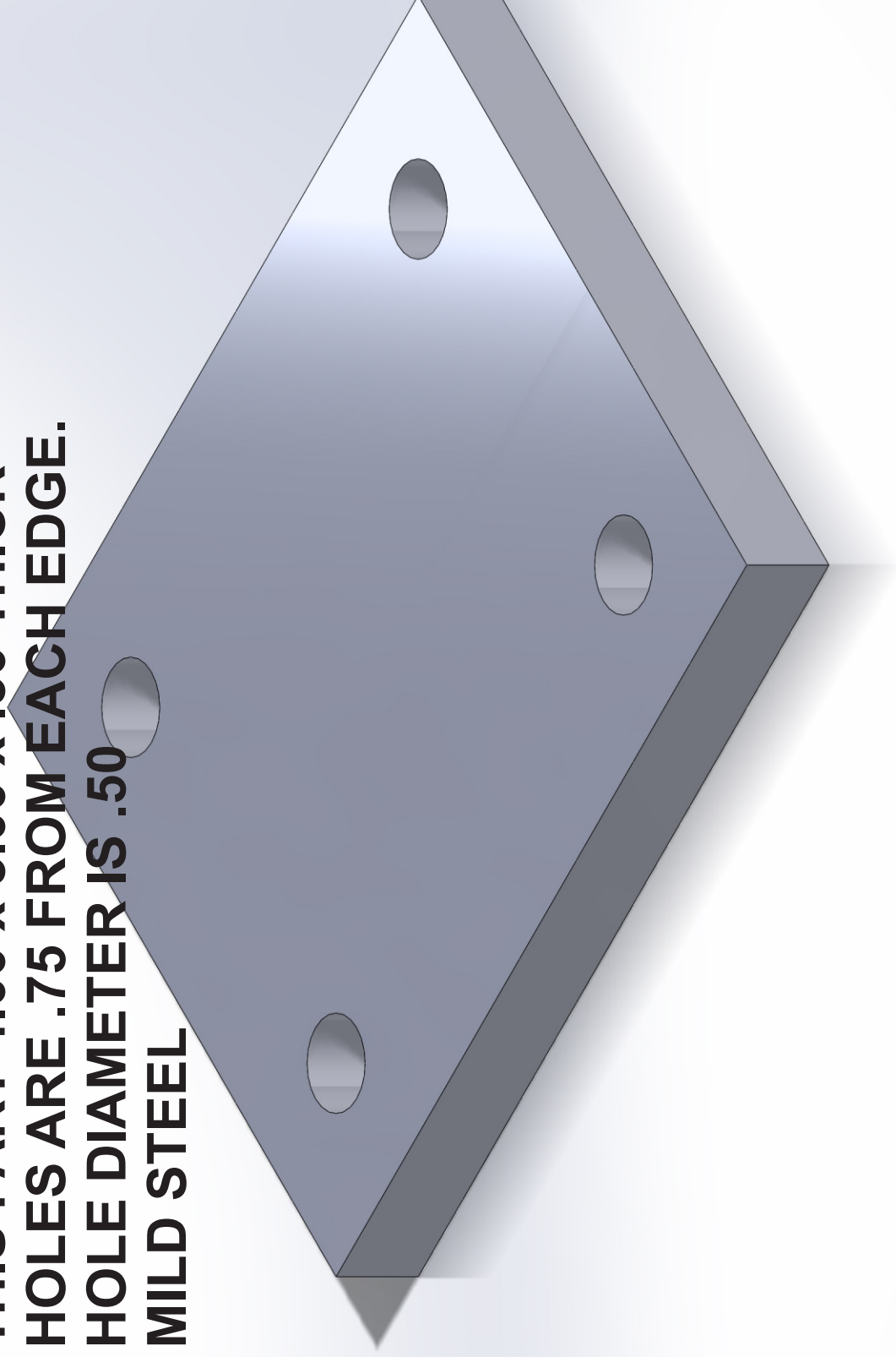


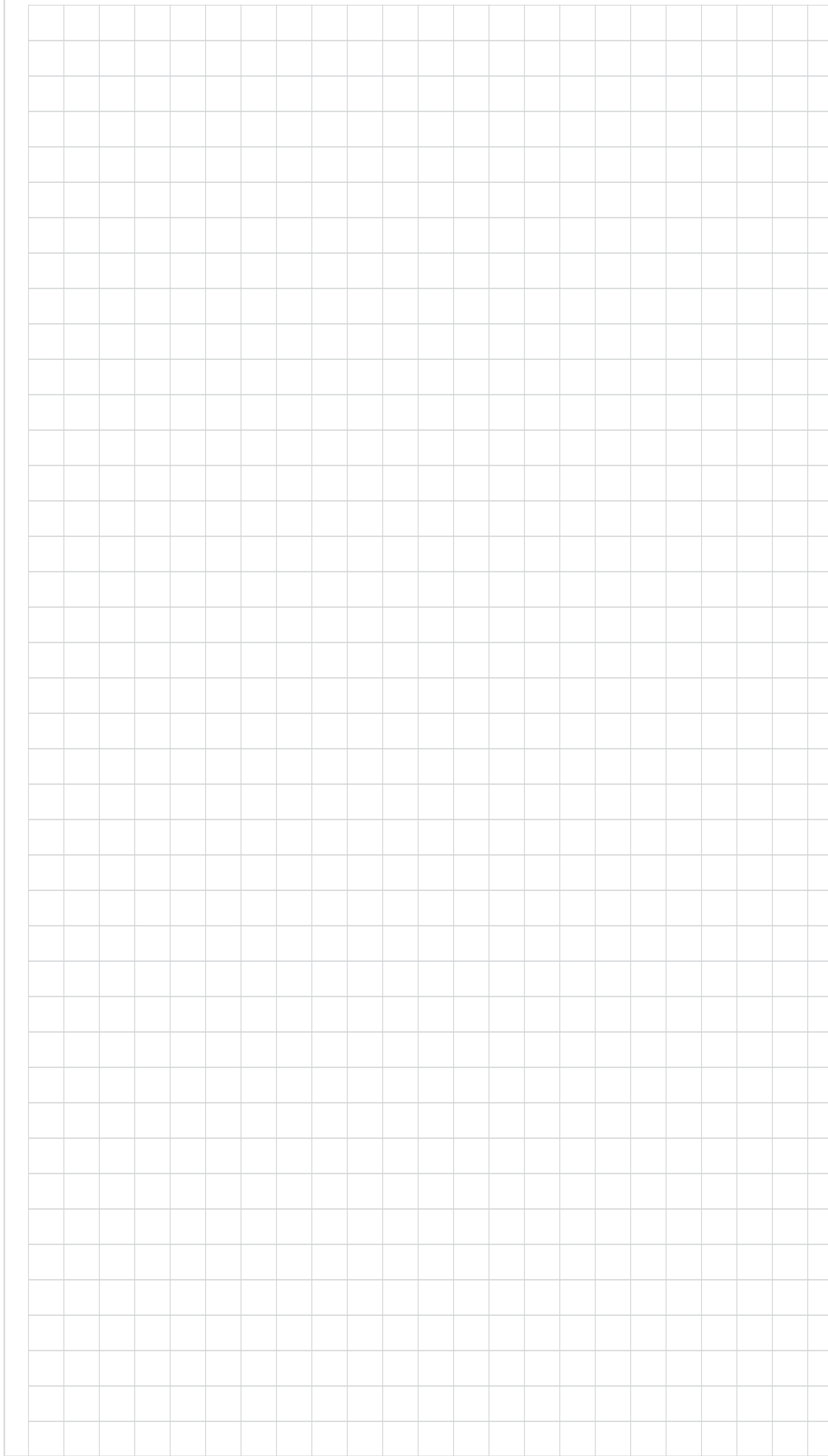


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		<p><b>SIZE</b>    <b>DWG. NO.</b></p> <p><b>A</b></p>	<p><b>REV</b></p>
<p><b>UNLESS OTHERWISE SPECIFIED:</b></p> <p>DIMENSIONS ARE IN INCHES</p> <p>TOLERANCES:</p> <p>Diameter ± .06</p> <p>ANGULAR: ± 1°</p> <p>TWO PLACE DECIMAL ±.06</p> <p>THREE PLACE DECIMAL ±.005</p>		<p><b>DRAWN</b></p>	<p><b>DATE</b></p>
<p>INTERPRET GEOMETRIC TOLERANCING PER:</p> <p>MATERIAL</p> <p>FINISH</p>		<p><b>CHECKED</b></p>	<p><b>NAME</b></p>
<p>DO NOT SCALE DRAWING</p>		<p><b>ENG APPR.</b></p>	<p><b>DATE</b></p>
<p>APPLICATION</p>		<p><b>MFG APPR.</b></p>	<p><b>COMMENTS:</b></p>
<p>NEXT ASSY</p>	<p>USED ON</p>	<p><b>SCALE: 1:1</b>    <b>WEIGHT:</b></p>	
<p>5</p>	<p>4</p>	<p>3</p>	<p>2</p>
<p>↑</p>		<p>1</p>	



**THIS PART 4.00 x 5.00 x .50 THICK  
HOLES ARE .75 FROM EACH EDGE.  
HOLE DIAMETER IS .50  
MILD STEEL**





**North Dakota State College of Science**

TITLE:

SIZE **A** DWG. NO. REV

SCALE: 1:1 WEIGHT: SHEET 1 OF 1

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

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN INCHES

TOLERANCES:  
 Diameter: ± .06  
 ANGULAR: ± 1°  
 TWO PLACE DECIMAL ±.06  
 THREE PLACE DECIMAL ±.005

INTERPRET GEOMETRIC TOLERANCING PER:

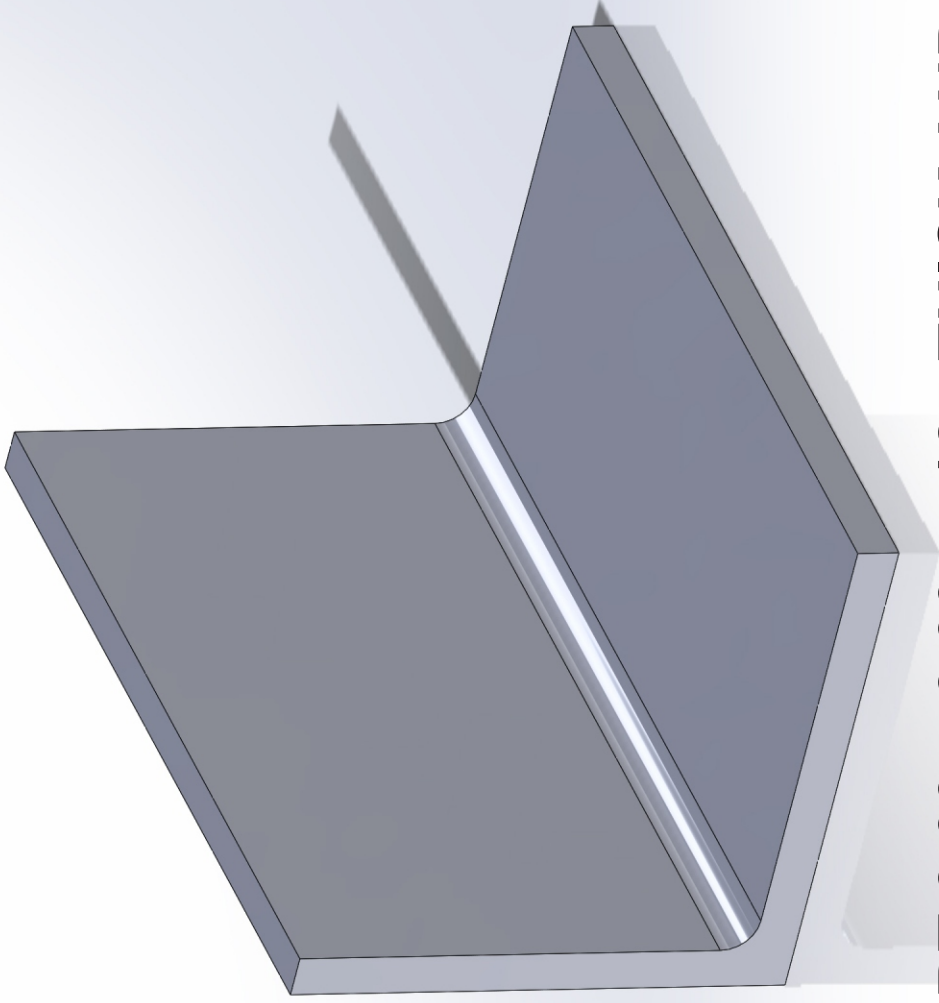
MATERIAL

FINISH

DO NOT SCALE DRAWING

APPLICATION	USED ON
NEXT ASSY	
APPLICATION	USED ON

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**THIS PART 3.00 x 3.00 x .125 THICK AND IS 5.00 LONG  
MILD STEEL ANGLE IRON**

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

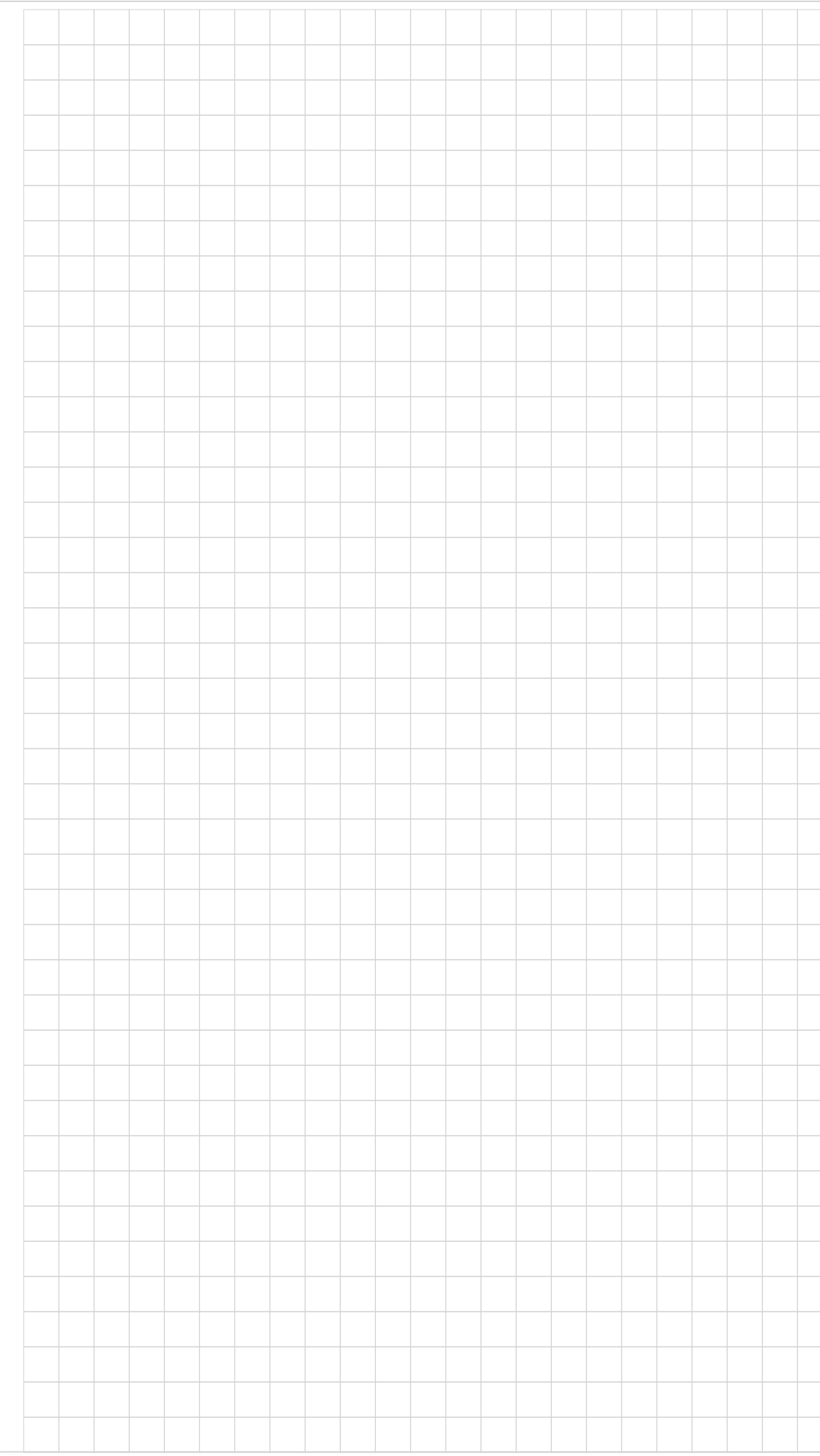
North Dakota State College of Science

TITLE:

SIZE	DWG. NO.	REV
<b>A</b>		

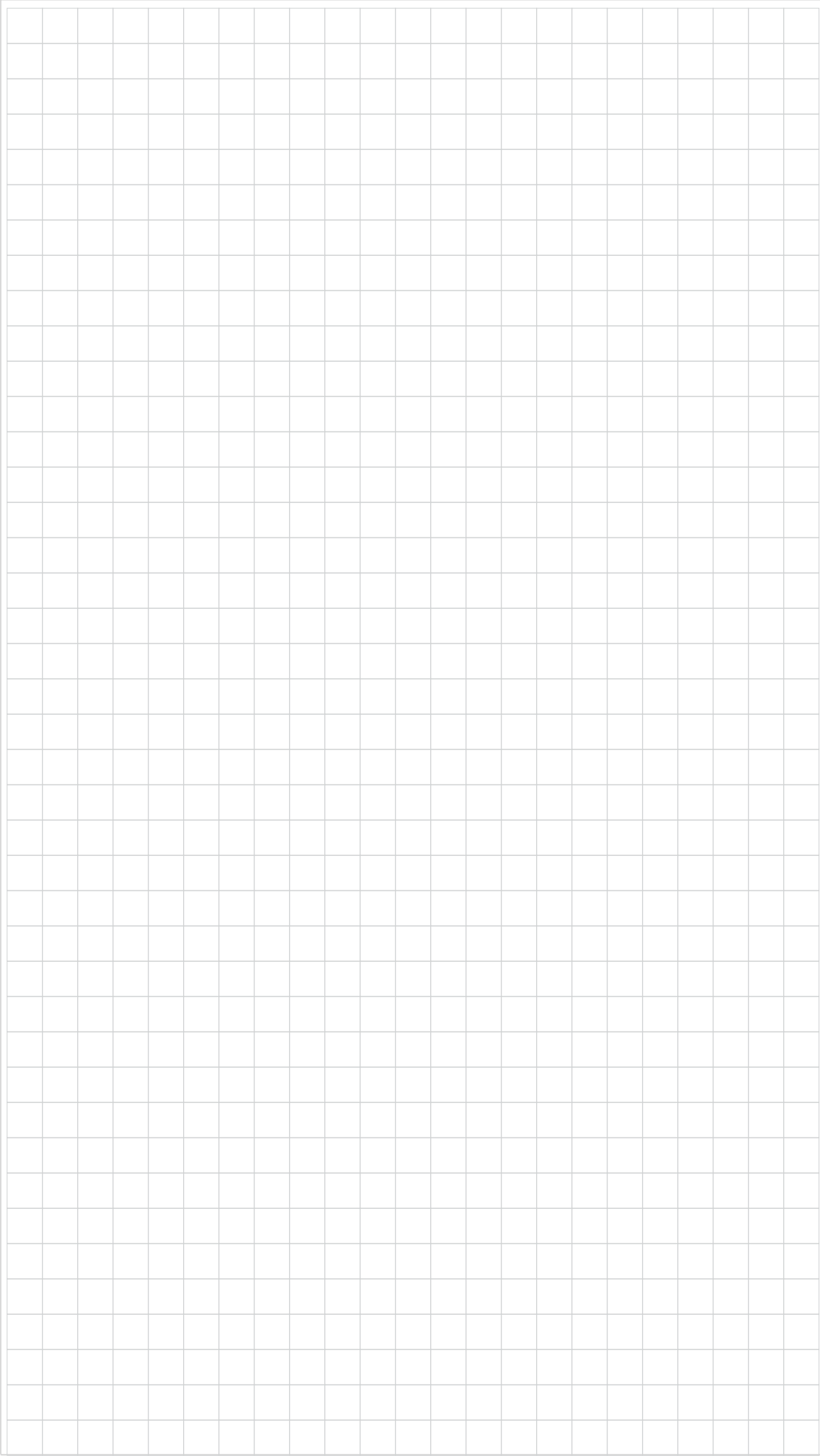
SCALE: 1:1 WEIGHT: SHEET 1 OF 1

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

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**North Dakota State College of Science**

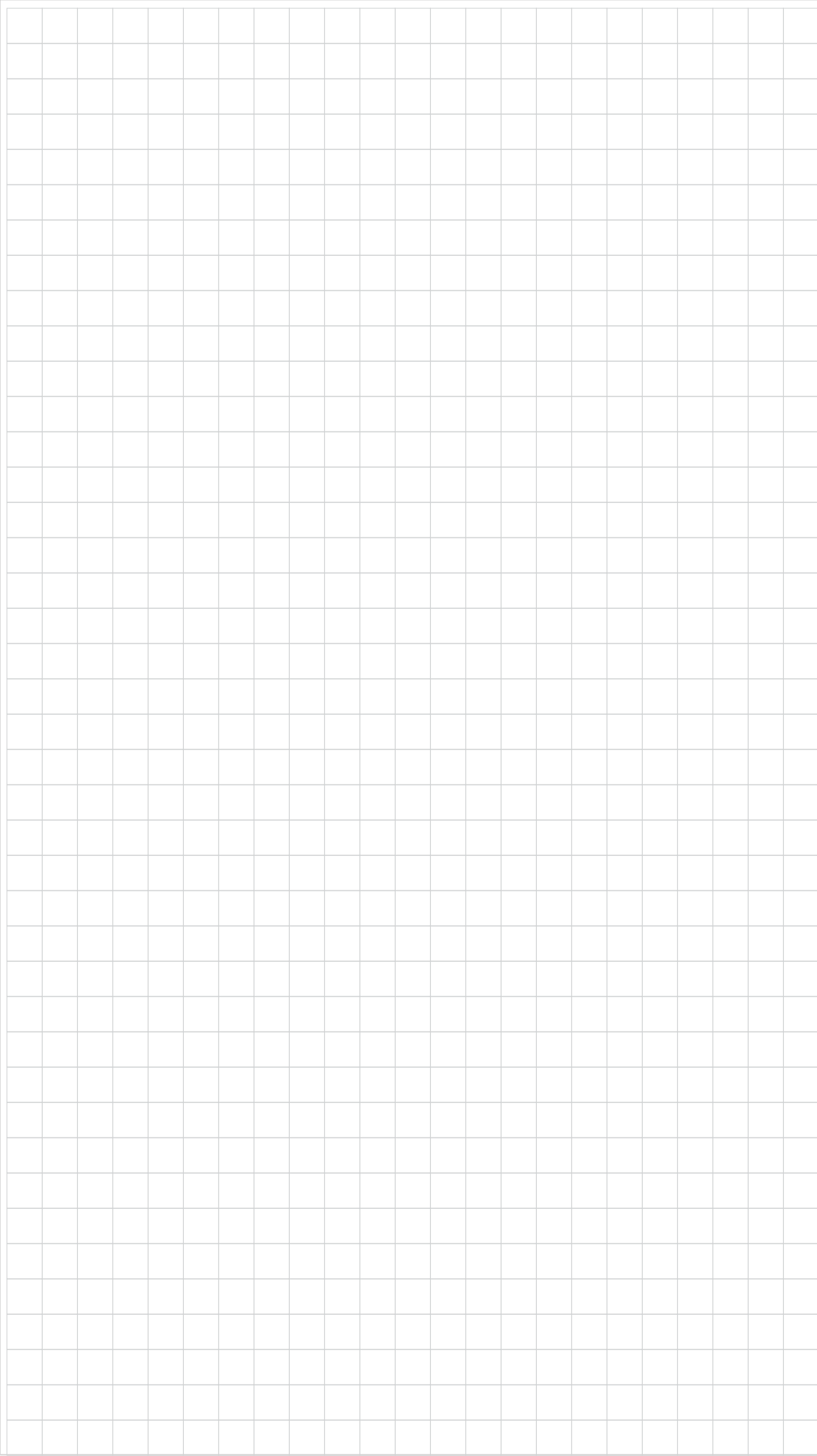
TITLE:

SIZE **A** DWG. NO. REV

SCALE: 1:1 WEIGHT: SHEET 1 OF 1

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

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**North Dakota State College of Science**

**TITLE:**

**SIZE:** **A**     **DWG. NO.:**     **REV:**

**SCALE:** 1:1     **WEIGHT:**     **SHEET 1 OF 1**

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

**APPLICATION**

NEXT ASSY     USED ON

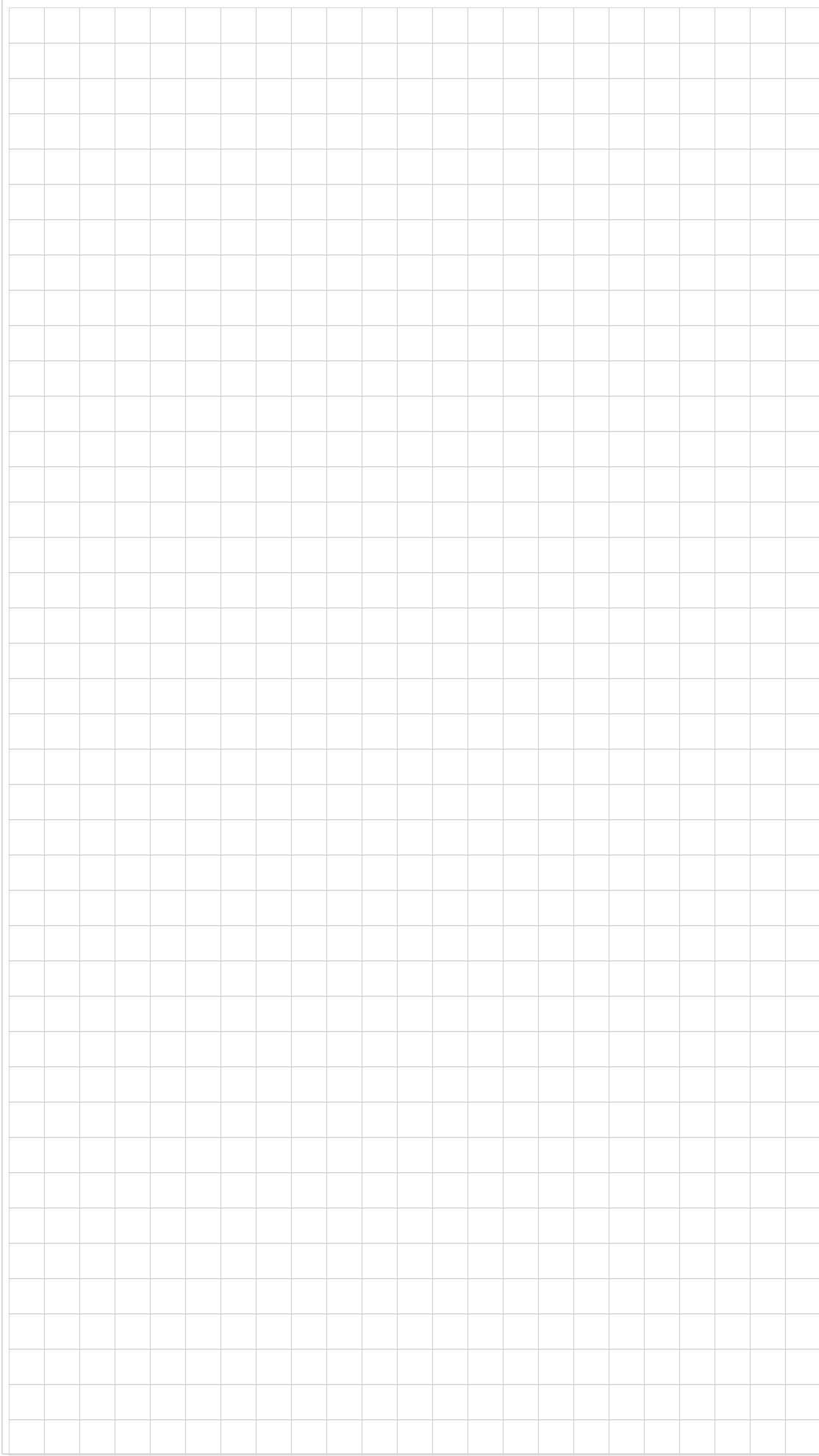
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2
3
4
5



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				CHECKED		ENG APPR.		MFG APPR.		Q.A.	
<p>INTERPRET GEOMETRIC TOLERANCING PER:</p>		<p>MATERIAL</p>		<p>COMMENTS:</p>		<p>SIZE DWG. NO.</p>		<p><b>A</b></p>		<p>REV</p>	
<p>FINISH</p>		<p>USED ON</p>		<p>APPLICATION</p>		<p>SCALE: 1:1</p>		<p>WEIGHT:</p>		<p>SHEET 1 OF 1</p>	





North Dakota State College of Science

TITLE:

DATE

NAME

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

UNLESS OTHERWISE SPECIFIED:  
DIMENSIONS ARE IN INCHES  
TOLERANCES:  
Diameter ±.06  
ANGULAR: ± 1°  
TWO PLACE DECIMAL ±.06  
THREE PLACE DECIMAL ±.005  
INTERPRET GEOMETRIC  
TOLERANCING PER:  
MATERIAL  
FINISH  
DO NOT SCALE DRAWING

USED ON

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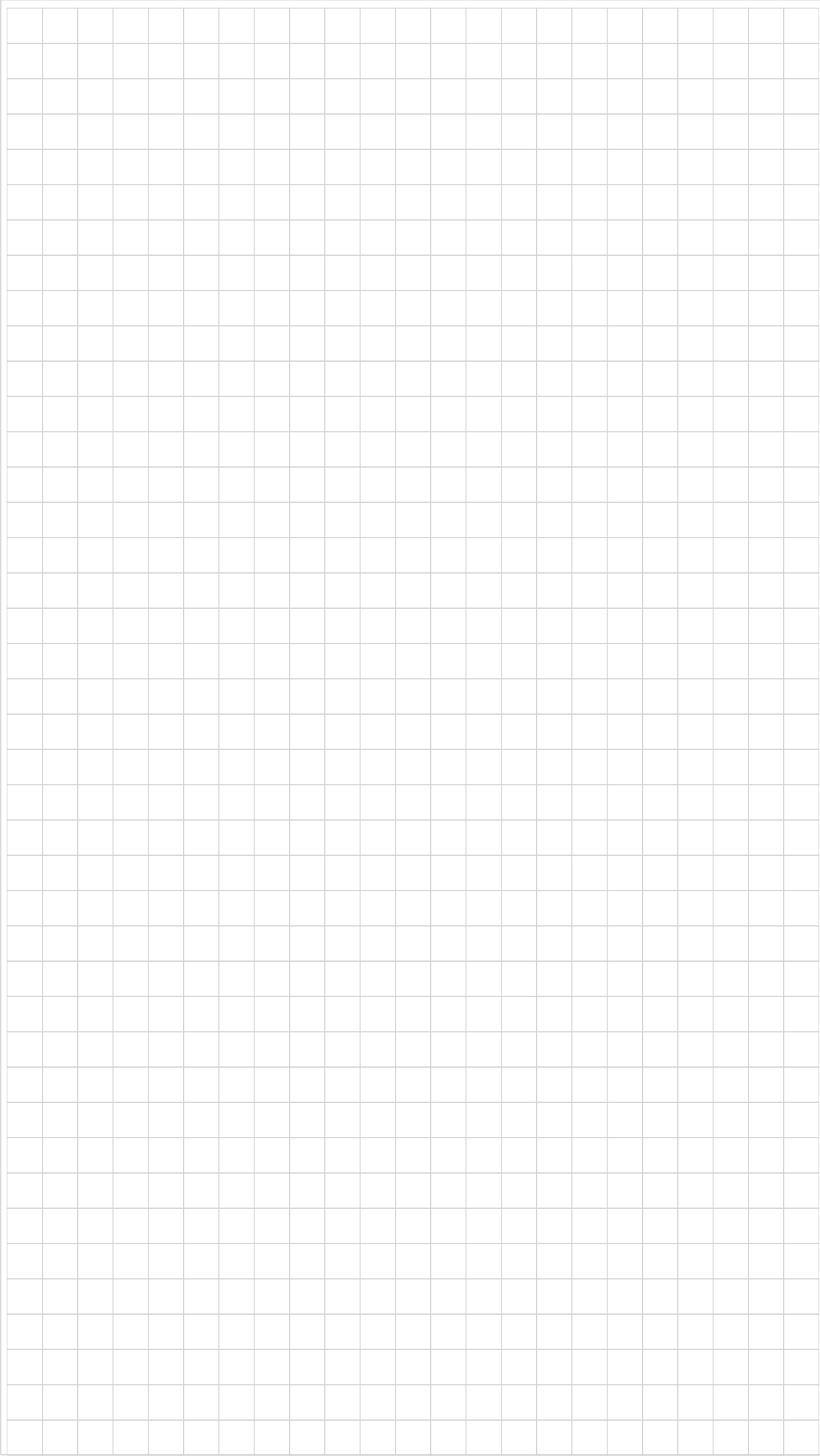
APPLICATION

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SIZE DWG. NO. REV

**A**

SCALE: 1:1 WEIGHT: SHEET 1 OF 1



**North Dakota State College of Science**

TITLE:

SIZE DWG. NO. REV

**A**

SCALE: 1:1 WEIGHT: SHEET 1 OF 1

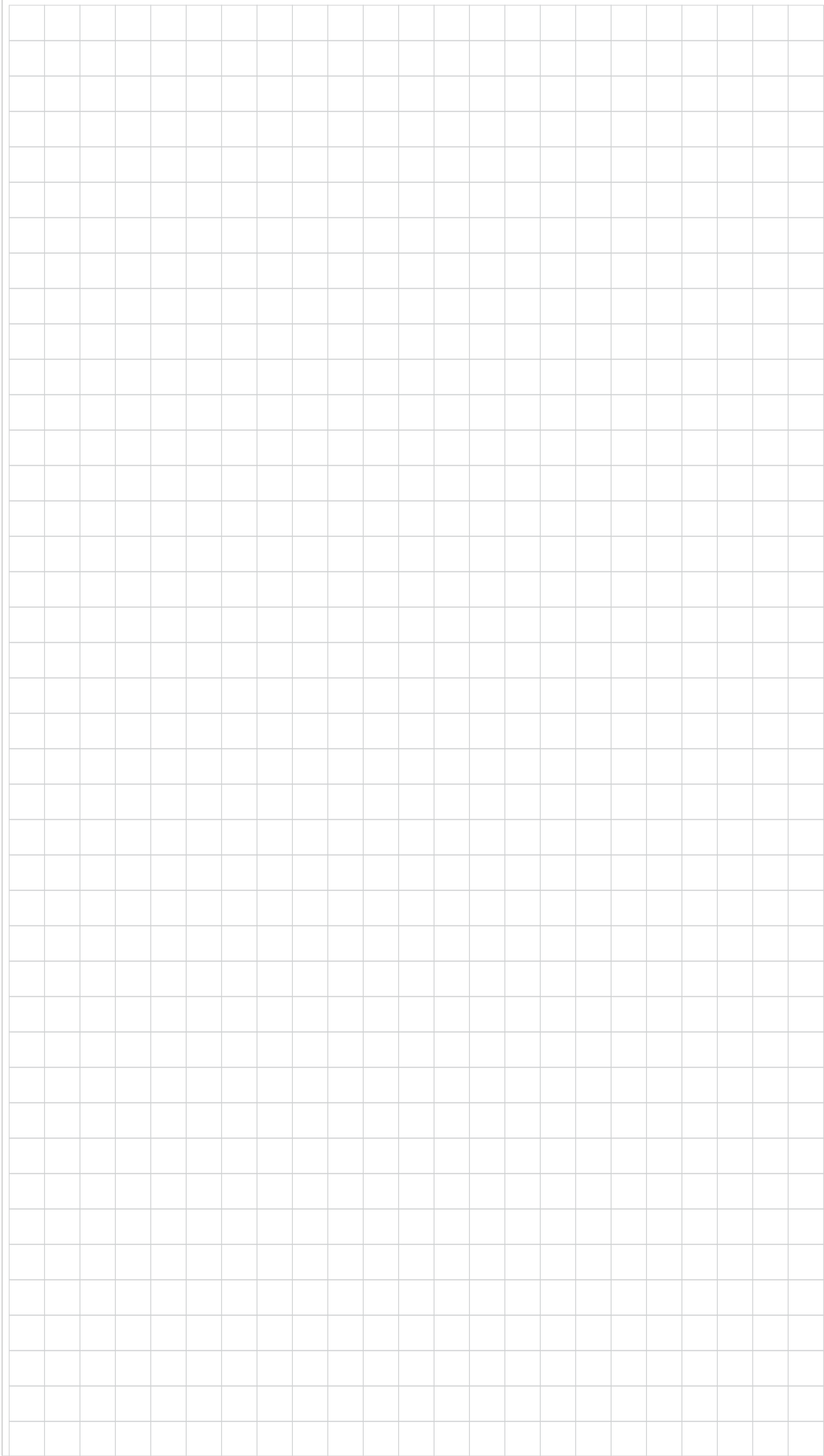
UNLESS OTHERWISE SPECIFIED:	NAME	DATE
DIMENSIONS ARE IN INCHES	DRAWN	
TOLERANCES: Diameter ± .06	CHECKED	
ANGULAR: ± 1°	ENG APPR.	
TWO PLACE DECIMAL ±.06	MFG APPR.	
THREE PLACE DECIMAL ±.005	Q.A.	
INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:	
MATERIAL		
FINISH		
DO NOT SCALE DRAWING		

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NEXT ASSY

USED ON

APPLICATION



**North Dakota State College of Science**

TITLE:

DATE

NAME

DRAWN

CHECKED

ENG APPR.

MFG APPR.

Q.A.

COMMENTS:

UNLESS OTHERWISE SPECIFIED:  
DIMENSIONS ARE IN INCHES  
TOLERANCES:  
Diameter  $\pm .06$   
ANGULAR:  $\pm 1^\circ$   
TWO PLACE DECIMAL  $\pm .06$   
THREE PLACE DECIMAL  $\pm .005$

INTERPRET GEOMETRIC  
TOLERANCING PER:  
MATERIAL

FINISH

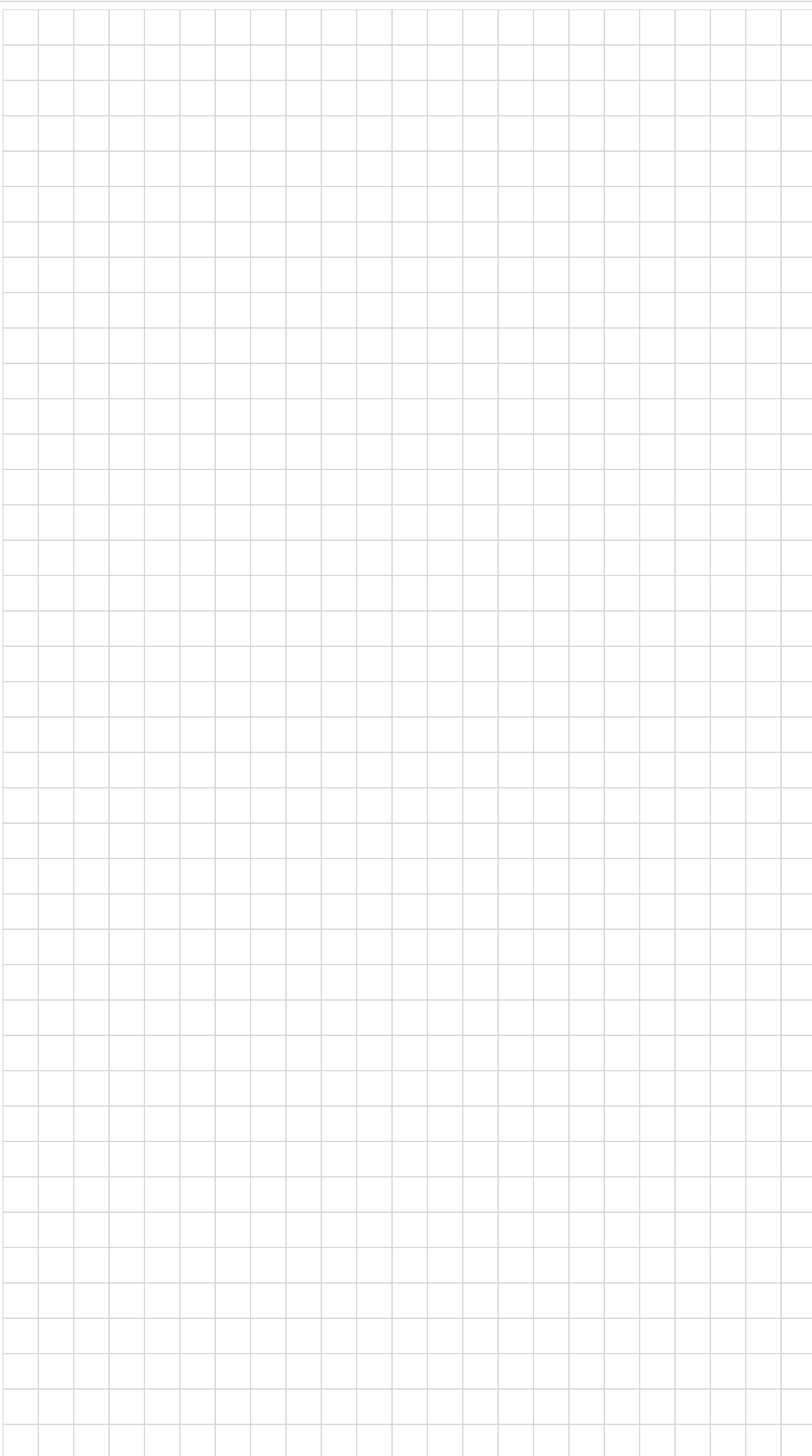
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SIZE DWG. NO. REV

**A**

SCALE: 1:1 WEIGHT: SHEET 1 OF 1



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		<p><b>SIZE</b></p> <p><b>A</b></p>	<p><b>DWG. NO.</b></p> <p>REV</p>
<p><b>UNLESS OTHERWISE SPECIFIED:</b></p> <p>DIMENSIONS ARE IN INCHES</p> <p>TOLERANCES:</p> <p>Diameter <math>\pm .06</math></p> <p>ANGULAR: <math>\pm 1^\circ</math></p> <p>TWO PLACE DECIMAL <math>\pm .06</math></p> <p>THREE PLACE DECIMAL <math>\pm .005</math></p>		<p><b>NAME</b></p>	<p><b>DATE</b></p>
<p>DRAWN</p>	<p>CHECKED</p>	<p>ENG APPR.</p>	<p>MFG APPR.</p>
<p>INTERPRET GEOMETRIC TOLERANCING PER:</p>		<p>Q.A.</p>	
<p>MATERIAL</p>	<p>COMMENTS:</p>		
<p>FINISH</p>	<p>DO NOT SCALE DRAWING</p>		
<p>NEXT ASSY</p>	<p>USED ON</p>	<p>APPLICATION</p>	
<p>SCALE: 1:1</p>		<p>WEIGHT:</p>	<p>SHEET 1 OF 1</p>