

ROSCOMMON EQUIPMENT CENTER

Project Number 57

Collapsible Fire Rake



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Northeast Forest Fire Supervisors

In Cooperation with

Michigan's Forest Fire Experiment Station

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Acknowledgments

This project's conclusion resulted from the cooperation and coordination of agencies from eight different states plus the federal government. We would like to thank all those who tested prototypes and took the effort to contribute their comments. Several people deserve special mention: Steve Creech, Fire Supervisor of Indiana, co-authored the project proposal and provided initial ideas and history. Steve Maurer of New Jersey, the proposal's other co-author, provided the tenacity to make sure someone took on this project. Larry Camp of GSA, Fort Worth, recognized the product's potential and made the effort to get it produced and stocked for wildfire use.

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Disclaimer

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The use of trade, firm or corporation names is for the information and convenience of the user. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement or approval of any product or service to the exclusion of others which may be suitable.

Note: The product design depicted in this report will be available through GSA in or early 1998. Order as national stock number (NSN) 4210-01-387-1392.

Background

In January 1995, Northeast Forest Fire Supervisors' (NFFS) Equipment Development & Testing Committee decided to have the Roscommon Equipment Center program design a collapsible fire rake. Collapsible, for this report, means that the rake tines are retractable reducing the length and width for storage. The State fire organizations of Indiana and New Jersey proposed the project. They originally proposed the project to the USDA Forest Service Technology & Development Program but other priorities prevented its' adoption. The proposal's problem statement said that, "eastern states needed a lightweight, compact, yet durable rake to remove hardwood litter during fireline construction. Current commercial rakes as well as GSA stocked models do not meet this objective."

For many years, Indiana used a collapsible rake that met much of its' needs. This rake was made in Kentucky and thought to be called the Wenzel. It was a heavy duty rake with a round handle, but it had some problems. The locking mechanism rotated on the handle, flattening out the tines. By the late 1970's, the company was no longer in operation.

Later a company called Abraham Enterprises in Butte des Morts, Wisconsin, made a rake similar to the Wenzel. The Abraham rake utilized square aluminum tubing for the handle. The squared handle and bracket

solved the problem of tine rotation but the sharp edges of the handle produced blisters on the hands of the user. Wearing gloves, wrapping the handle with tape or installing foam grips, helped but did not provide a total solution for user comfort. Additionally the locking mechanism, consisting of a bracket held by a bolt and wing nut, was barely adequate.

There are inexpensive collapsible leaf rakes sold commonly in discount stores. Some agencies have used these and found them too fragile and unacceptable.

REC began the project by seeking information from those who had experience with these previous rake designs. From this, REC built a single prototype rake that it brought to the NFFS annual meeting in June of 1995. The design had general acceptance from the interested agencies. The rake featured a handle made from 1-inch OD round aluminum tubing and a cam-type closure for adjusting the position of the tines. This report will describe additional features of this design. The appendix shows detail drawings.

For the spring 1996 fire season, REC made and distributed an additional 15 prototype rakes to eight states (CT, IN, MD, ME, MO, NJ, PA, WV). Evaluations were filled out by 26 users. Our conclusions are based on the prototype use.

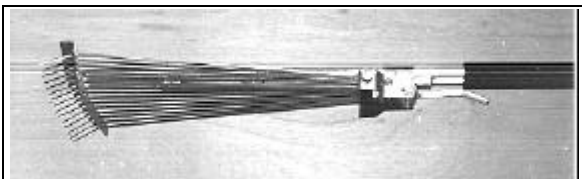
Fire Rake Design Evaluation

There are many possible ways to design and manufacture a rake for wildfire suppression use. REC developed the prototype rake design, in part, to help determine the important features required by the user. The future design may need modification to reduce the cost of manufacture or to better suit the manufacturing abilities of the producer. The following features, however, should not be overlooked.

1. Having a round handle is imperative. The square handle design of a previously made rake was uncomfortable to users. Working with the State of Indiana, REC tried using Eezer® brand foam grips to reduce the effect of the square handle. Users were still unhappy with the feel. Users liked the 1-inch OD round tubing used in the REC rake design. While square tubing simplified the design when

trying to prevent tine rotation, it is not acceptable in the user's grip area.

2. The cam lock feature for quickly adjusting the position of the tines is highly desired. Depending on the situation, users may have the tines fully extended, totally collapsed, or any position in between. The ability to quickly change the position is highly desirable. The lock mechanism must adequately secure the tine position. The lock should either be designed to compensate for future wear or be easy and inexpensive to replace after a reasonable amount of use.



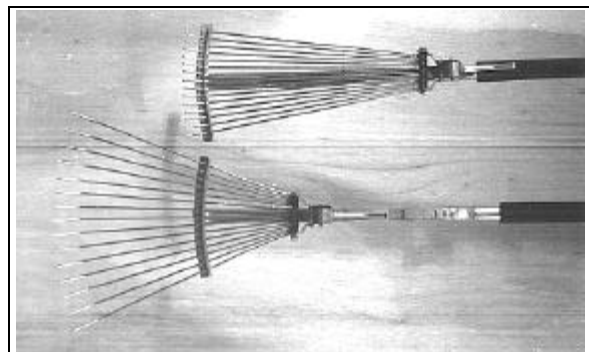
A cam and lever secure the desired tine position in the REC design. Release and adjustment are quick.

1. Most evaluators thought highly of the Eezer® foam grips. Two thought them too soft. One wished to use the handle end to turn over burned and possibly hot logs. The Eezer® grips will not withstand the heat in that situation. These comments aside, a solid majority preferred having comfort grips such as those made by Eezer® used on the prototypes.
2. Evaluators strongly concurred that the overall weight of the rake was reasonable. The users want durability and understand that reducing weight will compromise ruggedness. However, from comments, we surmised that adding more weight would make a rake unacceptable. We believe the 3 pound prototype rake is near the maximum acceptable weight.

3. The tine stiffness and material were appropriate. Prototype tines were made of stainless steel wire (0.148-inch diameter). This makes them durable and stiff for work around rock. The stiffness compares closely to the Wenzel and Abraham rakes of the past. One tester preferred a more flexible tine. Further compromise might be made between durability and flexibility. We concluded that tines stiffer than those of the prototype are unnecessary. Slightly lighter tines might be considered, but should be field tested. The 0.148-inch stainless tines do the job and withstand weathering.

4. The tines should slide easily when collapsing or extending the rake. On some prototypes, the user could pull the bend in the tines through the guide hole when collapsing the rake. It was then difficult to reopen the rake. Since the field prototype testing, REC made slight changes in the tine bend and the hole size in the tine guide to reduce this occurrence.

5. The length, both collapsed and extended, were appropriate. Storage behind seats of pickup trucks or in engine storage compartment was important. The opened length provided reasonable comfort for most sizes of people.



Comparitive view of rake in fully collapsed (top) and extended (bottom) positions.

¹* Eezer is a registered trademark of Eezer Products, Inc., Fresno, California.

Market Potential

REC queried agencies to determine rake purchase demand. We could not reach an adequate conclusion. Eight state agencies in the northeast have a need for such a product. Several of these states would purchase a hundred or more now if they were available. The number purchased would depend on several factors; the product cost, budget available and product performance versus competitive products. We feel that northeast state agencies would buy about 1000 initially if these factors were

favorable. We expect some interest from southeastern states and eastern federal agencies. Our guess is about 500-1000 rakes from those sources. Fire department demand is always tough to determine, but should be high enough to add another 1000 rakes. Hence, we estimate initial demand to be from 1500 to 3000 rakes. This estimate is an educated guess. A potential manufacturer would want to do additional market survey work.

Manufacturing Options

REC surveyed the interested northeast agencies to determine their preferences for obtaining collapsible rakes in the future. There were three alternatives to consider.

Alternative 1. Each agency could use the REC plans to either make their own rakes or bid for local construction.

Alternative 2. The REC plans could be used as a specification for a large multi-agency contract. In this case, each interested agency would determine their needs on a periodic basis. The agency orders would be consolidated and a contract would be awarded for the total order.

Alternative 3. A manufacturer might be found that would produce and sell the rake to both agencies and other potential users. Presumably agencies and others could order directly from the manufacturer or its' distributors on an as needed basis. Replacement parts would be available from the manufacturer. It is likely that the manufacturer would adjust the design based on manufacturing methods, cost and future user input.

REC surveyed interested northeast agencies. **Alternative 3, finding a manufacturer that would produce the REC rake or a rake with similar performance characteristics, was the preferred alternative.** This method would

make the rakes readily available to other users such as local fire departments or contractors. The *potential* sales market to local fire departments far exceeds that of state or federal wildfire agencies. If the rake is handed over to a manufacturer, agencies and other users would have the flexibility, presumably, to buy rakes in varying quantities on an as needed basis. Potentially an agency could seek large quantity pricing when purchasing in volume or buy in small quantities. Besides producing and distributing the product, the manufacturer likely would improve the rake based on future customer input, and develop repair parts distribution. We were not sure what the prospects are for securing such an arrangement, but felt it was reasonably good.

REC found minimal enthusiasm for either Alternative 1 or 2. Some agencies are better equipped than others to do small manufacturing "in house." The rake design is reasonably simple, but for practical purposes it would require a die to form the sheet metal tine bracket, some basic machining to produce the cam and the ability to TIG weld. The types of materials used in the prototype are relatively expensive when purchased in small quantities. Hence small quantity "in house" production would cost \$25-\$30 per rake for materials only.

If Alternative 3 could not be fulfilled, Alternative 2, a multi-agency bid for a determined quantity of rakes built to REC drawing specification was the next preference. This alternative presents two potential problems. Differing fiscal years and procurement policies would make fulfilling a single multi-agency bid difficult. Secondly, with the potential of the REC program ending in a couple years, REC may not be available to keep and update the specification in the future.

The interested northeast agencies overwhelmingly preferred Alternative 3, turning the rake over to a manufacturer for them to produce and market. Further, Alternative 1 and 2 presented difficulties that would be undesirable. *Energies needed to be focused on finding a manufacturer.*

In the fall of 1996, REC approached the General Services Administration (GSA) of the U.S. Government for advise on

manufacturing options. GSA indicated a possible interest. In January, 1997, REC met with GSA to discuss the proposal in detail. By late spring, GSA had decided to seek a contractor to build 3,000 rakes. The state agencies that REC worked with were enthusiastic about the prospects of the rake being available through the GSA Fire Catalog. GSA contracting and stocking would be a blend of Alternatives 2 and 3. Most importantly the agencies could buy the amount of product they need when they need it.

In November of 1997, a contract was awarded to Mercedes Textiles for initial production. The rake will be available as NSN 4210-01-387-1392 with expected delivery in late winter of 1998. The cost of the rake during the first contract will be \$38.26, delivered. This endeavor marks the first time REC produced a specification for a GSA Fire Catalog product.

Summary

- Several state wildfire agencies desired a collapsible, durable and lightweight fire rake similar to but with some improvements to a product formerly available.
- REC developed a prototype rake that the interested wildfire agencies felt performed as desired. Some modifications were made to the field tested version to resolve problems with the prototypes. The design is attached in the appendix.
- The report lists the characteristics that are required for a satisfactory collapsing wildfire rake.
- Those interested would prefer commercial production of the rake. REC also feels this would be the best situation. Turning over the design to a manufacturer would provide "as needed" purchasing, a parts source, a purchase source for fire departments and cooperators, and a company that could focus on future improvements and needs.
- REC had difficulty assessing the market for the rake. We estimate initial demand of 1500-3000 from state, federal and local fire agencies.
- REC explored with GSA the possible inclusion of the rake into the GSA Wildfire Supply Catalog. The project stage closed when GSA issued a contract for 3,000 rakes for spring, 1998. The order number is NSN 4210-01-387-1392.

Appendix Collapsible Fire Rake Data Chart

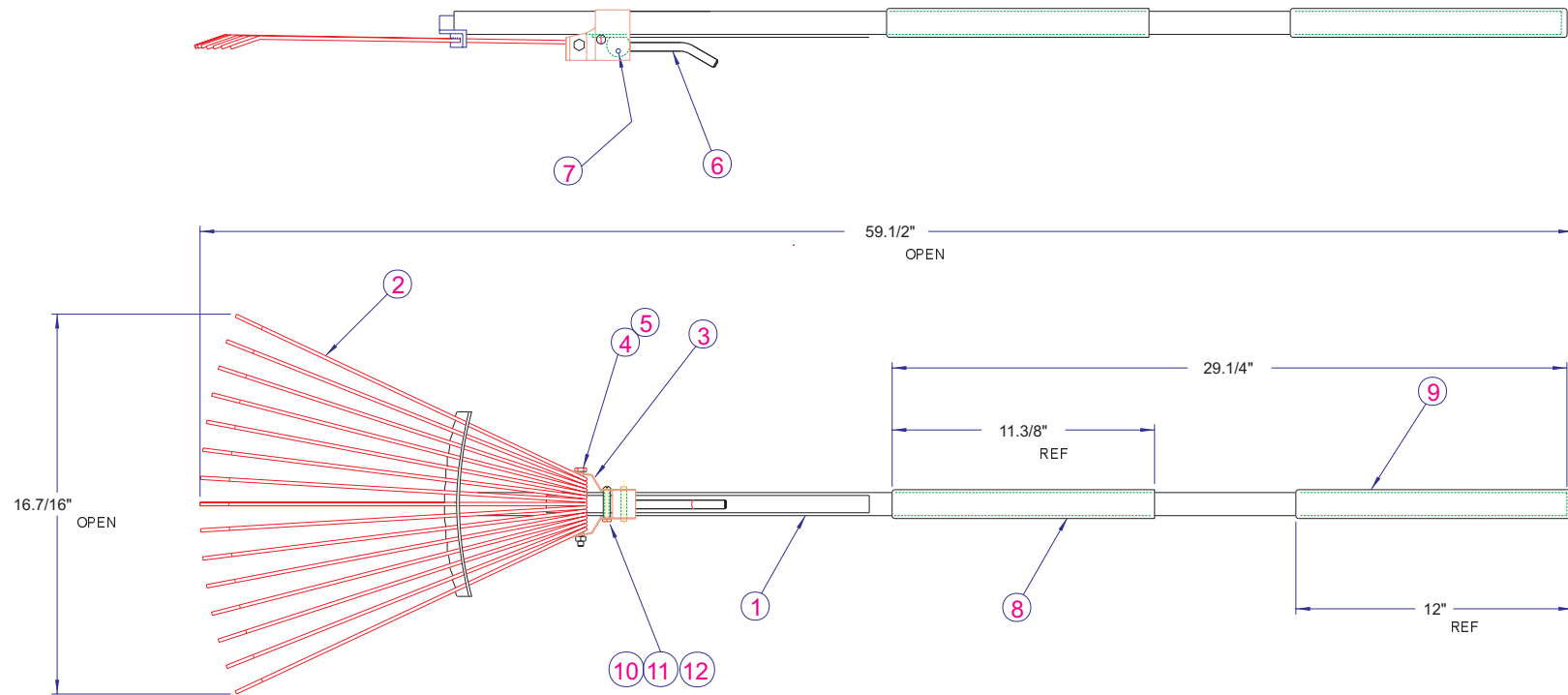
Number of Tines	15
Tine Spacing at Spreader Bar	0.5"
Finished Tine Length	15.5"
Tine Material	0.148" Dia. Stainless Steel Wire
Handle Material	6061-T6 Aluminum Tube 1" OD x 0.065 Wall
Tine Spreader Bar Material	6061-T6 Aluminum Angle 3/4" x 3/4" x 1/8"
Bracket Material	316 Stainless Steel - 20 Ga. Sheet
Length - Extended	59.5"
Tine Spread - Extended	16.4"
Length - Collapsed	49.4"
Tine Spread - Collapsed	7.7"
Weight	3.3 Lbs. w/Grips
Handle Tube Length	48"
Position Clamp Type	Aluminum Cam Latch
Storage Dimensions	49.9" x 8.4" x 2.4"

Collapsible Fire Rake Drawing Order

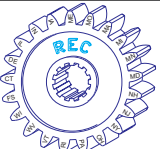
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90-5700C	Collapsible Leaf Rake A/C
90-5701C	Angle, Tine Guide
90-5702B	End Plug, Handle
90-5704A	Bar, Guide
90-5705A	Handle
90-5707C	Handle W/C
90-5708B	Tine
90-5709B	Cam
90-5710B	Latch Arm
90-5711B	Latch W/C
90-5712B	Foam Grip (Modified)
90-5713C	Bracket
90-5714A	Sleeve
33-0059B	Foam Grip

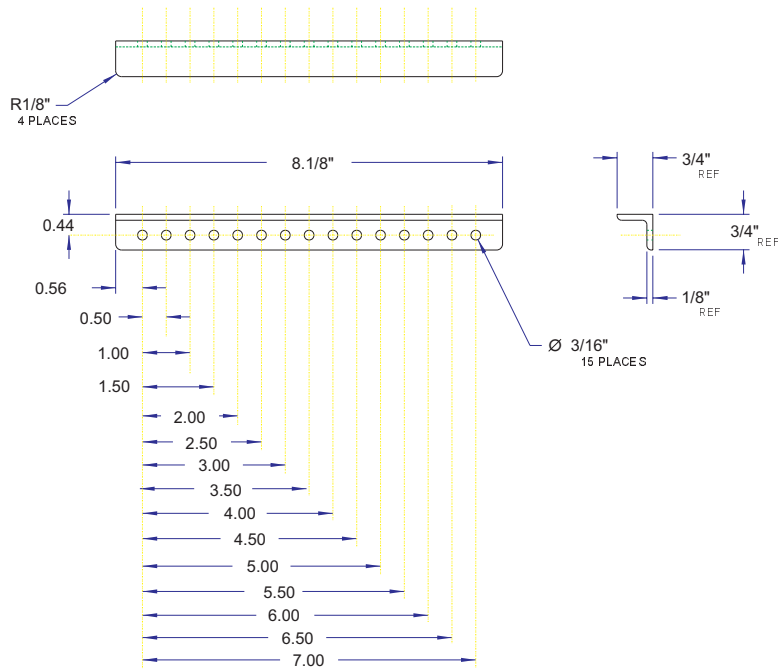
The following drawings show the rake as specified for the 1997 GSA contract. As with any product, changes are expected in the future for improvements or easier manufacturing. Using these plans will make a suitable tool, but these drawings may not be the most current design.

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1	90-5707	C	HANDLE W/C	1	1.30
2	90-5708	B	TINE	15	0.09
3	90-5713	C	BRACKET	1	0.12
4	TS-04GG26		SCREW, CAP HEX HEAD	1	0.06
5	TS-04GP		NUT, HEX	1	0.01
6	90-5711	B	LATCH W/C	1	0.11
7	R12-A96AC		ROLL PIN	1	0.01
8	90-5712	B	FOAM GRIP (MODIFIED)	1	0.19
9	33-0059	B	FOAM GRIP	1	0.22
10	90-5714	A	SLEEVE	1	0.02
11	TS-02CA12		SCREW, MACH. RD. HEAD	1	
12	TS-02CPL		NUT, HEX LOCK	1	

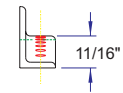
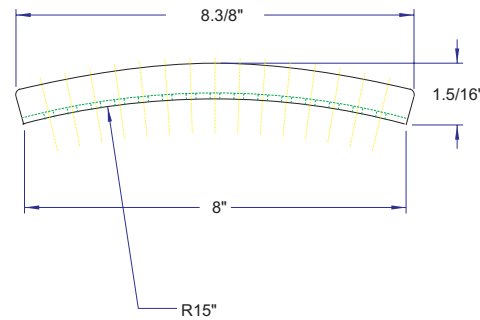


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EST WT: 3.40 LBS

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NO. BY DATE REVISION			
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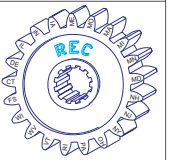


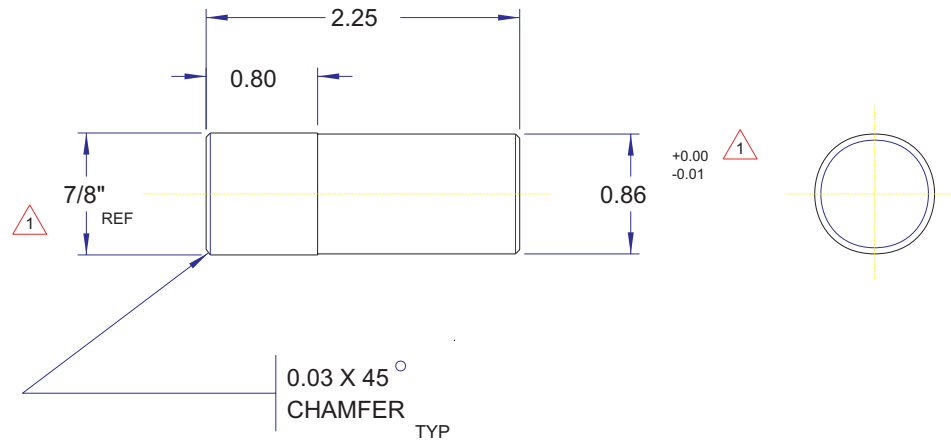
FLAT LAYOUT



PART NUMBER: 90-5701
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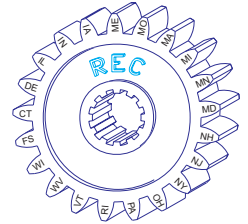
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NO.	BY	DATE	REVISION		
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P.O. BOX 68 ROSCOMMON, MICHIGAN 48653					
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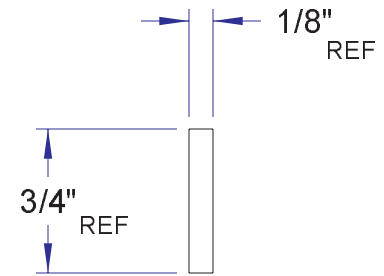
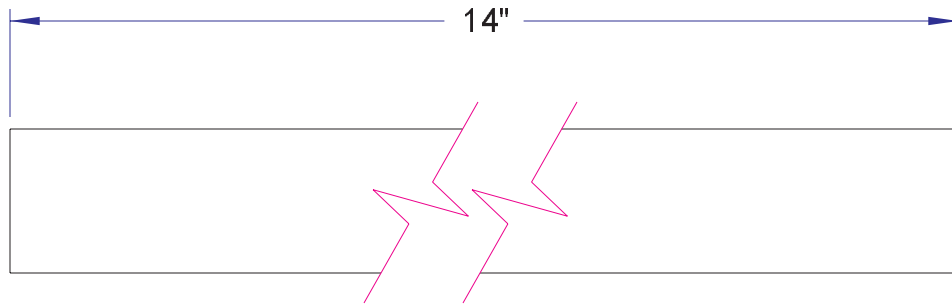


PART NUMBER: 90-5702
 MAT'L: BAR, ROUND 7/8" DIA ALUMINUM
 UNS A96061
 FFES SPEC NO: AC-00088BP
 EST WT: 0.13 LBS

STD. TOLERANCES								DRAWN: L.PARRIS	
FRACTIONAL: 0 TO 6 IN +- 1/32 6 IN AND UP +- 1/16								CHECKED: BAH	
DECIMAL: 1 PLACE +- 0.1 2 PLACE +- 0.01 3 PLACE +- 0.005		ANGULAR: +- 1 DEG		1	BH	9/96	WAS 0.862	APPROVED:	
				NO.	BY	DATE	REVISION		
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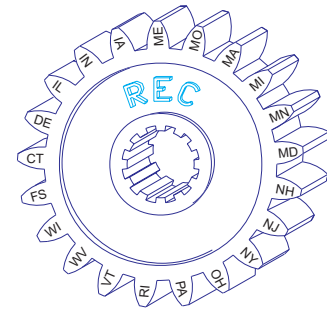


PROJECT NO.: REC 57



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 UNS A96061
 FFES SPEC NO: AB-00203BP
 EST WT: 0.13 LBS

STD. TOLERANCES										DRAWN: R.GREENLAW
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DECIMAL: 1 PLACE +/- 0.1 2 PLACE +/- 0.01 3 PLACE +/- 0.005		ANGULAR: +/- 1 DEG								APPROVED: BAH
			NO.	BY	DATE	REVISION				



FOREST FIRE EXPERIMENT STATION

P.O. BOX 68 ROSCOMMON, MICHIGAN 48653

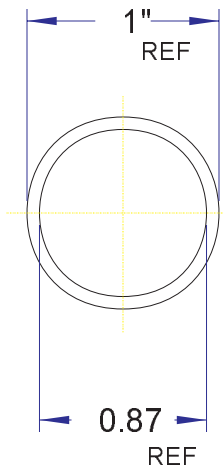
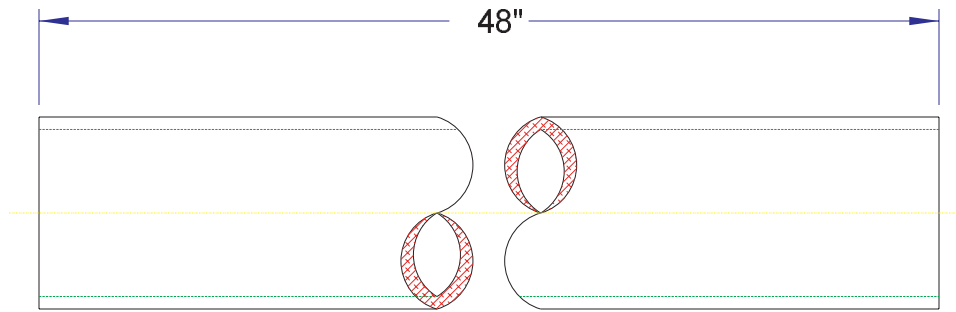
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SCALE:
FULL

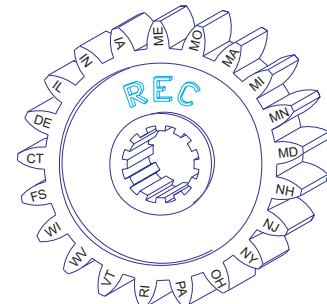
DATE:
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DWG. NO. **90-5704A**



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 UNS A96061
 FFES SPEC NO: AD-10016BP
 EST WT: 0.90 LBS

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		NO.	BY	DATE	REVISION					



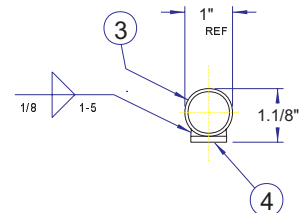
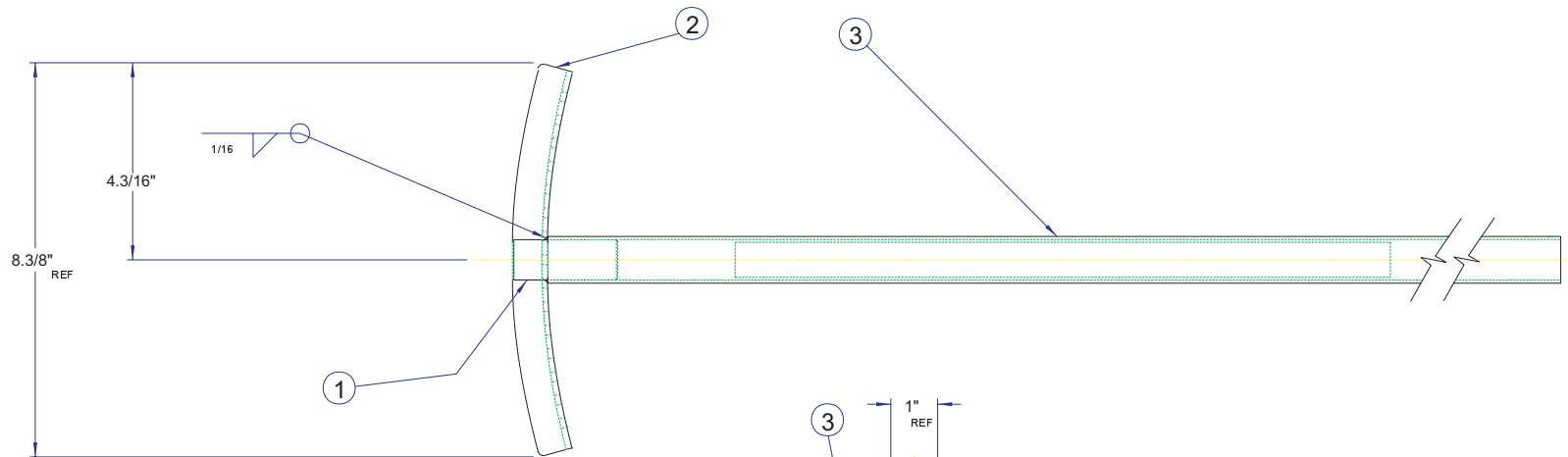
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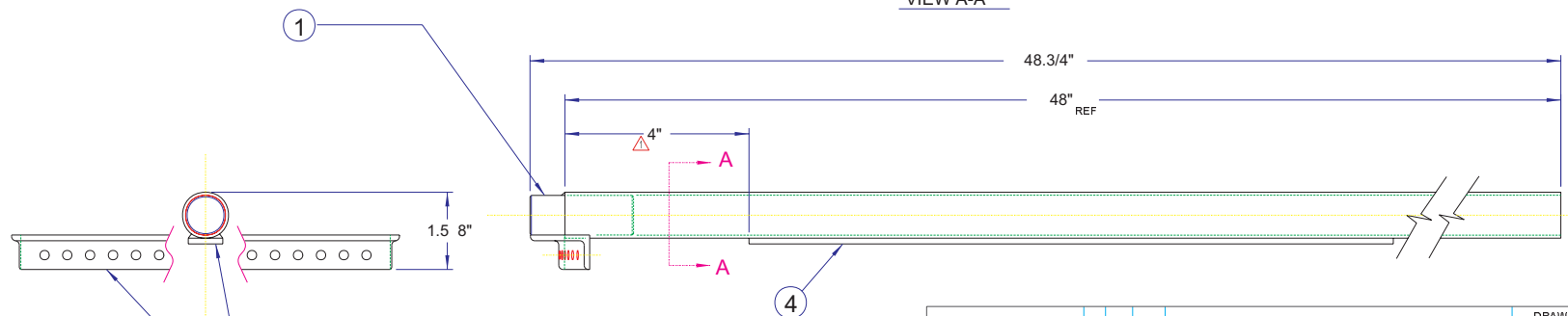
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3	90-5705	A	HANDLE	1	0.90
4	90-5704	A	BAR, GUIDE	1	0.13



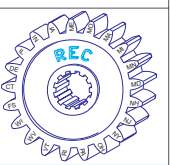
VIEW A-A

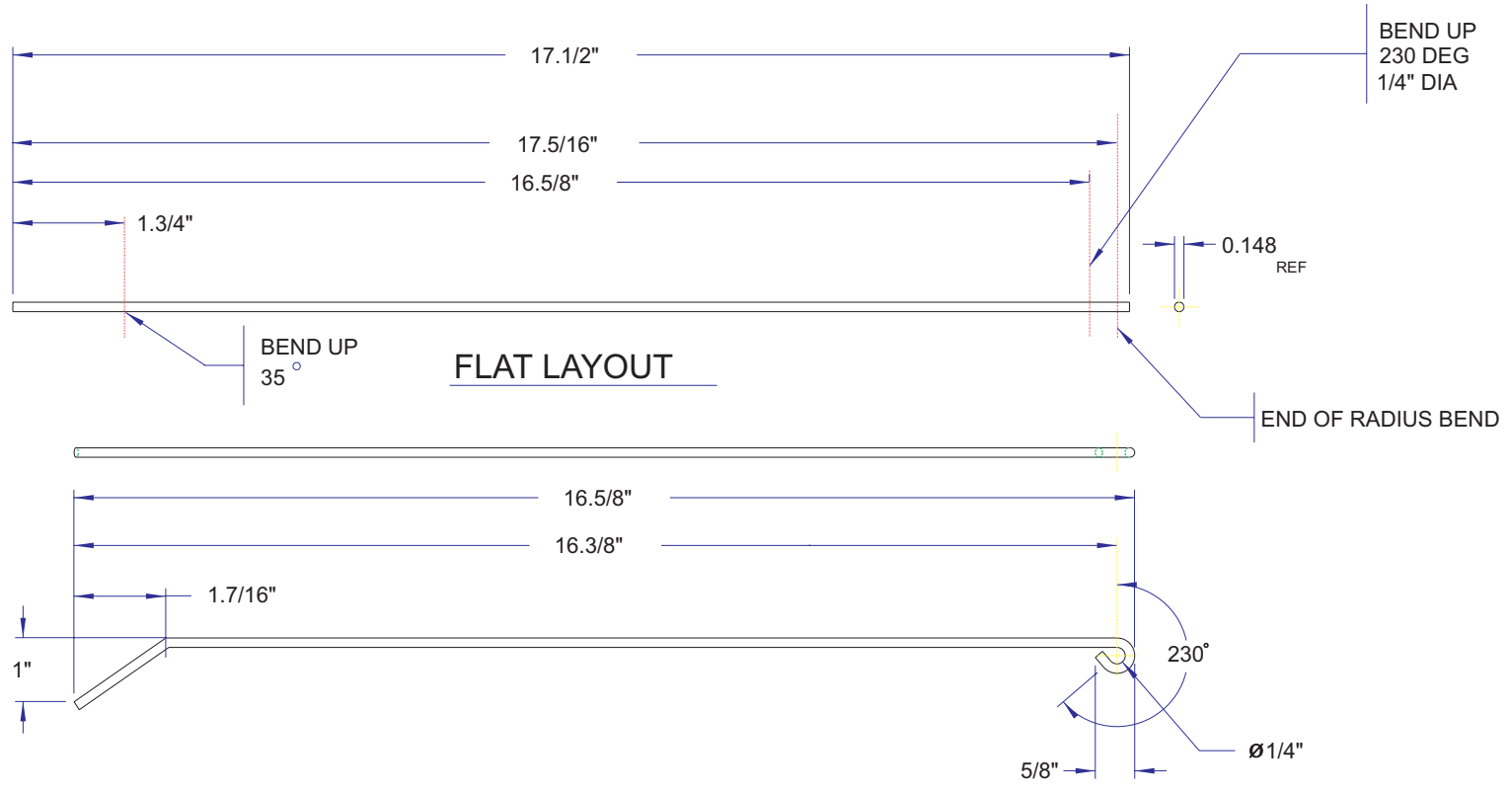


WELD ITEM #1
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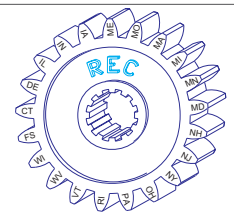
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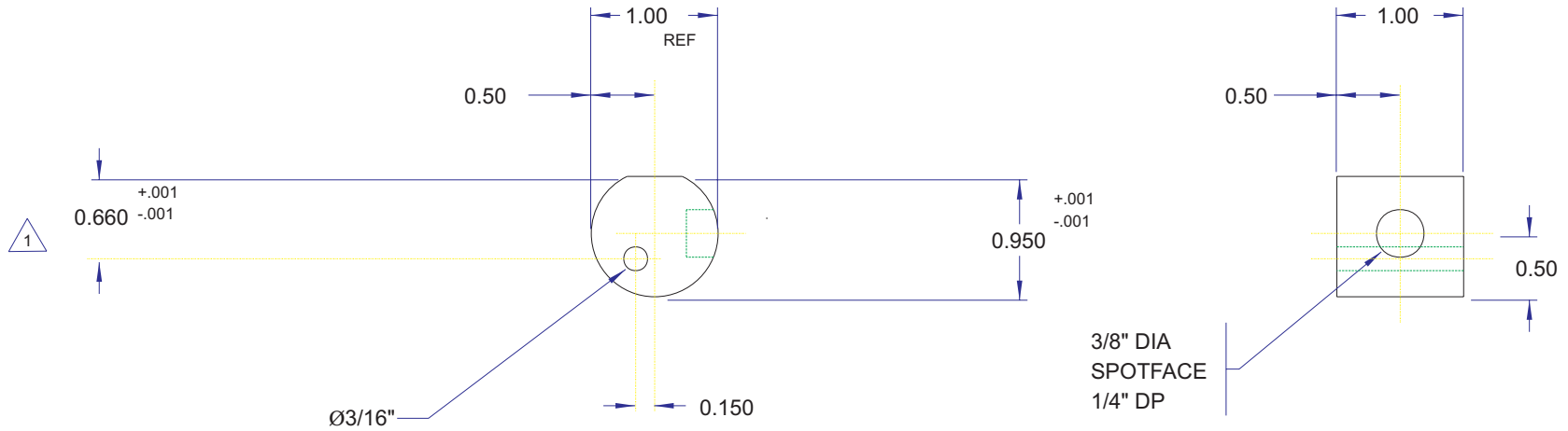
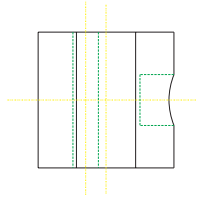
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FOREST FIRE EXPERIMENT STATION
 P.O. BOX 68 ROSCOMMON, MICHIGAN 48653

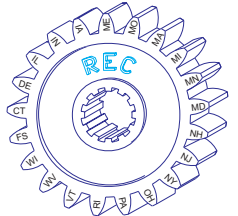
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TITLE: TINE	SCALE: 1/2	DATE: 9/6/96	DWG. NO.: 90-5708B
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PART NUMBER: 90-5709
 MAT'L: BAR, ROUND 1" DIA ALUMINUM
 UNS A96061
 FFES SPEC NO: AC-01000BP
 EST WT: 0.07 LBS

STD. TOLERANCES										DRAWN: L. PARRIS
FRACTIONAL: 0 TO 6 IN +- 1/32 6 IN AND UP +- 1/16										CHECKED: BAH
DECIMAL: 1 PLACE +- 0.1 2 PLACE +- 0.01 3 PLACE +- 0.005	ANGULAR: +- 1 DEG	1	BH	9/96	WAS 0.650 + .001					APPROVED:
		NO.	BY	DATE						



FOREST FIRE EXPERIMENT STATION

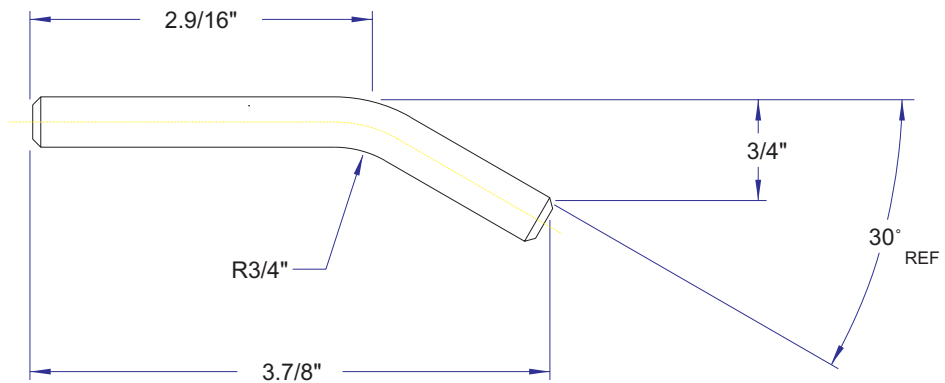
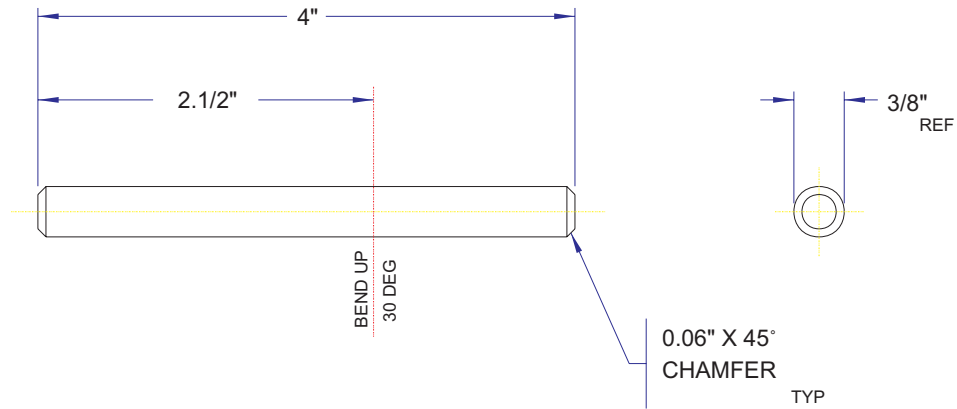
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PROJECT NO.: REC 57

TITLE: CAM	SCALE: FULL	DATE: 19 SEPT 96	DWG NO. 90-5709B
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FLAT LAYOUT

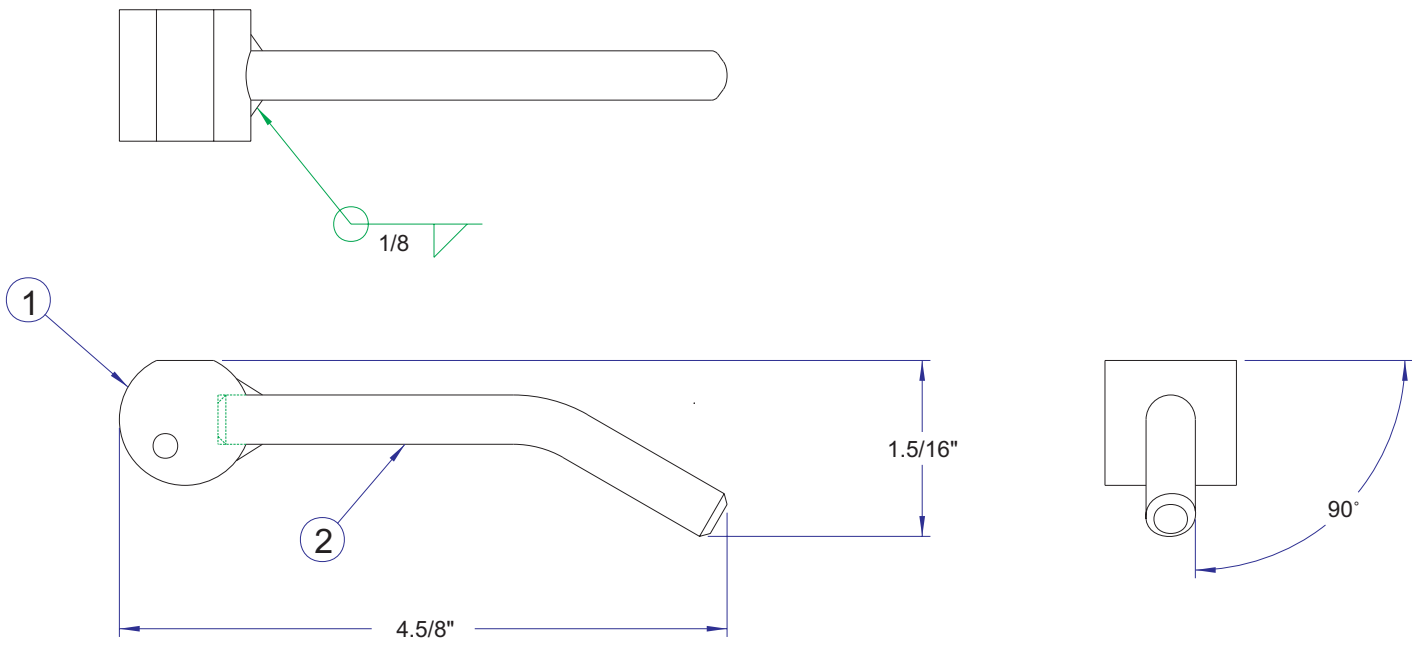
NOTE
BREAK ALL SHARP EDGES



PART NUMBER: 90-5710
 MAT'L: BAR, ROUND 3/8" DIA ALUMINUM
 UNS A96061
 FFES SPEC NO: AC-03750BP
 EST WT: 0.04 LBS

STD. TOLERANCES FRACTIONAL: 0 TO 6 IN +- 1/32 6 IN AND UP +- 1/16 DECIMAL: 1 PLACE +- 0.1 2 PLACE +- 0.01 3 PLACE +- 0.005 ANGULAR: +- 1 DEG		DRAWN: R.GREENLAW CHECKED: BAH APPROVED:		
NO.	BY	DATE		REVISION
FOREST FIRE EXPERIMENT STATION P.O. BOX 68 ROSCOMMON, MICHIGAN 48653				PROJECT NO.: REC 57
TITLE: LATCH ARM		SCALE: FULL	DATE: 03 JUL 95	DWG. NO.: 90-5710B

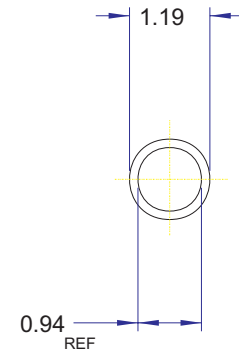
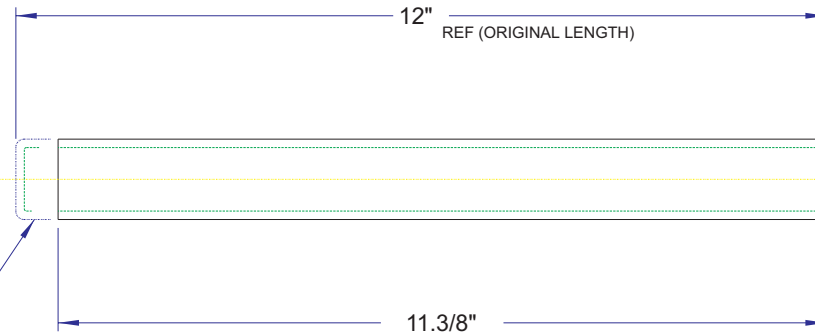
ITEM	PART NO	DWG	DESCRIPTION	QTY	EST WT
1	90-5709	B	CAM	1	0.07
2	90-5710	B	LATCH ARM	1	0.04



PART NUMBER: 90-5711
EST WT: 0.11 LBS

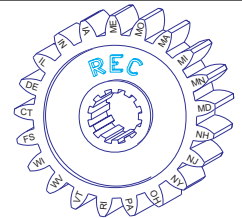
STD. TOLERANCES FRACTIONAL: 0 TO 6 IN + - 1/32 6 IN AND UP + - 1/16 DECIMAL: 1 PLACE + - 0.1 2 PLACE + - 0.01 3 PLACE + - 0.005 ANGULAR: + - 1 DEG		DRAWN: R.GREENLAW CHECKED: APPROVED: BAH	
NO. BY DATE REVISION		PROJECT NO.: REC 57 DWG. NO. 90-5711B	
FOREST FIRE EXPERIMENT STATION P.O. BOX 68 ROSCOMMON, MICHIGAN 48653			SCALE: FULL DATE: 06 JUN 95
TITLE: LATCH W/C			

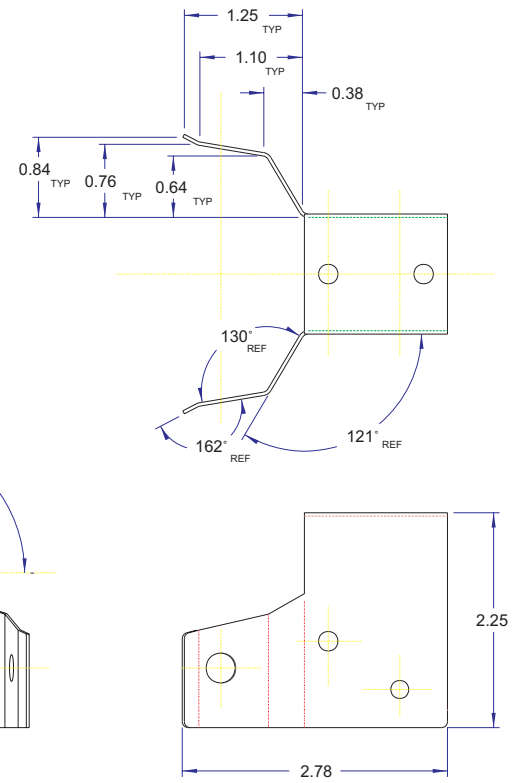
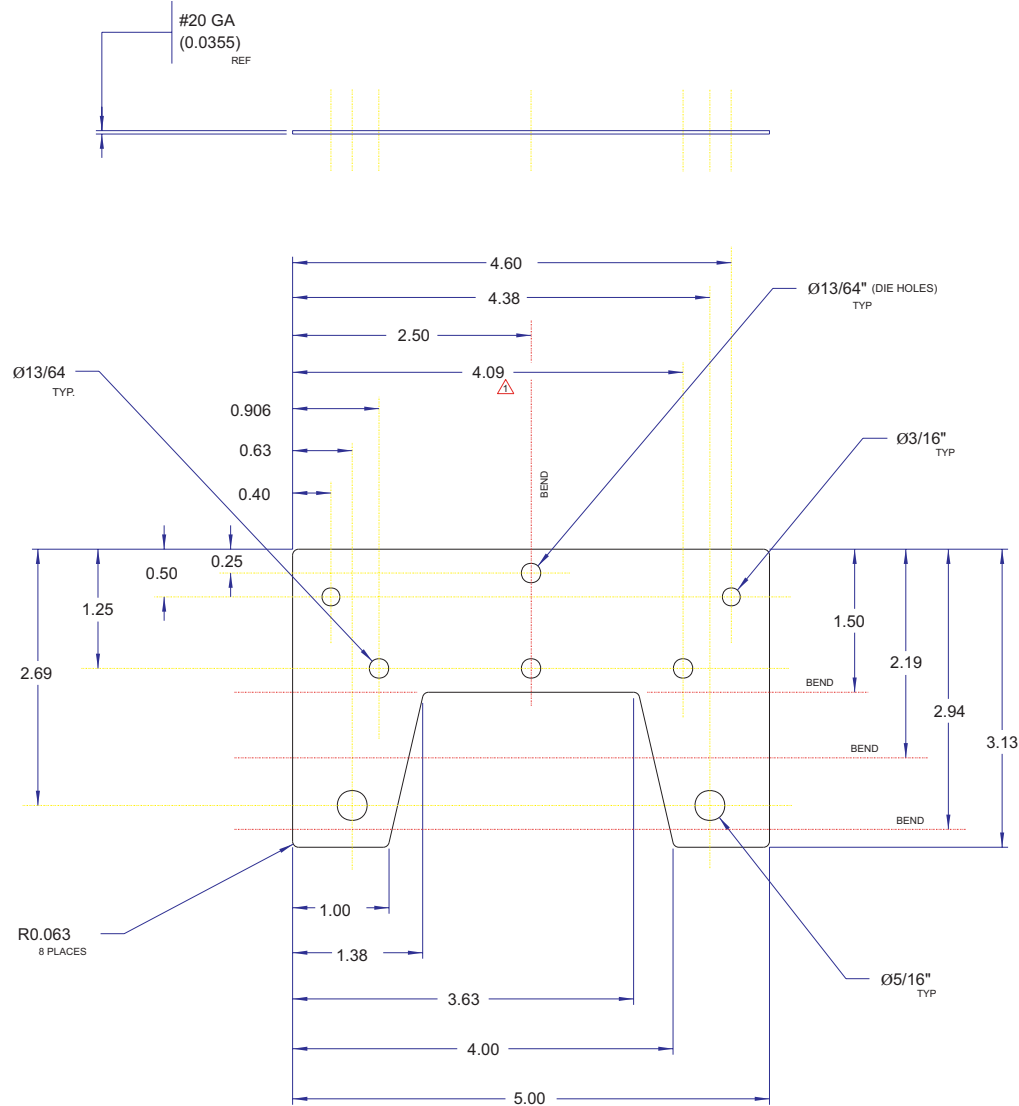
REMOVE LENGTH FROM
CLOSED END



PART NUMBER: 90-5712
MAT'L: MAKE FROM P/N 33-0059
EST WT: 0.19 LBS

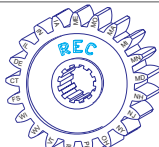
STD. TOLERANCES				DRAWN: R.GREENLAW	
FRACTIONAL: 0 TO 6 IN +- 1/32 6 IN AND UP +- 1/16				CHECKED:	
DECIMAL: 1 PLACE +- 0.1 2 PLACE +- 0.01 3 PLACE +- 0.005		ANGULAR: +- 1 DEG		APPROVED: BAH	
NO.	BY	DATE	REVISION		
<h2>FOREST FIRE EXPERIMENT STATION</h2> <p>P.O. BOX 68 ROSCOMMON, MICHIGAN 48653</p>					
TITLE: FOAM GRIP (MODIFIED)				SCALE: 1 = 2	DATE: 07 JUN 95
				PROJECT NO.: REC 57	
				DWG NO. 90-5712B	

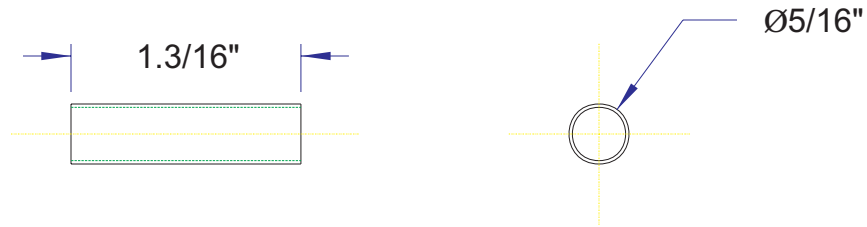




FLAT LAYOUT

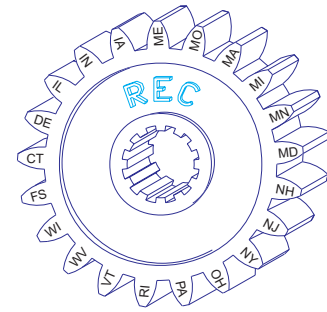
PART NUMBER: 90-5713
 MATL: SHEET, #20 GA (0.0355) STAINLESS STEEL
 UNS S31600
 FFES SPEC NO: AA-02048BR
 EST WT: 0.12 LBS

STD. TOLERANCES FRACTIONAL: 0 TO 6/32 ± .002 6 IN AND UP ± .015 DECIMAL: 1 PLACE ± .01 2 PLACE ± .001 3 PLACE ± .0005 ANGULAR: ± .1 DEG		DRAWN: R.GREENLAW CHECKED: BAH APPROVED:		
FOREST FIRE EXPERIMENT STATION P.O. BOX 68 ROSCOMMON, MICHIGAN 48653		PROJECT NO.: REC 57		
TITLE: BRACKET		SCALE: FULL	DATE: 10 JUL 95	DWG. NO. 90-5713C



PART NUMBER: 90-5714
 MAT'L: STAINLESS TUBING, 5/16" X .035 WALL
 UNS S30400
 EST. WT. 0.02 LBS.

STD. TOLERANCES						DRAWN: L.PARRIS
FRACTIONAL: 0 TO 6 IN +/- 1/32 6 IN AND UP +/- 1/16						CHECKED: BAH
DECIMAL: 1 PLACE +/- 0.1 2 PLACE +/- 0.01 3 PLACE +/- 0.005	ANGULAR: +/- 1 DEG					APPROVED:
		NO.	BY	DATE	REVISION	

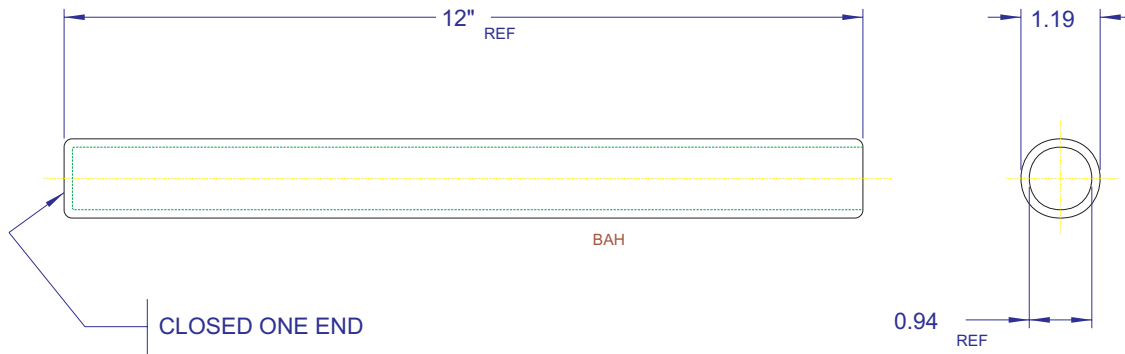


FOREST FIRE EXPERIMENT STATION

P.O. BOX 68 ROSCOMMON, MICHIGAN 48653

PROJECT NO.: **REC 57**

TITLE: SLEEVE	SCALE: FULL	DATE: 9-11-96	DWG. NO.: 90-5714A
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FOAM GRIP

TYPE: PVC VINYL, CLOSED CELL FOAM
 SURFACE: NON-SLIP
 CHARACTERISTICS: NON-ABSORBENT, RESISTS
 OILS, GREASE & DIRT
 INSIDE DIAMETER: 0.940"
 WALL THICKNESS: 0.125" COLOR: BLACK
 EST WT: 0.22 LBS

APPROVED MANUFACTURERS

PART NO

APPROVED MANUFACTURERS

PART NO

EEZER PRODUCTS, INC.
 4734 EAST HOME AVENUE
 FRESNO, CALIFORNIA 93703

100230

STD. TOLERANCES				DRAWN: R.GREENLAW		MICHIGAN DNR FOREST MANAGEMENT DIVISION	
FRACTIONAL: 0 TO 6 IN + - 1/32 6 IN AND UP + - 1/16				CHECKED:			
DECIMAL: 1 PLACE + - 0.1 2 PLACE + - 0.01 3 PLACE + - 0.005	ANGULAR: + - 1 DEG			APPROVED:			
		NO.	BY	DATE	REVISION		
FOREST FIRE EXPERIMENT STATION P.O. BOX 68 ROSCOMMON, MICHIGAN 48653						PROJECT NO.: REC 57	
PART NUMBER: 33-0059		TITLE: FOAM GRIP			SCALE: 1 = 2	DATE: 07 JUN 95	DWG NO. 33-0059B