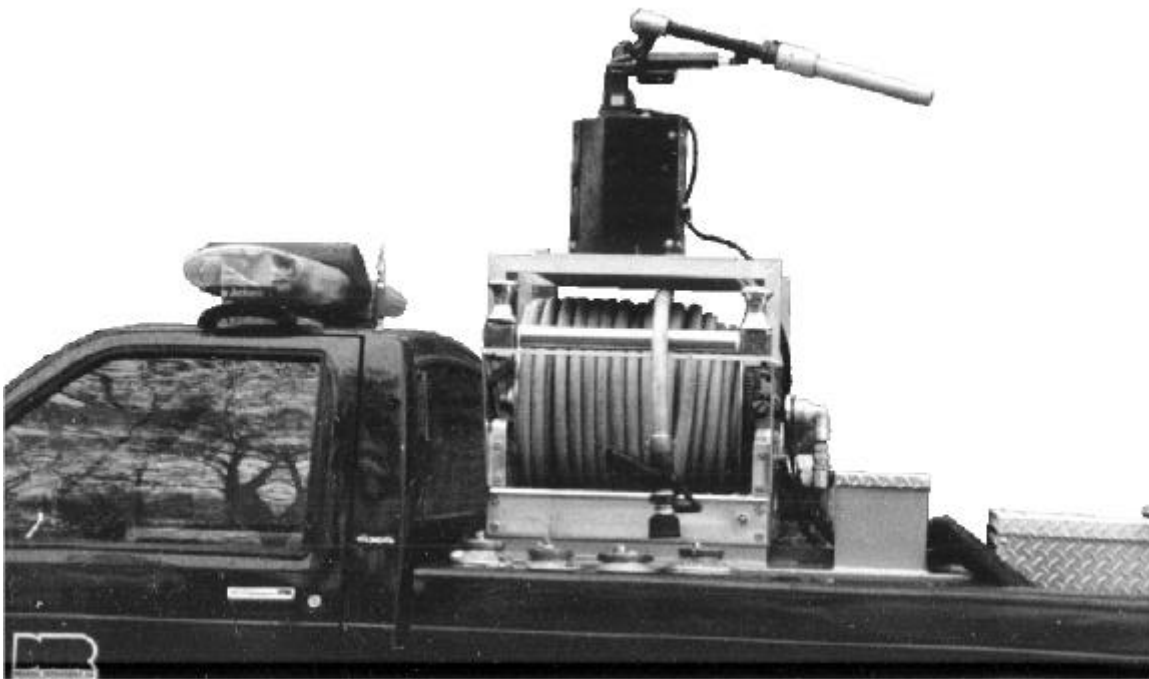


Roscommon Equipment Center Program

Project Number 58

LOW COST REMOTE CONTROLLED WATER TURRET



Published August 1990

Reformatted for Web Page December 1998

Northeast Forest Fire Supervisors

In Cooperation with

Michigan's Forest Fire Experiment Station

ACKNOWLEDGEMENTS

The Roscommon Equipment Center would like to thank the Indiana Department of Natural Resources and the Texas A&M Engineering School for their involvement.

The Indiana Department of Natural Resources initiated the REC project, tested the design, and provided much information.

DISCLAIMER

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Introduction

One frequently used wildland fire suppression tactic is “pump and roll”. During a pump and roll operation, the wildland engine moves slowly along while the crew suppresses the fire. In the past, agency personnel often rode on the engine spraying water (with a hose line) as the operator drove. Firefighter safety concerns have severely reduced this practice. Additionally, smaller budgets have made it more likely that an engine dispatches with a lone operator. These factors have increased the need for water discharge systems controlled from within the cab.

Monitor or turret water discharge devices can provide remote directional control. They are not new, however, most have been developed for high flows well past the needs of wildland fire. These systems have also carried a large price tag. Searching for a less costly solution, the Texas Engineering Extension Service approached Texas A & M's Engineering School in the early 90's, to develop a low cost monitor. The “Aggie Roll ‘N Squirt” was the result.

The Roll ‘N Squirt

The Roll ‘N Squirt was a cab-top mounted design created by a senior mechanical engineering class at Texas A & M. The system consisted of a shaft through the cab roof. On top of the cab, the shaft was connected to a pipe nipple via a pivot pin; one end had a fire nozzle attached, the other end the hose line from the pump. A motorized linear actuator was used to raise and lower the nozzle. Electric controls in the cab operate the linear actuator allowing one to change the angle of elevation. The shaft revolved by means of a handle in the cab. This allowed the operator to manually direct the spray by rotation. The amount of rotation available was restricted to that allowed by the wind up of hose or electric wire. For this reason, the total rotation was substantially less than 360 degrees.

The Roll ‘N Squirt met its’ design criteria. It was relatively inexpensive; about \$675, although it is unclear if this figure takes all the labor into account. It provided directional control of the water discharge from within the cab. It met the general requirements for “pump and roll” at grass fires.

In 1993, the Indiana Division of Forestry purchased from Texas A & M a redesigned version of the Roll ‘N Squirt for trial. This unit utilized an additional motor and electrical control to rotate the turret rather than use the manual method. Also, Indiana preferred not to mount the unit on the cab top, thus requiring a remote rotational control. A quick connect mount was developed by Indiana which allowed the operator to move the system between a “high” mount on top of the hose reel or a “low” mount on the tank. The first position allowed operator greater range and coverage. The second better protected the system in dense cover because of its’ below the cab top location. The cost increased slightly but came in at about \$735. This cost included machining but not assembly labor.

Indiana found that the unit worked well in grass fuels, but that its’ wires, drives, and controls were vulnerable in brush and timber fuels. They submitted a proposal to REC for solutions.

The REC Project



In 1994 the project proposal was approved and REC began a redesign. The criteria included:

- Protect vulnerable parts from brush.
- Provide for flexible mounting points, like the Indiana quick mount.
- Keep the cost low; target less than \$1000.
- Enhance features within cost parameter; continuous rotation, swivel joint hose connection and remote spray pattern control were considered.

In 1995, REC delivered a test unit to Indiana where it was field tested through 1996. The final product cost, including all labor, was just under \$1000 and features 360 degree noncontinuous rotation, significant improvement in electrical and drive components protection and wiring design. Additionally a swivel water connection eliminated the rotation of the water supply hose with the turret.

Simple, In Cab Water System Controls

The remote control nozzle system described in this report, provides an alternative to past pump and roll techniques where firemen rode with a nozzle on the truck outside of the operator's compartment. It is by no means the only method nor the least expensive. Several other concepts have been used in the past.

- Pulling the booster line into the cab. You cannot get simpler than this! We have not seen this method documented in print, but know that many engine crews have pulled line off the reel and into the cab with them so they can deliver water as they drive. A few have found that a sliding rear cab window makes it easier to get the hose in the cab.
- High pressure spray gun. Industrial and agricultural trigger-type spray guns work great from inside the cab. They are low volume, easy to control, and turn on or off with one hand. The Michigan Department of Natural Resources (MDNR) has used these successfully for 20 years. They can be plumbed directly into the cab with a short 1/2 inch ID hose and a swivel connection. Flows are about 10 gpm, depending on the size of the orifice disk. The pattern changes from mist to straight stream controlled by the trigger squeeze. Spraying Systems Company, North Avenue & Schmale Road, Wheaton, IL 60188, Model 43HA-AL-12 with 11990-19 swivel fitting is a good example. It is rated at 800 psi and costs about \$75.00.
- Fender nozzle system. Low flow "V" jet-type nozzles mounted at the front corners of an engine are ideal for hands free fireline control. REC's Project #39, Tanker Handbook: Military 5-Ton 6x6, 1500 Gallon Low Profile Tanker, shows such a system. A pipe fitting manifold can be plumbed under the operator's seat with valves to control each nozzle. The spray distance for this type of system is limited and the spray direction can be controlled only by maneuvering the vehicle.

REC Design

Table 1 lists the drawings for constructing the REC Remote Controlled Nozzle. The drawings are contained in Appendix A. Appendix B is a parts list including the manufacturer and cost. The completed assembly weighs approximately 48 pounds.

To keep costs low and make fabrication easy, most parts are made from mild steel. An exception is the mast tube which is made from

stainless steel. This part requires machining. We chose stainless because of the widespread use of class A foam. This chemical's corrosive nature makes it prudent to protect higher cost parts such as the mast tube. If you use these foam chemicals sparingly, lower cost carbon steel could be used. The cover was made from aluminum to reduce weight. This requires TIG welding skills and equipment.

The lower plate is the only other part requiring machining. Two slots must be made in this part. The other parts can be made with simple cutting

and drilling methods. Assembly is done by welding and simple fasteners.

Table 1 – Drawing List

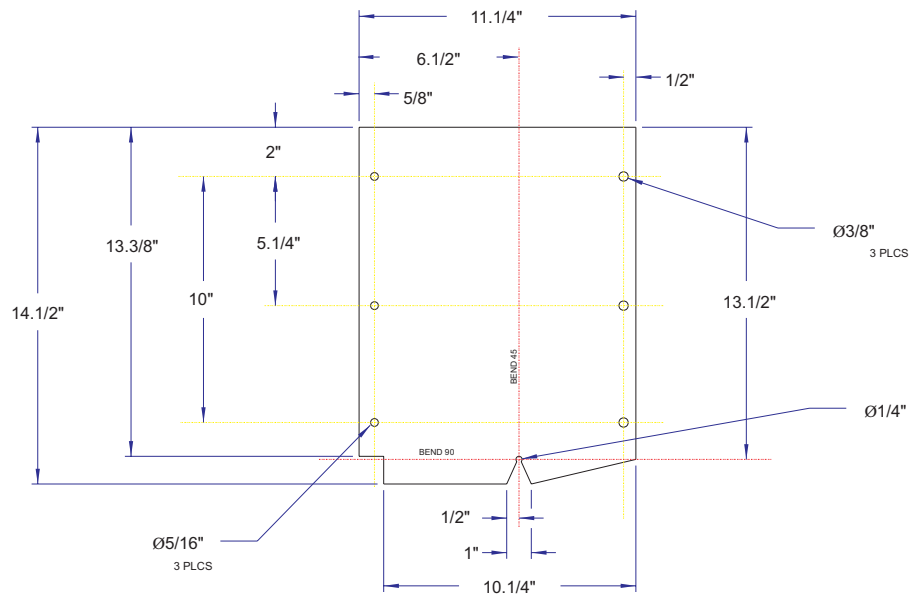
Drawing	Drawing Name	Description
90-5802C	Cover Assembly	Includes front, side, rear covers and their installation.
90-5803C	Mast Frame	Includes mast parts and welding instructions.
90-5804C	Monitor Details	Parts for turret construction.
90-5805C	Remote Control Monitor	Turret hardware overview.
90-5806C	Monitor Assembly	Parts and assembly information for turret hardware
90-5807C	Monitor Control Wiring	Wiring diagram for control box.
90-5808C	Monitor Harness	Electrical harness between monitor and controls.
90-5809C	Monitor Wiring	Electric diagram within turret hardware

Drawings 90-5807C through 90-5809C show the electrical control boxes and wiring diagrams. The design calls for a harness covered by automotive loom to help protect the wires. Utilizing the harness makes connections easy and reduces the chance for improper connection after unit has been removed or relocated.

The rotation of the turret is done with a small electric motor. REC looked at designing a collector ring to allow full continuous rotation. A collector ring is a rotating electrical junction; the electrical equivalent of a plumbing swivel joint. The cost of such a device would push the total cost above that of the criteria. Instead, the unit was designed for 360 degrees noncontinuous rotation controlled by limit switches. Hence, it will rotate one full revolution but rotation must be reversed at the end of one revolution. This creates what can be called a “dead spot” in the pattern.

The design allows this “dead spot” to be adjusted to an area of minimal user ease, i.e., where the operator has limited visibility already. To adjust the “dead spot”:

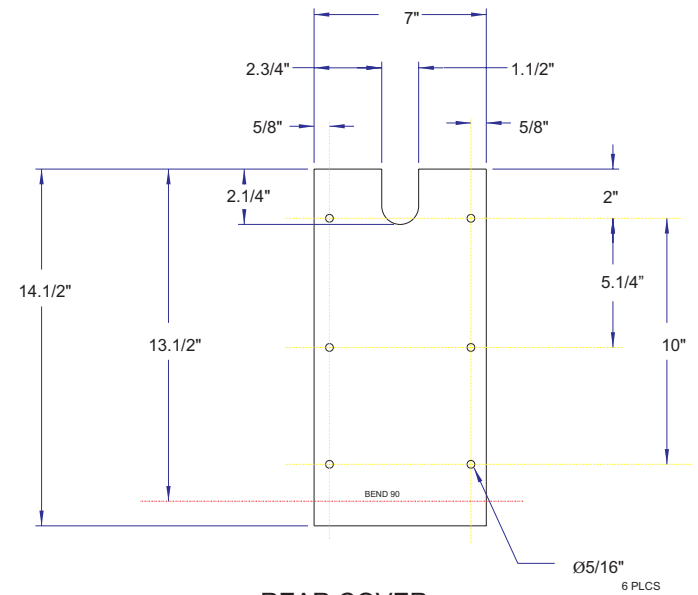
- First rotate the turret using the control switch until it contacts one of the rotational limit switches and stops. Remove the side covers.
- Loosen the set screws (4) in the drive collar (see drawing 90-5806C).
- Rotate the turret by hand to the desired location for the “dead spot”.
- Tighten set screws and install side covers.



SIDE COVER

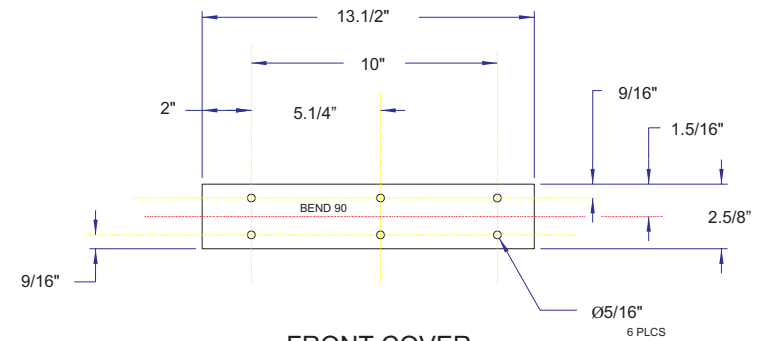
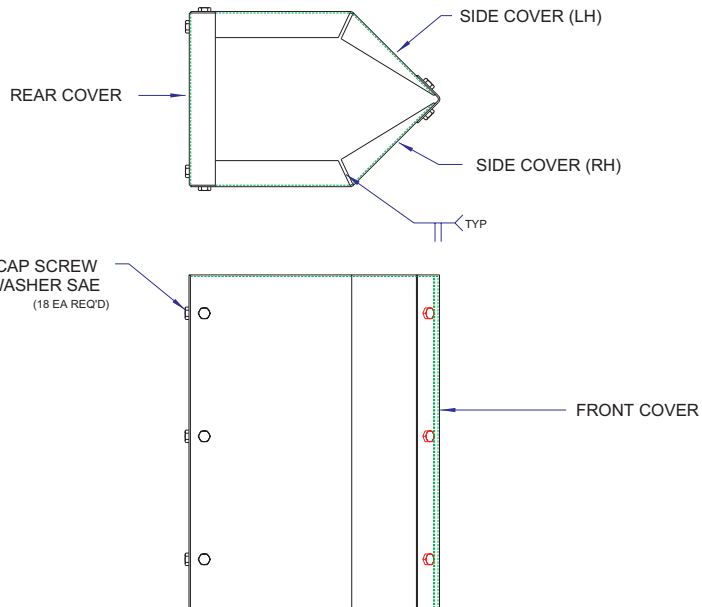
MATERIAL: SHEET .063"
3003 ALUMINUM

LEFT HAND-BEND DOWN
RIGHT HAND-BEND UP



REAR COVER

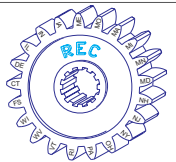
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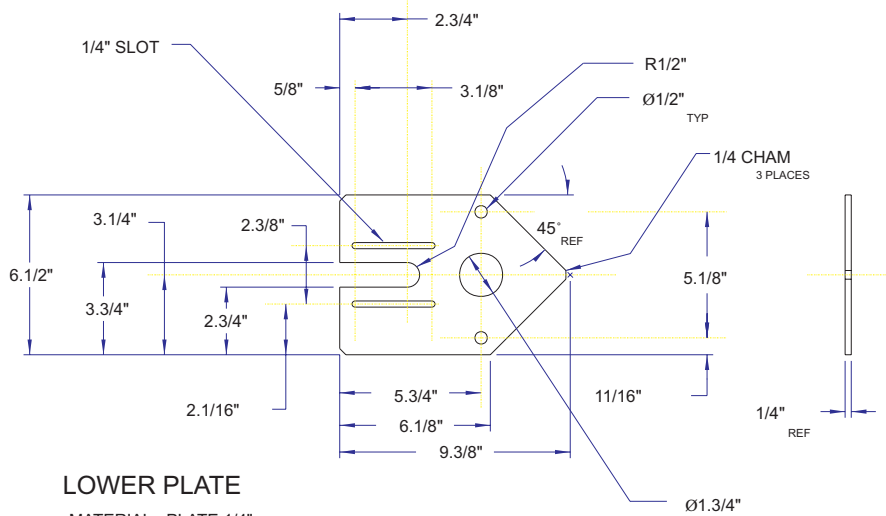


FRONT COVER

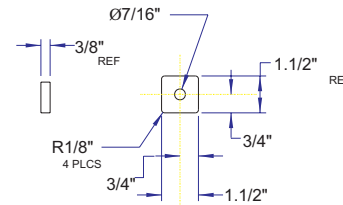
MATERIAL: SHEET .063"
3003 ALUMINUM

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DECIMAL: 1 PLACE ± .01 2 PLACE ± .001 3 PLACE ± .0005		APPROVED: KDB	
ANGULAR: ± .1 DEG		NO. BY DATE REVISION	
FOREST FIRE EXPERIMENT STATION			
P.O. BOX 68 ROSCOMMON, MICHIGAN 48653			
TITLE: COVER ASSEMBLY		SCALE: 1/4	DATE: 9/15/96
		PROJECT NO.: REC 58	
		DWG. NO. 90-5802C	



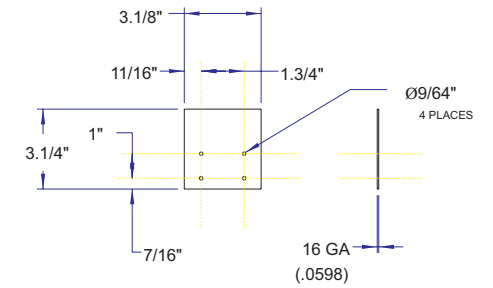


LOWER PLATE
 MATERIAL: PLATE 1/4"



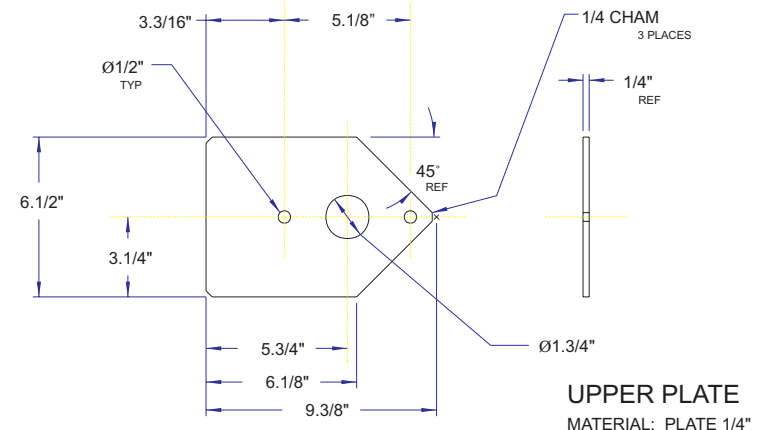
FOOT

MATERIAL: BAR, FLAT
 3/8 X 1.1/2 HR
 (3 REQ'D)



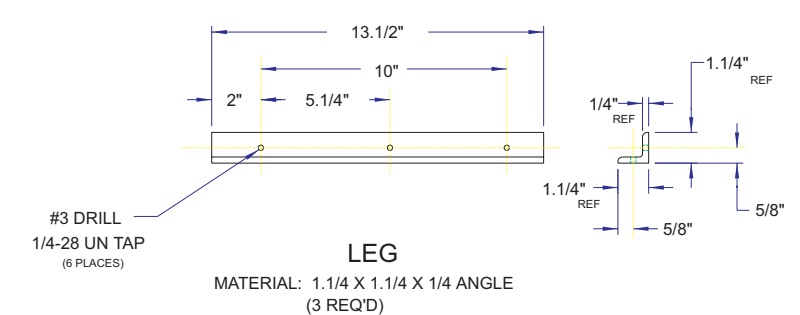
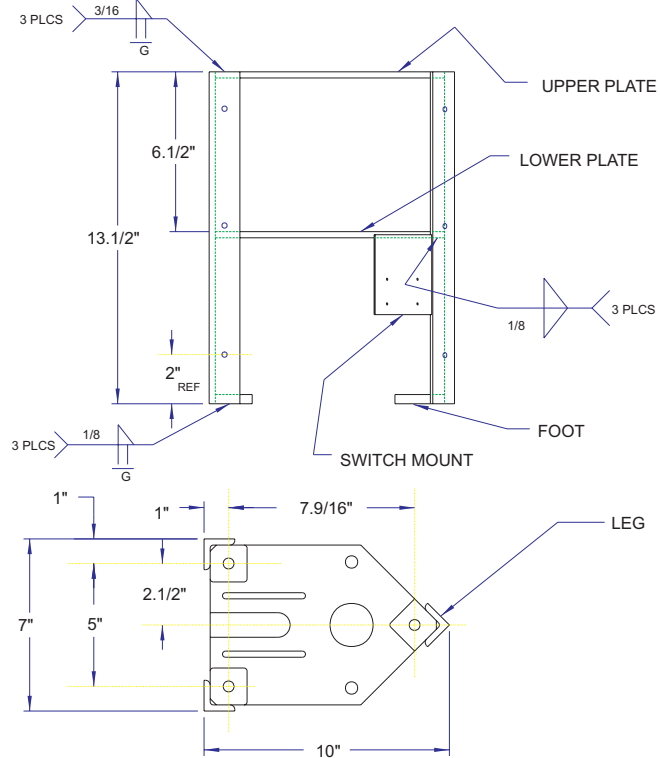
SWITCH MOUNT

MATERIAL: SHEET 16 GA



UPPER PLATE

MATERIAL: PLATE 1/4"



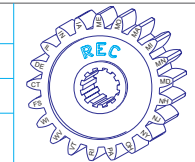
LEG

MATERIAL: 1.1/4 X 1.1/4 X 1/4 ANGLE
 (3 REQ'D)

STD. TOLERANCES		DRAWN: LLP	
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6 IN. AND UP ± .1/16			
DECIMAL:	ANGULAR:	NO. BY DATE REVISION	
1 PLACE ± .01	± .1 DEG		
2 PLACE ± .001			
3 PLACE ± .0005			

FOREST FIRE EXPERIMENT STATION

P.O. BOX 68 ROSCOMMON, MICHIGAN 48653



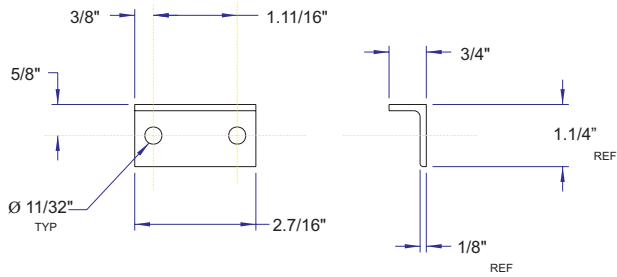
PROJECT NO.: REC 58

TITLE: MAST FRAME

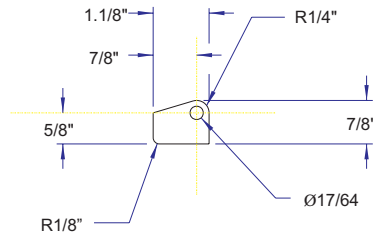
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DATE: 9/15/96

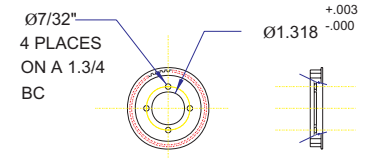
DWG. NO. 90-5803C



MATERIAL: 1.1/4 X 1.1/4 X 1/8 ANGLE
SCALE: 1/2

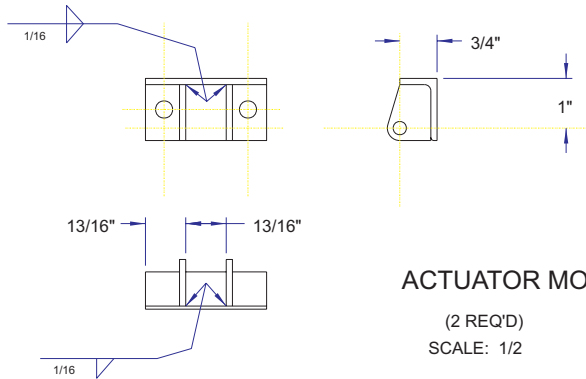


MATERIAL: BAR, FLAT 1/8 X 1 HR
(2 REQD PER ACTUATOR MOUNT)
SCALE: 1/2



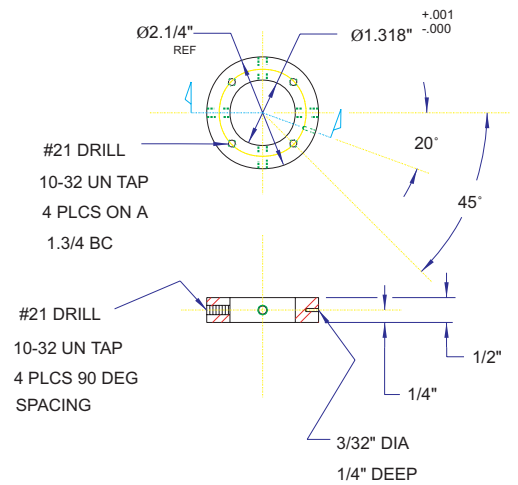
PULLEY

MAKE FROM 5mm X 50 TOOTH PULLEY



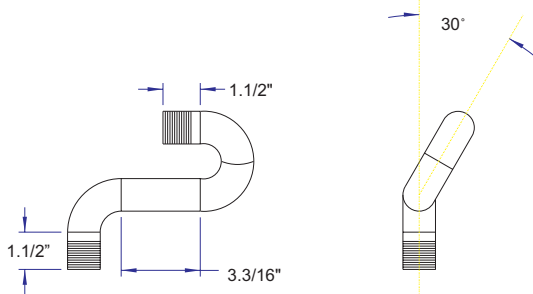
ACTUATOR MOUNT

(2 REQ'D)
SCALE: 1/2



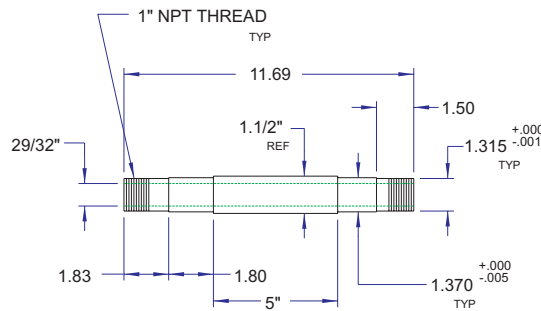
DRIVE COLLAR

MATERIAL: BAR, RD 2.1/4" DIA CD



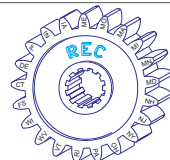
TURRET FITTING

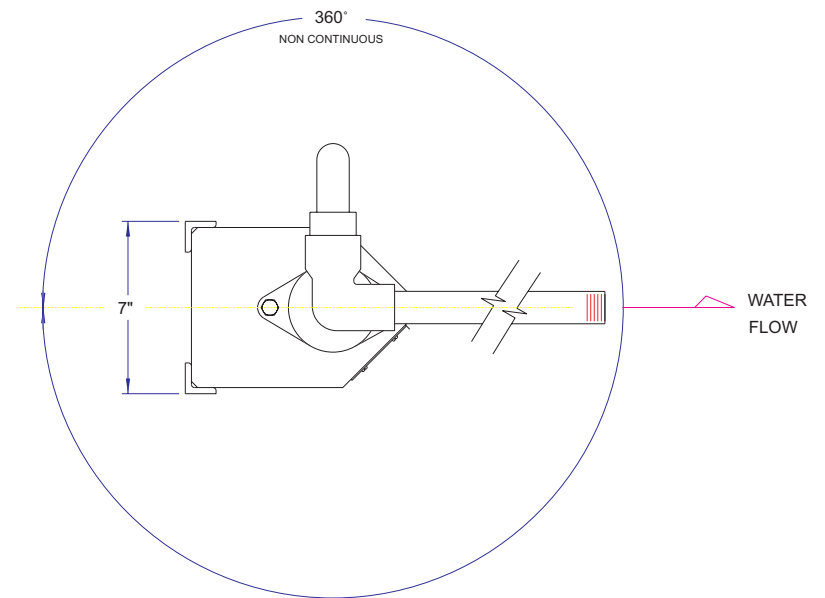
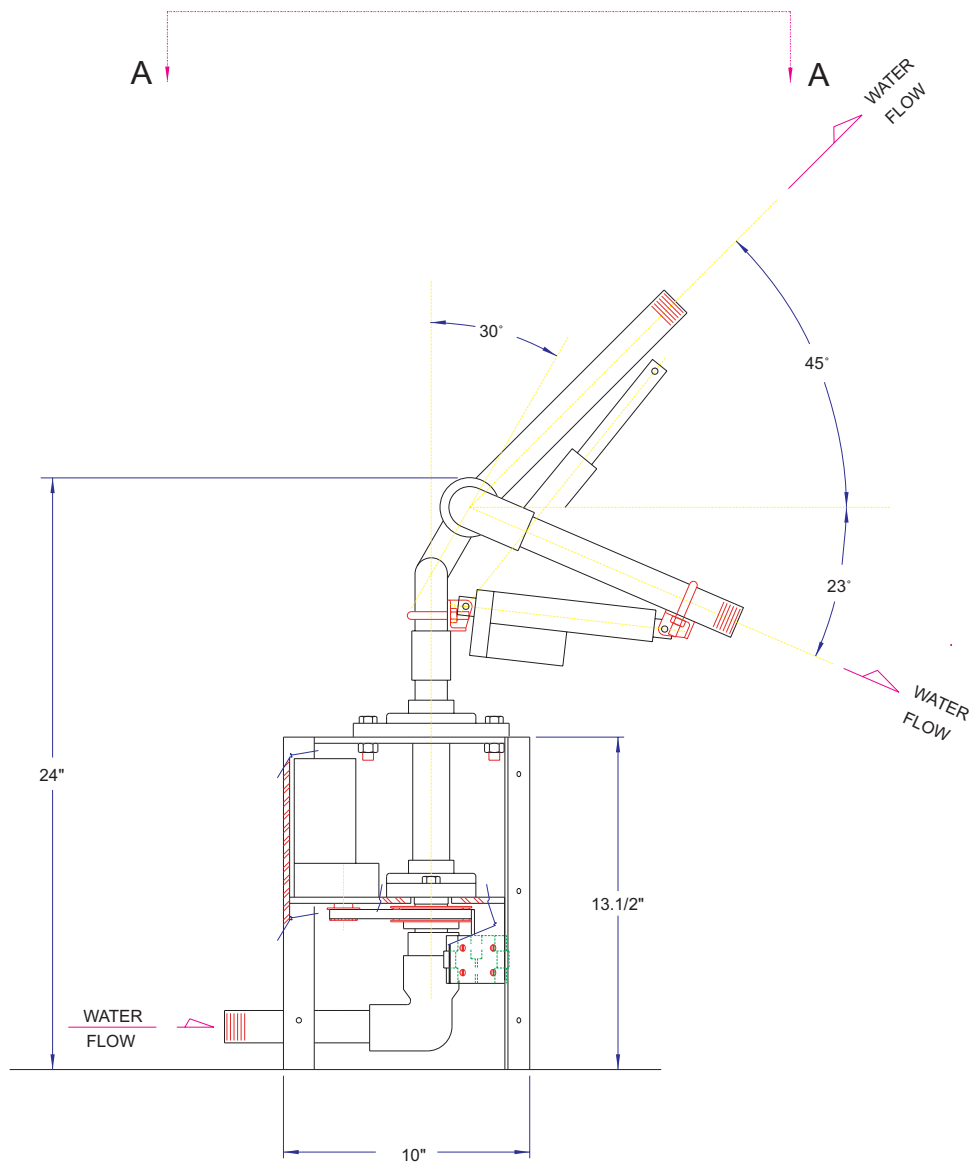
MATERIAL: PIPE NIPPLE, 1" X 6.1/2" LONG
SCHEDULE 40 BLACK (QTY 1)
ELBOW, BUTT WELD 90
1" LONG RADIUS (QTY 2)



MAST TUBE

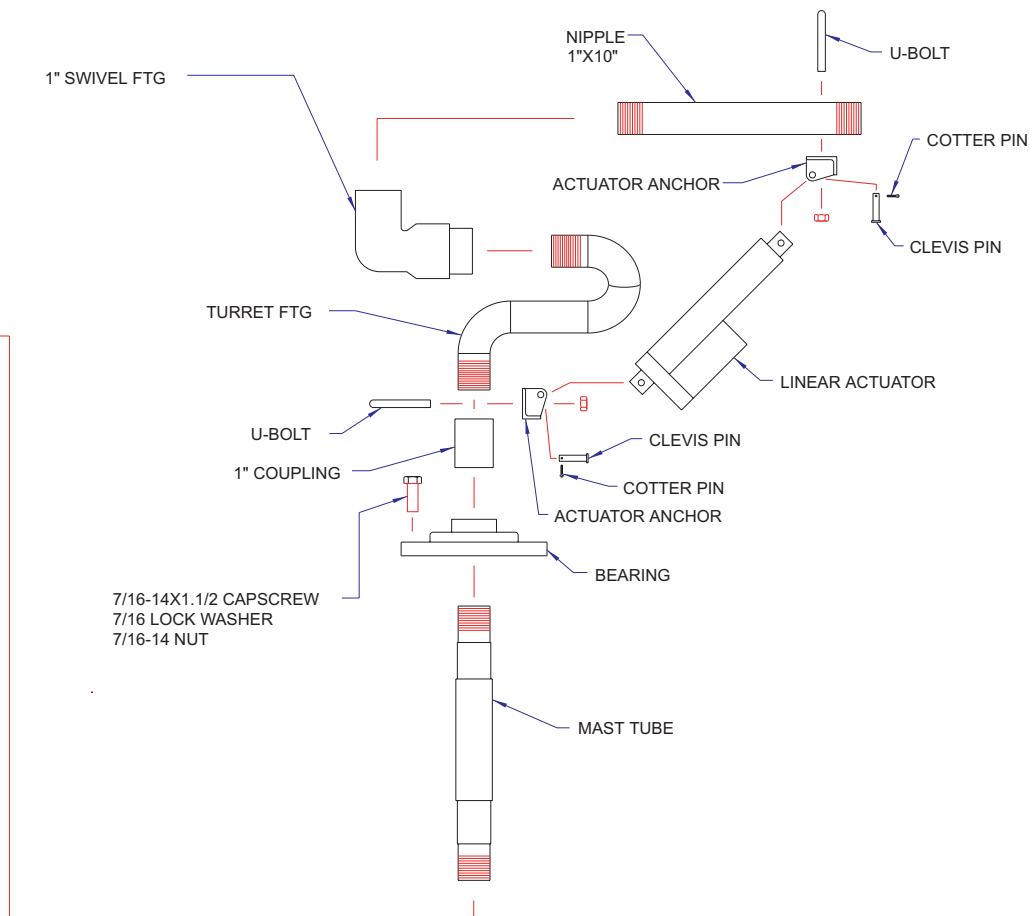
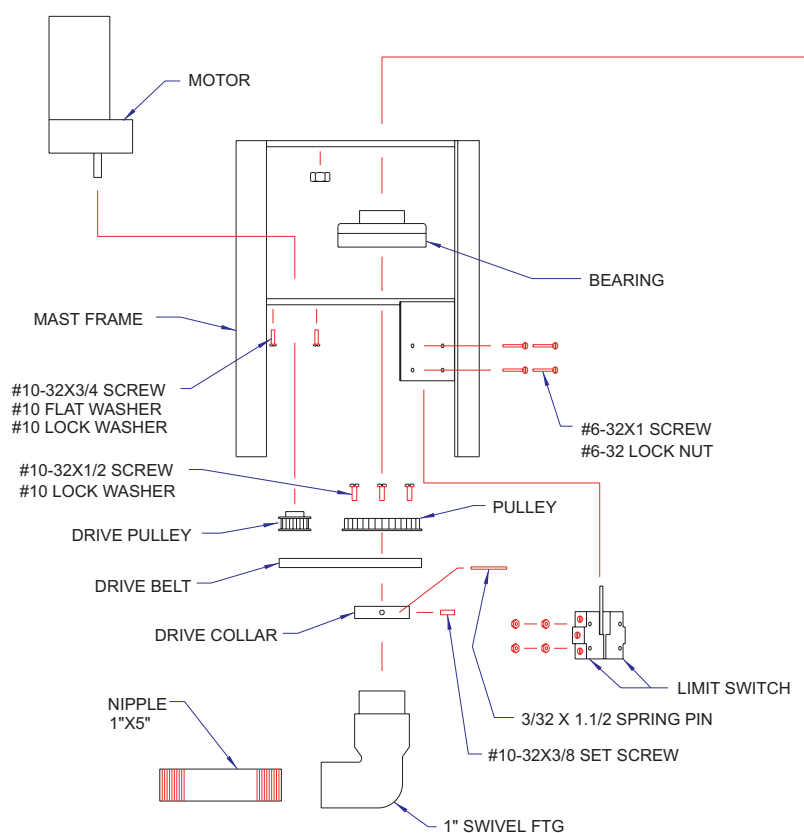
MATERIAL: BAR, ROUND 1 1/2" OD
304 STAINLESS

STD. TOLERANCES		DRAWN: LLP		
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DECIMAL: 1 PLACE +.01 2 PLACE +.001 3 PLACE +.0005		APPROVED: KDB		
ANGULAR: +/- 1 DEG		NO. BY DATE REVISION		
FOREST FIRE EXPERIMENT STATION				
P.O. BOX 68 ROSCOMMON, MICHIGAN 48653				
TITLE: MONITOR DETAILS		SCALE: 1/4	DATE: 9/15/96	PROJECT NO.: REC 58
				DWG. NO. 90-5804C

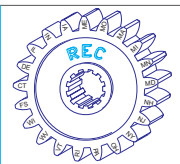


VIEW A-A

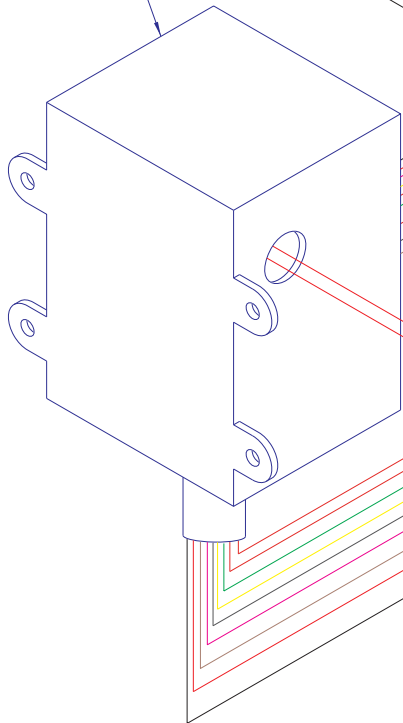
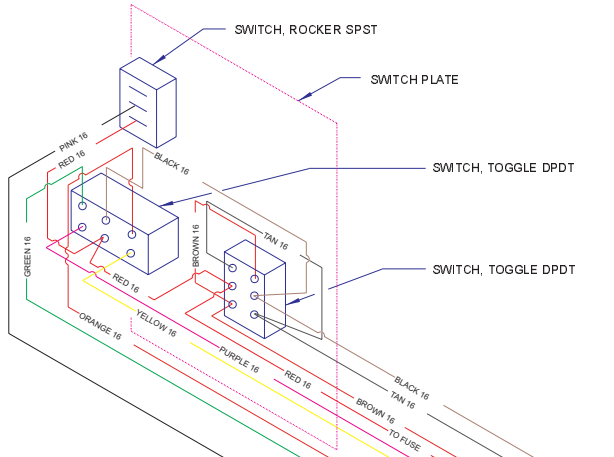
STD. TOLERANCES FRACTIONAL: 0 TO 6 IN ± .152 6 IN AND UP ± .115 DECIMAL: 1 PLACE ± 0.1 2 PLACE ± 0.01 3 PLACE ± 0.005 ANGULAR: ± 1 DEG		DRAWN: LLP CHECKED: KDB APPROVED:								
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NO.	BY	DATE	REVISION							
FOREST FIRE EXPERIMENT STATION P.O. BOX 68 ROSCOMMON, MICHIGAN 48653										
TITLE: REMOTE CONTROL MONITOR		LESS COVERS SCALE: 1/4	DATE: 9/15/96	DWG. NO.: 90-5805C						



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DECIMAL: 1 PLACE ± 0.1 2 PLACE ± 0.01 3 PLACE ± 0.005	ANGULAR: ± 1 DEG	APPROVED: KDB	
NO.	BY	DATE	REVISION
FOREST FIRE EXPERIMENT STATION			
P.O. BOX 68 ROSCOMMON, MICHIGAN 48653			
TITLE: MONITOR ASSEMBLY (LESS COVER PANELS)		SCALE: 1/4	DATE: 2/15/95
		PROJECT NO.: REC 58	
		DWG. NO.: 90-5806C	



BOX, RECEPTICAL SINGLE GANG
PLASTIC, WEATHERPROOF



FUSE HOLDER PANEL MOUNT
FUSE 10 AMP AGC TYPE

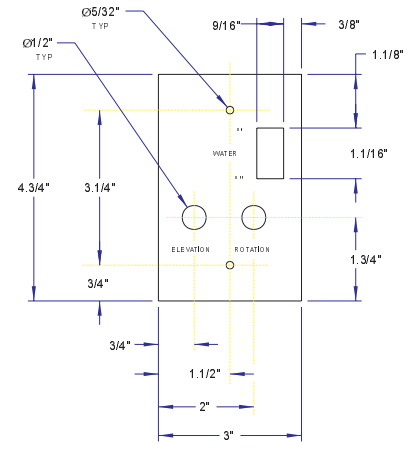
CONNECTOR, 8 WIRE PIN HSG
CONNECTOR, PIN 20-14 GA WIRE

CONNECTOR, 2 WIRE PIN HSG
CONNECTOR, PIN 20-14 GA WIRE

CONNECTOR, 2 WIRE SOCKET HSG
CONNECTOR, SOCKET 20-14 GA WIRE

CONNECTOR, 2 WIRE PIN HSG
CONNECTOR, PIN 20-14 GA WIRE

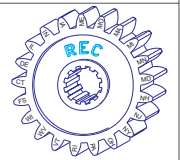
TO CHASSIS GROUND
TO 12 V DC POWER



SWITCH PLATE
LABEL AS SHOWN
SCALE 1/2

MATERIAL: SHEET .063" THICK
3003 ALUMINUM

STD. TOLERANCES		DRAWN:	
FRACTIONAL:		LLP	
0 TO 6/32 ± .130		CHECKED:	
BEYOND 6/32 ± .118		KDB	
DECIMAL:	ANGULAR:	APPROVED:	
1 PLACE ± .01	• • 1 DEG		
2 PLACE ± .001			
3 PLACE ± .0005			
		NO.	DATE
		REVISION	



FOREST FIRE EXPERIMENT STATION

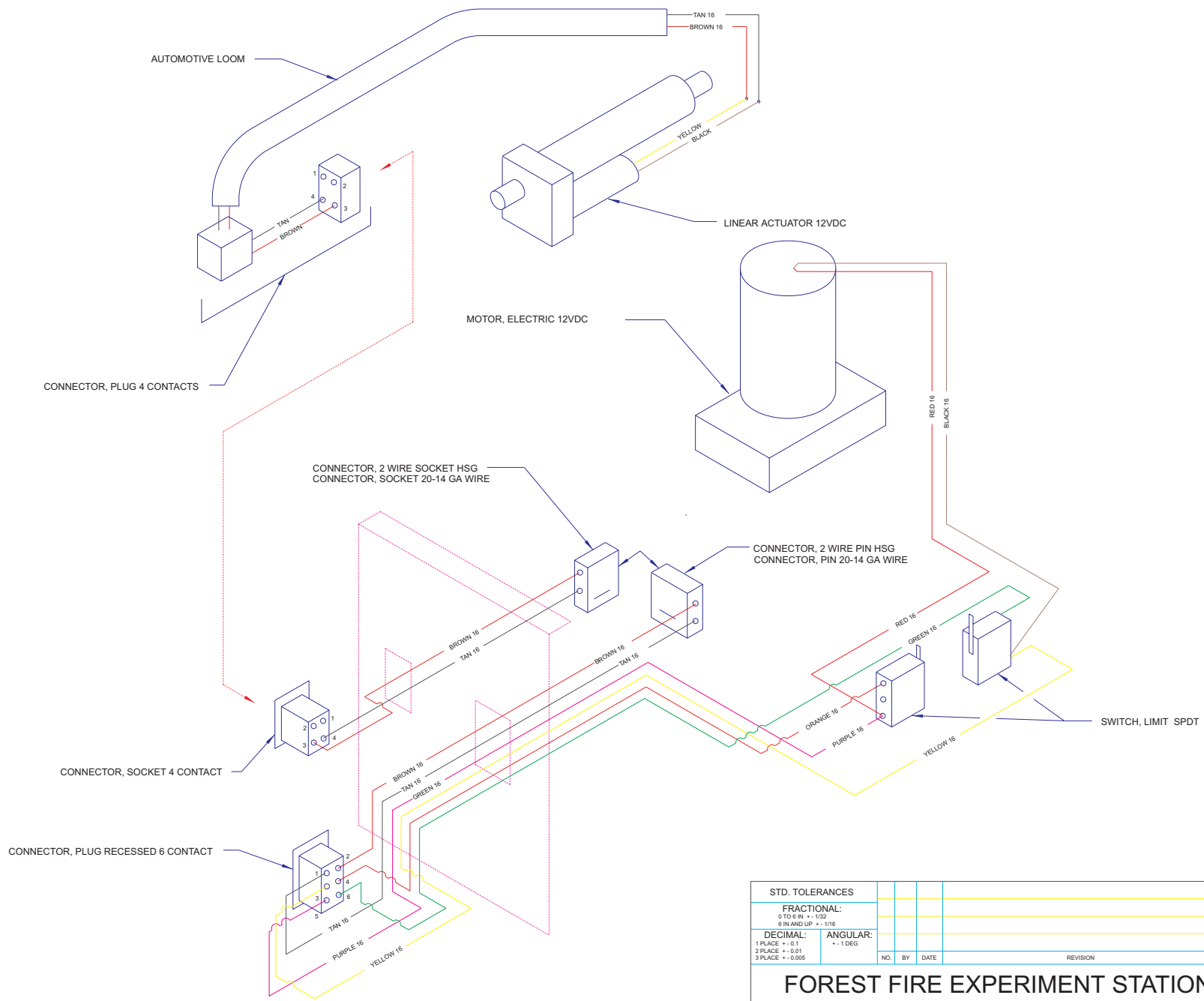
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PROJECT NO.: REC 58

TITLE: MONITOR CONTROL WIRING

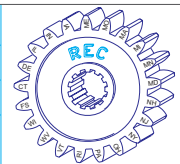
SCALE: NONE
DATE: 9/25/96

DWG. NO. 90-5807C



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FRACTIONAL: 0 TO 6 IN ± .152 6 IN AND UP ± .125		CHECKED: KDB	APPROVED:												
DECIMAL: 1 PLACE ± 0.1 2 PLACE ± 0.01 3 PLACE ± 0.005	ANGULAR: ± 1 DEG	REVISION													
NO.	BY	DATE													

FOREST FIRE EXPERIMENT STATION
P.O. BOX 68 ROSCOMMON, MICHIGAN 48653



PROJECT NO.: REC 58

TITLE: MONITOR WIRING	SCALE: NONE	DATE: 9/25/96	DWG. NO.: 90-5809C
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Low Cost, Remote Control Water Turret

Cost Procurement Information

Item	Qty	Units	Cost				Material	Manufacturer	Part Number	Information Location		
			Labor Hours	Each		Total				Detail	Assembly	Electric
				Labor	Mat'l							
Actuator Mount	2	EA	0.7	14.00	1.50	31.00	Steel Angle/Bar		90-5804C	90-5806C	90-5809C	
Actuator, Linear 12VDC	1	EA			122.00	122.00	Purchased	Warner Electric	Electrak 1 w/Limit switches		90-5806C	
Automotive Loom 3/4	10	FT			1.01	10.10	Purchased	McMaster Carr	7609K4		90-5807C, 90-5808C & 90-5809C	
Automotive Loom 3/8	5	FT			0.75	3.75	Purchased	McMaster Carr	7609K2		90-5807C, 90-5808C & 90-5809C	
Bearings, Flanged	2	EA			20.75	41.50	Purchased	Fafnir	SCJT 1 3/8	90-5806C		
Belt, Timing	1	EA			6.88	6.88	Purchased	Stock Drive Products	A 6R25M072090	90-5806C		
Box, Switch	1	EA	0.1	2.00	4.57	6.57	Purchased	Local Hardware			90-5807C	
Connector, 2 Wire Pin Housing	3	EA			0.21	0.63	Purchased	Allied Electronics	512-1455		90-5807C & 90-5809C	
Connector, 2 Wire Socket Housing	3	EA			0.20	0.60	Purchased	Allied Electronics	512-1405		90-5807C, 90-5808C & 90-5809C	
Connector, 6 Wire Pin Housing	1	EA			0.37	0.37	Purchased	Allied Electronics	512-1470		90-5807C	
Connector, 6 Wire Socket Housing	1	EA			0.44	0.44	Purchased	Allied Electronics	512-1420		90-5808C	
Connector, Pin 20-14 Ga Wire	11	EA			0.12	1.31	Purchased	Allied Electronics	512-1401		90-5807C & 90-5809C	
Connector, Plug 2 Contact	1	EA			3.68	3.68	Purchased	Allied Electronics	750-3300		90-5808C	
Connector, Plug 4 Contact	1	EA			2.61	2.61	Purchased	Allied Electronics	750-3104		90-5809C	
Connector, Plug 6 Contact Recessed	1	EA			3.09	3.09	Purchased	Allied Electronics	750-3107		90-5809C	
Connector, Socket 2 Contact	1	EA			3.76	3.76	Purchased	Allied Electronics	750-3301		90-5808C	
Connector, Socket 20-14 Ga Wire	11	EA			0.12	1.31	Purchased	Allied Electronics	512-1402		90-5807C, 90-5808C & 90-5809C	
Connector, Socket 4 Contact Recessed	1	EA			3.39	3.39	Purchased	Allied Electronics	750-3401		90-5809C	
Connector, Socket 6 Contact	1	EA			3.28	3.28	Purchased	Allied Electronics	750-3402		90-5808C	
Coupling 1" Galvanized	1	EA			1.75	1.75	Purchased	McMaster Carr	4638K166	90-5806C		
Cover, Front	1	EA	0.2	4.00	4.56	8.56	3003 Aluminum .063"			90-5802C	90-5802C	
Cover, Rear	1	EA	0.3	6.00	4.56	10.56	3003 Aluminum .063"			90-5802C	90-5802C	
Cover, Side (LH)	1	EA	0.5	10.00	4.56	14.56	3003 Aluminum .063"			90-5802C	90-5802C	
Cover, Side (RH)	1	EA	0.5	10.00	4.56	14.56	3003 Aluminum .063"			90-5802C	90-5802C	
Drive Collar	1	EA	1.5	30.00	2.00	32.00	Steel Plate			90-5804C	90-5806C	
Elbow, Swivel 1"	2	EA			57.1	114.20	Purchased	Aeroquip	FS590000-1616-01	90-5806C		
Fuse Holder, Panel Mount	1	EA					Purchased	McMaster Carr	7087K17		90-5807C	
Fuse, AGC 10A	1	EA			0.33	0.33	Purchased	McMaster Carr	7085K79 15 AMP		90-5807C	
Mast Frame	1	EA	1.8	36.00	10.00	46.00	Steel Plate/Angle/Bar			90-5803C	90-5806C	
Mast Tube	1	EA	2.5	50.00	18.32	68.32	316 Stainless Stl 1 1/2" Dia			90-5804C	90-5806C	
Misc Fasteners					5.00	5.00	Purchased					
Motor, Electric 12VDC	1	EA			84.90	84.90	Purchased	W. W. Grainger	1L478	90-5806C		
Nipple 1" x 10" Galvanized	1	EA			4.10	4.10	Purchased	McMaster Carr	4549K624	90-5806C		
Nipple 1" x 5" Galvanized	1	EA			2.12	2.12	Purchased	McMaster Carr	4549K618	90-5806C		
Pin, Clevis	2	EA			0.15	0.30	Purchased	McMaster Carr	98340A120	90-5806C		
Pin, Cotter	2	EA			0.04	0.09	Purchased	McMaster Carr	98355A010	90-5806C		
Pin, Spring 3/32 Dia x 11/2 Long	1	EA			0.05	0.05	Purchased	McMaster Carr	92383A216	90-5806C		
Pulley 18 tooth	1	EA			8.27	8.27	Purchased	Stock Drive Products	A 6A25M018DF0908	90-5806C		
Pulley 50 tooth	1	EA	0.4	8.00	7.62	15.62	Purchased & Modified	Stock Drive Products	A 6Z25M050SF0912	90-5804C	90-5806C	
Switch Plate	1	EA	0.3	6.00		6.00	3003 Aluminum .063"			90-5807C	90-5807C	
Switch Plate	1	EA	0.2	4.00	1.50	5.50	3003 Aluminum .063"			90-5807C	90-5807C	
Switch, Limit SPDT ON-ON	2	EA			5.64	11.28	Purchased	W. W. Grainger	6X289	90-5806C	90-5809C	
Switch, Rocker SPST ON-OFF	1	EA			2.95	2.95	Purchased	Allied Electronics	683-0117		90-5807C	
Switch, Toggle DPDT (ON)OFF(ON)	2	EA			13.94	27.88	Purchased	Allied Electronics	826-8904		90-5807C	
Terminal, Quick Slide 1/4" 16-14 Ga	2	EA			0.30	0.60	Purchased				90-5807C	
Terminal, Ring #8 16-14 Ga	18	EA			0.10	1.80	Purchased	Allied Electronics	512-5288		90-5807C & 90-5809C	
Turret fitting	1	EA	0.75	15.00	10.00	25.00	Purchased			90-5804C	90-5806C	
U-Bolt for 1" pipe	2	EA			0.59	1.18	Purchased	McMaster Carr	3043T24	90-5806C		
Wire 16Ga (Various Colors)	75	FT			0.09	6.75	Purchased				90-5807C, 90-5808C & 90-5809C	
Assembly Labor			10	200.00		200.00						

	Labor	Parts	Total
Total	395.00	571.48	966.48