C. Pick up the second strut, heat it the same way and press it on the skid until the skid projects rearward from it exactly 62mm. Again check drawings for orientation. The distance between the bolt holes from the front to the rear strut should be 165mm.

D. Grasp the forward strut again, heat its opposite end and, in a similar fashion, press the second skid through this hole. Continue until it is about to engage the second strut. Now heat the rear strut and, before the front one cools, slide the skid through both into its final position.

E. Install the landing gear with two landing gear braces #0177 between the landing gear and the lower aluminum frame #0163 and #0165. Use the four M3x18 bolts #0071 and M3 locknuts #0019.

VII. RADIO TRAY ASSEMBLE AND SERVO INSTALLATION

Step 1. **Installation of Radio Tray Frame Supports.**

Parts Required:

1	#0349-L	Lower Tray Frame Support (left)	Bag 7B
1	#0349-R	Lower Tray Frame Support (right)	7B
1	#0347	Upper Tray Frame Support	7B
2	#0063	M3x10 Hex Head Bolts	7B
4	#0019	Hex Locknuts 3mm	7B
2	#0089	M3x10 Hex Head Bolts	7B

Refer to Drawing #7.

A. Identify the placement of the upper #0347 and lower #0349 L + R radio tray frame supports on the drawing.

B. Mount the upper tray frame support #0347 to the vertical front plate #0175 using two M3x10 socket head cap screws #0063, and two locknuts M3 #0019. Only assemble loosely at this time.

C. Mount the lower tray frame support #0349-1 (left) and #0349-2 (right) using two M3x10 hex head bolts #0089, and two locknuts 3mm #0019. To the front side of the vertical front plate #0175. The two #0089 bolts are installed from the inside out on the #0175 for clearance of the fan shroud. Do not tighten completely.

Step 2. **Mount Servo's into Plastic Tray Components and Assemble Plastic Tray.**

Parts Required:

2	#0029	M2.2x13 Phillips Tapping Screws	Bag 7C
13	#0027	M2.2x9.5 Phillips Tapping Screws	7C
8	#0001	Flat Washers 2mm (small)	7C
2	#0575-3	Servo Spacer Blocks w/Three Holes	7C
4	#0575-1	Servo Screw Doubler Blocks w/Two Holes	7C
4	#0035	M2.2x16 Phillips Tapping Screws	7C
1	#0575-4	Upper Servo Tray	7A
1	#0575-5	Lower Servo Tray	7A
1	#0575-6	Main Vertical Support and Throttle Mount	7A
2	#0351	Roll Servo Pivots (male)	7C
2	#0353	Roll Servo Pivots (female)	7C
2	#0357	Plastic Pivot Bushings	7C

1	#0575-7	Secondary Vertical Brace "H"	7A
1	#0575-8	Switch Plate	7A

Refer to Drawing #7.

A. Examine exploded view showing the placement of plastic parts and servo in the Radio Tray servo placement. Examine the #0575-5 Lower Tray. You will see that long, thin slots are molded in the front and rear of this part. It is necessary to cut through the slots at the rear of the lower tray thus removing the last 20.0mm Lower Support Brackets.

B. **Servo Installation:** The order of assembly of the various plastic parts is not critical; however, experience has shown that it is more convenient to initially fit the servos prior to overall assembly. The reason for this is due to the adjustable nature of servo openings. Obviously this tray must accept all popular servo sizes, so the following will outline each servo installation.

Mount Servo's as Follows:

1. **Roll (Aileron) Servo:** Note that the aileron (roll) servo is mounted on pivots to allow it to rock fore and aft under control of the collective pitch servo ahead of it. Select the servo to be used for Roll control and install all four rubber grommets. Select a #0351 Roll Servo Pivot from the parts bag and, holding it in place under one end, use a small drill to mark it for proper hole drilling to accept two of the servo mounting screws from your radio hardware. (**NOTE:** Recognize that screwing this servo to the Pivot is just like screwing the servo down to a wood or plastic servo tray in that a small enough drill must be selected to allow your particular screws to thread into the plastic.) Drill the holes and screw the Pivot to the servo. In identical fashion, mount the remaining #0351 Pivot to the other end of the servo. Press two #0357 plastic pivot bushings into the holes in the two #0353 Roll Servo Pivots. Hold the servo in approximate position centered in its clearance hole in the tray and press the bushings of the Pivot Supports into the servo Pivot ends (lightly grease). **NOTE:** The servo should pivot freely. Slightly enlarge pivot bushing holes if needed.

Rotate each #0353 servo pivot into their respective position on the underside of the upper tray #0575-4. Hold the entire servo assembly and the upper tray together. Allow no side play in the servo and center the output spline with the true center of the tray(the rear hole of the screw to the vertical support #0575-6 is true center). Lightly cyano glue the pivot supports #0353. Re-check the servo alignment, good retention end-wise and freedom to pivot. Glue securely. From the top side of the upper tray drill two small holes through the slots provided into the servo pivots #0353. Secure using four #0027 (M2.2x9.5) self-tapping screws and four M2 washers #0001.

2. **Rudder Servo:** Select two plastic spacer blocks #0575-3. Using the original servo hardware, mount the blocks to the servo allowing at least 1.0mm of servo case clearance. Set the assembly into position in the tray. The output position of the servo is to the rear of the tray. Align the center hole on each block #0575-4 install a #0027 M2.2x9.5 Phillips Screw into each center hole. Center the servo within the opening and tighten all four servo screws previously installed. Apply a thin coat of cyano around each block #0575-3.

3. **Collective Servo:** Mount the collective servo with the splined output shaft towards the rear. Secure servo using the four servo screws provided in the radio system and two doubler blocks #0575-1.

4. **Throttle Servo:** Select the vertical tray support #0575-6. Mount the throttle servo with the splined output shaft towards the rear. Secure servo using four #0035 (M2.2x16) Phillips tapping screws, four #0001 (M2) washers, and two #0575-1 doublers. Cyano doublers from the back side.

C. **Overall Assembly:** Refer to **View** for overall positioning of all plastic parts. It is best if a thin line of cyano is put on the mating surfaces prior to installation of the screws. Using two #0027

(M2.2x9.5) Phillips self-tapping screws, fasten the vertical tray #0575-6 to the underside of the upper tray #0575-4. Secure the secondary vertical brace #0575-7 ("H" shaped) to the front side of the vertical tray #0575-6 using one #0027 M2.2x9.5) screw. Mount the vertical brace with the screw eyelets pointing forward(towards the helicopter's nose). Position the main lower plate #0575-5 and secure using two #0029 (M2.2x13) Phillips tapping screws through the front two holes in the upper servo plate #0575-4. Use two #0027 (M2.2x9.5) in the center two holes on the bottom side.

Step 3. **Mount Plastic Tray to Main Frames and add Front Brace.**

Parts Required:

2	#0560-8 Flat Washers M2.5	Bag 7D
4	#0061 M3x8 Socket Head Cap Screws	7D
2	#0009 Flat Washers M3 small	7D
4	#0003 Flat Washers M3 large	7D
8	#0019 Servo Screw Doubler Blocks w/Two Holes	7D
4	#0065 M3x12 Socket Head Cap Screws	7D
2	#0578-1 Aluminum Servo Tray Brackets	7A
2	#0029 2.2x13 Phillips Tapping Screws	7D

Refer to Drawing #7.

A. Push the tray up against the frame vertical front plate #0175, and the upper tray support #0347, assemble loosely in place using two M3x12 socket head cap screws #0065, two flat washers M3 small #0009, and two hex locknuts M3 #0019. As previously mentioned for .50/.60 installation, the lower tray was trimmed for clearance of the lower metal brackets #0349. In this installation, utilize the (2) 3.0mm holes lowest in the tray with two #0065 (M3x12) socket head bolts and two #0019 M3 locknuts.

B. Install one aluminum servo tray bracket #0578-1 in the direction shown in the remaining two holes on the bottom side of the lower servo tray #0575-5 using two flat washers M2.5 #0560-8 and two Phillips tapping screws M2.2x23 #0029. Do not fully tighten at this point.

C. Install the remaining #0578-1 vertical brace as shown on the tank tray, using two #0061 M3x8 socket bolts and two #0019 M3 locknuts (leaving them only slightly tight for future adjustment).

D. Install two #0061 M3x8 socket bolts with two #0003 flat washers through both vertical braces at the center followed by two #0003 washers and two #0019 M3 locknuts. Draw them up but do not fully tighten.

E. With everything generally in alignment, tighten the phillips screw first - then the M3x8 bolts in the tank tray.

F. Final tightening of the upper and lower tray supports and the center bolts in the #0578 vertical brace will be completed after installation on the fuel tank.

Step 4. **Mount Elevator Servo.**

Parts Required:

4	#0560-2 Phillips Machine Screws (M2.5x14)	7E
4	#0560-3 Brass Hex Nuts M2.5	7E
4	#0560-4 Lock Washer M2.5	7E

8	#0560-8	Flat Washers M2.5	7E
3	#0389	Electrical Wire Lead Retainer	7E
1	#0063	M3x10 Socket Head Bolt	7E
1	#0019	M3 Locknut	7E

Refer to Drawing #7.

A. Check servo clearance in the cutout #0365 elevator plate and increase if necessary. Install all four rubber grommets and brass eyelets into the elevator servo provided in your radio system. Drill four holes in the elevator plate #0365 to match the servo mounting holes. The hole drilled will need to be slightly larger than the 2.5mm bolts provided. Mount the servo with the out put position towards the front in the following order using four M2.5x14 Phillips machine screws #0560-2, four M2.5 flat washers #0560-8, the elevator plate #0365, the servo. Four more M2.5 flat washers #0560-8, four M2.5 lock washers #0560-4, and four M2.5 brass hex nuts #0560-3. Snugly tighten using blue Loctite.

B. Route the servo wire towards the front radio tray using the three electrical wire lead retainers #0389 provided. The retainers are used by pressing them onto the head on a 3mm bolt. A suggested wire route is to use the forward top bolt holding the tail boom support halves #0185, to the back bolt holding lower main shaft bearing block #0182 to the back bolt holding the start shaft bearing block #0198.

C. Install one #0063 M3x10 socket head bolt into the remaining hole in the elevator plate #0365. Secure from the inside with one #0019 M3 locknut. Tighten securely .

VIII. INSTALLING FUEL TANK SYSTEM

Step 1. **Assembling Fuel Tank System.**

Parts Required:

1	#0395	Fuel Tank	Bag 8
1	#0397	Fuel Line	8
1	#0401	Fuel Clunk	8
2	#0011	Fuel Fitting Washers	8
2	#0013	Fuel Fitting Nuts 5mm	8
1	#0403	Fuel Pick-up	8
1	#0405	Fuel Vent	8

Refer to Drawing #8.

A. As per the drawing mark where the fuel fittings are to be installed.

B. Use a #13 or a .185 drill bit to drill the holes for the fuel fittings. If the drill bit doesn't make a clean hole, use a sharp X-acto knife to clean up the holes.

C. Install the fuel pressure fitting #0405 from inside the tank followed by a fuel fitting washer #0011 then a hex nut #0013. Tighten the nut securely to prevent leakage.

D. Install the fuel line fitting #0403 in the tank from the inside. The threaded portion of the fitting should be on the outside on the tank. Place a washer and a hex nut on the fitting and tighten securely.

E. Cut a piece of fuel line (#0397) 86mm long. Push the fuel line up onto the fuel line clunk #0401 then using a long pair of hemostats slide the fuel line onto the fuel line fitting. Next hold the tank and rotate it and watch what the clunk does. It should rotate or flop freely about the tank and not be allowed to go all the way into a corner. This may cause it to suck up against a side while the engine is running and cause fuel starvation and possible failure.

F. Use double sided servo tape to secure the fuel tank to the top side of the tank support tray #0189. Center the tank in between the lower canopy stand-offs #0245.

G. At this time tighten all remaining bolts not tighten on the servo tray assembly from section VII, step 3-D.

IX. ASSEMBLE THE TAILROTOR TRANSMISSION

Step 1. **Assemble Tailrotor Hub and Blade Holders.**

Parts Required:

2	#0463	Tail Rotor Blades	9A
4	#0019	Hex Locknuts 3mm	9A
2	#0073	M3x20 Socket Head Bolts	9A
2	#0103	M2x5 Threaded Steel Balls (Long Thread)	9A
2	#0299	M4x10 Ball Bearings	9A
2	#0453	Tail Rotor Blade Mounts	9A
2	#0457	T/R Thrust Bearings	9A
4	#0446-3	Special Shims .001	9A
4	#0446-4	Special Shims .003	9A
1	#0446-1	One-Piece Machined 4mm Stud Steel Tail Rotor Hub	9A

Refer to Drawing #9.

NOTE: Remember to clean all steel components before applying Loctite.

A. Take the two tailrotor blade mounts #0453 and thread the M2x5 threaded balls #0103 into the outboard holes, using slow cyano.

B. Press the M4x10 ball bearing #0299 into the blade mounts, on the root end, seating them squarely and fully.

C. Lay out the two thrust bearing assembles #0457. Use two spare 4mm bolts for greasing and assembling the thrust bearings. Each bearing has one race that has a smaller I.D. Place the small I.D. halves on the two bolts with the ball grove facing up. Apply grease all the way around the groove. Next place the ball retainers with the cup sides up onto the balls. Apply grease to the top sides of the bearing race that has a larger I.D.. Place the other halves of the bearings on the bolts completing the assemblies, wipe off any excess grease.

D. Slide the blade holders onto the one piece machined steel T/R hub #0446-1 followed by the thrust bearings. **NOTE:** The large I.D. half of the thrust bearings has to go on the steel hub first, leaving the small I.D. half next to the shims #0446-3 or #0446-4.

E. Thread the #0019 M3 locknuts up onto the steel hub and lightly tighten. Check for end play in the blade holders. **NOTE:** If there is end play in the blade holders it will have **NO** adverse effect on the operation of the tailrotor due to centrifugal force loading the thrust bearing as it was designed to do. However two different sizes of shims are provided if you would like to remove

some of the end play. **NOTE:** A small amount of end play must exist so as not to put the bearing in a bind. If shims are used, place an equal amount on each side because it is important to keep the distance equal between the center of the hub and each blade pivot hole.

F. Insert into each blade holder #0453 one tail rotor blade #0463 followed by one M3x20 socket head bolt #0073. The tail rotor pivot bolts #0073 should be facing inward. Secure using one #0019 3mm locknut. Tighten only enough that the tail blade can rotate with slight pressure. **NOTE:** If the tail blade and mount are held horizontally the tail blade will not fall.

NOTE: Re-check drawing for correct tail blade directional orientation for a clockwise rotation.

Repeat entire procedure for the other tail blade.

G. To balance the entire tail rotor assembly the #0429 tail rotor output shaft found in section 9C may be used as a balance bar. Lightly grease the output shaft and slide the #0449 rubber dampener found in section 9D half way over the shaft. Clean the exposed shaft of grease. Slide the assembled tail rotor hub onto the rubber dampener.
NOTE: To accurately balance the tail rotor, the tailrotor blades must extend straight out from the hub and parallel to each other.
Set this entire unit in between two "glass" glasses on a flat surface. If there is an imbalance the heavy blade will hang lower. Add weight in the form of a narrow strip of colored tape or preferable use a small 3mm washer on the blade pivot bolt of the lighter blade, to balance. (If the washer is used trim the washer with a pair of cutters to achieve the proper weight needed.) The tail should remain in any position if balance is correct. Proper blade balance is essential. Remove the output shaft #0429 and rubber dampener #0449.

Step 2. **Assemble Pitch Slider and Bell Crank.**

Parts Required:

2	#0041	M2x8 Slotted Cheese Head Machine Screws	9B
1	#0101	M2x5 Thread Steel Ball(Short Thread)	9B
2	#0133	Long Ball Links -- Long	9B
1	#0435	Brass Tail Rotor Control Slider	9B
1	#0437	Plastic Control Slider Ring	9B
2	#0439	M6x10 Ball Bearings	9B
1	#0441	Plastic Pitch Plate - Tail Rotor	9B
1	#0443	Snap on Retainer Pitch Plate	9B

Refer to Drawing #9.

A. Begin by threading the M2x5 short threaded ball #0101 into the side hole of the control ring #0437. Use cyano and thread the ball squarely in place.

B. Place the two #0439 ball bearings (M6x10) on a clean paper with the balls visible. Lightly grease each.

C. Slide one bearing on the #0435 brass control slider. Lightly slide the control ring over the slider, followed by the other bearing, and finally the #0441 pitch plate small end first. Press together until the bearings squarely and completely enter the recesses in the control ring. Do not force.

D. Examine the #0443 pitch plate retainer, noting its four inside spring fingers and cupped shape. It will be pressed on the end of the brass slider to retain this subassembly, but this must be done with great care to ensure that the control ring is neither to tight nor to loose. The control ring

bearings are precise and delicate but necessary for a tight play free tail rotor control. Cut a hole just large enough to go over the end of the brass slider in a small piece of very thin plastic such as the flap from a plastic sandwich bag (Saran Wrap, etc) and place it over the slider against the pitch plate face. Rest the slider vertical against a wood or cardboard surface, pitch plate up, and press the retainer in place, cupped face **UP**. A piece of scrap wood with an appropriate drilled hole in it will be very helpful for this operation. Continue pressing the retainer in place until it seats against the thin plastic shim. Carefully tear and pull the plastic out. This should provide a subassembly in which the control ring is free to rotate smoothly but with negligible end play. Apply slow cyano to retainer clip where it touches the pitch control plate.

E. Screw #0133 ball links to the pitch plate using M2x8 machine screws #0041. Just seat the screws, so that the links can rotate with firm pressure.

Step 3. **Assemble the Gearbox.**

NOTE: At the builders discretion the bearings and shaft in this section may be glued together using locktite (red, green or blue). If you choose to do this the disassemble process will become very difficult and will require application of heat to break down the glue.

Parts Required:

1	#0423 T/R Input Shaft	Bag 9C
4	#0025 Phillips Pan Head Self Tapping Screws M2.2x6.5	9C
4	#0051 M3x3 Socket Set Screw	9C
1	#0421-A T/R Gear Box Housing	9C
1	#0421-B T/R Gear Box Housing	9C
4	#0425 M5x13 Tail Gear Box Ball Bearings	9C
1	#0429 T/R Output Shaft	9C
1	#0431 E-Clip - Output Shaft	9C
1	#0433 Plastic Gear Spacer - Output Shaft	9C
2	#0427 Bevel Gears	9C
1	#0015 M2 Hex Nuts	9C
1	#0043 M2x10 Slotted Machine Screw	9C
1	#0095 Special Bolt Tail Rotor Bellcrank	9C
2	#0159 M3x7 Ball Bearings	9C
1	#0361 M2 Steel Ball	9C
1	#0001 M2 Flat Washer	9C
1	#0445 T/R Bellcrank	9C
4	#0426 .005" (.12mm) Shims	9C

Refer to Drawing #9.

SPECIAL NOTE FOR INSTALLING #0427 OR #0547 TAIL ROTOR GEARS IN ALL X-CELL OR XL-PRO HELICOPTERS.

Four #0426 - .005" (.12mm) shims are provided for adjusting the gear mesh. In most cases none will be required, however in some cases 1 or 2 per gear may be necessary to achieve optimal gear mesh.

The set-up procedure is as follows:

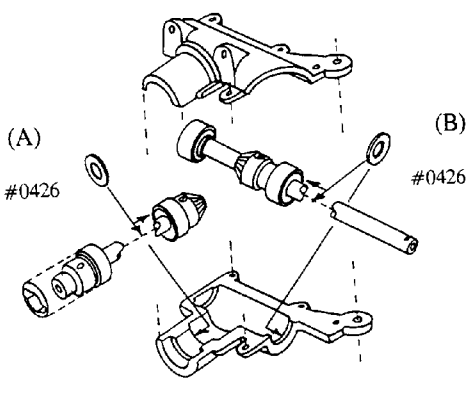
1.) Trial fit all components (without shims) and assemble gear box with a couple of the #0025 screws. To be accurate, it is necessary to insert the transmission into the tailboom each time you wish to check gear mesh. This is because the boom will slightly compress the transmission case.

Each shaft assembly should be individually test fitted with each transmission case in place to check for end-play and excessive bearing loads. The former is caused by the gear being set too far from the bearing or spacer and the later is from too much spacing causing the assembly to "snap" into place in the transmission.

2.) If it is determined that shims are required, trial fit one-at-a-time (never exceeding two in any one location) to optimize gear backlash. The above procedures must be adhered to each time a shim is tested (to avoid end play or bearing pre-load).

By examining the drawing you will see that only two positions are acceptable for shimming. Position (A) is behind the bearing nearest the gear on the input shaft and next to the stepped area of the transmission. Position (B) is outside the bearing on the output shaft but inside the flange of the transmission case.

The most desired gear mesh will be that of minimum backlash, even the point of having slight interference during rotation. This condition will " Break-in" during the first few flights. As with any similar system, we always recommend a through check over after the first 20 - 30 flights to ensure good mesh and change to new grease (to remove any break-in debris).



A. At this time clean the input shaft #0423 and the output shaft #0429, the inner race on the four ball bearings #0425 and the two bevel gears.

B. At builders discretion apply a small amount of blue Loctite to input shaft #0423 next to the delrin coupler. Slide one of the bearings #0425 all the way up against the delrin. Lay the lower half of the T/R gear box #0421-A on the table and hold the input shaft over the T/R gear box half and apply a small amount of Loctite where the second bearing goes and slide the bearing into position. Apply blue Loctite to the two M3x3 set screws #0051 and start each in to the bevel gear #0427. Place the gear on the shaft and run one of the set screws down and make sure that it is on the flat. Push this assembly down into the lower T/R gearbox half and adjust the gear so that no end play exist but without binding the two bearings. Tighten the two set screws thoroughly and set aside this assembly to cure for a few minutes.

C. Snap the E-clip #0431 into the groove on the T/R output shaft #0429. Apply a small amount of Loctite to the small portion of the shaft beside the E-clip. Slide one of the two remaining bearings #0425 onto the shaft and up against the E-clip.

D. Apply blue Loctite to the two remaining M3x3 set screws and start them onto the bevel gear #0427. Slide this gear onto the shaft teeth first and run one of the set screws down into the flat spot on the shaft. Slide the plastic spacer #0433 on next followed by the remaining ball bearing #0425. Apply Loctite where the bearing will sit. Lay the other T/R gear box half #0421-B on the table and place the output shaft into its perspective position. Once again adjust the gear and tighten so that there is no end play and no binding in the bearings. **Caution:** This is a small gear, do not over tighten.

E. After curing apply a liberal amount of grease to both gears. With the two shafts in there respective positions bring the two T/R gearbox halves together and install the four M2.2x6.5 phillips screws #0025. **NOTE:** Be sure to install the screws from the correct side. Check for binding, if any - sand plastic spacer between output gear and bearing and reposition gear.

F. Slide the T/R pitch slider onto the shaft. (Pre-Assembled in step 2)

G. Press two #0159 ball bearings into the holes in the tail rotor bellcrank #0445, using the special bellcrank bolt #0095 to keep the bearings aligned and in place.

H. Engage the control ring ball in the clip end of the bellcrank assembly #0445 and squarely thread the special bolt #0095 into the gear housing #0421 from the bottom. Tighten the bolt until there is no play or bearing drag.

I. Stack onto an M2x10 machine screw #0043 one M2 steel ball #0361, followed by one M2 washer #0001. Thread this assembly into the bottom side of the tail rotor bellcrank #0445 in the center hole. Secure in place with one #0015 M2 nut. Use Loctite.

Step 4. **Install Assembled Tail Rotor Hub.**

Parts Required:

3	#0447-1 Locking Clips (Circlips)	Bag 9D
1	#0447-2 Groove Pivot Pin	9D
1	#0449 Rubber Dampener	9D
2	#0001 Flat Washer 2mm (small)	9D
1	#0053 M3x5 Socket Set Screw	9D

(one #0447-1 has been supplied as a spare)

Refer to Drawing #9.

A. Press the silicone dampening #0449 sleeve onto the output shaft about 10mm. Use a 1.5 Allen wrench or a small drill to pierce through the silicone dampener and through the cross hole in the output shaft. Insert the M3x5 socket set screw into the end of the output shaft #0429 and temporarily tighten the M3x5 set screw #0053 against the Allen wrench or drill bit to ensure that no burrs exist in the shaft. Loosen the set screw and remove the allen wrench or drill bit. Check with the drawing to ensure the proper orientation of the delta tail hub before pushing it over the silicone sleeve. Hold the hub with the pin hole lined up with the hole in the output shaft then push the hub into position, a small amount of grease maybe necessary to get the hub to slide over. You may want to slide a smaller object than the pivot pin through the hub and shaft

initially to get the hub centered easily.

B. Center the pivot pin #0447-2 in the T/R hub than apply blue Loctite to the M3x5 set screw #0053, in the end of the output shaft and tighten. **NOTE:** Do not over tighten, breakage of the pin could result.

C. Place a M2 washer #0001 on the pivot pin then snap the clip #0447-1 into the groove. Repeat this process for the other end of the pin.

D. Snap the two ball links #0133 onto the balls #0103 on each tail rotor blade mount.

X. BUILDING THE TAILBOOM

Step 1. **Installing Wire Drive.**

Parts Required:

1	#0471	Aluminum Tailboom	Bag# 10A
1	#0474	T/R Brass Drive Shaft Tube	10A
4	#0475	Drive Shaft Tube Guides	10B

Refer to Drawing #10.

A. Sand the brass tube #0474 with 80 grit sand paper before assembly. Assemble as follows: Slide the four drive shaft tube guides #0475 on the brass tube #0474, all oriented alike; equal distance between each and placing the outer two approximately 6mm (1/4") from each end. Anchor in place with epoxy glue only. Slide the resulting assembly in position in the tail boom #0471, approximately centering it and drip some cyano glue down the inner wall of the tube from each end in turn, holding the tube at the proper angle, and rotating it to allow the glue to flow down to bond the end guides #0475 in place.

Step 2. **Installing Tail Rotor Push Rod Guides and Fin Mounts.**

Parts Required:

1	#0495	Aluminum Tailboom Support Strut	Bag# 10A
1	#0483	Rear Tail Boom Support Fitting	10C
1	#0375	T/R Push Rod (700mm)	10A
1	#0377	T/R Push Rod Extension	10A
1	#0481	Horizontal Fin	10A
1	#0486	Vertical Fin	10A
4	#0477	T/R Control Rod Guides	10C
1	#0385	T/R Control Rod Coupler	10C
1	#0479	Horizontal Fin Mount	10C
1	#0683	Tailbox Clamp(with pre-drilled hole)	10C
		Assembled Tail Rotor Gear Box (From Section X)	
4	#0015	M2 Hex Nuts	10C
4	#0043	M2x10 Slotted Machine Screws	10C
2	#0019	M3 Locknuts	10C
5	#0025	M2.2x6.5 Phillips Screws	10C
5	#0032	M2.9x9.5 Phillips Screws	10C
3	#0063	M3x10 Socket Head Bolt	10C
1	#0071	M3x18 Socket Head Bolt	10C

2	#0133	Plastic Ball Links(Long)	10C
1	#0187	Front Tail Boom Strut Support	10C
1	#0491	T/R Drive Shaft	10A
4	#0057	M4x4 Socket Set Screws	10C

Refer to Drawing #9 and #10.

NOTE: The notched end of the tail boom is the rear (Tail Transmission) side.

A. Slide the #0479 horizontal fin clamp onto the tailboom 8" from the rear. Loosely mount the four tailrotor control rod guides #0477 by wrapping them around the boom and securing each with an M2x10 machine screw #0043 and a M2 hex nut #0015. Mount one between the horizontal fin clamp #0479 and the "rear" end of the tailboom and mount the other three in front of the horizontal fin clamp.(The screws are long enough to allow the control rod to be snapped in from the sides when needed). Measuring from the notched end of the tailboom, the first control rod guide should be 125mm from the end. The next guide should be 190 millimeters from the first one. The next 2 guides should be 190 millimeters apart.

B. Slide the Tailbox clamp #0683 onto the boom and install the M3x10 bolt #0063 and M3 locknut #0019 which squeezes the clamp together. Do not fully tighten. **NOTE:** Notice that the boom is notched and that the tail box has a key on one side which when inserted into the boom notch will prevent any rotation of the tailbox.

C. On the input shaft of the tail rotor assembly, note the two threaded cross holes in the large diameter. Select two M4x4 socket set screws #0057, apply Loctite, and thread them partially in place.

D. Identify the flat on one of the drive shaft #0491 and, orienting it so that it faces one of the set screws, insert the drive shaft in the end hole of the input shaft as far as it will go. Tighten the set screw lightly against the flat (make certain of this orientation) and then tighten the opposite set screw. Then tighten the first set screw. Re-check the tightness of both set screws.

E. Lightly grease the drive shaft and slide it into the tailboom from the fin end until the tail rotor drive housing enters the boom. Press the housing halves together and orient so that the ridge of the housing enters the notch. Push it on until transmission butts up against the tail boom. Slide the clamp #0683 up against the tailbox and align the three holes. Screw the tailbox to the clamp using the three M2.9x9.5 Phillips screws #0032 and slow cyano. Ensure that the tailbox is fully seated then tighten the M3x10 bolt in the clamp.

F. There is a small hole pre-drilled in the top of the clamp #0683. Using a #55 or a (.052) drill bit, drill through the boom and the top half of the tailbox. The bit will stop when it hits the input shaft. Install one M2.2x6.5 Phillips screws #0025 into this hole. This screw will act as a safety to ensure that the tailbox cannot be ejected.

G. Using slow epoxy glue or J.B. Weld epoxy, glue one #0187 front tail boom strut support and one #0483 rear tail boom support fitting into each end of the aluminum tail boom support strut #0495. Lay the assembled support strut on a flat surface and drill a hole, one on each end midway through the aluminum tube into the plastic fittings, using a #49 or 1.8mm drill bit. Install one #0025 screw in each hole. View the drawing to verify correct orientation of the boom support #0395. Bolt this support to the horizontal fin clamp using a M3x18 socket head bolt #0071 an a M3 locknut #0019. Do not tighten.

H. If you are electing not to paint the fins you may install the horizontal fin #0481 and the vertical

fin #0486 at this time. Install the two remaining M2.2x6.5 Phillips screws #0025 in the two holes in the top of the horizontal fin #0481 and into the fin mount #0479. A small amount of Goop or silicone glue under the horizontal fin #0481 will help extend the life of the fin. Use two M2.9x9.5 Phillips screws #0032 to mount the vertical fin into the tail rotor transmission mount #0683.

I. Examine the central rod coupler #0385, noting that it will accept the control rods beyond their threaded portion. The intent is to better support the rods against bending. Use the coupler to join the tail rotor control rod #0375, and the tail rotor control rod extension #0377. (Protect the rods with tape or cloth when clamping them to allow the coupler to be screwed on.) Be sure both rods enter the coupler approximately 6mm in depth. Start a long plastic ball link #0133 on each end of the push rod. Exact adjustment will be made later.

J. Take the tail assembly and slide it partly into position between the halves of the front tail boom support. Holding the helicopter so that the end of the front tail drive shaft is visible ahead of the support, slide the boom further while engaging the drive shaft in the hole in the tail drive #0239. Slide the boom further until its front edge is flush with the front of the support. The drive shaft should project well into the tail drive but should not bottom. Sighting from the rear of the helicopter, rotate the boom until the vertical fin is parallel to the main shaft, and tighten the four support screws snugly. **Option:** Due to the size of some workshops and the aggravation of spinning a model around on the table wondering what you are going to knock over next with the tailboom, you may want to wait until you've finished setting up the main mechanics before installing the tailboom.

K. Identify the two frame holes through which the front tail drive can be seen and visibly locate the drive shaft flat. Select an M4x4 set screw #0057, apply Loctite and by holding it on a Allen wrench, screw it into one of the threaded cross holes in the shaft. Be positive that the flat on the drive shaft is felt under the set screw. Tighten only until contact is made, then add the second M4x4 screw in the opposite hole and tighten. Then tighten the first screw. **(This sequence is important.)**

L. Slide the fin clamp #0479 forward while guiding the lower boom support mount at the other end of the boom support assembly #0495 between the lower mainframes. Align the support with the two holes in the mainframe then thread two M3x10 socket head bolts #0063 into the mount and tighten. Rotate the horizontal fin mount back and forth slightly to ensure that it is not pushing or pulling the boom into a bind. Align the horizontal fin perpendicular to the mainshaft and then tighten the M3x18 bolt in the horizontal fin mount #0479.

M. Temporarily install the tail rotor push rod into the four pushrod guides #0477 and the front rod guide #0387. Align all the pushrod guides so that there is no binding throughout the travel of the pushrod. Snugly tighten the rod guides. Do not over tighten and cause binding.

XI. INSTALLATION OF REMAINING RADIO EQUIPMENT, ASSEMBLING AND INSTALLING PUSHRODS.

Step 1. **Install the Switch for the Receiver, Gyro , Radio Receiver, Battery and the Antenna**

Parts Required:

1 Gyro Unit

Refer to Drawing #11 and #7.

A. Provisions have been made in plastic tray switch plate #0575-8 for the receiver switch and the gain box for the gyro. If you elect to use these positions. Mount the two devices at this time.

B. Mount the gyro motor assembly onto the servo tray or the tank support tray #0189 using two layers of double-side servo tape to help isolate it from vibration. (Order #3869)

C. Plug all your servo leads into the receiver. Do not allow any wires to rub any moving part.

D. Mount the gyro amplifier on the bottom side of the plastic servo tray just ahead of the servo tray stiffeners #0578-1. Use double sided servo tape to secure in place.

E. Wrap the receiver and battery in foam and mount on the front of the plastic servo tray. the battery mounts best on the underside. Secure with either velcro or tie wraps loosely pulled.

F. If a whip antenna will be used, tests have proven that the best place to mount the antenna base is on the radio plastic tray #0575 sticking straight forward.

G. If you are electing to use a full length antenna, route it out of the canopy then down to the landing gear strut next to the skid and then back up to the tailboom. Again ensure that the wire doesn't rub any corners and is free from moving parts.

SPECIAL NOTE: If using a computer radio, clear all ATV's to 100%. Clear normal throttle and normal pitch curves so that they are symmetrical and throwing to there limits. Clear sub trims, trim memory, stunt trims, or anything that would change servo centering. Check direction of the servos.

In the following steps, be sure to use Loctite on all steel threaded balls nuts and screws.
All measurements given for pushrods are from the inside of the ball links at the connection point with the push-rods. Unless otherwise specified.

Step 2. **Install Rudder Pushrod.**

Parts Required:

1	#0043	M2x10 Slotted Machine Screw	Bag 11A
1	#0361	M2 Steel Ball	11A
2	#0015	M2 Hex Nut	11A

Refer to Drawing #11.

A. Activate electronic tail rotor compensation (ATV) for "RIGHT" (Clockwise) rotor rotation. Check direction of tail rotor compensation and gyro. Put collective stick at the mid-position. Position a servo wheel on the tail rotor servo wheel on the tail rotor servo that it is square to the servo. As per the drawing, install one M2x10 slotted machine screw #0043, one M2 steel ball #0361 and one M2 Hex Nut #0015 into a hole at least 11mm out on the servo wheel and mount it at 90 degrees facing inward, Secure with Loctite using one M2 hex nut #0015.

NOTE: The Rudder ball on the servo wheel will be in a neutral position at 1/2 collective stick.

B. Bend the tail end of the tail rotor control rod approximately 168 degrees in order to align with the tail rotor bellcrank #0445. Snap the rear ball link #0133 onto the steel ball in the tail rotor bellcrank #0445. Adjust the position of the four rod guides along the boom to allow a free-sliding control rod and tighten their screws as well as the one in the front rod support. (Use Loctite.)

Attach the front ball link to the rudder servo. Adjustment of the control rod will come later.

Step 3. **Install Elevator Pushrods.**

Parts Required:

2	#0133	Ball links (long)	11B
1	#0043	M2x10 Slotted Machine Screws	11B
2	#0015	Hex Nuts 2mm	11B
1	#0367	Control Rod M2x60	11B

Refer to Drawing #11.

A. Select the #0367 elevator control rod and two #0133 long ball links. Thread the links on the rod until the gap between ball link base to ball link base (Exposed 2.0mm wire) is 47mm.

B. Select a servo wheel with a minimum O.D. 24.5mm and mount it on the elevator servo with a selected hole 10.0 to 12.0mm from center. The selected hole should be mounted vertically upwards and parallel to the main shaft. Into the selected hole install one #0361 steel ball using one M2x10 #0043 screw with M2 nuts #0015 as spacers and retainers. This is to say that the screws are installed from the outside with a nut next to each surface of the plastic wheel. If there is not adhered to, it is possible interference could result during operation.

C. Snap the previously assembled push-rod onto the #0105 ball of the elevator bellcrank #0157 and the elevator servo.

Step 4. **Install Aileron and Collective Pushrods.**

Parts Required:

1	#0043	M2x10 Slotted Machine Screw	Bag 11C
2	#0371	Threaded Pushrods M2x90	11C
6	#0133	Ball Links (long)	11C
1	#0359	Roll Servo Link Retainer Bar	11C
3	#0361	M2 Steel Balls	11C
7	#0015	Hex Nuts 2mm	11C
1	#0101	Threaded Steel Ball M2x5	11C
2	#0045	M2x14 Threaded Machine Screws	11C
1	#0369	Collective Control Rod M2x35	11C

Refer to Drawing #11 and #7.

A. Study the drawing showing the special control arm assembly on the aileron pivoting servo. **NOTE:** that the three control rods running to it have their ball links trapped by the arm assembly and therefore, must be fabricated first.

B. Thread one #0133 ball link onto each end of the collective push rod #0369 until a distance of 21mm is achieved between the ball links.

C. Select the two thread pushrods M2x90 (curved) #0371 and thread one #0133 ball link(long) onto each end of both control rods. Thread the links on the curved ends of the rods until the base of the ball link #0133 is 11mm from the center of the bend in the rod #0371. Thread the remaining ball link on until a distance of 72mm is achieved between the base of the links.

D. Snap one M2 steel ball #0361 (drilled version) in the ball links on the bent ends of the two aileron rods #0371.

E. Insert one M2x5 threaded ball #0101 in the center hole of the roll servo link retainer bar #0359 from the bottom and secure it with one hex nut M2 #0015. Use Loctite.

F. Select a double ended servo arm from the radio system hardware, long enough to match the 24mm hole separation on the retainer bar. If necessary, obtain an un-drilled arm or wheel and drill and shape it to suit. Center the servo electronically and mount it exactly parallel with the servo lengthwise.

G. Insert an M2x14 screw #0045 in each end hole of the retainer bar, slide an aileron roll bar on each and secure with an M2 hex nut. Snap the collective rod ball link on the center ball and mount the assembly of the three rod to the servo arm. Secure with two M2 hex nuts from underneath the arm. Tighten securely using a small wrench or long-nosed pliers. Use Loctite. Check the configuration against the drawing. (collective rod forward).

H. Select a servo wheel with a minimum O.D. 24.5mm and mount it on the collective servo with a selected hole 12.0 to 14.0mm from center. The selected hole should be mounted horizontally inwards and parallel to the aileron servo opening. Into the selected hole install one #0361 steel ball using one M2x10 #0043 screw with M2 nuts #0015 as spacers and retainers. This is to say that the screws are installed from the outside with a nut next to each surface of the plastic wheel, if this is not adhered to, it's possible interference could result during operation. Snap the previously assembled collective pushrod onto the #0361 ball on the collective servo.

I. With the collective stick at open one-half position, the aileron servo should be exactly vertical and both aileron bellcranks are vertical (or level). Adjust the aileron rods #0371 until the bellcranks #0167 are positioned correctly. Keep both aileron rods the same length.

Step 5. **Install Throttle Pushrod.**

Parts Required:

1	#0373	Threaded Rods M2x130	Bag 11D
2	#0133	Ball Links (long)	11D
2	#0361	M2 Steel Balls	11D
4	#0015	Hex Nuts 2mm	11D
2	#0043	M2x10 Slotted Machine Screws	11D

Refer to Drawing #11.

A. Install one M2x10 slotted machine screw #0043, one M2 steel ball #0361, and one hex nut 2mm #0015, into the carburetor arm (outer hole). Secure on the back side with a hex nut 2mm #0015. Use Loctite. Adjust the carburetor arm so that it throws in a symmetrical arc on the upper side of the carburetor.

B. Start a long ball link #0133 on each end of the throttle pushrod #0373.

C. With the collective stick in the middle position, mount a servo wheel on the throttle servo pointing straight down. Position the carburetor at 50 percent or half-throttle. Adjust the throttle pushrod so that it is the same length as the distance between the carburetor arm and the center of the servo arm. Snap the pushrod on the carburetor. Move the collective throttle stick from high to low with the throttle trim full down moving the throttle rod with it to determine where

the control ball should be positioned on the servo wheel.

D. As described in step "A" install another steel ball assembly into the throttle servo wheel. Snap on the pushrod then adjust the A.T.V.'s at full and low stick to fine tune the throw.

Step 6. **Install Rotor Head, Flybar and Hiller Control Rods.**

Parts Required:

8	#0133	Ball Links (long)	11E
4	#0135	Ball Links (short)	11E
2	#0313	Threaded Rods M2x10	11E
2	#0335	Threaded Rods M2x75	11E
2	#0337	Threaded Rods M2x27	11E

Refer to Drawing #11.

A. Remove the special head bolt #0091 from the head, slide the head down onto the mainshaft and align the hole on the top side of the main shaft with the hole in the head block. This can be accomplished by holding the rotor head in one hand and spinning the maingear clockwise with the other. Re-install the special bolt and tighten.

B. At this point check to see how free the washout block slides up and down the guide pins #0297 in the bottom of the head block. If it is stiff, disengage the wash out block and rotate it 180 degrees and try again. Determine which way is best and use pliers to tweak the pins a small amount as needed to one side or the other until the washout block slides up and down the pins with a minimum of drag.

C. Start a long ball link #0133 on each of the two flybar control rods #0337 and adjust to 9mm. Snap both control rods to the flybar control arms and washout arms.

D. Start a long ball link on each end of the Hiller control rods #0335 and adjust to a length of 58mm. These rods go from the bell mixers on the blade holders to the swashplate. Snap both into position.

E. Start a short ball link #0135 on each end of rod #0313 and adjust to a length of 1mm between the ball links. These rods go from the bell mixer to the delta plate on the rotor head.

Step 7. **Collective Decal.**

Parts Required:

1	Degree Decal from Decal Sheet #0500

Refer to Drawing #11.

A. If you desire. The degree decal may be applied to the left main frame as per the drawing. Clean surface well before applying.

XII. CANOPY PREPARATION

Step 1. Assemble Canopy and Paint

Parts Required:

1	#0497 Canopy (2 pcs)	Box
1	#0499 Canopy Latch	Bag #11F
1	#0500 Trim Decal Sheet	Box
1	#0498 Rubber Band	Bag #11F
1	#0502 Special Canopy Bonding Adhesive **(optional)**	

Refer to Drawing #12.

A. Examine the two Canopy halves. Note that they have been die cut to minimize cutting and trimming operations before bonding together. It is still necessary to cut out the back, top and bottom portions along the molded-in guide lines. Use scissors and/or a Dremel tool or a hot knife (a small soldering iron fitted with a collet to hold an "x-acto" blade).

B. Clean the bonding surfaces of the Canopy parts carefully and moderately sand using 80-100 grit sandpaper. Apply glue (#0502) to one side only. Align the surfaces to be bonded and secure in place using masking tape or paper clamps. Re-check parts alignment.

C. Cut small reinforcement strips and bond one at the end of the glue bead on the bottom of the canopy and the other just inside the upper end of the seam leaving room for the canopy latch. Refer to the drawing for placement. Allow 3-4 hours partial cure time, 24 hours full cure time.

D. Trim the canopy edge to 3mm (1/8") all around and sand all plastic edges smooth. (Protect the canopy surfaces with masking tape.)

E. Using glue #0502, mount the #0499 Canopy Latch in place.

F. Carefully wash the canopy with detergent. Mask the window area, sand the area to be painted with a scotch brite pad or 320 grit sand paper. Paint as desired.

G. The decorative Trim Decal Sheet can be used to finish the Canopy as desired.

XIII. BUILDING THE ROTOR BLADES.

Step 1. Assembling Blade Mounts

Parts Required:

2	#3651	Main Rotor Blades	Wrapped in Box
4	#0034	M2.9x13 Phillips Screws	Bag #12A
2	#3721	Blade Mount Reinforcements (2 pr) (Upper & Lower)	Bag #12A
2	#3723	Brass Blade Bushings	Bag #12A

Refer to Drawing #13.

A. Sand each rotor blade with 220 or 320 grit sandpaper until very smooth. (Use of a sanding block and proper attention to thin trailing edges will ensure retention of the correct airfoil. Be certain the trailing edge remains straight during this operation.)

B. Lay all four blade reinforcement halves on a table with insides facing up. Match male and female reinforcement halves together. Using slow cyano only, choose the male reinforcement half and apply even amounts of slow cyano to inner surface of reinforcement and line up with rotor blade root. Push reinforcement onto blade root until it is completely snapped down. It may be necessary to use a rubber hammer for this step. Take care not to damage rotor blade. Immediately apply cyano to matching female reinforcement half and assemble on blade in the same manner as the first half. Press the brass bushing #3723 completely into blade mount pivot hole. Insert two #0034 M2.9x13 Phillips screws into remaining two holes in blade mount reinforcements. Next, apply pressure to the reinforcement halves by either clamping together or using a heavy object as weight on top of the blade reinforcement. Tighten securely. Set aside and allow to dry and repeat process on second blade.

Step 2. Adding Lead Strips

Parts Required:

2 #3710	Lead Strips	Bag	#12B
2 #3712	Balsa Strips		#12B

Refer to Drawing #13.

A. Cut the lead strips #3710 equal in length to the slots provided in the main rotor blades and equal length to each other.

NOTE: Using a sanding block, sand each lead strip on a flat surface by rolling under sanding block.

B. Place all the lead strips in their respective slots and weigh the blades on a gram scale or our new blade balancing system #0514. The total weight should be the same. If not, trim the lead in one of the slots until equal weight is achieved.

NOTE: If a gram scale is not available the following guide may be used:

Net blade weight (weight is written or root of blade)	+____ grams
Full length of lead strip w/balsa caps	+_21__ grams
Blade covering installed	+_14__ grams
Approximate weight of blade mounts installed	+____ grams

C. If less weight is desired, trim one of the lead pieces in each blade until desired weight is achieved.

D. If more weight is desired, you may also add bronze powder #3709 to the blades.

E. Starting at the outer end of the slot, apply a coat of thin cyano around the lead in the slots. Allow to sit for about 30 seconds, then apply cyano accelerator. Repeat this process until near the top. A small gap must be left as to allow room for the balsa strip #3712.

Step 3. **Initial Balance.**

Refer to Drawing #13.

A. As an initial step in balancing, we will now establish the center of balance point. Using a BIC type pen, dowel, or tube of any type, position the blade lengthwise in front of you on a level

surface. Using the pen as a fulcrum at 45 degrees to the leading edge, determine the balancing point, mark the blade accordingly, and repeat at 90 degrees to the previous line. (Hint: Gently rotate the pen right or left until the balance is established, and mark well for future reference, even after sanding). Both blades should balance within 1-2 millimeters of each other. Since they were factory matched and all material added accurately measured, you should have no difficulty. However, if there is an imbalance, the blades may be matched by two possible methods. First, determine which blade you wish to shift and in which direction. For example, if tip weight is to be added, simply rout out a small area at the tip of the blade slot and glue in a small amount of the excess lead strip as needed. Keep in mind that any weight added to the blade being corrected, must also be added to the other blade at the **center of balance point**, thus retaining the original balance of the two blades. The optional bronze #3709 powder may also be used as a balancing aide.

B. Cut balsa strips #3712 for each slot and trim to fit (i.e. round corners). Press balsa firmly into slots and secure with cyano on all sides. Block sand the raised portion until flush with the blade surface. Coat with a film of cyano and wipe away excess.

C. At your option, seal the wood at the hub and tip areas with either instant cyano or fuel-proof paint. Lightly re-sand blades with 220 or 320 grit sandpaper once again. Carefully remove all dust using a clean towel or a tack rag, wiping several times. At clean blade is a must for proper adhesion of the blade covering material.

Step 4. **Cover Blades.**

Parts Required:

2 #3701	Blade Covering	Box
1 #0500	Blade Balance Decal Sheet	Box

Refer to Drawing #13.

A. With the blades now ready for cover, select a clean flat surface and after removing the backing material from a piece of blade covering #3701, lay it adhesive side up. Now carefully measure 10mm in from the near edge and mark each end with a ballpoint pen. Holding the blade with the hub in your left hand and the blade tip in your right hand, set the trailing edge down on the mark from the left end of the covering in a position to just clear the base of the hub when it is wrapped into position. Rock gently to adhere the covering to the trailing edge.

At this point, the 10mm section of blade covering will be visible between yourself and the blade trailing edge. Fold the blade toward yourself and apply pressure on the 10mm section of the marked covering. This will establish the bottom of the blades. Lift the blade up with covering clinging to the trailing edge and firmly smooth the short 10mm side onto the underside of the blade with a continuous slide of the finger. Continue rubbing the entire trailing edge as you rotate the blade upright. Do not allow the covering to touch the top blade surface until the trailing edge is firmly bonded with a clean, sharp fold.

Now rotate the blade further and progressively smooth the covering end to end as you go. Continue around the leading edge and back to overlap the starting edge of the covering on the bottom of the blade. Trim excess covering neatly from the blade and smooth the entire surface again. Repeat this process with the other blade. **Note:** A useful technique to allow good control of this sticky material and to prevent it from prematurely adhering to the blades in any area, weight the covering by sticking a piece of wire on what will be the final edge of the covering to be adhered, before starting. This will cause the covering to maintain a

continuous roll-away from the blade surface until deliberately pressed down. Repeat entire process with the remaining blade.

Step 5. **Final Balance of Blades and Rotor Head.**

Refer to Drawing #13.

Equipment Required: **NOTE:** The performance potential of modern R/C helicopters is so great that the use of specialized equipment for proper assembly and set-up is fully justified by the results achieved. This is particularly true of balancing procedures for all rotating parts. Nothing so clearly distinguishes one helicopter from the rest as perfect blade tracking and freedom from vibration. This manual describes only the procedure usable without special equipment which includes balancing the fly bar on its own bearing in the pivot block, and then suspending the head with main blades from the flybar across two straight edges, such as two rectangular blocks of wood. This procedure has been proven very effective and produces a vibration free head. The ultimate in head balance can be achieved by using a good static balancer such as the balancer #0514 sold by Miniature Aircraft USA or its equivalent. Its value lies in its ability to include main blade balance. If you have such a unit, use it following the instructions with it.

A. First determine the type of flight characteristics you would like to see your model respond to. This step would have been completed in Section 1, Step 6, Paragraph A. Center flybar #0303 on main rotor head #0289. Flybar measurements should be equal distance from tip of flybar paddle to delta offset plate #0339. Make sure main rotor blades are snug in blade holders #0317 and blades are extended out in a straight line to each other for normal flight condition. With main rotor blades perpendicular to tailboom, view flybar from the front of the helicopter. Manually place flybar in a horizontal position and note paddle reaction. If paddles remain horizontal paddles are balanced. If flybar falls to one side, try adjusting the last screw placed in the flybar paddle; in or out to see if balance improves. If condition remains the same remove the last brass insert #0561-1 from the heavy paddle and grind small quantities of brass material from brass insert until paddle balance is achieved. This concludes flybar balancing.

B. Remove the rotor head from the main shaft. Mount the main rotor blades to the head using M4X35 socket head bolt #0082 and M4 lock nuts #0021, temporarily installed in section I. Position the blades straight out from the head and tighten the screws just enough to hold the blades in position.

C. Obtain two wood blocks at least 75mm (3 inches) high with parallel surfaces (2 short sections of good quality 2x4 serve very well) and two single side razor blades. Then, suspend the head and blade assembly between them supported on the fly bar. One main blade will invariably tilt downward.

Note: As described, before rotation of main blade on rotor head may result in a better balance. Cut a partial strip of the red tape provided (the degree of unbalance will give an indication of the width necessary) and apply near the end of the light opposite blade. Just stick a corner of the tape to the blade until the exact amount is determined. When exact balance is achieved (when the blade tips are equal distance from the bench top) apply the tape to the blade starting underneath, as with the regular covering.

D. Re-install the entire balanced rotor head assembly onto the main rotor shaft.

Step 6. **Adjustment of Static Tracking.**

A. Screw in (2) M3x8 socket set screws #0563-2 at the base of the main rotor head block until they just contact the mainshaft. Stand your transmitter antenna (or something else to use as a measure) under the tip of the one blade and rotate the head carefully to make a comparison of the tip height of each blade. Adjust each set screw until moderate pressure exists on the main shaft and each blade tip is at the same height.

First Flight Tip

After hovering the model, land and let blades stop by themselves. Recheck tip height and readjust, if necessary. **IMPORTANT:** Always be sure that the blade pivot bolts are quite snug--offering significant resistance to the lead/lag of the blades. Also, after this procedure, it may be necessary to readjust the tracking slightly.

XIV. FINAL MECHANICAL AND ELECTRONIC SET-UP

Step 1. **Setting up the Collective Servo and Collective Arm.**

Refer to Drawings #11 & #14.

A. Move the collective stick slowly all the way to the top and check that the collective arm is going as far as possible without putting the elevator bellcrank #0157 in a bind where it sticks through the mainframe and adjust ATV as necessary.

B. Move the collective stick slowly all the way to the bottom and adjust the ATV so that the collective arm goes all the way to the bottom without binding.

C. With the pushrod lengths given you should be able to use 100 to 110% ATV travel on the pitch servo.

D. With the collective stick at the top check that the swashplate is moving all the way to the top without binding. Adjust the four lower swashplate rods #0227 if necessary.

E. Once again check all collective and aileron, servo's, bellcranks, and pushrods at one half throttle stick for vertical and horizontal positioning.

Step 2. **Final Swashplate and Fly-Bar Alignment.**

Refer to Drawing #11 & #14.

NOTE: Miniature Aircraft offers both swashplate and fly-bar alignment tool kits. Order #0510 and #0512.

A. **Swashplate:** A final check for a level swashplate may be achieved with the use of a main rotor pitch gauge (#0526) and a fly-bar lock (#0505). All transmitter stick and servo arms should be in a neutral position. Snap the fly-bar lock into the rotor head. Position the pitch gauge on one main rotor blade and set the pitch reading in the blade. Rotate the main rotor head in all four 90 degree positions. If the swashplate is truly level,the pitch reading will remain the same in all four positions. If incorrect, adjust the rods just below the swashplate until a level swashplate is achieved.

B. **Fly-Bar Paddles:** Now that the swashplate has been leveled, the fly-bar paddles may also be leveled, set your pitch gauge on 0 degrees. position on the paddle and adjust the paddles until they are level(Parallel) with the main rotor head. A straight rod such as a fly-bar may be used on the rotor head top as an aid in aligning the paddles. It is very important that the fly-bar control #0307 and the fly-bar paddles are all parallel to each other. For an excellent aid order #0510. (Fly-Bar alignment tool kit).

Step 3. **Adjusting Pitch Curves.**

Refer to Drawing #14.

A. If you have selected an FAI type set up, you will probably want to run, depending on blade selection, 5 to 6 degrees of pitch in a hover (one half collective stick position) with about 10 degrees of pitch at full stick position and about 3 degrees of negative at low stick position. For the idle-up(s) you will want around 4.5 to 5 degrees of pitch at hover, 8.5 to 9.5 degrees at full top and 2.5 to 4 degrees of negative at low. For throttle hold, you will need about 5 degrees at hover, 11 or 12 degrees of positive at full and 4 to 5 degrees of negative at the low.

If you are setting up for hot-dogging, normal stick for hovering should be roughly the same as an FAI set-up. The same is true for the first idle up if your radio is equipped with two idle ups. You would use the first idle up for doing normal aerobatics, then the second idle up would be set up with 0 degrees of pitch at half stick, 4 degrees of negative at quarter stick, 4 degrees of positive pitch at three quarter stick and between 8.5 to 9.5 degrees of positive pitch at full and between 8.5 to 9.5 degrees of negative pitch at low. Throttle hold should be similar to the FAI set up, with the exception of maybe having a little more negative pitch at low for quick descents.

Step 4. **Adjusting Swashplate Throw.**

Refer to Drawing #14.

A. Set the pitch gauge for 0 degrees of pitch. Move the collective stick until pitch gauge lines up with flybar. Set the pitch gauge for -6 degrees and with the main blades running parallel to the tail boom, give full right cyclic and adjust ATV so that the rotor blade has -6 degrees of cyclic pitch change. Repeat this process for the other side using +6 degrees on the pitch gauge. Repeat process for the elevator set up. This is the recommended maximum amount of swashplate travel that should be used.

Step 5. **Adjusting Rudder.**

Refer to Drawing #14.

First check servo for proper directional travel. Right tail stick command pulls the pushrod forward. Reverse if necessary. Turn on the ATS mixing function (for right hand rotation) on your transmitter. The 0 point should be at 1/2 throttle stick position. Adjust the low and high point to approximately 25% each. This will provide a good starting point for your first flight. Check for proper compensation direction by increasing the throttle stick. This should result in pulling forward like a right hand command. Re-Check that at 1/2 throttle stick the rudder servo arm has remained in neutral.
With the throttle and rudder stick in their center position adjust the tail rotor control rod until the outer hole in the tail rotor bellcrank #0445 is approximately 1-2mm rearward from the back edge of the tail rotor transmission housing #0421. This should result in approximately 20mm distance between the tail rotor blades when folded together. Check both left and right tail rotor commands at low and high throttle positions for no binds. Adjust transmitter ATV's if necessary.

Step 6. **Gyro.**

A. Carefully read the gyro instructions provided. Set gyro sensitivity to approximately 40-50%. Turn gyro and radio switches on and check for proper gyro/rudder direction operation. Helicopter nose pulled to the left should result in a right tail rotor command. Reverse gyro if incorrect. When using a gyro, a battery pack with 1000mah minimum is recommended. When switching gyro on and off, observe that rudder servo retains its same centering position. If needed, adjust gyro centering per gyro instructions.

Step 7. **Elevator and Aileron Dual Rates and ATV's.**

Depending on the characteristics of which you desire dual rates should be set for your flying style. A starting point of about 70% on aileron and elevator work well. ATV's should be set for no binding.

XV. FINAL ASSEMBLY AND BALANCE

Parts and Equipment Required:

1 Helicopter Muffler or Tuned Pipe with Mounting Hardware

A. Install the Muffler or Tuned Pipe per its instructions. Connect a section of fuel line from the Tank clunk fitting to the carburetor, incorporating a fuel filter (not supplied) is recommended. Add a (muffler to tank line), with filter, if tank pressurization is desired.

B. Balance: Check the completed helicopter by suspending it from the flybar (with the flybar crosswise) just above a level surface. With an empty fuel tank, it should remain level or tilt forward no more than 6 or 7mm (1/4") as measured over the length of a skid. Adjust battery pack position (or similar system element) to achieve this.

XVI. FINAL ASSEMBLY INSPECTION

A. Recheck entire machine for any loose nuts, bolts, or screws.

B. Re-check plans for proper installation.

C. Inspect radio installation. Check to see that there is no mistake in the operational direction of each servo with no binds.

D. Check all rod connections for proper installation.

E. Check all moving components on helicopter for bind free operation.

F. After completion of the final inspection, we recommend that you familiarize yourself with all stick movements, switches and functions of the radio system as it relates to your helicopter. Practice until you feel comfortably ready for your first flight. Be careful to always ensure that the batteries in your radio system are fully charged before each flying session. We recommend the use of a good battery voltage meter to monitor the voltage level during use.

XVII. NECESSARY FLIGHT ITEMS

A. Obtain items necessary for flight use
1) Glow fuel(Nitro; about 10 - 30%)
2) Fuel pump (electric or manual)
3) Electric starter (12v)
4) Special starter extension (Part #4681 from Miniature Aircraft, USA)
5) 12v battery (preferably a gel-cell; 5.5 amp minimum)
6) 12 volt charger
7) 1.5v glow plug battery with charger
8) Extra glow plugs
9) Ample tools for field use
10) Frequency flag displaying your transmitters' frequency colors or numbers (Supplied with your radio system)
11) Power Panel (optional)

B. At the Flying Field:

1) Obey any flying field rules
2) Check the frequency board or any fliers for frequencies in use before turning on your transmitter
3) Perform a pre-first flight radio range check as per radio specifications
4) Pre-check all radio functions
5) Check for possible help from other helicopter pilots
6) Be sure not to leave radio unit on between usage

XVIII. STARTING AND STOPPING OF THE ENGINE

TO START: Always start the engine by using the transmitter trigger only (high throttle trim, low throttle stick). Check idle-ups and throttle hold for proper position of switches (off). Connect the glow plug battery connection selected to the engine glow plug. Connect the starter to the 12v battery and check that it operates in a counter-clockwise rotation. Hold the rotor head firmly with one hand. Engage the starter extension on the starter with the starter cone on top of the engine start shaft and rotate. When the engine starts remove the starter and glow plug battery.

TO STOP: Set the transmitter throttle stick and trimmer to its lowest setting. If it does not stop, but is running slow enough to halt the rotor blades, then do so and remove the fuel line to stall the engine. In this case, re-adjust throttle ATV until engine may be stopped by use of a transmitter trimmer. (After daily use of your model, we recommend the use of an after run oil for engine protection.)

XIX. FIRST FLIGHT ADJUSTMENTS

NOTE: After the first flight remember to check the static tracking.

A. Before flying double check direction of each control; tailrotor compensation direction and gyro direction. The first few flights should be limited to hovering only.

B. **Engine Carburetor Settings:** With the engine running, set the idle adjustments to enable the engine to maintain a rich reliable idle (trying to four cycle) at low throttle, mid to high trim. Set the high speed needle to accelerate, but slightly rich. The motor should transition smoothly from high rpm's to low rpm's during the flight of the helicopter. Short duration vertical climbs to test the top end are the safest method to get the high speed needle valve setting close.

Throttle and Pitch Curve: After the needle valves are adjusted the model can be trimmed for hover. The throttle curve should be adjusted so that the model is almost to the hover head speed just above quarter stick. This helps the model lift off smoothly and also allows you to do slow vertical descents without the engine dropping out. The throttle curve above half stick should also be adjusted so that slow vertical ascents can be made without the engine speeding up or slowing down. Simultaneously adjust the hover pitch and hover throttle for the head speed you want to hover at, also ensure that the model is hovering at half stick. Next adjust the high and low side of the normal pitch curve until the model has the collective response you want in a hoover.

NOTE: Try to maintain original hovering recommended pitch settings. Flight trim for fine tuning once engine settings have been achieved. Fine tune low pitch settings for aerobatic maneuvers desired. Fine tune high pitch settings to match performance level of engine used.

C. Tail Rotor Trimming: Adjust tail rotor trimming as needed by moving transmitter until a stabilized tail is achieved. Re-center trimmer and adjust tail rotor control rod clevises until tail stabilizes with trimmer in neutral.

D. Tail Rotor Compensation: With the model in a trimmed stationary hover adjust the top tailrotor compensation so that the nose of the model stays straight. Starting at a height of fifteen to twenty feet,

descend and watch for the nose of model to change direction or drift to one side or the other. Adjust lower tail comps to correct this. **NOTE:** The speed that you ascend and descend should be as slow as a FAI pilot might ascend and descend his heli while performing a top hat maneuver.

E. Swashplate Trimming: When the helicopter drifts to the left or the right, adjust aileron transmitter trimmer until stabilized. Re-center trimmer and adjust lower swashplate aileron rods until stabilized again. Repeat same process for fore and aft (elevator) control.

Gyro:

F. If you are using a dual rate gyro adjust the high rate for hovering as high as it will go without oscillation of the tail once you get the model flying in forward flight. Adjust the gyro on the low rate as high as it will go without the tailrotor oscillating.

G. Main Rotor Blade Tracking: The tracking of the main rotor blades may be checked just prior to lift-off. Be sure to maintain a safe distance from your machine. The adjustments can be made by changing the length of the Hiller Rods, #0335, on each side of the head. A piece of colored tape must be applied to one blade during balancing in order to determine which blade is high or low. Tracking procedure:

- Blade speed is low, lower the higher blade
- Blade speed is high, raise the higher blade
- If blades are out an inch or better, re-check original bench pitch settings

H. Top Pitch: Adjust the top end pitch on your idle up functions so that the model will fly at full throttle without losing head speed. A model with to much top end pitch tends to be "pitchy" and unstable.

We wish you good luck and many happy hours of flying!
If you have any further questions, feel free to call us.

The staff at Miniature Aircraft USA would like to express their appreciation to Tim Schoonard and Paul Bittengle for their time and dedication in the creation and final production of the X-Cell Standard .60 Instruction Manual.

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SPECIAL NOTICE
XL-SERIES HELICOPTERS VERSES DUAL-TAIL USAGE

Subject: A). #0541 and 0541-1 High Performance Dual FAI Tail Rotor System.

B). #1006 XL-PRO and #1007 Optima XL-PRO.

C.) #0547 High Speed Tail Gear .30, .40, .50 and .60 size.

1). If the customer purchases a 0541 & 0541-1 Dual Tail Rotor System for installation on a XL-PRO .60 Graphite FAI Helicopter Kit #1006 or Optima XL-PRO .60 Graphite FAI Kit #1007, the customer is required to purchase (2) #0427 Tail-Rotor Beveled gears for proper operation and installation.

2). If the customer purchased #0547 High Speed Tail Rotor gear kit for X-Cell .30, .40, .50 and .60's and decides to install a #0541 or #0541-1 Dual-Tail Rotor System, the customer is required to re-install the #0427 Tail-Rotor gears supplied with the kit or purchase (2) #0427 replacement parts.

Common Solution to Tracking Problems on X-Cell 50, 60 Series Helicopters

- **Probable Cause** -
  Thrust bearing limited by Loctite contamination.
  Solution - Apply loctite inside axle hole rather than on bolt. Use very small amount and allow at least 1 hour cure prior to use.

- **Probable Cause** -
  Thrust bearing is notchy from a contamination of dirt and or crash. Since thrust bearings cannot be properly checked without operational loads it is best to not reuse them after a crash or extended operation. (Avg. use 1 year)
  Solution - Replace units as per manual.

- **Probable Cause** -
  Thrust bearing installed backwards.
  Solution - Always be sure that the load bearing side be nearest the bearing bolt. In other words, the larger I.D. side goes nearest the head block. Carefully reassemble in correct orientation.

- **Probable Cause** -
  Thrust bearing bound-up on head axle. This inhibits correct thrust bearing operation as blade loads vary.
  Solution - Do not overtighten axle bolts. This will cause the ends or the axle to "Swell" or "Roll" slightly limiting the thrust bearing. This is noticeable when the thrust bearing will not easily slide off the axle. Prior to replacement, the axle should be replaced.

- **Probable Cause** -
  Main axle bent causing intermittent tracking problem as the axle tries to rotate slightly within the head block.
  Solution - Replace axle.

- **Probable Cause** -

  Bell mixers are not uniformly installed. This can be either a mixer reversed on the pivot bolts or rotated so that dissimilar length control balls connect to the hiller rods on each side of the head.

  Solution - Carefully study the instruction manual and the appearance of the mixers on the rotorhead. Each mixer has a "stepped" area surrounding one bearing. This "step" should always face the pitch arm portion of the blade holder also, the short control ball #0109 must always connect to the long hiller rods and not the short flybar yoke rods.

- **Probable Cause** -

  Blade pivot bolts are too loose. Due to slight variations in blade cordwise C.G. and the oscillation state in which the blades function during pitch changes, it is suggested that the pivot bolt be used as a "shock absorber" to hinder exaggerated blade oscillation.

  Solution - Tighten blade pivot bolts until the blades are very snug within the mounts - commonly, this would mean that by holding the blade and the flybar, and pivoting the blade the flybar would deflect at least 2" prior to blade movement. 9 out of 10 modelers set this up far too loosely.

- **Probable Cause** -

  Improperly assembled blade reinforcement causing considerable difference in one hiller rod and the other to achieve tracking.

  Solution - Replace blades and study the assembly procedures carefully prior to assembly.

- **Probable Cause** -

  Blade spanwise C.G. not matched.

  Solution - It is most important that the spanwise C.G. be exactly matched prior to covering and that the blades have the same total weight.

NO.	I.D.	O.D.
0001	2.0	5.0
0003	3.0	9.0
0273	6.5	8.5
0009	3.0	7.0
0327	5.0	10.0
0007	6.6	12.3
0005	7.4	14.0
0213	6.2	12.9
0329	8.0	13.0x.25
0331	8.0	13.0x.50
0325	10.0	15.8

NO.	SIZE
0161	3.0x11.7
0225	2x13.7
0451	2x17.7
0297	2.5x24

NO.	SIZE
0025	2.2X6.5
0027	2.2X9.5
0029	2.2X13
0035	2.2X14
0051	M3X3
0053	M3X5
0054	M4X6
0057	M4X4
0033	M3X5
0031	2.9X6.5
0034	2.9X13.0
0089	M3X10
0093	M3X15
0095	M3X19
0097	M3X22
0099	M3X30
0081	M4X16
0083	M4X35
0085	M5X16

NO.	SIZE
0015	M2
0017	M3
0019	M3
0021	M4
0041	M2X8
0043	M2X10
0045	M2X14
0047	M2X16
0061	M3X8
0063	M3X10
0065	M3X12
0067	M3X14
0069	M3X16
0091	M3X16
0071	M3X18
0073	M3X20
0075	M3X25
0077	M3X30
0079	M3X35

M1:1