X-Cell Fury Tempest FAI Instruction Manual

Miniature Aircraft p/n #122-100A

R/C HELICOPTER SAFETY

A radio-controlled model helicopter is a technically complex device that must be built and operated with care. It is also a fascinating and challenging part of the R/C Sport, the mastery of which is very rewarding.

A model helicopter must be built exactly in accordance with the building instructions. The kit manufacturer has spent much time and effort refining his product to make it reliable in operation and easy to build. The essentially bolt-together construction can proceed quite rapidly, giving the builder a strong sense of accomplishment that encourages hasty progress from one construction phase to the next, so that the completed model can be more quickly seen and enjoyed. It is essential to recognize and guard against this tendency. Follow building instructions exactly. Use only original parts – even single screws – and consider no alterations. Vibration and stress levels are high and all fasteners and attachments must be secure for safety in operation.

Note that this is the first use of the word SAFETY in these comments. Previously the kit manufacturer's efforts to ensure RELIABLE operation were mentioned. That is ALL that he can do. Safe operation is the responsibility of the builder/flyer and starts with careful construction and continues with selection and installation of reliable radio equipment, engine, and fuel system, and the proper use of starters and other support equipment.

The need for safety is nowhere greater than at the flying field. A number of guidelines for safe flight have been developed by experienced flyers and are set down here. It is urged that they be read, understood and followed.

GUIDELINES FOR SAFE R/C HELICOPTER FLIGHT

Fly only at approved flying fields and obey field regulations.
Follow frequency control procedures. Interference can be dangerous to all.
Know your radio. Check all transmitter functions before each flight.
Be aware that rotating blades are very dangerous and can cause serious injury. Always hold the rotor head while starting the engine and do not release until at the take off point.
Never fly near or above spectators or other modelers.
If a beginner, get help trimming the model, and flight training later.
Don't "track" the main blades while holding the tail boom. This is a temptation to builders who cannot hover yet and is very dangerous.
Follow all recommended maintenance procedures for model, radio, and engine.

WARNING

This helicopter is not a toy, but a complex flying machine that must be assembled with care by a responsible individual.

Failure to exert care in assembly, or radio or accessory installation, may result in a model incapable of safe flight or ground operation. Rotating components are an ever-present danger and source of injury to operators and spectators.

Since the manufacturer and his agents have no control over the proper assembly and operation of his products, no responsibility or liability can be assumed for their use.

X-CELL LIMITED WARRANTY

The warranty covers defects in material or workmanship or missing components to the original purchaser for 30 days from the date of purchase. Miniature Aircraft, USA will replace or repair, at our discretion, the defective or missing component. Defective components must be returned to us prior to replacement.

Any part, which has been improperly installed, abused, crash damaged or altered by unauthorized agencies is not covered. Under no circumstances will the buyer be entitled to consequential or incidental damages. The components used in this kit are made from special materials designed for special applications and design strengths. We recommend that all replacement parts be original parts manufactured by Miniature Aircraft, USA, only to ensure proper and safe operation of your model. Any part used which were manufactured by any firm other than Miniature Aircraft, USA VOIDS all warranties of this product by Miniature Aircraft, USA.

WARRANTY PROCEDURES

Mail all **warranty information within 15 days** of original purchase date. If service is required, send the component in question (if not missing) together with a **photocopy** of your **bill of sale** and an **accurate description of the problem and part**. Ship components fully insured and prepaid. Miniature Aircraft, USA is not responsible for any shipping damages. We will, at our discretion, notify you of any costs involved, or ship it COD. **You are required to pay all postage, shipping and insurance charges**.

X-CELL FURY WARRANTY REGISTRATION

Please print or type, filling in the information listed belowand mail immediately

Model No: _____ Serial No: _____ Price Paid: _____
Owners Name: _____ Age: _____
Address: _____ Phone_____
City: _____ State:_____ Zip:_____
Purchased From: _____
Dealer's Address: _____
_____
Comments:_____

MINIATURE AIRCRAFT USA
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Sorrento Fl 32776

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FAX (352) 383-3204

X-CELL FURY TEMPEST FAI

INTRODUCTION

These instructions apply to Fury Tempest Kits #1022-5.

Congratulations! You have purchased a quick assembling, high quality helicopter kit ideally suited for beginners through expert pilots. Please pay particular attention to each assembly step.

SYSTEM REQUIREMENTS

A minimum five channel "helicopter" type radio with electronic swash plate mixing capability (known as C.C.P.M.) and five high quality servos ("digital" type preferred due to their superior centering and equality).

A yaw rate gyro (basic or heading lock type) to stabilize and assist in tail rotor control – select the unit best suited to your choice of radio and budget – be aware that even a beginner will appreciate the improved function of a top quality gyro, so choose wisely.

Helicopters require special engines not commonly used in airplanes, so choose a quality product made for or known to work properly in a model helicopter. There are a few good choices and the staff at Miniature Aircraft USA will be happy to assist you. Mufflers or tuned pipes are also important choices and are more limited.

Section VII of this manual will describe some of the choices that are available.

THE KIT PACKAGE

The kit includes detailed drawings showing all parts, part numbers, fastener information and complete radio installation data. Metric hardware is used throughout with correct tensile strength and heat treatment required for each position.

Each assembly step requires that only its corresponding parts bag be utilized, avoiding confusion between similar appearing parts and fasteners for subsequent steps.

Also included are a bag of spare hardware, Allen wrenches (hex keys) and certain other special tools to assist in assembly.

TOOLS AND/OR MATERIALS REQUIRED

The following items are suggested to assist in building the kit:

Screwdrivers - small straight and Phillips
Pliers – small regular, needle nose and forceps
Hand drill with drill bits
Open end wrenches – 5.5mm (7/32"), 7.0mm (9/32") and 8.0mm (5/16")
Dremel tool with sanding drum and carbide disc
Tape
Metric ruler
Small hammer
Appropriate "thin wall" socket to fit your engine crankshaft nut
Vinyl two-sided tape – 1/8" thick (M.A./USA p/n #3869)
Glow plug wrench (M.A./USA p/n #2957-7)
Slow and fast Cyanoacrylate glue (CA) (M.A. USA p/n #4960-1 and #4964-1)

Heat gun
High Quality Synthetic Grease (M.A./USA p/n #4707)
Light oil (Teflon type M.A./USA p/n #4801)
Canopy finishing materials (described elsewhere)
180-220 grit "wet or dry" sandpaper
"C" clip pliers (both expanding and contracting types)
Silicone glue

The following are optional tools:

Ball link installation tool (M.A./USA p/n #0529)
5.0mm nut driver (M.A./USA p/n #2957-1)
5.5mm nut driver (M.A./USA p/n #2957-2)
7.0mm nut driver (M.A./USA p/n #2957-4)
Flybar lock (M.A./USA p/n #0506-1)
Flybar alignment kit (Expert models) (M.A./USA p/n #0510-1)
Swashplate Alignment Tool (M.A./USA p/n #0513)
Pitch gauge (M.A./USA p/n #0526)
Custom hardened hex tools – 1.5mm (M.A./USA p/n #2984-1), 2.0mm (M.A./USA p/n #2984-2), 2.5mm (M.A./USA p/n #2984-3), 3.0mm (M.A./USA p/n #2984-5)

The following items are required or useful in the operation of any R/C helicopter:

Glow fuel specifically formulated for helicopter use with a percentage Nitro-methane content as suggested by your engine's manufacturer or your personal preference (10% - 30% is the normal range). M.A./USA technicians can assist you in your selection.
Fuel pump (We suggest M.A./USA p/n #4331 Electric pump or M.A./USA p/n #4333 Manual pump).
12 volt electric starter.
Starter extension adapter for 6.0mm diameter start shaft (we suggest the "Pro-Flex" start system M.A./USA p/n #4684)
12 volt battery (6.0 amp minimum).
1.5 volt glow battery or glow driver and a connection method to ignite the glow plug. The most convenient connection method is using medium to large "alligator" clips. We suggest you contact M.A./USA to review other available connection options.
Extra glow plugs. Glow plug selection should be of suitable heat range and quality to endure helicopter applications. Avoid "cheap" plugs.
Various selection of quality tools as used in the kit assembling steps.
Frequency flag displaying your radio frequency and color code (included in radio)
Academy of Model Aeronautics (A.M.A.) membership (those individuals not residing in the U.S.A. should join the modeling organization for their country). Membership in the Academy of Model Aeronautics allows you to fly at registered flying sites and events and provides liability insurance. Information is available by calling 1-800-435-9262 or by visiting the A.M.A website at www.modelaircraft.org.
Premium grade fuel filter(s).

ASSEMBLY INSTRUCTIONS

Please take the time to review all instructions and drawings before building the kit.
Each step will list bags, tools and parts required to proceed.
Any position calling for the installation of steel threaded hardware into non-locking threads will refer to the addition of Blue Loctite thread locker (included). Any position using steel hardware into plastic will refer to the addition of slow Cyanolate glue (not included) as a thread locker. Always clean the threads with alcohol and use the locking material sparingly.

For individuals wishing to know, the following maximum torque values apply to metal to metal positions on the model:

Bolt Size	NCM (Metric)	Inch/Pounds (U.S.)
M3	40.0	3.5
M4	70.0	6.2

This information is provided only for interest and in no way indicates that a torque wrench is needed to successfully build the model.

When installing hardware into plastic, be aware that a) threads are forming so hold the item straight while tightening and b) you must stop tightening as soon as the flange or head contacts the plastic surface. Frequently, the text will refer to items known as "PEM" nuts, these are M2.5 and M3.0 threaded steel inserts that are factory installed in both side frames and various frame channels used in the kit. They are non-locking and require the use of Loctite on any related bolts or screws. Do not attempt to remove them and avoid over-tightening hardware into them. They are quite secure with only minimal tightening and Loctite.

ASSEMBLY SEQUENCE SUMMARY

Section
I Building the Rotor head
II Building the Left Main Frame
III Installing the Main Shaft, Main Gear and Front Tail Drive
IV Building and Installing the Radio Support Assembly
V Installing the Right Main Frame, Bell cranks and Gyro Brackets
VI Building and Installing the Landing Gear
VII Installing the Clutch, Fan and Engine Assembly (Including Guidelines for Engine and Exhaust Selection)
VIII Building and Installing the Fuel Tank Assembly
IX Installing the Swash plate, Washout Unit and Rotor head Assembly
X Building the Tail Rotor Assembly
XI Building the Tail boom Assembly, Boom Supports and Installation onto the Main Mechanics
XII Installing the Radio System and Pushrods
XIII Preparing the Canopy
XIV Rotor Blades
XV Final Mechanical and Electronic Set-up
XVI Cliff Hiatt's Recommendations
XVII Final Inspection
XVIII Pre-Flight Information
XIX Starting and Stopping Procedures
XX First Flight Adjustments

I. BUILDING THE ROTOR HEAD

Bags Required: 1A through 1D

Tools or materials required:

Small Phillips screwdriver
Small hammer
Solvent (thinner or alcohol)
Loctite – Blue and Green
Slow Cyanoacrylate (CA) glue
M1.5, 2.5 and 4.0 Allen tool
"Q-Tip" cotton swabs or tissue
Needle nose pliers or forceps
A few inches of masking tape
3/8" or similar socket with an O.D. of 14.0 –16.0mm
Grease

Step 1: Installing the Flybar and Control Arms

Parts Required:

Qty	Part Number	Part Description	Found in Bag
1	#122-01	Flybar Support Tube Assembly	1A
1	#0568-1	Flybar (525mm)	11A
2	#0115	M3 x 10.5 Threaded Balls	1B
2	#0572-7	Aluminum Stand-off	1B
2	#122-03	Flybar Control Arm	1B
6	#0051	M3 x 3 Socket Set Screws	1B
2	#0065	M3 x 12 Socket Bolts	1B
2	#0067	M3 x 14 Socket Bolts	1B
2	#122-05	Flybar Collar	1B

Refer to Drawings #1A and #1B

A. Select two #122-03 flybar control arms, two #0065 M3 x 12 Socket Bolts, two #0572-7 aluminum stand-offs, and two #0115 M3 x 10.5 threaded balls. Assemble each flybar control arm per the drawing. Tighten securely using blue Loctite.

Note: Each flybar control arm #122-03 contains three optional positions. Generally the center hole will be used, but if increased paddle control is desired, the inside hole may be used or if less control is desired, use the outmost hole.

B. Study the drawing for the orientation of each flybar control arm assembly in the #122-08 see-saw. Insert the #0568-1 flybar into either end of the see-saw. Continue to slide the flybar while simultaneously inserting the control arms in their proper positions. Slide one #122-05 flybar collar onto each end of the flybar. Using Blue Loctite, insert two #0051 M3 x 3 socket set screws into each flybar collar. Center the flybar within the #122-08 see-saw assembly and tighten both flybar collars.

C. Choose either one of the flybar control arms, secure in place in the center of the oval cavity in the see-saw using one #0051 M3 x 3 socket set screw. Use Blue Loctite.

D. Repeat with the opposite flybar control arm while keeping both arms parallel to each other. A simple test to insure that they are parallel, is to rotate the flybar until one of the control arms make contact with the upper or lower side of the oval cavity. The opposite arm should make contact with the opposing side of the oval cavity.

E. Select two #0067 bolts and temporarily thread each into holes provided near the base of the head block. Note that even though the holes are threaded full depth, the bolts install from the side closest to the slot at each corner. Do not tighten until Section IX, Step 2F.

Step 2: Installing the Bell Hiller Mixers

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
2	#122-10	Bell Hiller Mixers	1C
4	#106-02	M3x7x3 Flanged Bearings	1C
2	#122-09	M3x0.270"x0.187" Brass Spacer	1C
2	#0091	M3x16 Phillips Bolt	1C
4	#0101	M2x5 Threaded Ball	1C
4	#0562-1	M3x0.09 Shim Washer	1C

Refer to Drawings #1C and #1C-1

A. Press one #106-02 M3x7x3 Ball Bearing into each #122-10 Bell Mixer. A light amount of Green Loctite is mandatory on the outer race of each bearing. Insert one #122-09 Brass Spacer into each bearing cavity opposite the installed bearing, Followed by another #106-02 bearing in the opposite side of the bearing cavity in the bell mixer.

B. Refer to drawing #1C-1 for the various mixing ratios that are possible with the Bell Mixer control ball locations. We suggest starting with the 1:0.9 ratio.

Install two #0101 M2x5 Threaded balls into the outermost M2 tapped holes on the extended bearing mount side of each bell mixer (1:0.9 Ratio). Use Blue Loctite.

C. **Note:** Extra care must be taken when installing the #0091 bolt into the #122-08 Flybar seesaw. Thoroughly clean both #0091 bolts using thinner or alcohol to remove any oil reside.

TIGHTEN FIRMLY BUT DO NOT OVER TIGHTEN THE #0091 BOLT AS IT COULD RESULT IN STRIPPING THE THREADS. If the bolt is removed for any reason, such as a Delta change, thoroughly clean the threads to remove any hardened Loctite and re-apply fresh Loctite before reinstalling the #0091 bolts.

Install each bell mixer (extended bearing mount side first) onto the #122-08 Seesaw using one #0091 M3x16 Phillips Head Bolt and two #0562-1 M3x0.09 Shims. Use Blue Loctite. Each unit should pivot freely after being tightened.

Step 3: Installing the Upper Head Block Assembly

Parts Required:

Qty	Part Number	Description	Found in Bag#
1	#122-14	Upper Head Block	1A
1	#122-17	Head Button	1D
4	#0061	M3x8 Socket Bolt	1D
2	#0088	M3x8 Flat Head Bolt	1D
1		**Pre-assembled Lower Block Assembly from Step 1**	

Refer to Drawing #1D

A. The upper head block #122-14 is symmetrical by design, therefore it may be installed on either side. Slide the upper head block onto the pre-assembled lower block assembly. It may be necessary to lightly tap both components together. Use a plastic or rubber hammer. If any metal device is used protect the parts with a piece of hard wood. Secure together with four #0061 M3x8 socket bolts. Use Blue Loctite.

B. Install the #122-17 head button to the top of the lower head block #122-15. Using two #0088 M3x8 flat head bolts. Use Blue Loctite.

Step 4: Assemble the Main Blade Mounts and Head Axle

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
2	#0011	M5 Washer	1E
2	#0023	M5 Locknuts	1E
2	#0060	M3x5 Socket Bolt	1E
4	#0061	M3x8 Socket Bolt	1E
2	#0086	M5x12 Flanged Socket Bolt	1E
2	#0107	M3x6 Threaded Balls	1E
2	#0105	M3x4.5 Threaded Balls	1E
4	#0319	M8x16x5 Ball Bearing	1E
2	#0329	M8x13x0.25 Shim	1E
2	#0331	M8x13x0.50 Shim	1E
2	#0426	M8x13x0.10 Shim	1E
2	#0840-10	M8x12x0.80 Spacer	1E
2	#0840-12	3 piece Thrust Bearing	1E
4	#0844-7	50-D Rubber O-rings (1 yellow dot)	1E
4	#0844-8	60-D Rubber O-rings (2 yellow dot)	1E
2	#0848-4	Aluminum retainer sleeves	1E
2	#0848-3	M8x12x2.0 Hinge Ring	1E
1	#122-02	Head Axle	1E
2	#122-11	Machined Main Blade Mounts	1E
2	#0086-2	M5 Main Blade Bolts	1E
2	#122-13	M5 Fiber blade Spacers	1E
2	#122-16	Pitch arms	1E
2	#122-18	Negative Delta Spacers	1E

Refer to Drawings #1E, #1F, and #1G

NOTE: Two different hardness of O-rings dampeners and three sets of shim thickness are included. The specific dampening may vary depending on the main blades chosen or your personnel flying style. We suggest starting with the O-rings and shims described in the following building sequence.

-Std. Dampening	2	50-D O-rings	(#0844-7)
	2	60-D O-rings	(#0844-8)
	2	(.25) Shims	(#0329)
-Softer Dampening	4	50-D O-rings	(#0844-7)
	Various combinations of the #0329, #0331, or #0426 Shims		
-Stiffer Dampening	4	60-D O-rings	(#0844-8)
	Various combinations of the #0329, #0331, or #0426 Shims		

A. Select one #122-02 head axle, two #0844-7 50-D O-rings (one yellow dot), and two #0844-8 60-D O-rings (two yellow dots). **(Do not lubricate the O-rings with any oil, grease or Vaseline**. If aid is needed in installing the O-rings, only use liquid which will evaporate such as window cleaner). Center the head axle in #122-14 upper head block. Slide one #0844-7 50-D rubber O-ring on each side of the head axle, followed by one #0844-8 60-D rubber O-ring on each side. Push the O-rings into the upper head block while centering the axle.

B. On one end of the head axle assemble the following components in the sequence shown.

1) one #0329 M8x13x0.25 Shim
2) one #0848-3 Hinged ring (cupped side facing the O-rings)
3) one #0319 M8x16x5 Ball Bearing
4) one #0848-4 Aluminum retainer sleeve (counter-bore side facing the bearing)
5) one #0840-12 Thrust bearing (3 piece)

Special Note: The thrust bearing will contain one outer ring that has a smaller I.D. hole than the other outside ring. Identify this feature before proceeding. Install the larger I.D. bearing race with the groove side away from the retainer sleeve. Apply grease to the groove. Next slide the ball/cage into position, using more grease. Slide the remaining small I.D. bearing race into position with the groove facing the ball/cage.

6) one #0840-10 M8x12x0.80 Spacer
7) one #0319 M8x16x5 Ball Bearing
8) one #0011 M5 Washer
9) one #0086 M5x12 Flanged socket bolt

NOTE:Sparingly apply Blue Loctite to the threads and install into the axle. Tighten only finger tight at this time.

C. Repeat step "B" on the opposite end of the head axle. Tighten both #0086 bolts using two 4mm Allen wrenches.

D. Slide one #122-11 blade mount into position on the bearing assembly and align the holes with those of the aluminum retainer sleeve #0848-4. On the side of the blade mount with only one hole, install one #0060 M3 x 5 socket bolt. Only finger tighten at this time.

E. Select two #122-16 pitch arms, two #0109 M3 x 8 threaded balls, and four #0061 M3 x 8 socket Bolts. Install the #0109 threaded balls into the ends of each #122-16 pitch arm. Use Loctite. Study the drawings and position the assembled pitch arms into the milled groove side of the blade mounts #122-11. Using two #0061 M3 x 8 socket bolts on each arm.

F. **NOTE:** The rotor head is designed to accommodate various degrees of positive or negative Delta. Listed below are the possible combinations. We suggest starting with threaded balls described in the building sequence.

Positive Delta	No spacer – one #0109 M3 x 8 Threaded Ball
	(+3.3 degree Delta) Least Positive Delta
	No spacer – one #0107 M3 x 6 Threaded Ball
	(+5.3 degree Delta) Most Positive Delta
Negative Delta	One #122-18 Spacer and One #0107 M3 x 6 Threaded Ball
	(-3.3 degree Delta) Least Negative Delta
	One #122-18 Spacer and One #0109 M3 x 8 Threaded Ball
	(-5.5 degree Delta) Most Negative Delta

When using negative Delta the fly-bar control arms and the bell mixer must be mounted on the opposite sides of the flybar support tube. In most cases the -3.3 degree Delta position has been the pilots choice.

Note: The pitch arm is a light press fit.

Start to thread one or both #0061 bolts a few turns with a small amount of Loctite. Using a plastic tool handle or a wooden block, tap the pitch arm into place. Moderately tighten both #0061 bolts in each arm. Remove the previously installed #0060 bolt, add Loctite and moderately tighten.

G. Temporarily install the two #0086-2 M5 blade bolts, two #0023 M5 locknuts, and two #122-13 M5 fiber blade spacers.

Step 5: Assembly of the Flybar Paddles

Parts required:

Qty	Part Number	Part Description	Found in Bag#
4	#0051	M3x3 Socket Set Screw	1F
2	#0561-9	Flybar Paddle Aluminum Safety Locks	1F
2	#122-20	Main Paddle Section	1F
2	#122-21	Inner Paddle Cap	1F
2	#122-22	Lead Strips 190mm (7.5")	1F

Refer to Drawing #1H

NOTE: Before assembling the paddles, it will be necessary to choose the overall paddle weight desired by the number of lead strips used to achieve your desired flying characteristics. Our recommendation is a paddle weight of 45-51 grams while using the middle hole in the flybar control arm.

The following characteristics may be expected with the installation of the lead strips:

With no lead: (Approximate total weight 38.0 grams)
-Crisp control with fast cyclic authority.
With single strip of lead in leading hole: (Approximate total weight 51.0 grams).
-Crisp control will remain with increased stability.
With two strips of lead in both holes: (Approximate total weight 65.0 grams)
-Excellent hover control with increased forward flight stability.

A. Assemble both paddles simultaneously.

Remove both sections of lead. Roll the lead strips under a sanding block or a wood block until the lead is straight. Cut the lead into two 90.0mm (3.54″) and two 100.0mm (3.93″) sections. The 90.0mm sections are for the forward most holes in the paddle. The 3.0mm hole on the outside edge of the main paddle, are to aid in removing the lead if desired. Insert the desired lead into the main paddle section #122-20. Snap the #122-21 inner paddle cap into the main paddle section. This will naturally capture the lead in the main paddle section eliminating the need to glue the two paddle sections together. Press in the #0561-9 paddle safety lock into the main paddle section.

B. If a gram scale is available, weigh both paddles to determine if they are matching in weight. Correct if needed by slightly trimming the lead in the heavier paddle.

C. From each end of the flybar, measure in 47mm and place a mark (masking tape works well). Thread each flybar paddle up to the marks. Each paddle must be equal distance out on the flybar. The paddle and flybar arms must be level and in line to each other.

D. Temporarily thread two #0051 M3 x 3 socket set screws into each aluminum safety lock. The set screws may be fully tightened after the flybar balance and alignment process has been completed in Section XIII.

II. BUILDING THE LEFT MAIN FRAME

Bags Required: 2A, 2B, and 3A

Tools or Materials Required:
M2.5 Allen Tool
M5.5 (7/32") flat wrench
M7.0 (9/32") flat wrench

Assemble the Left Main Frame

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
1	#0064	M3x8 Button Head Socket Bolt	2B
2	#0009	M3 Washer	2B
2	#0019	M3 Locknut	2B
4	#0060-1	M3x6 Socket Bolt	2B
7	#0061	M3x8 Socket Bolt	2B
4	#0063	M3x10 Socket Bolt	2B
1	#0089	M3x10 Hex Bolt	2B
1	#0169	Bell Crank Pivot Stud	2B
1	#0823-2	CNC Machined Anti-rotation Guide	2B
1	#115-10	Vertical Rear Channel w/Bearing	2A
1	#115-12	Vertical Front Channel	2A
1	#115-18	Lower Main Shaft Bearing Block	2B
4	#115-20	Frame Spacers	2B
1	#120-8	Main Shaft/Tail Rotor Drive Block Assembly	2B
1	#120-12	Upper Main Shaft Bearing Block	2B
1	#122-25	Carbon Left Main Frame	2A
1	#122-27	Rear Canopy Hex Spacer Mount	2B
1	#120-46	CNC Machined Aluminum Guide Block	2B

Refer to Drawing #2A

A. Select the #122-25 carbon left main frame, one #115-10 vertical rear channel, one #122-27 hex spacer, one #0089 M3 x 10 hex bolt, one #0061 M3 x 8 socket bolt, and one #0019 M3 lock nut. Orient the frame and the rear vertical channel as shown. Install the required hardware. Use Blue Loctite on the #0089 hex bolt. Tighten securely.

B. Select one #0169 bell crank pivot stud and one #115-20 frame spacer. **Note:** The position for the pivot stud is on the out side of the main frame. Install both components. Tighten securely with Blue Loctite

C. Assemble the #120.46 CNC swash plate guide together using one #0060-1 M3 x 6 socket bolt with Loctite. Tighten securely. Install the swash plate guide onto the left main frame using two #0060-1 M3 x 6 socket bolts, align in a vertical position and tighten securely. Use Blue Loctite.

D. Install the #115-12 vertical front channel using one #0061 M3 x 8 socket bolt, one #0063 M3 x 10 socket bolt and one #0019 M3 lock nut. The open side of the channel faces forward. Temporarily install the #0063 M3 x 10 socket bolt into the fifth hole from the bottom of the frame in the location for the channel as shown. Temporarily lightly tighten the bolt so the channel can be aligned at the bottom. Align all holes and install one #0061 socket bolt with one #0019 M3 lock nut into the hole, fourth up from the bottom. Tighten the bolt and nut securely.

E. Install the #120-12 upper main shaft bearing block (hump side upward) using two #0063 M3 x 10 socket bolts. Use Loctite. Do not fully tighten.

F. Install the #120-8 main shaft –tail rotor bearing block as shown using one #0060-1 M3 x 6 socket bolt, one #0061 M3 x 8 socket bolt, and one #0064 M3 x 8 button head socket bolt. Use Loctite. Do not fully tighten.

G. Install the #115-18 lower main shaft block as shown (full diameter of the bearing facing down) using one #0061 M3 x 8 socket bolt and one #0063 M3 x 10 socket bolt. The #0063 will be removed later. Add Loctite to the #0061 socket bolt only.

H. Remove the #120-10 main shaft from bag 3A. Slide it down through all three bearing blocks. Securely tighten all the bolts except the #0063, installed in the lower block #115-18.

I. Remove the main shaft.As per the drawing, install three #115-20 frame spacers in the inner front of the main frame. Using three #0061 M3 x 8 socket bolts. Tighten securely with Loctite.

III. INSTALLING THE MAIN SHAFT, MAIN GEAR AND FRONT TAIL DRIVE

Bags Required: 3A, 3B, 3C

Tools or Materials Required:
M1.5, 2.0 and 2.5 Allen tools
M5.5 flat wrench
Tri flow #4801 or similar Teflon oil

Step 1: Installing Front Tail Rotor Drive Gear and Shaft

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
3	#0051	M3x3 socket set screws	3A
1	#0232	15 tooth bevel gear	3A
1	#0237	M5 retaining collar	3A
1	#120-9	Front transmission shaft	3A

Refer to Drawing #3A

A. Select one #120-9 front transmission shaft, one #0237 retaining collar and one #0232 (15 tooth) bevel gear. Examine the drawing and note the orientation of these parts. Insert the #120-9 front transmission shaft from the rear of the main frame through the bearing in the #115-10 vertical rear channel. With 25-30mm exposed in front of the bearing, slide the #0237 retaining collar followed by the #0232 bevel gear onto the shaft.

B. Select one #0051 M3x3 socket set screw, apply Loctite and partially thread into the #0237 retaining collar. Push the shaft forward into the #120-8 front transmission block and bearing. Apply forward pressure on the white Delrin portion of the #120-9 shaft while pressing rearward on the #0237 retaining collar. Tighten the #0051 M3x3 socket set screw within the collar. Check to see that no end-play exists in the shaft. If yes, then reposition the collar.

C. Select two #0051 M3x3 set screws. Note the #120-9 front transmission shaft has a “flat” for a set screw securing the #0232 bevel gear. Select one #0051 M3x3 set screw and install it into the gear, tightening it enough to be certain it has engaged the “flat” and the gear can be moved for final positioning. The final gear set position after the main gear is installed, observing the rule that the bevel gear be centered within the main gear. Check this for a full rotation of the main gear. Always remember to install the remaining #0051 M3x3 socket set screw and double check the contact of the first set screw within the “flat” provided. Use Blue Loctite on each set screw.

Step 2: Assemble the Constant-Drive Autorotation Upper Section

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
8	#0088-1	M3x5 flat head screws	3B
1	#0866-5	70T upper bevel gear	3B
1	#0866-6	Upper gear mounting base w/main shaft sleeve	3B

Refer to Drawing #3B

Select eight #0088-1 screws and prepare each with Loctite. Select the bevel gear and mounting base. Press the mounting base downward into the upper surface of the bevel gear, aligning the holes as you proceed. From the underside, install the eight flat head screws, tightening them a little at a time in a "star" pattern. Tighten all with light torque.

Step 3: Install the Outer Main Gear onto the Autorotation

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
4	#0088	M3x8 flat socket head bolts	3C
1	#0865-93	93T Outer Main Gear	3C
2	#0866-10	M14.0x20.0x0.2 shim rings	3C
1	#0866-11	M14 Teflon O-rings	3C
1	#0866-4	Lower Housing w/sprag Bearing	3C

Refer to drawings #3C and #3D

A. Select four #0088 bolts and prepare with Loctite. Select the outer main gear and note the four countersunk holes on the upper surface. For this application, only the countersunk holes will be utilized. Press the gear atop the upper housing, align the counter- sunk holes, install the four bolts and tighten with light torque.

B. Select one #0866-10 shim ring and apply a little grease to each side. Set this ring atop the oilite bushing (visible at the top of the upper housing, protruding through the main gear).

C. Select another #0866-10 shim ring, apply grease and slide upward to meet the gear mount. Select one #0866-11 Teflon O-ring and install it next to the shim ring. Set the main gear/sprag housing assembly upright on the table. Insert the upper gear/sleeve assembly downward into the sprag clutch. When it makes contact, rotate the upper assembly slightly clockwise while lightly pressing downward. When it drops inward about 5.0mm (easily noticed as you rotate and push downward) lift the combined parts off the table. Hold them inverted at about a 45 degrees angle and apply a liberal amount of Tri-flow oil to that portion of the sprag clutch that is visible just inside the lower Oilite bushing in the lower hub. Rotate the unit as you apply more oil. The unit will hold about 7-8cc (1/4 ounce) of oil. When oiling is completed, press the upper gear fully into the lower gear and wipe away any excess oil.

Note: never force the main shaft sleeve into the sprag clutch. If it does not insert easily while rotating, look from beneath the sprag to be sure that the cogs look uniformly positioned. There are only retained by an outer spring and it is possible to dislocate one during insertion. If necessary, remove the sprag clutch from the housing and it will return to its proper configuration.

Step 4: Installing the Main Shaft and Main Gear/Auto-rotation Assembly

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
1	#0057	M4x4 socket head set screw	3D
2	#0059-1	M2.5x6 socket head bolts	3D
1	#120-10	Main shaft	3D
1	#0840-6	M3x20 dowel pin	3D
1	#0865-6	M10.1x15.8x0.1 shim ring	3D
1	#0865-7	M10.1x15.8x0.2 shim ring	3D
1	#0866-10	M14.0x20.0x0.2 shim ring	3D
1	#0866-11	M14 Teflon O-ring	3D
1	#0866-12	Retaining collar (black)	3D
1	#0866-13	M14.0x20.20x0.1 shim ring	3D
2	#0875-1	Split type main shaft collars	3D
1	#115-22	M10.1x11.1x7.8 brass tube	3D

Refer to drawings #3D and #3E

A. Select the #120-10 main shaft.

NOTE: The main shaft must be installed per the drawing. Apply a little light oil to a cloth and briskly wipe-down the shaft. This will remove the protective coating. It is suggested that a trial fit of the main shaft be preformed prior to assembling the main shaft components. It may be necessary to loosen the lower block for alignment, re-tighten with the main shaft in place.

As noted above, insert the correct end of the main shaft into the upper main shaft bearing block at the top of the mainframe. Slide it through so that 20-30mm is exposed below the bearing block.

B. Select two #0875-1 "Split" type main shaft collars. Examine the collars. One end of each collar has a flat surface with a 0.30mm raised step near the bore. This end is always to face a ball bearing. Using this criteria, slide two split collars onto the main shaft exposed below the upper bearing block. The upper collar should have it's flat surface (with step) facing up to the underside of the upper bearing block and the lower collar should "face" the bearing in the lower block.

C. Slide the main shaft further downward into and through the lower bearing block until about 6.0 – 7.0mm is exposed below.

NOTE: the following orientation and selection of parts is considered the "normal" parts required. Package 3E will also contain two sizes of special shim rings (#0865-6 and #0865-7) which will only be used to fine-tune an "unusual" fit and would only be utilized ***between*** the #115-22 spacer washer and the auto-rotation unit. Select the #115-22 brass tube. Slide the tube onto the main shaft and up inside the lower bearing block. Approximately 1.0mm will be exposed below the bearing block.

Select the previously assembled auto-rotation, the #0840-6 dowel pin, the #0866-10 shim ring, the #0866-11 Teflon O-ring, the #0866-12 collar and the #0866-13 shim ring. It should now be determined which (or both) shim rings (#0866-10 and/or #0866-13) are required. Invert the auto-rotation assembly and note the Oilite bushing exposed at the base of the housing.

D. A shim ring should ***always*** be placed ***next*** to this bushing. As a trial, install the #0866-10 M14.0x20x0.2 shim ring followed by the Teflon O-ring and the black retaining collar. Temporarily insert the #0840-6 dowel pin through the collar (large I.D. hole) and into the auto-rotation sleeve. Rotate the outer main gear against the inner and check smooth rotation. Move the gear up and down between the upper gear and the remaining collar. The desired situation, is that the gear rotate freely but have very little up/down play. If is too tight, substitute shim ring #0866-13 for the #0866-10. If it is too loose, add shim ring #0866-13. If there is no free play and the rotation is with very light friction, it can remain as is since the Teflon O-rings will break-in quickly. It should be noted that there is no operational problem or risk even if the unit develops as much as 0.5mm of free play (at your option the O-rings could be replaced or a shim added) .

E. When the correct shim(s) has been determined, remove the dowel pin, the retaining collar, the O-rings, and the shim(s). Apply a little grease to each side of the shim(s) and reinstall all items except the dowel pin.

NOTE: Concerning step "F" below, it may be necessary to loosen the lower main shaft block #115-18 to allow the main shaft to slide into the bearing easily. Re-tighten the bolts after the main shaft has been tightened.

F. Slide the auto-rotation unit into position and slide the main shaft downward. Align the holes within the #0866-12 retaining collar, the sleeve on #0866-6 and the lower main shaft hole. Note: that the #0866-12 retaining collar has one large hole and one small hole. The large hole is for insertion of the #0840-6 M3x20 dowel pin and the subsequent #0057 M4x4 socket set screw. The small hole is for removal of the pin using a 1.5mm Allen tool or similar device. Insert the #0840-6 dowel pin as shown in drawings 3E . The pin should easily slide in far enough to allow installation of the set screw. If this is not possible then there are two possible causes and various steps to cure the problem:

1) The pin may not insert fully due to an obstruction within the collar. Remove the collar and trial fit the pin. Look for any metal debris lodged in the "small hole" side of the collar. If any exist, use a 1.5mm tool to push the debris out.

2) The pin may not insert fully due to misalignment of the holes in the related parts. The main shaft hole is suspect here. The easiest solution is to run a ***sharp*** 0.120 (3.0-3.1mm or #31) Drill bit into the assembled retaining collar, sleeve and main shaft. This will deburr any offending hole and will not harm anything. The drill will stop automatically as it reaches the small hole on the opposite side of the collar and is too small to harm the M4 threads at the inlet.

G. Reinstall the pin followed by the #0057 M4x4 set screw with a very small amount of Loctite (on the set screw only).

Note: The sprag bearing should be cleaned and re-lubricated periodically (approximately every 50-75 fights).

H. The main shaft must now be adjusted and secured at the middle bearing block. Select one #0059-1 M2.5x6 socket head bolt, apply a little Loctite and insert an M2 Allen tool. Rotate the lower main shaft split collar (#0875-1) for access to the threaded hole and install the bolt, leaving it loose and the tool in place. Pull upward on the main shaft while pressing downward on the split collar. Tighten the bolt. Check the gear mesh during a full rotation of the main gear. If the gear mesh is "notchy" and tight throughout the 360 degree rotation (and the tail rotor bevel gear is confirmed to be correctly positioned as per Section III Step 1C) then an adjustment is required. This can be accomplished, by either adding a shim ring as per section III step 5D, or slight repositioning of the #0232 bevel gear. The shims are the preferred method. If the gear mesh has only one or two small tight spots during a full rotation, nothing is required as they will break-in quickly.

I. To avoid loss and prepare for final adjustment during a later step, select the remaining #0059-1 M2.5x6 socket head bolt and temporarily install it in the upper split collar, move the unit up to the upper bearing block and lightly tighten.

IV. BUILDING AND INSTALLING THE RADIO SUPPORT ASSEMBLY

Bags Required: 4A and 4B

Tools or Materials Required:
M2.0 and 2.5 Allen tools
M5.5 flat wrench (7/32")

Build the Radio Support Assembly

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
4	#0019	M3 hex lock nuts	4B
2	#0064	M3x8 button head bolts	4B
1	#0089	M3x10 flat hex head bolt	4B
2	#0840-31	M3x16 button head bolts	4B
1	#106-41	Canopy stand-off	4B
1	#115-24	Horizontal channel	4A
1	#122-26	Tank plate	4A
1	#119-28	Radio/battery plate	4A
1	#115-30	16.0x305.0mm red Velcro	4A
2	#115-32	Plastic spacers	4B

Refer to Drawings #4A and #4B

A. Select the #115-24 horizontal channel. Being a "u-shaped" channel, we'll consider the bottom to be the flat side. Select the #122-26 tank plate. Two-sided adhesive tape has already been applied. This side will be the "bottom" side. Review Drawing #4A to determine what is "front" and "rear" for each part. Select two #0064 M3x8 button head bolts and two #0019 M3 hex lock nuts. The two bolts should enter the tank plate from the bottom ("two-sided adhesive tape side") up through the flat side of the #115-24 horizontal channel, followed by two #0019 M3 hex lock nuts from above. Tighten both securely.

B. Select the #119-28 radio/battery plate, the #115-30 Velcro strip, two #0840-31 M3x16 button head bolts, two #115-32 plastic spacers and two #0019 M3 hex lock nuts. At this time, it is suggested to make a determination of final battery position for correct model C.G., two positions are possible, on the radio/battery plate. In general, you will want to locate the plate in the forward position using the most narrow bolt spacing.

C. The #119-28 radio/battery plate is reversible so either side can be considered the top. Holding the Velcro strip firmly against the bottom of the radio/battery plate (with the three holes aligned) insert two #0840-31 M3x16 button head bolts from the topside of the plate and through the Velcro strip. Select two #115-32 plastic blocks and slide each onto an exposed bolt. Position this assembly onto the front end of the #115-24 horizontal channel (the side opposite the previously installed tank plate and the open part of the "u-channel" upward). The plastic blocks will sit inside the open side of the channel. Install and tighten two #0019 M3 hex lock nuts onto the bolts and against the bottom "flat" side of the channel.

D. Select one #106-41 canopy stand-off and one #0089 M3x10 flat hex head bolt. The sides of the #115-24 horizontal channel each have three holes. Two are with PEM nuts and one, at approximately center, is open. From inside the u-channel, insert one #0089 M3x10 flat hex head bolt so it protrudes out of the "left side" open hole. Examine the left main frame. In the lower front section, the left frame has three holes which correspond to those on the left side of the horizontal channel. Apply Loctite to the previously inserted #0089 bolt and insert it with the horizontal channel into the furthermost forward hole in the main frame. From outside the main frame, install one #106-41 canopy stand-off onto the #0089 bolt. Align the remaining two holes and tighten the bolt into the stand-off using a flat wrench.

V. INSTALLING THE RIGHT MAIN FRAME, BELL CRANKS AND GYRO BRACKETS

Bags Required: 5A through 5E

Tools or Materials Required:
M1.5, 2.5 Allen tools
M5.5 and 7.0 (5/32" and 7/32") flat wrenches
Small Phillips screwdriver
Slow Cyanolate glue (CA)

Step 1: Installing the Rear Elevator Bell Crank

Parts required:

Qty	Part Number	Part Description	Found in Bag#
2	#0003	M3 Washer	5B
2	#0107	M3x6 Threaded Balls	5B
1	#122-29	Rear Elevator Bell Crank	5B
1	#0099	M3x30 Phillips Bolt	5B
1	#0019-1	M3 Lock Nut (special low profile)	5B
1	#0597-1	M3x3.19x4.75 Brass Spacer	5B
1	#0597-2	M3x3.42x4.75 Brass Spacer	5B
1	#122-36	Carbon Right Main Frame	5A
1	#122-18	Threaded Spacer	5B

Refer to Drawing #5A

A. Study the drawing for proper orientation of the assembly of the elevator bell crank #122-29. Install one #0107 M3 x 6 threaded ball onto the bell crank as shown. Install the #122-18 threaded spacer on the elevator ball crank. Install one #0107 M3 x 6 threaded ball onto the stand off. Use Blue Loctite and tighten all components securely.

B. As shown on the drawing, insert one #0099 M3 x 30 Phillips bolt and one #0003 M3 washer into the appropriate hole for the elevator bell crank on the left main frame #122-15. On the inside of the left frame slide one #0597-1 brass spacer, followed by the #122-29 elevator bell crank assembly, and one #0597-2 brass spacer.

C. Position the #122-36 right main frame onto the #0099 elevator bell crank bolt. Lightly secure in place with one #0003 M3 washer and #0019-1 M3 low profile locknut.

Step 2: Installing the Right Main Frame

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
1	#0064	M3x8 Button Head Socket Bolt	5C
9	#0061	M3x8 Socket Bolt	5C
4	#0063	M3x10 Socket Bolt	5C
2	#0019	M3 Lock nut	5C
2	#0089	M3x10 Hex Head Bolt	5C
3	#0060-1	M3x6 Socket Bolts	5C
1	#0169	Bell Crank Pivot Stud	5C
1	#106-41	Canopy Stand Off	5C
1	#122-27	Rear Canopy Hex Spacer Mount	5C
2	#0009	M3 Washers	5C

Refer to Drawing #5B

Use Blue Loctite on all hardware except the #0019 M3 lock nuts and corresponding socket bolts. **Do not fully tighten** until all components have been installed. Install the following:

A. One #0169 bell crank pivot stud into the #115-20 frame spacer opposite the #0169 pivot stud in the left main frame

B. Two #0063 M3 x 10 socket bolts into the #120-12 upper shaft bearing block

C. One #0089 M3 x 10 hex bolt and one #106-41 canopy stand off opposite the canopy stand off installed in Section 4-B.

D. One #0089 M3 x 10 hex bolt and one #122-27 rear canopy hex spacer mount into the upper hole in the rear channel #115-10.

E. One #0061 M3 x 8 socket bolt and one #0019 M3 lock nut into the fourth hole down in the #115-10 rear vertical channel

F. Two #0061 M3 x 8 socket bolts into the rear two PEM nuts in the horizontal front channel #115-24.

G. Two #0060-1 M3 x 6 socket bolts and two #0009 M3 washers into the C.N.C. swash plate guide block #122-29.

H. One #0061 M3 x 8 socket bolt and one #0019 M3 lock nut into the fourth hole up in the front vertical channel #115-12. Temporarily install one #0063 M3 x 10 socket bolt into the fifth hole up. **Do not tighten this bolt.**

I. One #0060-1 M3 x6 socket bolt, one #0061 M3 x 8 socket bolts and one #0064 head socket bolt onto the #120-8 main shaft T/R drive bearing block.

J. One #0061 M3 x8 and one #0063 M3 x 10 socket bolt into the #115-18 lower main shaft block. **Do not fully tighten the #0063 bolt.**

K. Three #0061 M3 x 8 socket bolts into the three #115-20 frame spacers.

Tighten all components securely unless otherwise noted.

Step 3: Installing Aileron Bell Cranks

Parts required:

Qty	Part Number	Part Description	Found in Bag#
2	#122-23	Aileron Bell Cranks w/ Bearings	5D
2	#122-35	Bell Crank Collars	5D
2	#0051	M3x3 Socket Set Screws	5D
2	#0115	M3x10.5 Threaded Ball	5D
2	#0109	M3x8 Threaded Ball	5D

Refer to Drawing #5C

A. Refer to the drawing for orientation of the threaded balls in each bell crank. The installation of all the balls will be on the side of the bell crank with the longest bearing boss. The ball must be installed in a manner which creates a right and a left unit.

B. Using Blue Loctite, install one #0109 and one #0115 threaded balls into each #122-23 bellcranks.

C. Select two #0051 M3 x 3 socket set screws, two #122-35 retaining collars and the assembled bell cranks. **Note:** The position of the previously installed #0169 pivot studs near the main shaft in each main frame. Slide one bell crank onto each #0169 pivot stud with the flat side towards the main frame and the #0115 threaded ball (long one) towards the top (the balls should be facing outwards). Followed by one #122-35 collar. Apply Loctite to each #0051 M3 x 3 socket set screw and install in each collar. Adjust each so that the bell crank pivots move freely without end play. The set screws only require moderate tightening torque.

Step 4: Final Main Shaft Adjustment

This step involves the #0875-1 upper split main shaft collar and #0059-1 M2.5x6 socket head bolt (previously temporarily installed in Section III, Step 5H). Place a small drop of Loctite on a scrap plastic bag. Rotate the main shaft until the bolt in the upper collar is visible through the upper frame "window," insert a finger through the opposite frame "window" and secure the collar. Use an M2.0 Allen tool to remove the bolt, dip into the Loctite, and re-install into the collar. While holding the collar with the tool, apply light downward pressure on the main shaft, upward pressure on the collar, and tighten the bolt using moderate torque. The main shaft should rotate freely and have no vertical free-play.

Step 5: Assemble and Install the Rudder Bell Crank

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
1	#0009	M3 flat washer (small)	5E
2	#0061	M3x8 socket head bolt	5E
1	#0105	M3x4.5 threaded ball	5E
1	#0107	M3x6 threaded ball	5E
2	#0636	M5x10x3 flanged bearings	5E
1	#0862-4	Brass spacer ring	5E
1	#0862-1	Rudder Bell Crank Stand off	5E
1	#0063	M3x10 Socket Bolt	5E
1	#122-37	Rudder Bell Crank	5E
1	#0019	M3 Lock nut	5E

Refer to Drawing #5D

A. Select two #0636 flanged ball bearings, one #0862-4 brass spacer ring, and one #122-37 rudder bell crank. Press one bearing into one side of the bell, insert from the opposite side one #0862-4 brass spacer followed by the remaining bearing (the brass spacer will limit full insertion of the second bearing by .03-.04mm to prevent bearing damage after installation on the stand-off).

B. Examine the drawing and note the orientation of the bell crank on the model and the required threaded balls (flat side facing towards the right main frame, long end downward, longer threaded ball on the long end/flat side and shorter ball on the short end facing the main frame).

C. Select one #0862-1 bell crank stand off and install it on the right main frame using one #0063 M3 x 10 socket bolt, through the fourth hole up on the rear vertical channel #115-10 and the right frame.

D. Select one #0105 M3x4.5 threaded ball and one #0107 M3x6 threaded ball. Apply a small amount of slow Cyanolate their threads and install in the appropriate positions on the bell crank.

E. Select one #0009 M3 flat washer (small) and one #0061 M3x8 socket head bolt. Press the bell crank onto the stand-off previously installed on the rear of the left main frame as shown. Place the #0009 washer onto the #0061 bolt and add a small amount of Loctite to the threads. Install this into the stand-off and tighten with moderate torque. Check for smooth movement of the bell crank.

F. Install one #0061 M3 x 8 and one #0019 M3 lock nut into the fourth hole up in the rear vertical channel and the left main frame. Tighten securely.

Step 6: Install the Gyro Brackets

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
2	#0061	M3x8 socket head bolts	5F
1	#0595-1	Gyro bracket (A)	5F
1	#0595-2	Gyro bracket (B)	5F
1	#115-20	Hex spacer	5F

Refer to Drawing #5E

A. Examine the drawing and note front/rear orientation of the gyro brackets (always the same) and the two width possibilities corresponding to your choice of gyro. Make the best selection for your gyro sensor.

B. Select one #115-20 M3 hex spacer, two #0061 M3x8 socket head bolts, one #0595-1 type "A" gyro bracket and one #0595-2 type "B" gyro bracket. Install the brackets as shown, making sure they are well tightened and aligned to form a uniform flat top surface.

VI. BUILDING AND INSTALLING THE LANDING GEAR

Bags Required: 6A and 6B

Tools or Materials Required:

M2.5 Allen tool
Small Phillips screwdriver
Hand drill with 2.35mm (3/32") drill
Small hammer
Slow Cyanolate glue
M5.5 (7/32") wrench
Tape

Installing Landing Gear Braces and Struts

Parts Required:

Qty	Part Number	Part Description	Found in Bag#
4	#0003	M3 flat washers (large)	6B
8	#0019	M3 hex lock nuts	6B
4	#0065	M3x12 socket head bolts	6B
4	#0075	M3x25 socket head bolts	6B
2	#0151	Black struts	6A
2	#122-39	Titanium skids	6A
4	#0153-1	Plastic skid caps	6B
2	#115-40	Black aluminum landing gear mount	6B
1	#122-41	Lower frame plate	6A
4	#0058-1	M4 x 6 Hollow Point Set Screw	6B
2	#0009	M3 Flat Washers (small)	6B
4	#0061	M3x8 Socket Head Bolt	6B
1	#122-86	Support Block	6B

Refer to Drawings #6A and #6B

A. Select four #0003 M3 large flat washers, four #0019 M3 hex lock nuts, four #0075 M3x25 socket head bolts, two #0151 struts one #122-41 lower frame plate and two #115-40 machined landing gear mounts.

B. Examine the drawing and note the orientation of parts to be attached to the strut. As noted, install one #115-40 landing gear mount, one #122-41 (the front side) lower plate, two #0003 M3 washers, two #0019 M3 hex lock nuts and two #0075 bolts. Do not fully tighten the bolts to allow alignment later. Repeat the steps for the remaining strut. Use the slots in the rear side of #122-41 lower plate.

C. Install one #122-86 Support Block into the frames using four #0061 M3x8 Socket Head Bolts and two #0009 M3 Washers. Use Blue Locktite. Tighten securely after step D.

D. Examine the drawing and note the orientation of the parts as they attach to the main frame assembly. The main frame assembly will slide downward into the channel formed at the top of each #115-40 landing gear mount. Select four #0065 M3x12 socket head bolts and four #0019 M3 hex lock nuts. Install each strut

assembly onto the main frame with the lower end of each strut "swept forward" (meaning that, as viewed from the side, the top of the strut appears further rearward on the model than the lower part of the strut where the skid inserts). Leave this hardware slightly loose for alignment. With the bottom of each strut squarely on a flat surface, tighten all eight previously installed bolts. Check to be sure that the #122-41 lower plate remains flat with no bow.

E. Select two #122-39 skids and four #0153-1 skid caps. Install a skid cap into each end of each strut by applying a small amount of slow Cyanolate glue inside the strut and pressing the cap fully in place.

F. Examine the top of each strut in the area where the skid is inserted. Each will have an 8.0mm diameter raised "boss" for the following procedure. Select an electric drill with a 2.35mm (3/32") drill bit. Holding the drill vertical directly over the molded 8.0mm diameter "boss" of the strut, drill downward into the "boss". Select another drill bit measuring 3.43mm (0.135") and enlarge each hole. Thread one #0058-1 M4 x 6 socket set screw approx. half way into the drilled holes.

G. Select each skid and apply a piece of tape just ahead (nearer the curved end) of a measured mark 266.0mm (10.5") from the rear end of the skid (measure at the "skid end" not the cap).

H. With the model sitting atop a flat surface, slide each "marked" skid into each strut so that the front edge of the front strut contacts the measured "tape" mark and each skid appears straight and vertical as viewed from the front "eye level" with the table top. Keep the model secure in this position. Tighten all four #0058-1 set screws down against the top side of the skids. Each skid should be secured in place.

VII. INSTALLATION OF THE CLUTCH, FAN AND ENGINE ASSEMBLY (INCLUDING GUIDELINES FOR ENGINE AND EXHAUST SELECTION)

Bags Required: 7A through 7F

Tools or Materials Required:

M2.5 and 3.0 Allen tools
M5.5 (7/75") flat wrench
Light oil
"Thin wall" (12 point) socket and ratchet to fit the crankshaft nut of your chosen engine
6.0-7.0mm (1/4") diameter wooden dowel of minimum – 75mm (3") length
Small Phillips screw driver
Sharp modeler's knife or Dremel tool with cutting wheel
Cyanolate or silicone glue

Central Guidelines to Assist in Properly Handling the Engine and Fan Hub Assembly:

Always remove the carburetor to facilitate safe tightening of the crankshaft nut (the only exception being the Y.S. engines which should, instead, have its crankshaft secured through removal of the crankcase backing plate). Use a wooden dowel or 6.0-8.0mm (1/4"-5/16") in diameter to secure the crankshaft during the tightening of the crankshaft nut. Additionally, the kit includes a flat plate #0546-21 to be attached (via the included M4x12 bolts) to the top of the fan hub so the fan is not damaged. Never use the fan blades as a device to grip the hub. Never use any device that secures the crankshaft by contacting the top of the piston as this can damage the engine.

Always use the proper socket to fit the crankshaft nut. **NOTE**: Most Sixty thru .91 engines with larger diameter crankshaft require "thin wall" (12 point) type sockets due to their larger crankshaft hex nuts. Do not use any nut other than that supplied by the engine manufacturer.

All Fury kits utilize a "dual collet" system to secure the fan hub. In all cases, the engine's factory installed drive hub (along with any factory Woodruff key, collet or washer) are to be removed and not utilized. It is recommended that a very light coat of oil be applied to each brass collet (supplied with your kit) to improve its fit into the fan hub. Additionally, the fan hub should be rotated about one turn (with light tension from the crankshaft nut) upon the collets to improve the contact.

Guidelines for Engine Selection:

The following engines are best suited to your kit:

O.S. 91H
Y.S. 80H
Y.S. 91H

NOTE: If desired, the Tempest can be flown using a .61 size engine with no problems, however a gear ratio change will be required. If you wish to consider other choices and have questions, contact Miniature Aircraft USA for assistance.

Guidelines for Exhaust System and Fuel Selection:

Many choices in exhaust systems are available and their performance is directly related to the choice of fuel. Always use the highest quality "helicopter only" fuel. The nitro-methane content is an important factor in choosing an exhaust system.

Exhaust systems can be classified as two types: mufflers (a canister bolted directly to the engine or attached with an O-ring to an adapter) and tuned pipes (identified by a curved tubing manifold, silicone or Teflon coupler; and a tapered or cylindrical "tuned pipe").

Mufflers – generally considered the most "user friendly" systems, requiring little or no maintenance, compatible with all levels of nitro-methane and least sensitive to glow plug choices.

The following are to be considered in your selection of an exhaust system:

Muffler Systems

Hatori #9914 80/90 two piece muffler (with "O" rings)
Hatori #9916 90 two piece muffler (with "O" rings)

Engines:

Collets and related components for suggested engines (each listed in order of assembly starting at the engine front bearing):

O.S. 91H

Qty	Part Number	Description
1	#0331	M8x13x0.50 Shim
1	#0546-6	Base collet
1	#0579-4	Cooling fan/hub
1	#0546-5	Upper collet
1	#0331	M8x13x0.50 Shim
1		Hex nut

Y.S.(Yamada) .80

Qty	Part Number	Description
1	#0546-6	Base collet
1	#0579-4	Cooling fan/hub
1	#0546-5	Upper collet
2	#0331	M8x13x0.50 Shim
1		Hex nut

Y.S. .91H

Qty	Part Number	Description
1		Stock Washer
1	#0619	M10x16x0.50 Shim
1	#0546-6	Base collet
1	#0579-4	Cooling Fan Hub
1	#0546-11	Upper Collet
1	#0331	M8x13x0.50 Shim
1		Hex Nut

Step 1: Installation of the Fan Hub Assembly On the Engine

Parts Required:

Qty	Part Number	Description	Found in Bag#
2	#0078	M4x12 socket head bolts	7B
1	#0546-6	Base collet (9.5mm I.D.)	7B
2	#0546-16	Molded rubber dampeners	7B
1	#0579-4	Fan/hub assembly	7A
1	#0546-21	Fan tool	7A
2	#0331	M8.0x13.0x0.5 flat washers	7B
1	#0546-5	Collet (8.0mm I.D.)	7B
1	#0546-11	Upper Collet (Y.S. .91)	7B
1	#0619	M10 x 16 x .50 Shim	7B

Refer to Drawing #7A

A. Following the previous guidelines, select the correct collets and related hardware and install the fan on your engine of choice. Be sure to use Loctite and tighten the hex nut with moderate torque using a ratchet wrench of at least 6.0" in length (typical 3/8" drive ratchet wrench).

B. We highly suggest checking the run out of the fan hub with a dial indicator. This may be checked on the face or the inside wall of the fan hub. A reading of .002" or less is acceptable.

C. At this time, it is wise to make a simple test to check clearance between the clutch driver and the tip of the engine crankshaft. Select the #122-44 clutch/bearing block/driver assembly from bag 7B. **Note**: The Delrin ball (bronze in color) and drive pins protruding from its base. As a test, press this end into the fan hub until flat atop the hub. While this is not as it will ultimately be positioned, it will determine that a proper gap exists between the tip of the crankshaft, the crank nut, and the clutch driver. If it will not press fully in place, then the crankshaft must be shortened accordingly, or you have used the incorrect washer(s) under the crank nut. The problem is rare but still important to consider. If necessary, place the engine/fan assembly into a plastic bag (exposing only the tip of the crankshaft) and use a Dremel tool with carbide disc to remove a little material from the crankshaft tip.

NOTE: The #122-44 clutch/bearing block/clutch driver assembly is provided to you *temporarily* inserted in the #122-51 clutch bell/pinion gear/upper bearing block assembly.

D. Select two #0546-16 molded rubber dampener. Examine each, noting that one side will have a 4.5mm hole (sometimes a "through" hole) and a small 2.0mm "dimple." This side will face up, away from the fan hub. Each dampener can be installed dry or with talcum powder using a blunt tool or finger tips to insert fully into the hub. They sit "flush" or within 0.25mm of the top surface of the hub.

Step 2: Installing the Clutch Assembly

Parts Required:

Qty	Part Number	Description	Found in Bag#
20	#0009	M3 flat washers (small)	7C
8	#0063	M3x10 socket head bolts	7C
1	#122-44	Clutch/lower bearing block/clutch driver assembly	7C
1	#122-52	Clutch bell/pinion gear/upper bearing block assembly	7C
1	#115-45	M6 O-ring	7C
8	#0065	M3x12 Socket bolt	7C
2	#122-57	Graphite Doubler Plates (7.66/7.75)	7A

Refer to Drawing #7B

A. Select the #122-44 clutch/lower bearing block/clutch driver assembly, the #122-52 clutch bell/pinion gear/upper bearing block assembly, the #115-45 M6 O-ring and the #122-57 clutch doubler plate.

B. Slide the #115-45 O-ring onto the exposed 6.0mm shaft of the #122-44 clutch/driver assembly followed by the #122-52 clutch bell assembly.

C. Remove the four #0063 bolts previously installed in the right and left sides of the upper hole in the front vertical channel #115-12 and the front bolts in the lower main shaft block #115-18.

D. Select the twenty #0009 M3 washers, eight #0063 M3 x 10 socket bolts and eight #0065 M3 x 12 socket bolts from Bag 7C. Place one #0009 washer on each bolt including the bolts from Step B.

E. Install the clutch/clutch bell unit in place in between the main frames. Examine the drawing and note the position of the #0063 M3 x 10 socket bolts and the #0065 M3 x 12 socket bolts through the doubler plates into the clutch unit. Lay one #122-57 graphite doubler plate in position on the left main frame. Using Blue Loctite, install two #0063 bolts and two #0009 washers through the doubler plate into the inner most holes in the clutch unit lower bearing block. Install two #0065 and #0009 bolts and washers into the clutch bell upper block. Repeat on the right main frame.

Do not fully tighten at this time.

F. Install two #0065 M3 x 12 socket bolts and two #0009 M3 washers through the doubler plates and into the outer positions in the clutch units lower bearing block.

G. Prepare eight #0063 M3 x 10 socket bolts and eight #0009 M3 washers with a little Loctite. Examine the drawing and note the position for each bolt around the perimeter of each #122-57 doubler plate.

Do not fully tighten at this time

H. Slide a small piece of note book paper in between the clutch bell gear and the main gear. Tighten a four bolts in each doubler plate from Step “F”. Next tighten all twelve bolts holding the clutch/clutch bell unit in the doubler plates. Remove the paper.

I. The gear mesh should have minimal free play and be smooth. The gears may require a few flights to "BREAK IN" so disregard any minor irregularities in the mesh.

Step 3: Installing the Motor Mounts and Engine

Parts Required:

Qty	Part Number	Description	Found in Bag#
6	#0003	M3 flat washers (large)	7D
6	#0019	M3 hex lock nuts	7D
2	#0063	M3x10 socket bolt	7D
4	#0067	M3x14 socket head bolts	7D
2	#0077	M3x30 socket bolts	7D
2	#0079	M3x35 socket head bolts	7D
4	#0080	M4x14 socket head bolts	7D
1	#0546-19	Alignment tool	7D
1	#115-53	Inner motor mount block	7D
1	#119-50	Left Motor Mount	7D
1	#119-51	Right Motor Mount	7D
4	#115-47	Motor Mount Shims	7D

Refer to Drawings #7C and #7D

A. Select four #0003 M3 flat washers (large), four #0019 M3 hex lock nuts and four #0067 M3x14 socket head bolts. Additionally, select one each #119-50 and 119-51. Examine the drawing and note two 3.0mm holes (ahead of the vertical slots) passing through each side frame and the #115-12 vertical front channel. Prepare four #0067 M3x14 socket head bolts by installing one #0003 M3 flat washer on each. Loosely install the appropriate motor mount onto each side frame by inserting a bolt and washer at each hole (through the vertical front channel) and adding one #0019 M3 hex lock nut inside, tighten each so that the mounts are secure but can be slid up/down for the next step.

B. Select two #0079 M3x35socket head bolts and add a little Loctite. Select one #115-53 inner motor mount. Examine the drawing and note the opposite direction for the installation of each #0079 bolt, and install the block and bolts. Tighten them so that the motor mount can still slide up and down.

C. Using the two lower holes below the motor mounts, install two #0077 m3x30 bolts and two #0019 M3 locknuts on the opposite side. On the underside of the #122-41 lower plate, below the inner motor mount #115-53, install two #0063 M3x10 bolts and two #0003 M3 washers. Use Loctite on the bottom bolts. Tighten all bolts securely (with exception of the two #0079 bolts).

D. Select four #0080 M4x14 socket head bolts, four #115-47 motor mount shims, and the #0549-19 alignment tool. Examine the alignment tool and note the slot next to the half-round cut-out area. The tool is intended to set a gap between the clutch driver and the fan hub, with the slot and cut-out providing clearance around the drive pins and Delrin ball on the clutch driver.

E. Prepare each engine mounting bolt by adding Loctite. Prepare the engine by making sure the carburetor stop screw is adjusted to allow for a fully closed carburetor (determined by visually observing the closed barrel and the inability to blow air through fuel line connected to the fuel inlet).

F. The #0546-16 molded dampeners within the fan hub will accept the clutch driver pines in any one of three ways 1) dry or lubricated with 2) talcum powder or 3) a thin coat of petroleum jelly (Vaseline). Do not lubricate the Delrin ball.

G. Slide the engine into position, making sure each drive pin is properly in each dampener. Install two #115-47 shims on each motor mount and four of the appropriate mounting bolts to secure the engine, leaving the bolts loose enough to allow engine movement. Insert the #0546-19 tool from either side and firmly push the engine/fan assembly against it and the clutch driver. The most convenient method to apply this force is by putting the thumbs of each hand (from each side) atop the clutch bell and the remaining fingers below the fan, then squeezing with both hands until the two components are fully engaged.

H. The engine should "hang" naturally in alignment with the motor mount as viewed from all sides. Since the "motor mount to frame" bolts are still loose enough to allow adjustment, you should be able to align all components (it may be helpful to lightly tighten the "motor to motor mounts" at this point to clarify the alignment. This procedure is important since a poor alignment will prematurely wear out the clutch bearings, ball and dampeners. Since the clutch ball can act as an "articulated joint", the important factor it that, even if the engine were at a slight angle, the fan hub and clutch delrin ball be aligned at the point of contact. This "point of contact" is approximately 3.75 to 4.0mm below the top surface of the fan hub. After alignment, tighten all related bolts with moderate torque. Note, future removal of the engine will not require loosening the motor mounts at the frames so the process will be much simpler.

Step 4: Installing the Fan Shroud and Switch Plate

Parts Required:

Qty	Part Number	Description	Found in Bag#
5	#0029	M2.2x13.0 Phillips self-tapping screws	7E
2	#0032	M2.9x9.5 Phillips self-tapping screws	7E
2	#0060-1	M3x6 Socket Head Bolts	7E
2	#0061	M3x8 socket head bolts	7E
2	#0063	M3x10 socket head bolts	7E
2	#0079	M3x35 socket head bolts	7E
1	#0548-5	Left and right fan shroud	7A
4	#115-58	Fan shroud braces	7E
2	#115-60	M5.75x27.5 carbon tubes	7E
1	#122-79	Switch plate	7E
4	#3923-1	M4.0x14.6x4.9 round plastic spacers (black)	7E
2	#0065	M3x12 socket head bolts	7E

Refer to Drawings #7E and #7F

Please note the following before proceeding to install the fan shroud:

Some additional trimming of the fan shroud may be required depending on your choice of engine. It is assumed you will trial fit the shroud prior to any modification. In general, trimming is for carburetor and/or cylinder head clearance. If your carburetor inlet comes to within 8.8mm of the fan shroud, trimming is suggested. The "trimming" can simply be to add about a 20.0mm diameter hole directly in-line with the carburetor inlet or making a "u" shaped cut-out extending downward into the cylinder head opening at the base of the shroud (the latter will eliminate one #0029 M2.2x13 Phillips screw and the surrounding material – which is not a problem). Trimming can easily be done by using a sharp modeler's knife (scoring the surface deeply and bending the material to break it away) or a Dremel tool with cutting wheel or abrasive drum.

A. Select two #0079 M3x35 socket head bolts, one #115-58 fan shroud brace, two #115-60 carbon tubes and one #122-79 switch plate. Examine the drawing and note the orientation of the switch plate and related parts. Prepare each bolt with Loctite. Insert each bolt through the switch plate followed by a carbon tube and the fan shroud brace. Install this assembly onto the left main frame and into the threaded inserts of the left side of #115-24 horizontal channel. Leave each bolt just loose enough to allow adjustment in the next steps.

B. Select two #0061 M3x8 socket head bolts and one #115-58 fan shroud brace. Prepare each bolt with Loctite and install (similar to the previous step) in the right main frame opposite the switch plate/fan shroud brace of the left frame. Again, leave the bolts loose enough to allow adjustment.

C. Select two #0063 M3x10 socket head bolts, the two remaining #115-58 fan shroud braces, and two #3923-1 plastic spacers. Examine the drawing and note that each frame has two holes for attachment of the rear fan shroud braces. For this step, the forward hole (containing a threaded insert) in each frame is utilized. Prepare each #0063 socket head bolt with Loctite and insert first into the fan shroud bracket hole (nearest the bend) and then through one #3927-1 plastic spacer. Install each onto either side of the frame assembly, noting that they should be horizontal and not so tight as to restrict adjustment. Keep in mind that the rear holes will be utilized during later steps so the holes should remain aligned with the frame and vertical channel holes.

D. Select two #3923-1 plastic spacers and two #0065 M3x12 socket head bolts. Prepare each bolt with Loctite. Slide a plastic spacer between the rear fan shroud brace on each side and install a #0065 socket head bolt in each threading into the vertical rear channel. As with the preceding hardware, leave just loose enough to allow adjustment.

E. Select both halves of the #0548-5 Fan Shroud and two #0029 M2.2x13 Phillips self-tapping screws. Examine the drawing and slide each half of the shroud in position between the previously installed braces. While loosely sitting within the frames, install the two #0029 screws (one front and one rear, from the left side) to hold the shroud halves together. Take this opportunity to align all the braces and shroud mounting holes visually and check for any clearance issues as described at the beginning of this assembly sequence Step 4. If needed, the #0032 M2.9x9.5 Phillips self-tapping screws and the #0060-1 M3x6 Socket Head Bolts that secure each corner of the shroud to each brace can be utilized to assist in positioning the shroud while checking clearances.

F. When you are satisfied with the fit of the shroud, select and install the remaining three #0029 M2.2x13 Phillips screws and (if not already utilized) the two #0032 M2.2x9.5 Phillips screws and two #0060-1 M3x6 Socket Head Bolts in the rear of the fan shroud, as shown in the drawing, leaving any screws in the braces loose for adjustment. Align the shroud using the following criteria: the shroud should have approximately equal clearance above and below the fan and should be centered horizontally around the fan hub/clutch driver assembly. Tighten all brace to frame bolts and the two #0032 shroud to brace screws as well as the two #0060-1 Socket Head Bolts. Later, should you wish to remove the shroud (all or half) the "brace to frame" bolts need not be loosened again. This greatly simplifies later servicing.

VIII. BUILDING AND INSTALLING THE FUEL TANK ASSEMBLY

Bag Required: 8

Tools or Materials Required:

Modeling knife or razor blade
8.0mm (5/16") flat wrench
2.25mm diameter (.086") drill bit (optional)
Small pliers or vice grips (optional)
Forceps (hemostats) (optional)
Premium grade fuel filter(s) (two in all cases except Y.S. engine)

NOTE: The correct procedure for installing #0405 fuel tank fittings is as follows: Insert fitting from inside the fuel tank using forceps or fingertips, pull through a snug-fitting hole until the inner flange is flush against the tank inner surface, install the washer and nut finger tight, insert the shank of 2.25mm diameter (.086") drill bit into the fitting's hole (to prevent collapse), lightly grip the nipple with pliers while tightening the nut with an 8.0mm (5/16") flat wrench. When fully tightened, there will be a "circle" of tank material surrounding the fitting flange which will "raise" above the tank surface about 0.5mm. This process assures a good seal.

Preparing the Fuel Tank

Parts Required:

Qty	Part Number	Description	Found in Bag#
1	#0011	M5 flat washers	8
1	#0013	M5 hex nut	8
1	#0397	Medium fuel tubing (483.0mm plus)	8
1	#0401	Fuel pick-up "clunk" (brass)	8
1	#0405	Fuel vent fitting (brass)	8
1	#0408	Fuel pick-up fitting	8
1	#0409	90 degree external tank fitting	8
1	#106-52A	Pre-drilled fuel tank with cap	8
1	#115-64	Two-sided Velcro (13.0x330.0mm)	8
1	#115-65	Special fuel pick-up tubing (73.0mm)	8

Refer to Drawings #8A and #8B

Special Information Regarding Fuel Pick-up Tubing Materials: Radical 3-D type flight demands that the fuel pick-up tubing be very flexible. Your kit includes a special material for this position which eliminates the need for an auxiliary fuel tank. It is not mandatory *but suggested* that you use the special tubing if radical 3-D flight is anticipated. If not, the normal type tubing is acceptable. The general deterioration of the fuel pick-up tubing within the tank (at a much more rapid pace than outside the tank) is caused by two primary factors: exhaust gases re-circulated into the tank via the connection of the vent fitting to a fitting on the exhaust system and the presence of nitro-methane in the fuel. All engines (except Y.S. with its own internal pressure system) benefit from the typical "exhaust pressure set-up" to enhance fuel flow so it's faults must be accepted. The nitro-methane content (low 5-10% through high 30%) is also beneficial so this too must be accepted as a factor contributing to fuel tank maintenance. In basic terms, you must pay frequent attention to the fuel tank if your goal is to maximize performance and reliability. Should you use any other flexible fuel tubing at the clunk, always maintain the exact length of 73.0mm. Frequency of service should be every six to ten gallons of fuel burned (depending on the variables mentioned).

A. Select one #0401 pick-up "clunk," one #0408 pick-up fitting and one #0405 vent fitting. Examine each, making sure the hole in each is clean and unobstructed. Select the #115-65 special fuel pick-up silicone tubing and press one end fully onto the nipple on the non-threaded end of the #0408 pick-up fitting. Press the tubing until it meets the hex surface. Press the other end fully onto the #0401 pick-up "clunk."

B. Insert the prepared fuel pick-up tube, clunk and fitting (from inside the tank) out through the hole supplied in the side of the tank and secure with one #0409 90 degree external tank fitting. Tighten securely resulting in the 90 degree fitting pointing rearward. A 5.5mm hex is provided on the pick-up fitting to aid in tightening. Install the #0405 vent fitting in the top of the tank and secure it with one #0011 washer and one #0013 hex nut.

C. Thoroughly blow-out the inside of the tank to remove any debris and install the cap. Screw the cap in place with light pressure until it stops and then turn it one-eighth turn further.

D. The tank position is critical for canopy clearance. Examine the drawing and note the orientation of the tank to the mechanics. Note that a small "notch" is provided on the right side of the #122-26 tank plate – the #0405 vent fitting, installed in the top of the tank, will center directly within this "notch" when the tank is correctly installed following the next procedure.

Select the #115-64 two-sided Velcro strip. Note the slot on the tank plate, just outside the main frame, on each side. Working from the right side of the model, push the end of the Velcro strip downward into the first slot, under the midpoint and the frames and up into the slot on the left side of the model. Adjust the position of the Velcro so that, when pulled taught and straight outward on each side, there is 67.0mm (2-5/8") of Velcro strip outside the *right* hand edge of the tank plate.

E. Remove the protective covering from the two-sided tape on the bottom surface of the tank plate. Clean the top surface of the tank with alcohol. Align the tank, as indicated, under the tank plate and press firmly upward. (The tank will be slightly off centered) Pull the Velcro strip tightly as you wrap it around the tank (slightly compressing the tank sides) and overlap itself on the right side of the tank. The grip of the two-sided tape onto the tank will increase within a few hours.

F. All cuts to fuel line should be made using a sharp modelers knife or razor blade. Select the #0397 fuel tubing. Cut one piece 205.0mm (8.07"). Attach this piece to the fuel pick-up fitting on the left side of the fuel tank. Install a fuel fitting at the other end. Determine the remaining length from fuel fitting to carburetor by holding the fuel filter in-line with the carburetor inlet at a distance from the tank that forms the connecting fuel tubing in a natural arc as it exits the tank fitting. After making the connection to the carburetor, the fuel tubing should sit naturally without sagging more than 25.0mm (1.0") or creating sharp bends.

G. Complete the tank installation by connecting the tank vent to the exhaust pressure fitting (excluding Y.S. 91 & Y.S. 80). The final tubing length should not interfere with the main gear nor create any sharp bends. It is highly recommended that you add a fuel filter to the exhaust pressure tube to minimize any debris coming back into the fuel supply. Note: Due to its proximity to exhaust heat and combustion by-products, the exhaust pressure tubing will require periodic replacement similar to the fuel pick-up tubing within the tank.

IX. INSTALLING THE SWASHPLATE, WASHOUT UNIT AND ROTOR HEAD ASSEMBLY

Bags Required: 9A and 9B

Tools or Materials Required:
M1.5 and 2.5 Allen tools
Medium Phillips screwdriver
Small good quality pliers
Small flat screwdriver

Step 1: Assembling the Swashplate

Parts Required:

Qty	Part Number	Description	Found in Bag#
1	#0009	M3 flat washer (small)	9A
4	#0051	M3x3 socket set screws	9A
1	#0065	M3x12 socket head bolt	9A
3	#0107	M3x6 threaded balls	9A
4	#0109	M3x8 threaded balls	9A
1	#0159	M3x7 ball bearing	9A
1	#0217	Swash plate	9A
1	#0597-3	M3.0x4.75x4.60 brass spacer	9A

Refer to Drawing #9A

A. Select and examine the #0217 swash plate. Note the four M3 threaded holes at each 90 about the base of the lower swash plate ring. Select four #0051 M3x3 and prepare each with Loctite. These four holes and set screws are for periodically minimizing any free-play that may develop as the swash plate bearing wears (excessive free-play can cause inaccuracies in control inputs). Install each set screw loosely. The adjustment procedure is to rotate the inner swash plate ring within the outer ring and adjust the set screw until a slight irregularity or "notchy" feeling occurs, then loosen the set screw just enough to return to a smooth rotation of the inner ring. Repeat the procedure for each set screw. In most cases, this procedure should be done after every twenty gallons of fuel. This procedure can easily be done on an assembled model by simply disconnecting the related ball links.

B. Examine the swash plate once again and note the positions for installation of the threaded balls into the inner ring. Four of the six threaded holes (those at each 90 position) are utilized. Three threaded holes (at 120 degree intervals) are utilized for three #0107 M3x6 threaded control balls in the outer ring. Select four #0109 M3x8 threaded balls and three #0107 M3x6 threaded balls. Prepare each with Loctite, and install in each position previously indicated.

C. Slide the swash plate down the main shaft. Rotate it so that one outer control ball is pointed rearward and the remaining two balls are pointed forward at an angle on each side of the mechanics. This orientation will align one empty threaded hole straight forward at the #0832-2 anti-rotation.

D. Select one #0009 M3 flat washer, one #0065 M3x12 socket head bolt, one #0159 M3x7 ball bearing and one #0597-3 brass spacer. Slide each onto the #0065 bolt beginning with the ball bearing, followed by the brass spacer and the washer. Apply a small amount of Loctite to the exposed threads, insert the assembly through the #0823-2 anti-rotation then into the swash plate and tighten. The swash plate should now be free to slide upon the main shaft without rotating.

Step 2: Assembling the Washout Unit and Installing the Rotor Head

Parts Required:

Qty	Part Number	Description	Found in Bag#
1	#0057	M4x4 Socket set screw	9B
2	#0092	M3x18 Phillips Bolt	9B
4	#0562-1	M3x0.09 Shim	9B
2	#0107	M3x8 Threaded Ball	9B
4	#106-02	M3x7x3 Flanged bearing	9B
2	#106-05	CNC Machined Wash out Arm	9B
1	#0571-1	CNC Machined Wash out Hub	9B
2	#122-28	3/16" x 0.125" x 0.097" Brass Spacer	9B
4	#106-06	M2x5 Flanged Bearing	9B
2	#0009	M3 Washer	9B
2	#0051	M3x3 Socket Set Screws	9B
1	#0840-6	M3x20 Dowel pin	9B
2	#0869	Washout ball links	9B
2	#106-07	M2x16 Pivot pins	9B
5	#106-08	M2 Cir-clips	9B

Refer to drawing #9A

Note: One extra #106-08 cir-clip is included.

A. Take the two machined wash out control arms #106-05 and two M3 x 6 balls #0107 and thread a ball into the hole in the long end of each arm from the flat side. Use Loctite.

B. Press the M3 x 7 flanged ball bearings #106-02 into one side of the center holes in both control arms, using red or green Loctite. Do not allow Loctite to get into the bearings. It is best to apply the Loctite to the outer race of each spacer inside. Insert one #122-28 3/16" x .125" x .097" brass spacer into the bearing cavity followed by another #106-02 flanged bearing, capturing the brass spacer inside.

C. Locate four #106-06 M2 x 5 flanged bearings and press two into each end of the control arms #106-05. Seat squarely in place. Using two #106-07 pivot pins, assemble the wash out special link #0869 to each control arm through bearings #106-06. Their orientation is shown on the drawing. **Note:** They mount in the short end if the arms, projecting inward. The pins press in place centered in the links. Secure each end if the pins using cir-clips #106-08.

Note: The #106-08 cir-clips are most easily installed by the following method:

-Lay the cir-clip flat on a hard surface
-Hold the #106-07 pivot pin with a pair of pliers, while aligning one end of the pivot pin vertically on top of the cir-clip
-Tap the opposite end of the pin with a small hammer into the cir-clip. This will start the cir-clip onto the end of the pin.
-Drill a hole in a piece of hardwood slightly larger than the pivot pin.
-Align the pivot pin/cir-clip over the hole, slightly tap the pin again. This will drive the pin through the cir-clip.
-Repeat in the opposite end of the pivot pin after the #0869 links and #106-05 arms have been joined together.
-The wash out links #0869 should have no end play and pivot freely, slide an Xacto blade or razor blade around the pin in between the plastic link and the wash out arm. This will slightly remove any plastic burrs.

D. Using two special bolts #0092, four special shim washers #0562-1, two M3 small washers #0009, and carefully follow the drawings, screw the arms on the aluminum wash out center hub #0571-1. Use Loctite. The control ball should face inward. Tighten entire assembly until there is no lateral play and no bearing drag. To secure each #0092 bolt, thread one #0051 M3 x 3 socket set screw into the opposite side of the #0571-1 hub. Use Loctite and tighten both set screws up against the end of the #0092 bolts. Repeat the process for the remaining arm.

E. Slide the assembled wash out unit down onto the main shaft and snap the two #0869 wash out links onto any two opposite #0109 steel balls on the inner ring of the swash plate. The wash out unit should slide freely on the main shaft. If there is drag, slightly polish the main shaft or the inside of the wash out hub #0571-1.

F. Select the previously assembled rotor head , the #0057 M4x4 socket set screw and the #0840-6 dowel pin. Slide the rotor head down onto the main shaft and align the cross hole at the upper end of the main shaft with the hole in the head block just below the fly bar pivot bearings (Note: the larger of the two holes is for dowel insertion and the smaller hole is for pushing the pin back out using a 1.5mm Allen tool). Alignment can be accomplished by holding the rotor head rotating the main gear clockwise and viewing the holes from the side at eye level.

Note: ***Important Precaution:*** There have been instances where a builder thought he had all the holes aligned but the main shaft was actually fully beneath the head block holes. To avoid this, it is helpful to confirm the alignment by simply inserting a 2.0 or 2.5mm Allen tool in place of the dowel pin and lifting the model by the rotor head. It pays to be cautious.

G. If the dowel pin will not fully insert through the main shaft with moderate pressure, rotate the head 180 degrees upon the main shaft and repeat. The dowel pin is always to be installed with the “chamfered end” first. Once the dowel pin is properly fitted, secure it with the #0057 M4x4 set screw and a small amount of Loctite. Apply Loctite sparingly and only to the set screw to avoid contacting the dowel pin and making later servicing more difficult. Next, tighten the previously installed #0067 M3x14 socket head bolts clamping the base of the head block about the main shaft.

X. BUILDING THE TAILROTOR ASSEMBLY

Bag Required: 10A, 10B, and 10C

Tools or Materials Required:

M1.5 Allen tool
M6.0 socket nut driver
M7.0 (9/32"-5/16") socket (optional)
Small hammer
Small Phillips and straight screwdrivers
Grease
Pliers
Red or green Loctite (optional)

Step 1: Assembling the Tail Rotor Hub and Blade Holders

Parts Required:

Qty	Part Number	Description	Found in Bag#
2	#122-66	Tail Rotor Blade Mounts	10A
2	#0019	M3 Locknut	10A
2	#0095	M3x19 Phillips Bolt	10A
2	#120-39	M5x4x10 Ball Bearings	10A
1	#122-65	Tail Hub	10A
2	#0457	Thrust Bearing (3 piece)	10A
2	#0021	M4 Locknut	10A
2	#0446-4	0.003 Shim	10A

Refer to drawing #10A

A. Select two #120-39 M5 x 10 ball bearings and two #122-66 Tail Rotor Blade Mounts. Press one bearing into each blade mount towards the control arm side. The bearing should be even with the outer surface of the blades mount.

B. Select two #0457 Thrust Bearings. Each is made up of a ball complement (spaced by a brass retainer) and two outer grooved rings. This assembly will only function when arranged properly within the blade mount. Examine each outer grooved ring and determine which one has the larger inside diameter (a simple test is to slide each onto the #122-65 Steel Tail Rotor Hub and select the one that fits loosely). This ring will be the first part of the thrust bearing installed in the Tail Rotor blade mounts. Using a socket or wood dowel that will fit inside the blade mount, install the larger I.D. thrust bearing ring (grooved side facing out) into the #122-66 Tail Rotor Blade Mounts. Use light pressure until fully seated. Repeat with the other thrust bearing and blade mount. Next, apply grease to the cupped side of the ball brass retainer ring and the grooved side of the outer grooved ring (the small I.D. race).

IMPORTANT:

Thoroughly remove any excess grease from the center I.D hole in the ball race and the outer grooved ring. This is to ensure that no grease smears onto the threads on the #122-65 Tail Rotor Hub. With the forked end of the tail rotor blade grips facing upward, install the brass ball retainer race (cupped side facing down) followed by the outer grooved ring (grooved side facing down) on top of the previously installed inner grooved thrust bearing ring. Again, look for any grease residue in the I.D. openings.

C. Select the #122-65 Steel Tail Rotor Hub, one #122-66 T/R blade mount, the remaining #0457 Thrust Bearing components, one #0446-4 M4 Shim Washer, one #0021 M4 Locknut and a 7.0mm socket or nut driver. While holding the tail hub in a vertical position, slide one of the #122-66 Tail Rotor Blade Mount assemblies onto the T/R hub, followed by one #0446-4 0.003" shim. Using a small screwdriver or toothpick, apply Green Locktite to the threaded portion of the #0021 M4 Locknut. Install the locknut using a thin-walled 7mm socket wrench onto the threaded portion of the tail rotor hub. Select any tool that will insert into the hub center hole to stop rotation. Tighten the #0021 M4 locknut until a slight amount of tension is felt on the tail rotor blade grip while rotating. Slightly back off the M4 locknut until the tail rotor blade grip rotates freely with little or no play. Repeat the process for the opposite tail rotor blade mount. Adjust the end play to match the first mount installed.

D. **NOTE**: The opportunity exists, at this time, to balance the hub assembly. If a very thin coat of grease was applied to the thrust bearings, then balancing can be done at this time. If, however, you used more grease than suggested, we recommend waiting until one flight is complete since the excess grease will no longer be a factor in the balance procedure. Balancing the assembly is not mandatory ***but highly recommended***.

The following will describe the process. If a balancer is not available, select the #0541-8 tail rotor output shaft from the bag #10C. Obtain a large glass with a smooth top rim of at least 90.0mm (3.5") in diameter. Use the shaft as a pivot point by inserting it into the hub and sliding the hub to the center. The shaft will then sit atop the glass allowing the hub assembly to pivot freely. The proper balance method is called a "four point" balance. Two steps are involved. Always orient the blade mounts with the threaded control arms in opposite directions (as in flight). First, rotate the unit atop the glass so that the tips of each blade mount point at six and twelve o'clock positions. Releasing them at this position should result in the assembly remaining vertical. Second, rotate the assembly until at three and nine o'clock positions. If the assembly will not remain at the three/nine o'clock position then you can select a shim or washer and install it under the pivot bolt in the blade mount to secure the tail blade, it may be necessary to trim the washer to adjust the weight. Select two #0019 locknuts, two #0095 bolts and two of the appropriate tail blades. Install each blade orientated as shown in drawing 10A, noting that each leading edge corresponds to a pitch arm control ball on each blade mount. Temporally tighten each blade so that they will not pivot easily during handling. Rotate each blade so that the trailing edges can be simultaneously pressed against a straight edge (table top) while pulling out firmly. This will approximate flying position. Set the assembly (with shaft #0541-8 still temporally installed) atop two glasses on a level table top (or suitable blade balancer) and observe which (if any) blade appears heavier. Balance can be achieved easily by either adding a small piece of tape to the lighter blade tip or trimming a little plastic from the "heavy" blade tip. Loosen each blade pivot bolt until the blades will pivot freely (but not by there own weight alone). Remove the #0541-8 shaft.

Step 2: Assembling the Pitch Slider

Parts Required:

Qty	Part Number	Description	Found in Bag#
2	#0015	M2 hex nut	10B
2	#0049	M2x10 socket bolt	10B
1	#0435	Tail rotor pitch slider (brass)	10B
2	#0443	M6 retaining ring	10B
2	#0859-16	Pitch links w/bearings	10B
1	#122-68	Tail rotor pitch yoke	10B
1	#0859-12	CNC Machined Delrin Pitch Ring	10B
2	#0283	Flanged Bearings	10B

Refer to Drawing #10B

A. Select two #0283 ball bearings. Place each on a clean surface, "ball" side up and add grease. Press one into each side of the #0859-12 pitch ring.

B. Select the #0435 pitch slider. Slide the #0859-12 pitch ring fully up to the flange of the pitch slider.

C. Select the #122-68 pitch yoke. Examine the drawing and note that the angled parts face away from the pitch ring. Slide the pitch yoke onto the pitch slider up to the previously installed pitch ring.

D. Select two #0443 M6 retaining ring. It is "cupped" and this "cupped" side will face away from the pitch yoke. Stand the pitch slider/ring/yoke assembly upright on the flange. Position the #0443 retaining ring over the exposed end of the pitch slider. Use a small hammer and 7.0mm (9/32"-5/16") socket to cautiously tap the retaining ring downward to meet the pitch yoke. The desired situation is that the components on the pitch slider have no end-play and the pitch ring freely rotates with no binding of the ball bearings. If you go too far with the retainer, place a small piece of hardwood or plastic across the exposed end of the brass pitch slider, support the pitch yoke near the ends and tap the wood very lightly with a small hammer or tool handle. The retaining ring should move enough to relieve the bearings. Be very careful not to distort the pitch slider at the end. Orientate the second retaining ring such that the prongs fall in between the first ring. Apply a small amount of slow cyanolate glue in the "cupped" area of the retaining ring to lock it in place.

E. Examine the pitch yoke #122-68, noting that one side of each arm has a molded cavity which accepts a M2 hex nut. Press one #0015 M2 hex nut into each arm. The opposite side of each arm will be used for mounting the pitch links #0859-16. Mount each pivot by inserting one #0049 m2x10 socket bolt through the flange side of one of the bearings in the pivot then through the pitch yoke arm #122-68 as described use a slight amount of blue Loctite inside the threads of the M2 hex nuts. Tighten securely. NOTE: When properly assembled, each pitch link plate will be "captured" between the bearing flange and the mounting surface. This is important as a security if any bearing would fail. The same is true for the later connection to each tail blade grip.

Step 3: Assembling the Tail Rotor Gear Box

Materials and tools required:

M1.5 and 2.5 Allen (Hex) tools
" inside type" Retaining ring pliers
Green, Blue and Red Loctite
Suitable grease with thin nozzle or "spring type" applicator (Miniature Aircraft #4707 recommended)
Small Phillips screwdriver

Parts Required:

Qty	Part Number	Description	Found in Bag#
2	#0001	M2 Washer	10C
1	#0019	M3 Lock nut	10C
2	#0049	M2x10 socket bolts	10C
7	#0051	M3x3 socket set screws	10C
2	#0056	M3x5 "dog-point" socket set screws	10C
4	#0425	M5x13 ball bearings	10C
2	#0427-1	Bevel gear set	10C
1	#0541-8	Tail rotor output shaft	10C
1	#0432	M5.0x7.0x3.15 brass spacer	10C
1	#0800-7	Tail rotor input shaft with female universal joint	10C
1	#0061	M3x8 socket bolt	10C
1	#0861-5	CNC Tail Rotor Gear Box Housing	10C
1	#0861-7	13mm stepped spacer	10C
1	#0861-8	13mm C-ring	10C
1	#122-74	Bell Crank Support Arm	10C
1	#122-70	M5x0.25x6.85 Shim	10C
1	#122-72	M5 Collar	10C
1	#0099-1	M3x30 Phillips Bolt (with #0687 Sleeve)	10C
1	#0562-1	M3x0.09 Shims	10C
1	#122-76	Graphite Bell Crank Control Arm	10C
1	#122-78	CNC Machined Tail Rotor Bell Crank	10C
1	#0109	M3x8 Threaded Ball	10C
2	#0059-1	M2.5x6 Socket Bolt	10C
1	#106-02	M3x7x3 Flanged Bearing	10C

Refer to Drawings #10C-1, #10C-2, and #10C-3

NOTE: The longevity of the shafts and gears within the tail rotor gearbox can be greatly enhanced by "mounting" each with red or green "permanent type" Loctite. Each part should be cleaned with alcohol at the contact area. Follow directions provided by Loctite. Removal will require a modeler's heat gun. We recommend that 3-D and/or experienced pilots consider this option.

Clean the following parts with thinner to remove any oil.

#0427-1	Bevel Gear	
#0541-8	Tail Rotor Output Shaft	(shaft portion contacting Bevel Gear)
#0432	M5.0x7.0x3.15 Brass Spacer	
#0800-7	Tail Rotor Input Shaft	(shaft portion contacting Bevel Gear)
#0425	Ball Bearing	(inner diameter only)

Some assembly positions will require **red or green** (both are permanent type) Loctite. Please do so, as this is a critical procedure required for proper tail rotor function.

WARNING: FAILURE TO ACCURATELY FOLLOW THESE INSTRUCTIONS COULD RESULT IN LOSS OF TAIL ROTOR CONTROL

A. Select the #0861-7 stepped spacer from the parts bag. (Note: At your option, you may choose to "mount" each bearing on the input shaft with green or red Loctite. It is optional at this position and mandatory elsewhere in the assembly procedure). Slide a #0425 bearing, the #0861-7 spacer, another #0425 bearing and the bevel gear onto the #0800-7 input shaft. Press all parts firmly against the Delrin end piece. Prepare two #0051 M3x3 socket set screw with blue Loctite and install them into the gear (making certain that one squarely contacts the "flat" on the shaft). Tighten each with moderate torque. There should be no end play in the assembly.

B. Select one #0425 ball bearing, one #0541-8 output shaft, one #122-70 M5 x .25 shim, one #0427-1 T/R gear and two #0051 M3 x 3 socket set screws. Lay the #0425 bearing on a flat surface. Apply a small amount of green or red Loctite to the short end of the shaft next to the groove. Lay the bearing on a flat surface and insert the shaft fully into the bearing. Allow to dry in a vertical position. Prepare one #0051 socket set screw with blue Loctite and install it into the #0427-1 gear. Slide one #122-70 shim, followed by one #0427-1 bevel gear onto the long end of the output shaft. Simultaneously, locate the set screw over the flat on the shaft while pressing the gear down; sandwiching the shim in between the gear and bearing. Using Blue Loctite install the remaining #0051 set screw and tighten both securely.

C. Select one #0425 ball bearing, one #0432 brass spacer, one #122-72 M5 collar, and one #0051 M3 x 3 socket set screw. Slide the #122-72 collar followed by one #0432 spacer and one #0425 bearing onto the output shaft. Apply blue Loctite to the #0051 M3 x 3 set screw and install it into the #122-72 collar. Only tighten enough that allows the collar to move.

D. Slide the shaft assembly (longer end first) into the housing and install the #0861-8 M13 retaining ring (using the proper tool). Rotate the shaft so that a 1.5mm allen tool can be inserted thru the M3 threaded hole (at the rear of the housing) into the set screw of the #122-72 collar. Firmly press the long end of the output shaft towards the #0861-8 retaining ring while using the 1.5 Allen tool to firmly press the collar in the opposite direction along the shaft. Tighten the set screw while applying this pressure. Check to see that there is no free play in the shaft assembly. If there is, repeat the process.

NOTE: A simple test can be performed at this time to determine whether or not to use the #0426 .005" gear shim. Select the previously assembles input shaft. Slide it into the tail rotor housing. Apply a slight amount of inward pressure and rotate the shaft, noting the feel of the two gears meshing. Now remove the input assembly and the previously installed output shaft. Loosen the set screws in the gear on the #0541-8 output shaft. Add one #0426 gear shim to the output shaft assembly as per the drawing. Re-install and adjust the output assembly as previously done. Once again press in the input shaft assembly. Compare the gear mesh to the mesh with the shim removed. Choose the smoother of the two possibilities. Remove the input assembly. Check to see that there is no free-play in the output shaft assembly. Once again remove the retaining ring and slide the shaft assembly out of the housing. Remove the outer bearing and spacer. Clean the inside of each with alcohol as well as the output shaft. Apply **green** and **red** Loctite to the corresponding area of the output shaft and reinstall the spacer and bearing firmly against the bevel gear. Re-check the tightness of the set screws. Always keep one set screw tight while adding Loctite to the opposite screw. Re-install the output shaft assembly into the gear housing. At your discretion the O.D. of the #0425 bearings may be green Loctited inside the gear case. If you Loctite it in place, the disassembly procedure will be more difficult, but the life of the unit will be extended.

E. Select the previously assembled input shaft. Slide it into the tail rotor housing. NOTE: There are two M3 threaded holes at 180 degrees apart on the housing inlet. Install one M3x3 set screw very lightly to provide a little friction against the input shaft spacer #0861-7. Set the desired gear mesh and tighten the set screw. Install the remaining set screw and tighten. NOTE: If repeated installation of the set screw creates burrs on the spacer (which can limit the fine tuning adjustment of the gear mesh), simply rotate the sleeve so that the set screw faces a fresh surface.

F. Grease is applied through the large diameter hole in the rear of the housing. Use a suitable size syringe (Miniature Aircraft #4707 or #4709 is recommended). This access hole will later be concealed by the bell crank support arm. **DO NOT ATTEMPT TO FILL THE CASE WITH GREASE** since it serves no purpose. Simply concentrate the grease application towards the gears and rotate the input shafts to get coverage. The applicator is helpful and avoids getting grease in the threaded area (which would have to be removed to enable the Loctite to work properly). The bell crank support #122-74 installs by keying it into the groove in the back of the T/R housing #0861-5, it is secured with one M3 socket bolt #0061. Use blue Loctite.

G. Select the #122-78 Tail Rotor Bell Crank. **Note:** One of the #106-02 Flanged Bearings is pre-installed. Bolt the #122-76 Graphite Bell Crank Control Arm onto the preassembled bearing side of the #122-78 Tail Rotor Bell Crank using two #0059-1 M2.5x6 Socket Head Bolts and two #0001 Washers. The arm must be mounted with the pre-installed pem nut on the top side. Use Blue Loctite.

H. Insert the #122-74 Bell Crank Support into the inside of the #122-78 Tail Rotor Bell Crank on top of the pre-installed #106-02 bearing. Install one #0099-1 Phillips bolt into the assembly. Apply a small amount of green Loctite to the outer race of the uninstalled #106-02 Flanged Bearing found in the parts bag. Insert this bearing into the #122-78 Tail Rotor Bell Crank on top of the #0099-1 Phillips Bolt. Secure in place using one #0562-1 M3 Shim, and one #0019 M3 Locknut. Adjust the tightness of the bolt and nut until the bell crank has no vertical free play, yet pivots smoothly. From the underside of the control arm, install one #0109 M3 x 8 threaded ball. Use Loctite.

I. Select the Pitch Slider Assembly (from Step #2). Position the Tail Rotor Bell Crank Assembly onto the pitch slider and install the entire unit onto the #0541-8 Output Shaft. Key the #122-74 Bell Crank Support into the groove in the back of the #0861-5 Tail Rotor Housing. Secure in place using one #0061 M3x8 Socket bolt. Tighten securely using Blue loctite.

J. Select the previously assembled tail rotor hub assembly. Examine the drawing and note the orientation of the hub, blade mounts and the gearbox. For further clarity, hold the hub assembly and view it as though you were looking directly at the 5.0mm diameter through hole. Position the blade mount pointing at three and nine o'clock positions. The correct view should show the blade holder to your left (nine o'clock position) as having its control arm above, the blade mount to your right (three o'clock position) as having its control arm below, and each threaded M3 hole in the hub be at the one and seven o'clock positions. [**Note:** for future reference, considering the view you now see, the tail rotor blade for the "left (nine o'clock) blade mount" would have its leading edge pointing upward and the tail rotor blade for the "right blade mount" would be pointing its leading edge downward.] Slide the hub assembly onto the output shaft, aligning the M3 threaded holes in the hub with the M2 countersunk holes in the shaft. Select two #0056 M3x5 "dog-point" socket set screws. The term "dog-point" refers to the 2.0mm diameter protrusion at the end. This will directly engage the 2.0mm diameter hole in the output shaft. Prepare each with Loctite and install into the hub and through to the output shaft. Tighten each simultaneously a little at a time until fully tight. Note: recheck the tightness periodically with the previously mentioned method in mind.

K. Connect the two pitch pivots #0859-16 to the hole in the arm of the T/R blade mounts using two M2x10 socket bolts #0049. Use blue Loctite on the tip of the bolt, taking care not to let any get into the bearings. **Tighten securely.**

XI. BUILDING THE TAIL BOOM ASSEMBLY, BOOM SUPPORTS, AND INSTALLATION ONTO THE MAIN MECHANICS

Bags required: 11A through 11D

Tools or materials required:

M1.5 and 2.5 Allen tools
M5.5 (7/32") flat wrench
Small pliers
Small straight blade and Phillips screw drivers
Hand drill with 1.30mm (.055") drill bit
Heat gun
"J-B Weld" epoxy or similar slow cure epoxy, slow Cyanolate glue and silicone glue
Small piece of 180 - 22- grit sandpaper
Light oil or Vaseline petroleum jelly.

Step 1: Installing the Tube Drive, Push Rod Guides, and Fins

Parts Required:

Qty	Part Number	Description	Found in Bag#
8	#0003	M3 flat washers (large)	11B
2	#0006	M2.5 "toothed" lock washers	11B
4	#0015	M2 hex nuts	11B
5	#0019	M3 hex lock nut	11B
1	#0024	M2.2x4.5 Phillips self tapping screw	11B
2	#0027	M2.2x9.5 Phillips self tapping screw	11B
5	#0032	M2.9x9.5 Phillips self tapping screw	11B
2	#0043	M2x10 slotted machine screw	11B
2	#0044	M2x12 slotted machine screw	11B
1	#0063	M3x10 socket head bolts	11B
4	#0077	M3x30 socket head bolts	11B
2	#0186	Front tail boom clamp halves	11B
2	#0477	Push rod guide support	11B
1	#0683	Tail rotor gearbox clamp	11B
4	#0800-5	O-rings	11B
2	#0868-5	Push rod guides	11B
1	#0870-1	Horizontal fin mount	11B
1	#0587-14	Graphite Tail Boom Ultra 33"	11A
1	#0867-15	Torque tube assembly	11A
1	#122-80	Horizontal Fin	11A
1	#122-82	Vertical Fin	11A

Refer to Drawings #11A, #11B, and #11C

A. Select the #0867-15 torque tube assembly. The ball bearings at the center are surrounded by plastic housings which requires the addition of four O-rings #0800-5. Select and install these O-rings. Apply a light coat of oil or Vaseline lubricant and slide the assembly into the tail boom: #0587-14.

B. Slide one #0870-1 fin mount onto the rear (notched end) of the tail boom, positioning it approximately 175mm from the end.

C. Select two #0006 M2.5 "toothed" lock washer, four #0015 M2 hex nuts, two #0043 M2 x 12 slotted machine screw, two #0477 push rod guide support and two #0868-5 push rod guide. Wrap the #0477 support around the boom as shown and install one #0043 screw from above along with a #0015 nut from beneath. Tighten only enough to allow adjustment and slide the support to a position approximately 272mm from the front edge of the tail boom and the second one approx. 226.0mm from the rear edge of the boom.

Install the #0868-5 guide, #0006 lock washer, #0015 hex nut and #0044 screw into the horizontal hole within the #0477 push rod guide supports.

D. Select one #0019 M3 hex locknut, one #0063 M3 x 10 socket head bolt, three # 0032 M2.9 x 9.5 Phillips tapping screws, the #0683 tail rotor gearbox clamp, and the previously assembled tail rotor gearbox. Examine the #0683 clamp and note that the rear is the side with three horizontal holes. Slide the clamp onto the rear of the tail boom until even with the end (orientated so the slot within the clamp is centered over the notch in the tail boom). Apply a small amount of grease to the torque tube drive end. Press the gearbox into the boom, fully engaging its molded "key" into the tail boom notch. Align the clamp with the gearbox housing and install three #0032 tapping screws with a small amount of slow Cyanolate glue on each. Do not over-tighten. Confirm that the gearbox is fully inserted into the tail boom by tapping on its rear flanged surface with plastic tool handle or wooden block. Tighten the clamp about the tail boom by installing one #0063 bolt and #0019 locknut into the hole provided. Do not tighten so much as to distort the clamp.

E. Examine the lower surface of the gearbox clamp and note a small hole at the center. This hole must now be duplicated in the tail boom. Using a 1.30mm (.055") drill bit, drill straight upward through the hole and the tail boom. Use light force so that if is easy to stop drilling as soon as the resistance stops. Select the #0024 M2.2 x 4.5 Phillips tapping screw and install it into the drilled hole. This particular length screw will protrude partially into the gearbox housing but not contact its input shaft (do not make any substitutions). As an extra precaution it is suggested that the #0683 clamp be glued to the tail boom by "wicking" a light bead of thin CA glue around the front edge of the clamp where it meets the tail boom. Let dry naturally without accelerator.

F. Select two #0027 M2.2 x 9.5 Phillips self tapping screws, two #0032 M2.9 x 9.5 Phillips self tapping screws, one #122-80 horizontal fin. Install the horizontal fin atop the #0870-1 fin mount with two #0027 screws. Install the vertical fin #122-82 onto the #0683 gearbox clamp using two #0032 screws.

G. Select eight #0003 M3 flat washers, four #0019 M3 hex locknuts, four #0077 M3 x 30 socket head Bolts, and two #0186 front tail boom clamp halves. Examine the drawing and note the hardware securing the front tail boom clamp halves to the main frame. Leave all bolts loose.

H. Apply a small amount of grease to the tube drive end. Install the tail boom into the #0186 clamps. Hold the main gear while rotating the tail rotor hub and apply pressure forward on the tail boom assembly. After less than one rotation, the tail boom assembly should move further forward (verify that the torque tube universal joints are properly engaged). Push the tail boom as far forward as possible. **DO NOT PULL BACK ON THE TAIL BOOM. THE STOP MOLDED IN THE BOOM CLAMP IS DESIGNED TO ALLOW FREE-PLAY IN THE TORQUE TUBE**. Lightly tighten all four mounting bolts. View the model straight from the rear and rotate the boom as needed to ensure that the gearbox output shaft appears perpendicular to the main shaft. Apply slight pressure forward on the tail boom while

tightening all four boom clamp bolts.

Step 2: Installing the Tail Boom Supports

Parts Required:

Qty	Part Number	Description	Found in Bag#
6	#0003	M3 Washers – Large	11C
2	#0093	M3 Washers – Small	11C
4	#0048	M3x30 Phillips Bolt	11C
2	#0872-5	Graphite Tubes 25"	11C
2	#3923-1	Plastic Round Spacers	11C
4	#0872-2	Molded Boom Support Ends	11C
1	#0065	M3x12 Socket Head Bolt	11C
2	#0009	M3 Washers – Small	11C
1	#0019	M3 Locknut	11C
2	#0079	M3x35 Socket Head Bolts	11C

Refer to Drawings #11D and #11E

A. Select four #0048 M3.5x25 Socket Set Screws and two #0872-5 Graphite Tubes. Clean each set screw thoroughly with alcohol or lacquer thinner. Use a cotton swab (Q-tip) to clean inside each end of each carbon tube. Roll a small piece of 180 - 220 grit sandpaper into a small tube and use it to roughen the inside surface at each end of each tube.

Select four #0872-2 Molded Boom Support Ends. Each has a 5.75 mm diameter hole in the end followed by a 3.0 mm diameter hole set approximately 10.0 mm deeper. Install one #0048 set screw from Step A into each 3.0 mm hole so that approximately 7.5 - 8.5 mm is exposed past the end of the Molded Boom Support End.

Examine the "ball end" of the #0872-2 Molded Boom Support End. The factory installed ball has a molded "boss" of approximately 6.3 mm diameter on either side of the ball. One side protrudes 1.0 mm while the other is 1.5 mm. The 1.5 mm thick side should always face the mounting surface to which the tail boom brace will be fastened. This is of particular importance at the front mounting positions.

B. Remove one of the #0075 M3x25 Socket Head Bolts that are temporarily securing the rear landing gear strut to the landing gear mount. Select four #0003 M3 Flat Washers, two #0079 M3x35 Socket Head Bolts, two #3923-1 Plastic Round Spacers, and two of the prepared Molded Boom Support Ends from Step A. Install one washer onto one #0079 bolt and insert into the brace end with the shorter molded "boss" (as discussed in Step A) nearest the washer. Slide one #3923-1 spacer onto the opposite side of the brace end and insert the assembly into the hole within the landing gear previously occupied by a #0075 bolt. Reinstall the washer and lock nut beneath the landing gear strut. Remove the remaining #0075 bolt on the opposite side of the landing gear mount and repeat the above procedure.

C. Select the #0872-5 Graphite Tubes and the two remaining prepared Molded Boom Support Ends from step (A). Note the 1.5mm hole on each brace end. During proper assembling, a small amount of glue will exit this hole.

Graphite tubes can be bonded with "J-B Weld" epoxy (or similar slow curing epoxy) or slow CA glue. The epoxy allows much more time for the assembly steps while the slow CA glue will allow only a minimum working time. Be prepared if CA type glue is used.

D. Apply a liberal amount of your chosen adhesive to the threads exposed on the brace end and inside the graphite tube end. Insert one tube into one brace end until it stops (about 9.5 - 10.0 mm) and secure it from moving while the glue sets. Repeat for the remaining brace.

E. Select two #0003 M3 Flat Washers, two #0093 M3x18 Special Phillips Bolts, and the two prepared graphite tubes (from the previous step). It is suggested that both braces be aligned and fitted prior to final gluing. Install one washer on one #0093 bolt and insert into one brace end. With the graphite tube pointing forward, temporarily thread the bolt and brace into one of the molded holes on either side of the horizontal fin mount. Repeat the process for the remaining brace on the opposite side of the fin mount.

F. Align the brace ends attached to the main frames (either at the fan shroud brace or rear strut) with both graphite tubes and slide the horizontal fin mount forward until the graphite tubes insert into the holes in the front brace ends. Check to see that everything sits naturally without any binding.

G. Select one #0019 M3 hex locknut, two #0009 M3 Washers, and one #0065 M3x12 Socket Head Bolt. Install these into the bottom "clamping" portion of the #0870-1 horizontal fin mount. Level the fin and tighten the bolt.

H. Remove both side bolts that secure the rear of each brace to the horizontal fin mount. Stand the model vertically on its radio tray (easiest in the corner of a room or between your knees while in a seated position). For each brace/graphite tube, prepare the open end of the tube and the threaded part of the brace end on the main mechanics with the glue of your choice. Insert the tube fully into the end and align the rear with the horizontal fin mount and reinstall the #0093 Phillips bolt. Repeat the procedure for the opposite side and keep the model vertical until the glue dries. This procedure assures that the tail boom and braces sit straight and without any pre-load induced from their own weight.

Step 3: Installing the Graphite Tail Rotor Push Rod

Parts Required:

Qty	Part Number	Description	Found in Bag#
2	#0133-1	Special ball link	11D
2	#0868-4	Heat shrinkable Teflon tubes	11D
2	#0868-7	M3 x 60 threaded stud	11D
1	#0868-10	Graphite push rod 31"	11A

Refer to Drawing #11F

A. Select two #0868-7 threaded studs. Clean each with alcohol or lacquer thinner. Each stud is to be installed into the graphite tube to a depth of 23.0mm. Select the #0868-11 graphite tube. Prepare each stud by applying J-B Weld epoxy (or similar slow drying epoxy) and insert each into the tube to the correct depth. Set aside to dry or apply mild heat from a hair dryer.

B. Select one # 0133-1 special ball link and two #0868-4 Teflon shrink tubes. Slide each Teflon tube onto the graphite tube (final positions to be determined later) and thread the ball link on the threaded stud of the graphite tube, concealing about 7.0 mm of the threads. From behind the tail rotor gearbox slide the graphite push rod assembly (leading with the threaded end which has no ball link installed) through each previously installed push rod guide. Select the remaining #0133-1 special ball link and thread it onto the pushrod to a depth of about 7.0 mm. Connect one link to the front bell crank and one to the rear. Temporarily slide each Teflon tube to the ends of the graphite tube so they do not interfere with final adjustment. Adjust each ball link until the front bell crank is vertical and the rear bell crank is parallel with the rear of the T/R transmission case.

Manually operate the push rod and make preliminary adjustments to each guide so that it operates freely and approximately centered within each guide.

C. Tighten each #0868-5 guide and #0477 support. Slide the Teflon tubes into position within each guide so that compete operation of the push rod does not surpass the length of either Teflon tube. Mark the position of each and disconnect both ball links so that the push rod and Teflon tubes can be moved away from each guide. Use a heat gun to shrink each Teflon tube and reinstall the push rod in its proper location.

XII. INSTALLING THE RADIO SYSTEM AND PUSHRODS

Bags required: 12A through 12G

Tools or materials required:

Small Phillips screw driver
1.5mm Allen tool
small pliers or forceps
4 large heavy duty servo wheels or arms
(J.R. Super Servo Horn set - purchased separately)
(Futaba - 45.0 mm diameter wheel - standard with servos)
Thick two-sided foam tape
Slow Cyanolate glue or epoxy

Step 1: Installing the Radio System

Parts Required:

Qty	Part Number	Description	Found in Bag#
16	#0038	M2.5 x 10 Phillips machine screws	12A
4	#0389	Wire retainers (small)	12A
3	#0390	Wire retainers (large)	12A
20	#0560-8	M2.5 flat washers	12A
2	#115-30A	16.0 x 152.0 mm Velcro (red)	12A
1	#115-30B	16.0 x 305.0 mm Velcro (red)	12A
2	#0560-1	Aluminum Servo Spacer	12A
4	#0039	M2.5 x 12 Phillips Machine Screws	12A

Refer to Drawings #12A, #12B, #12C, #12D, #12E, and #12F

A. All servos (except throttle) mount using #0038 M2.5 x 10 Phillips machine screws and #0560-8 M2.5 flat washers into steel threaded inserts (factory installed) in the side frames. The throttle servo will use two #0560-1 aluminum spacers under the servo mounting ears with four #0039 M2.5 x 12 Phillips screws and four #0560-8 M2.5 washers. All servos mount to the outside surface of the side frames with the exception of the uppermost servo which mounts to the inside of the left main frame. Each should be installed with Loctite. The bolt spacing for each servo has been selected to allow the installation of all popular servos with minor deflection of the servo's rubber grommets and bushings. For example, 4000 series J.R. servos will show the bushings (within the grommets) slightly shifted away from servo case, 8000 series J.R. servos will be similar but less and 9000 series Futaba servos will show the bushing shifted slightly inward towards the case. The following table will indicate the Servo Number, Frame Position, Receiver Connection, and Model Connection:

Servo Number	Frame Position	Receiver Connection	Model Connection
1	Top of Left Frame	Elevator	Rear Bellcrank
2	Second from Top of Right Frame	Aileron	Right Front Bellcrank
3	Third from Top of Left Frame	Pitch	Left Front Bellcrank
4	Fourth from Top of Right Frame	Rudder	Rudder Bellcrank
5	Fifth from Top of Right Frame	Throttle	Carburetor

Servo Location and Installation

B. Examine the drawings and be sure to mount each servo in the correct front/rear orientation.

Do not install any servo arms at this time.

C. Select your battery pack (flat type/ 1400 ma or greater preferred). Apply two strips of thick foam tape and fasten the battery squarely on the #115-28 radio/ battery plate (evenly spaced between the Velcro). Wrap the Velcro firmly across the battery.

D. Wrap your receiver in dense foam. We suggest the M.A./ USA radio installation kit #3051 which includes a foam tube which fits the receiver very nicely. Leave an opening for the servo wiring. Set the prepared receiver atop the battery and secure with the #115-30B Velcro strap (the strap is to be inserted through slots provided in the plate on either side of the battery).

E. Install the switch into the #115-62 switch plate, taking care to center the switch so there can be no contact in either the on or off position.

F. Install the gyro following the manufacturer's instructions. Examination of the left and/or right frame will reveal two horizontal slots on each at the very front. Velcro strips #115-30A are provided to secure any component such as the gyro amplifier or governor to either side frame. Always use thick two-sided tape in addition to the Velcro.

G. Make all necessary servo, gyro and switch connections in an orderly manner, routing wires to avoid contact with frame edges and moving parts. Use the #0389 (single servo wire) and #0390 (two servo wires and/or gyro wires) retainers to secure the wiring. These items will press onto the head of any M3 socket head bolt. The bolts retaining the uppermost #115-20 hex frame spacer are ideal positions to install #0389 for servos #1 and #2. Bolts retaining the gyro mounting brackets are suitable positions for #0390 retainers.

H. Remote base loaded antennas (such as #4623 for 72 MHz.) are recommended. The "stick-on" types are preferred and provision is provided for mounting this type on the right side frame just in front of servo #1. Do not bundle the antenna lead wire with itself or other wires. Aim the antenna straight forward and curve as needed to clear the canopy inner surface.

Step 2: Basic Radio Programming

Preliminary adjustments must be made to the radio before installing servo arms (wheels) and push rods. Typical settings are listed for popular radios.

J.R. X 8310/ PCM 10 Series

Select swash type function 65.
Select 120 C.C.P.M. function.
Retain all "default" C.C.P.M. settings of 60%.
Set aileron, elevator and pitch ATV at 100%.

Futaba 8 UHP / 9 CH / 9 ZH

Select SR3 swash type in "model" menu.
Retain "default" settings at 60% for aileron, elevator and pitch.
Set aileron, elevator and pitch ATV at 100%.

NOTE: Do not adjust ATV for any trimming or set up changes.

Use only AFR or SWH menus for trimming adjustments.

Step 3: Installing Servo Arms (Wheels) and Pushrods

NOTE: Servos 1 - 3 require large servo output positions. For J.R., use the heavy duty J.R. Super Servo arms (available as an option from J.R. in a package of five) in the outer hole (20.0 mm from the center screw). For Futaba, use the large 45.0 mm diameter wheel (included with all Futaba servos) in the outer hole (19.50 mm from the center screw). We do not recommend the use of after-market metal servo arms.

All servos must be in the "neutral" position before proceeding. If you are a beginner, the amount of negative pitch that you will not be using can be eliminated electronically within your radio's pitch curve prior to flight.

Servos #1, 2 and 3 are set at neutral positions by placing the throttle stick at the center of it's travel. Servo #4 is set at neutral as per the instructions provided with your gyro. Servo #5 is set at neutral by adjusting 50% throttle in the throttle curve center point and placing the throttle stick at the center of it's travel.

Always maintain a minimum of 5.0 mm of push rod threads within a ball link.

Refer to Drawing #12G

Servo #1

Parts Required:

Qty	Part Number	Description	Found in Bag#
1	#0015	M2 hex nut	12B
1	#0103	M2 x 5 threaded ball	12B
2	#0133-1	Ball links (long)(grey)	12B
1	#122-95	M2.6 x 129 Push Rod	12B
1	#123-07	Clear Lexan Guide	12B

Refer to Drawing #12H

A. Select the #122-95 push rod and two #0133-1 ball links. Install each ball link and adjust to the preliminary length of 112.7 mm (measured as the amount of push rod exposed between the ball links).

B. Select the appropriate servo arm (wheel), neutralize the servo and temporarily press the arm onto the servo spline so that the output hole is exactly above and on a vertical line 2.5 degrees rearward from a vertical center line with the hole for the arm retaining screw. **Note:** A special guide has been provided to aid in achieving the 2.5 degree measurement. This guide may also be used to find 0 degree on the remaining servos. Test the position until the criteria is satisfied, note the position and remove the arm. Install the #0103 control ball from the backside of the servo arm (so it will ultimately face the left side frame) and secure from the outside with Loctite and one #0015 M2 hex nut. Install the arm, leaving the retaining screw out for Step 6. Snap the prepared push rod in place connecting the servo to the rear swash plate bell crank.

Servos #2 and #3

Parts Required:

Qty	Part Number	Description	Found in Bag#
2	#0015	M2 hex nuts	12C
2	#0103	M2 x 5 threaded balls	12C
4	#0133-1	Ball links (grey)	12C
2	#122-94	2.6 x 97.0 Push rod	12C

Refer to Drawings #12H and #12I

A. Select the #122-94 push rod and two #0133-1 ball links. Install each ball link and adjust to the preliminary length of 81.2 mm. As with servo #1, the arm for servo #2 must be the correct size and positioned with the output hole beneath and on a vertical centerline with the arm retaining screw hole (servo in "neutral"). Servo #2 utilizes the control ball to the inside of the servo wheel. Select and install one #0015 hex nut and one #0103 control ball with Loctite. Snap the prepared push rod in place connecting the servo to the right cyclic bell crank. Select another #122-94 push rod and two #0133-1 ball links. Install each ball link and adjust to the preliminary length of 81.2 mm.

B. As with servo #2, the arm for servo #3 must be the correct size. Contrary to servo #2, servo #3 requires the control ball be on the center line directly **above** the arm retaining screw. As with servo #2, this servo will utilize the control ball **inside** the servo arm and towards the left frame. Select one #0015 M3 hex nut and one #0103 control ball and install in the arm with Loctite. Snap the prepared push rod in place connecting the servo to the left cyclic.

Servo #4

Parts Required:

Qty	Part Number	Description	Found in Bag#
1	#0015	M2 hex nut	12D
1	#0103	M2 x 5 threaded ball	12D
2	#0133	Ball links (long)	12D
1	#0679	M2 x 170 push rod	12D
1	#122-98	M4 x 160mm graphite tube	12D

Refer to Drawing #12I

A. Select the #0679 push rod and two #0133 ball links. Install each ball link and adjust to the preliminary length of 155.0mm. As per your gyro instructions install a control horn with a arm length resulting in a ball position that is 13-15mm out from the center. Neutralize the servo and temporarily press the arm onto the servo spline so that the output hole is exactly beneath and on a vertical centerline. Select and install one #0015 M2 hex nut and one #0103 control ball on the outside of the control arm. Snap the prepared control push rod in place connecting the servo to the rudder bell crank. The rudder bell crank control ball should be in a vertical position at this time. Adjust the control rod if necessary.

B. Select the #122-98 graphite tube. Sand on the end of the tube until its overall length matches the exposed rod in between the ball links. Remove one ball link. Wipe the push rod with alcohol and apply slow Cyanolate and epoxy about 10.0mm long at the center of the push rod. Slide the graphite tube over the push rod and re-install the remaining ball link, tightening it fully against the graphite tube. Align each link in the same orientation and wipe away excess glue. Snap the assembled rod in place.

Servo #5

Parts Required:

Qty	Part Number	Description	Found in Bag#
2	#0015	M2 hex nut	12E
2	#0103	M2x5 threaded ball	12E
2	#0133	Ball links (long)	12E
1	#0373	M2x130 push rod	12E

Refer to Drawing #12I

A. Select two #0133 ball links and the #0373 push rod. This push rod has extended threaded surfaces and may be too long for some applications. To determine the correct length, measure the exact distance from servo #5 (throttle) spline hole to center point of the carburetor barrel. Subtract 18.0mm from this distance. The result will be the total length of the #0373 push rod. If any material must be cut, do approximately half at each end. Install two ball links and adjust so that holding the prepared push rod up to the original measuring points (the servo center screw hole and the carburetor barrel center point) will show each directly on center and visible through the hole in each ball link.

B. Select a servo control arm or wheel which is equal or greater in length from center to output hole as compared to the same measurement on the carburetor control arm. With the servo at "neutral" (50% throttle curve of your transmitter and the throttle stick at the center of it's travel) position the servo arm so that it's output is visually perpendicular to a line connecting the servo spline to carburetor arm mounting bolt centerline. Determine the position of the carburetor barrel at 50% throttle and attach the carburetor arm with the same criteria. Install one #0015 M3 hex nut and #0103 control ball in each arm using Loctite.

NOTE: Due to variations in carburetor design, make the determination as to if the carburetor control arm ball should be inside or outside the carburetor arm based on which will provide a straighter push rod orientation when viewed from above.

C. Snap the prepared push rod in place connecting the servo to the carburetor.

Step 4: Installing the Swash plate Lower Push Rods

Parts Required:

Qty	Part Number	Description	Found in Bag#
6	#0133	Ball links (long)	12F
3	#0227	M2x42 push rods	12F

Refer to Drawing #12J

Select six #0133 ball links and three #0227 push rods. Install two links on each push rod, adjusting each until adjusting each until 26.0mm (if calipers are used make them 25.2mm each) of push rod is exposed between the links. Snap each prepared push rod onto each control ball on the outer swash plate ring and the corresponding bell crank below. Orientate each ball link on each push rod so each link is uniformly centered on it's respective control ball.

Step 5: Installing the Rotor Head Push Rods

Parts Required:

Qty	Part Number	Description	Found in Bag#
10	#0133	Ball links (long)	12G
2	#0135	Ball links (short)	12G
2	#122-96	M2x15 push rods	12G
2	#0337	M2x27 push rods	12G
2	#0367	M2x60 push rod	12G

Refer to drawing #12J

A. Select four #0133 ball links and two #0337 push rods. Install two ball links on each push rod, adjusting each to a length of 16.1 mm (exposed push rod between each link). Snap each prepared push rod in place connecting each fly bar control arm to each #0109 control ball of the #106-05 washout arms.

B. Select four #0133 ball links and two #0367 push rods. Install two ball links on each push rod, adjusting each to a preliminary length of 40.0 mm (exposed push rod between each link) and orientate each link perpendicular to the other. Snap one prepared push rod in place connecting the outer ball (the ball nearest out the center of the rotor head) in the #122-10 bell Hiller mixer with one of the two remaining #0109 control balls of the inner swash plate ring. Repeat the process for the opposite side. More information will be provided later in this text regarding the bell mixer ratio choices available on this model.

C. Select two #0135 ball links (short type), two #0133 ball links and two #122-96 push rods. Install one #0133 and one #0135 on each push rod, adjusting each perpendicular to the other and with a gap of 4.25 mm. Snap one prepared push rod in place connecting the inner outer most ball on the #122-10 bell mixer (farthest out from the center of the head block) to the threaded ball on the #122-16 pitch arm. Repeat the process for the opposite side of the rotor head.

Step 6: Installing the Ball Bearing servo Output Supports

Important Note: Futaba and Hi-Tech servos require an M2.6 threaded fastener/bearing pivot (#115-73) for retaining the servo wheel and J.R./Sanwa require an M3.0 threaded fastener/bearing pivot (#115-74). Do not make any substitutions for the correct parts or a failure could occur.

Parts Required:

Qty	Part Number	Description	Found in Bag#
4	#0016	M3 "intenal toothed" lock washers	12H
2	#0037	M2.5x25 Phillips screws	12H
6	#0037-1	M2.5x30 Phillip screws	12H
4	#115-73	M2.6 pivot stud (Futaba, Hi-Tech)	12H
4	#115-74	M3.0 pivot stud (J.R./Sanwa only)	12H
2	#115-80	M2.8x4.5x16.5 spacer tube	12H
6	#115-82	M2.8x4.5x23.0 spacer tube	12H
4	#119-86	Servo output support plates with ball bearings (J.R./Sanwa, Futaba)	12H
8	#0560-8	M2.5 flat washers	12H

Note: for any application utilizing Futaba servos, the appropriate Futaba servo wheel must be modified for clearance as shown in drawing 13C. Position each servos #1 - 3 at neutral and modify each wheel at this time. A Dremel tool with coarse sanding drum is most useful for this procedure. *Refer to drawing 13C.*

Refer to drawing #12K

A. Installation on Servo #1. Select one appropriate pivot stud (#115-73 for Futaba / Hi-Tech or #115-74 for J.R./Sanwa) and one #0016 lock washer. Remove the factory supplied screw retaining the servo arm (wheel) and install the pivot stud and lock washer in it's place.

B. Select the two #0037 M2.5x25 Phillips screws, the two #115-80 spacer tubes, support plate #115-86 and two #0560-8 M2.5 flat washers. Examine the support plate and note the flanged side of the ball bearing. This flange ***must*** face the servo arm (wheel).

C. Press the support plate (with ball bearing) onto the pivot stud about one quarter the length of the stud. Each end of the support plate is secured to the right main frame by a #0037 M2.5x25 screw, a #115-80 spacer tube and a #0560-8 M2.5 flat washer. The washer ***must*** be next to the frame. Install the hardware at each end with Loctite and moderate torque. Note: allow the support plate to "center" itself before simultaneously tightening the screws to avoid inducing a "pre-load" to the servo.

D. Installation on Servos #2 through #4. The procedure for these servos is the same except that all spacer tubes and corresponding screws are changed. The longer spacer tubes #115-82 and screws #0037-1 are used.

XIII. PREPARING THE CANOPY

Bag required: 13A

Tools or materials required:
Slow cyanoacrylate glue (CA)
(Optional) Painting materials (See text supplied with the decal sheet)

NOTE: Refer to the *"Suggested locations for decals"* sheet. Drill holes and cut out areas as shown. Painting can be done before or after the following steps but trial fitting is suggested.

Step 1: Installing Mounting Hardware and Fitting the Canopy

Parts Required:

Qty	Part Number	Description	Found in Bag#
4	#106-22	Rubber grommets (large)	13A
1	#122-90	Canopy	Box
1	#122-92	Decal Sheet Tempest	Box
4	#122-99	Canopy Retaining Knobs	13A
4	#0053-5	M3x16 Set Screw	13A

Refer to drawing #13

NOTE: Before gluing any of the grommets into position, finish step "B" first.

A. Select four #106-22 rubber grommets and the canopy. Drill one 1/8th" (0.125") hole in the center of each mounting cavity in the canopy sides. Slide the canopy in position on the model. Using any size 3mm screws, attach the canopy to the model. Observe whether any of the holes need to be repositioned. Do so until all four screws easily mount without distorting the canopy. Open each hole to a dimension of approximately 0.260" - 0.265" (6.60mm - 6.73mm) using an "H" drill bit.

B. Insert each grommet into each hole. Assemble each canopy knob using one #0053-5 M3x16 socket set screw. Tighten securely using Red or Green Loctite. Trial fit the canopy using the assembled retaining knobs. Adjust if necessary. Once you are satisfied with the fit, go to the inside and secure the perimeter of each grommet to the canopy with CA glue.

Step 2: Canopy Finishing Suggestions

At your option, the canopy can be used in the "white" form provided or painted to your choice. If overall painting is chosen, these instructions assume you have the necessary experience and materials therefore only the steps required to finish the canopy in "white" are described below. **Note:** If you are changing the color, be aware that the decals are best applied only over white or very light colors.

NOTE: Refer to Table 3: Finishing Methods and Procedures. After choosing your finishing methods, please consider the following list of optional materials:

3M Scotch brite pad or fine steel wool and ¾" masking tape
Strong detergent
Masking paper or newspaper
Alcohol or paint prep solvent (such as Dupont #3919 prep-sol)
"Tack" cloth

Paint selection - Paint must be chosen to be fuel proof or compatible with fuel proof clear-coat. Automotive poly-urethanes are best but modeler's epoxy or urethane can also be used. Always apply a light coat first, allowing 15-30 minutes set-up time, before final gloss coats.

Finishing Methods and Procedures

Painting	**Finish Choice:**	
	Clear-coat Method	**Non Clear-coat Method**
Characteristics:	Longer completion time, high gloss, best decal protection, slightly increased weight	Quicker completion time, shorter decal life, lightest weight
Procedures		
Step (1)	Wash thoroughly with warm water and detergent	Wipe with alcohol or paint prep solution
Note: The canopy can be left as is or further detailed. If you wish to smooth it further, apply ¾" masking tape (in two layers thick) on both sides of the seam and sand with 400 grit wet-or-dry paper. If overall painting is chosen, imperfections in the seam can be filled with glazing putty or similar material.		
Step (2)	Scuff overall with ScotchBrite abrasive pad or fine steel wool. Wipe again with cleaner.	Mask area surrounding the "window". Scuff window area with ScotchBrite pad or fine steel wool and wipe again with cleaner.
Step (3)	Mask area surrounding the "window" and spray with color of choice. Remove masking tape.	Spray window area with color of choice. Remove masking tape.
Decal Application	**Dry Method**	**Wet Method**
Characteristics:	Quicker, but only one opportunity to position decals	Slower, easy repositioning of decals
Procedures		
Step (4)	Carefully cut decals from sheet using sharp scissors or a clean modelers knife. Study decal application sheet for suggested positioning,	
Step (5)	Apply decals and firmly burnish to canopy surface using the decal backing paper and firm finger pressure.	Apply window cleaner to canopy. Position each decal and remove excess liquid with a soft rubber squeegee. Allow to dry – Canopy is completed.
Step (6)	Wipe the canopy with a tack cloth and apply clear-coat of choice by first applying a very light "tack" coat (allowing it to dry 15-30 min.) followed by a wet coat. Canopy is completed.	

XIV. ROTOR BLADES

It is recommended that a blade length of 680mm to 700mm be used. A good quality rotor blade is suggested. Miniature Aircraft USA offers a variety of high quality rotor blades suitable for the Fury Tempest.

XV. FINAL MECHANICAL AND ELECTRONIC SET-UP

NOTE: The following procedures will be described using a pitch gauge, fly bar lock and paddle gauges. The use of these items is highly recommended since without them an accurate set-up is very difficult. Refer to the beginning of the manual for the correct order numbers.

A. Install the rotor blades, noting that the leading edge of each corresponds to a bell mixer on each side of the rotor head (clockwise rotation). The pivot bolts must be tightened the correct amount. This is best described by indicating what is too loose and too tight. If the model is leaned to one side and the blades swing together by their own weight, the bolts are too loose. If a fly bar paddle is held in one hand, a blade tip on the other and an effort is made to fold the blade, the result should not deflect the fly bar more than 25.0mm (1.0″). These are approximate values.

B. Install a flybar lock onto the rotor head. Install a pitch gauge onto one rotor blade.

C. Set all transmitter trim levers and servos/bell cranks at neutral as described in Section XII, Step 2. The swash plate can now be adjusted to a level position (perpendicular to the main shaft and parallel to the main gear/frames) by adjusting the rods below it. This procedure can be assisted by the use of a straight-edge or bubble level placed across the top surface of the swash plate outer ring. The final confirmation is done at the rotor blade. Read the pitch at the blade (the exact value in degrees does not matter at this stage). The pitch reading should not change as you rotate the head, checking it at each 90 position (starting directly over the tail boom for example). Miniature Aircraft USA offers an excellent tool for leveling the swash plate, order #0513.

NOTE: Adjustments should be split at opposite sides (half turn longer on the left side, half turn shorter on the right side, for example).

D. Adjust the rods (#0337) from the washout to the flybar control arms until the flybar arms and the wash out arms are level.

E. Adjust the rods (#0367) from the swash plate to the bell mixers are 2mm below level with the flybar level.

F. The fly bar paddles must now be aligned with the swash plate. This can be confirmed by visually comparing the paddles to the swash plate from the side view. Some pitch gauges will adapt to the paddles or you can use the X-Cell paddle gauges #0510-1. The fly bar lock can be removed for this step if tilting the fly bar helps your view. Adjust each paddle until they are level and parallel to each other.

G. Adjust the rods (#0313) from the bell mixer to the pitch arms for =2 degrees pitch in the rotor blades.

H. Adjust the transmitter's collective throw (ATV/AFR, collective CCPM) for =12 degrees to –8 degrees total range.

I. Adjust the individual pitch curves as desired in the transmitter

Below are the suggested pitch settings

The use of an electronic governor is highly recommended. These settings will result in a hover stick position above mid-stick.

Initial Pitch/Throttle Settings

Desired Flying Style/Type	Throttle/Collective Low Stick Position	Throttle/Collective Half Stick Position	Throttle/Collective Full Stick Position	Rotor Head RPM
Basic Flying and Hovering	-4° (20%)*	+5° (50%)	+11° (90%)	1300 to 1500
Aerobatics (Idle-up 1)	-6° (60%)	+2° (60%)	+9° (100%)	1750 to 1850
Hold/Autorotation	-7°	+2°	+12° (100%)	

*(Percentages Shown are Approximate throttle settings)

J. Cyclic pitch can now be set. With the fly bar lock and pitch gauge in place, position the rotor head so that one blade is directly over the tail boom. Move the collective/throttle stick until exactly zero degrees pitch is shown on the blade. Do not move the stick again. Apply full right and full left "aileron," reading the pitch at each. The result should be ±6 to 6.5 degrees. Adjust AFR as needed. Rotate the rotor head so that the flybar is directly over the tail boom and repeat the process for "elevator."

K. Dual rates for aileron, elevator, and/or rudder can be set at 60% if desired. These can be fine tuned at anytime.

L. Set the throttle settings to approximate those shown in the chart or to the governor settings.

XVI. Cliff Hiatt's Recommendations for the Rotor Head Setup

I get a lot of requests for information about how I setup my models, so I'll go ahead and provide my recommendations for setting this head up for FAI style flying. Keep in mind that my setup includes ALL these recommendations. If you intend to use **only some** of them, you may need to make other changes to get the best results.

Dampening

I've found that installing the softer dampeners dry (with no lubricants) and using a .25mm shim on each side gives pretty close to linear dampening rates and flew the best for me. For those of you familiar with the dreaded "wobble" that you often see happen to helicopters, using linear dampening and/or negative Delta offset seems to be the trick to be the trick in preventing it.

Flybar Paddles

The head will support both short and long flybars and has been successfully tested with paddles as heavy as 50 grams. The flybar supplies with the kit will work with whatever paddle weight you want, however most contest pilots use a weight between 35 grams and 45 grams.

Of course any of the flybar lengths that MA manufactures can be used. Use the combination of flybar length and paddle weight that suits your flying style. I personally like the long flybar and "New X-Cell paddles #

Bell / Hiller Mixing

I've found good results using the 1 to .90 ratio.

Delta Offset

I'd commend using the 3.3mm negative delta offset option. As to whether you use positive or negative correction, there has been a lot of discussion regarding this subject lately about the pros and cons of each. Using one of the other will depend on whether you believe the blade disc is upset by wind gusts or the helicopter body is. As I discussed earlier, it is easy to change the head setup to achieve whichever you want.

Rotor Blades

I would recommend that you use 700mm blades that weigh in at approximately 200 grams. This is mostly because heavier blades can effect gyroscopic precession in aerobatics. Use whatever blade profile suits your style of flying at the head has been tested with symmetrical, semi-symmetrical and progressive profile, all with good results.

I am currently using 700mm Hi-Product TZ-91 II Progressive airfoil blades that weigh about 200 grams.

Head Speeds

I have hovered this head down to 1150 rpm, but it seems to be happiest hovering in the 1400-1500 rpm range. Depending on the length of rotor blades, I'd recommend 1850-1900 rpm for crisp aerobatics.

Exhaust System

Install the exhaust system as per the manufacturer's instructions. In the case of all popular motors, except the Y.S. install a section of fuel tubing from the pressure fitting of the muffler (or manifold) to the fuel tank vent fitting. It is suggested that a fuel filter be installed in this tube to avoid any exhaust system debris from entering the fuel supply. Arrange the tubing (by adjusting its length) so it does not interfere with any moving parts on the model. Also be sure the canopy will not rub an abrasive edge against it. If necessary, a “heat shrink tubing” “protective sleeve” can be added or tie wraps can secure the tubing away from interference.

CG/Balance

Lift the model by the flybar (near the head) and note its balance. With an empty fuel tank, and canopy installed the skids should be level when supported over a level surface. If needed, adjust the radio/battery from Section IV, Step 1B to suit. Normally with popular components, the model should not require any lead added but some exhaust systems combined with lightweight battery packs may cause a balance problem. The model will not perform properly if it is tail heavy.

XVII. FINAL INSPECTION

Recheck overall for loose fasteners, interfering components, or incorrect radio installation. Operate all radio controls making certain that none are reversed and that the throttle can properly close the carburetor. Be certain the gyro functions in the correct direction.

XVIII. PRE-FLIGHT INFORMATION

At home:

Be sure you have all necessary equipment to operate or service the model.
Be sure all batteries are fully charged.

At the flying site:

Observe any flying site rules.
Check the frequency board or nearby pilots to clear your frequency.
Range check your radio as per the manufacture's instructions.
Pre-check all controls.
Obtain assistance from more experienced pilots of possible.
Never leave the transmitter in a position that would allow it to be handled or upset while you are starting the model.
Check your battery status whenever possible. Most factory shipped batteries can only sustain three "tank-full" flights before needing a re-charge. Do not take any unnecessary risks. Always turn off all components between flights.

XIX. STARTING AND STOPPING PROCEDURES

TO START: Always start the engine by using the transmitter trimmer only (*high* throttle trim, *low* throttle stick). Check idle-ups and throttle hold for proper position of switches (off). Connect the glow 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, viewing the model from above. Hold the rotor head firmly with one hand. Engage the starter extension of the starter with the shaft or adapter on top of the engine 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 the throttle ATV until the 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). ***Never attempt to stop the blades while they are rotating.***

XX. FIRST FLIGHT ADJUSTMENTS

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

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 desired hovering RPM 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 hover.

Tail Rotor Trimming

Adjust tail rotor trim as per your gyro instructions.

Tail Rotor Compensation for Torque

(Note: Not required if you own a heading lock gyro). All adjustments are made from hover (at least 15' in height) with a "trimmed" tail rotor. When properly adjusted the model should not rotate to the right or left when ascending or descending. See your radio manufacturers instruction manual.

Swash Plate Trimming

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

Main Rotor "Dynamic" 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 rod (#0367) on each side of the head. A piece of colored tape may be applied to one blade during balancing or tracking in order to visually determine which blade is high or low.

Tracking Procedure:

- Low blade speed >> Lower the high blade
- High blade speed >> Raise the low blade
- If blades are out of track ½" or more, re-check original pitch settings.

Setting Top Pitch

Adjust the top pitch on you **idle-up** functions so that the model will fly at full throttle and maintain proper head speed. Too much top end pitch/ too low RPM 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.

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