Author has many pulse-jet-powered CL scale ships, such as Sabre jet in background. Here he adjusts canopies on Phantom for display.

all photos by Bill Hannan

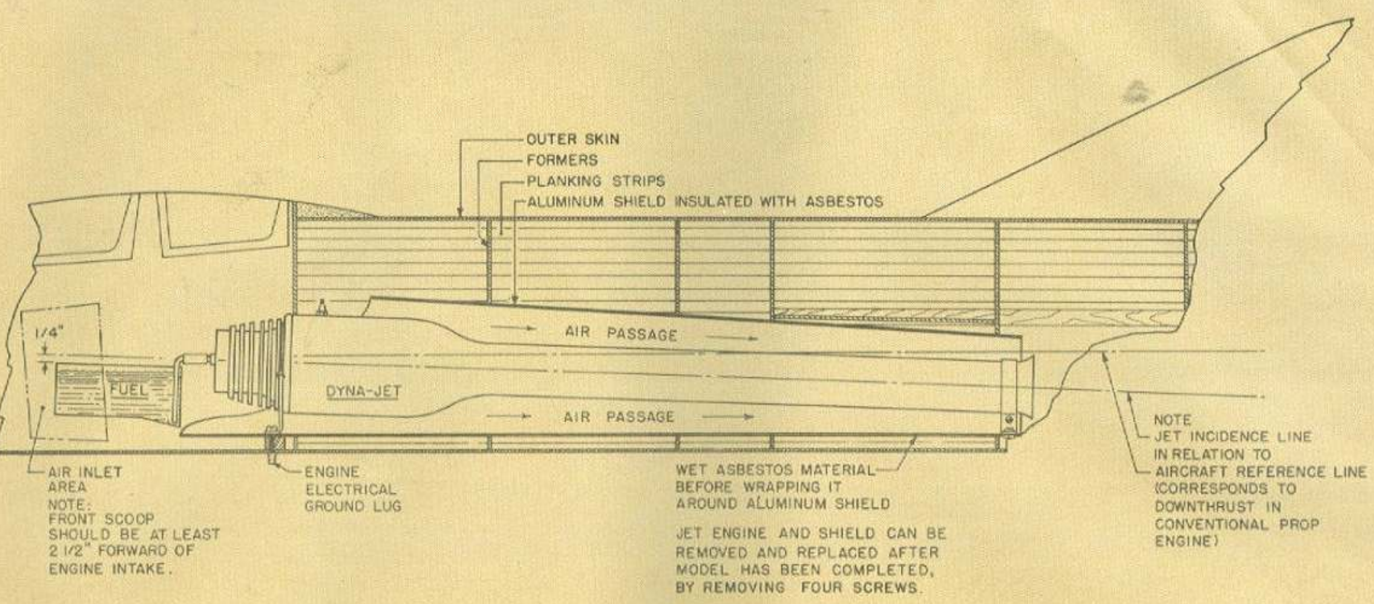
PLANE ON THE COVER

JET RC PHANTOM!

Many years of experience with Dyna-Jets have made this dream plane a practical and successful model aircraft. And it is much simpler than it seems.

Black object in foreground is removable, simulated dual jet exhaust. Only deviations from scale are airfoil and area changes.

Since the model flies at over 160 mph, pilot must be sharp. Canopies are firmly latched down. Landings are always dead-stick.



With model's lifting airfoil, downthrust is needed. Note angle of engine relative to centerline. It is very important.

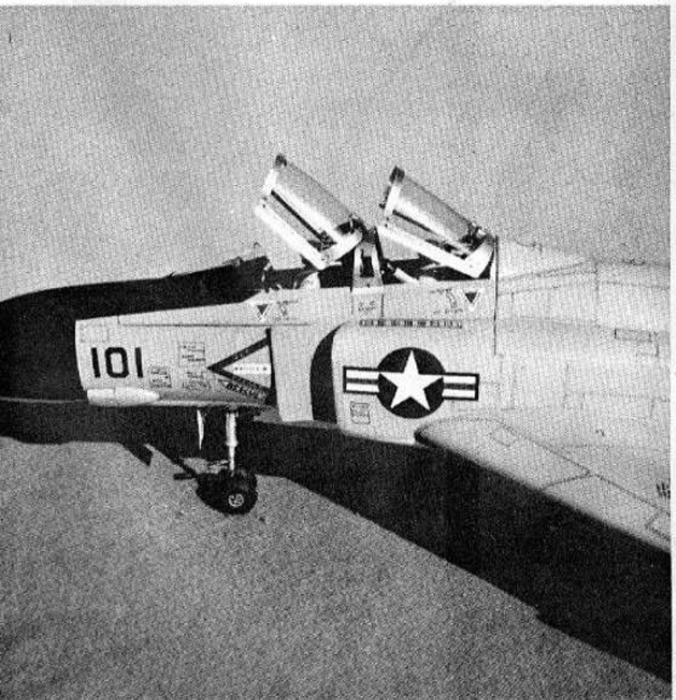
RALPH SALDIVAR

THIS IS THE JET AGE, yet surprisingly few jet-powered models are seen. It is a pity, since nothing is more realistic than the sight and sound of a scale model with a genuine jet engine aboard!

There are several possible approaches to propelling models of jet aircraft. For small free flight models, Jetex units and ducted fans have been used. Ducted fans have also been employed in U-Control and radio-controlled model aircraft with at least some success. Modelers also have resorted to using conventional glow engines and propellers, rationalizing that the prop disk can scarcely be seen in an airborne model. However, none of these forms of propulsion is a complete or truly satisfying answer. After all, when trying to duplicate an actual jet aircraft, why not power it with a jet engine?

The pros and cons of true jet power should be examined. Without a doubt, *(Continued on page 73)*

Most of the lettering has been expertly hand-painted. LetraSet can also be used. Small wheels are scale. A smooth runway is required.



With hatch removed for engine starting, heat/fire shield and tank are seen. Indirect scale air intakes are adequate.

Jet RC Phantom

(Continued from page 23)

the greatest single drawback is noise! Unlike conventional reciprocating engines which can be muffled, little can be done to reduce the sound level. Thus, the areas where jets can be operated are rather limited. On the other hand, flying detailed scale models is usually limited to contests. Most major contests do permit (and often encourage) jet model flying.

Some model builders shy away from jets because of envisioned difficulties with engine installation and operation. True, some items, such as engine installation and fuel tank design, must be given special consideration during construction. Yet once the requirements for jet engine operation are understood, these problems are solved quite easily. Another concern is the potential fire hazard, which has been exaggerated. By taking proper precautions such difficulties can be virtually eliminated—but do keep a fire extinguisher handy.

On the plus side of the ledger, model jet engines of the pulse variety are readily available in the U.S. Best known is the Dyna-Jet, which operates on the same principle as the engines that propelled the German V-1 Buzz Bombs in WW II. The model engines are more efficient, with the lowest fuel consumption for thrust developed and highest cycle frequency of any production-type jet. These engines run well on low-cost "white" gasoline, which is so mild no elaborate and expensive fuel-proof finishes are needed.

Naturally, techniques for starting and operating jet engines must be learned, but one quickly can become familiar with the required procedures. Lots of pioneering remains to be done with this type of aircraft, so join in! Let's get more true jet models into the air.

A certain amount of courage is required to tackle a project of this magnitude, but the reward of seeing the finished jet aircraft in action will more than repay the effort involved. Although my Phantom was radio-controlled, this ship also would be ideal for U-Control. It is definitely **not** a beginner's project, but construction should not offer any particular problems to the experienced scale modeler.

To improve flying characteristics, the Phantom incorporates a few departures from exact scale. The wing chord was increased, as was the airfoil thickness. With these changes, the relatively small wing of the one inch to the foot model was successfully utilized. In addition, the upper fuselage line has been raised slightly to provide extra space for the rudder and stabilator actuating servos. The changes have not disturbed the overall appearance of the aircraft to any great degree, and the alterations usually go unnoticed.

Before reaching for the balsa, study the photos and plans (See centerspread, May 1970 AAM, 10¢). Most potential "worry areas" will vanish when approached in a patient, logical manner. Unless otherwise specified, all balsa employed in this model is medium hard.

Construction

Fuselage: Using carbon paper underneath the plans, transfer the outlines of formers F-1 through F-10 onto 1/8" plywood. Cut them out accurately, since they create the basic fuselage contour and some of them also determine incidence alignments.

Next, construct the simple fuselage assembly jig from 3/4" pine or plywood. Any errors built into it are passed along to the model, so take time to line everything up correctly. If desired, the first two jig members may be notched to accept the nose-gear mounting strip.

Cut the fuselage longerons to size from spruce that is free of warps or twists. Place one directly over the plans and mark the location of each former. Slide all formers onto the longerons and set the resulting skeleton framework onto the assembly jig. The framework can be temporarily secured to the jig with tape. Install the upper 1/4 x 1/8" spruce longeron to help hold the formers in alignment, but do not glue it at this time.

The inner wing ribs (R-1) are cut from medium hard 3/32" balsa, and placed on formers F-4, F-5, and F-6. Recheck that formers F-2 through F-10 are in proper alignment, then glue in place. The R-1 ribs are not glued on but are removed to be assembled later on the wing jig. A long, straight strip of balsa can be used to check alignment along the sides of the formers. In the top view, note the "Coke bottle" effect created by the outer contours of the fuselage.

Next, the 1/2 x 3/8 x 10 1/2" spruce nose-gear support member is added, along with former F-1. While they are drying, glue and secure the longerons in place.

Wings: Cut out the pine front and center wing spars, and the medium hard balsa ribs. Construct a simple jig (indicated on the plans) to support the spars during wing assembly. Note that the inner wing ribs are reinforced with plywood segments. Place wing ribs R-1, R-2, R-3, R-4 and R-5 in their correct locations on the spars, and place each assembly on its wing jig. Check for correct alignment before gluing the parts in place. After the assemblies have dried (wing tips have not yet been added), slide them into position on the fuselage sides. Clothespins may be used to hold them during the next operation, which establishes the proper dihedral angle for the inboard wing panels.

This is measured by placing a straightedge under the longeron just forward of F-6. The vertical distance can be measured at location No. 3, as indicated on the top-view drawing, and should be ⅜" on each side. If fuselage formers F-4, F-5, and F-6 have been made and installed correctly, the wing incidence (+2 degrees) will be built-in automatically. When satisfied that these angles are as they should be, drill through the ⅛" dia. holes in formers F-5 and F-6 into the wing spars adjacent to them. These holes will accept bolts during the assembly phase (see locations No. 1 and No. 2 on the top-view drawing).

Now remove the wing panels from the fuselage, and replace them on their jigs. Cut and splice the center and rear wing spars to achieve the specified wing tip dihedral, as indicated on the spar drawings, and add the remaining wing ribs. The leading edges and tip blocks may then be installed. After everything has dried, the wings may be removed from their jigs, and fastened permanently to the fuselage.

Landing Gear: Bend the main landing gear struts from 5/32" music wire and install them with J-bolts, as indicated in the wing top-view drawing. The nose-gear strut is constructed from mild steel rod so that it can be flattened and bent as shown on the detail drawing. Also, mild steel is much easier to solder than music wire. Assuming that the model lands in the recommended nose-high manner, the main gears will absorb most of the landing loads anyhow. The nose-gear pivot bearing is machined from aluminum stock and is held in place by a large washer which is soldered in position. The axle also is soldered in position. As an extra precaution, it is well to wrap a few turns of fine wire around this junction before soldering. Note that the upper steering arm of the nose-gear is drilled to accept the link pin of a Nyrod, which will be actuated by the rudder servo. The nose-gear strut bearing is liberally coated with epoxy and inserted through the hole in the nose-gear support member. In addition, a small pair of wood screws is used to hold the bearing flange against the support member (see fuselage side-view drawing).

Once the basic structure is built, attention can be turned to the various subassemblies. A 3/32" plywood servo mounting board is cut to size and installed between formers F-7 and F-8. A pair of short longerons also is added on each side between F-7 and F-10. Now is a good time to make and install the ½" sq. hardwood engine mounting blocks.

Several items, such as the engine heat shield, are unique to jet models and must be constructed from metal. Those reluctant to make this unit can have it fabricated by any sheet metal shop for a reasonable fee. Such a shop would most likely close the joint in the tube with a folded lap seam, but a simple overlap secured with ⅛" dia. aluminum rivets will do just as well. After the tube has been completed, it is wrapped with a single layer of 1/32" thick asbestos cloth, obtainable from a hardware store. This material is usually used for insulating steam pipes. Wet it before wrapping around the tube; when it is dry, it will retain the curve. The heat shield tube is held in the fuselage by the engine mounting screws.

The forward engine mount is cut and filed to shape from .051 aluminum sheet. The lower flanges are bent at right angles and fastened to the engine mounting blocks with 4/40 machine screws. One of the screws also serves as a grounding point for the engine-starting electrical lead. The external connection points on the model were the removable tips from automobile spark plugs. (See fuselage side-view drawings.) A 3/64" dia. piece of music wire is used to secure the engine in the mount. The rear of the engine is held in place with a simple .012 thick stainless steel strap (detailed on plan). If stainless steel is not available, .035 or thicker aluminum may be substituted.

The rear heat shield, which fits directly above and behind the engine tailpipe outlet, is cut from .016 sheet aluminum. 1/32" asbestos cloth cut to the same size is sandwiched between the shield and the underside of the fuselage, and secured with wood screws.

Fuel Tank: This important item must be carefully constructed to assure that the engine will not flame out because of faulty fuel feeding. The drawing shows the proper method of construction; .008 tin sheet is suggested. The main portion of the tank is bent from a single sheet, and the baffle, ends, and lower fuel reservoir are soldered on separately. An optional fuel shut-off device also is shown. This involves an additional servo fitted with a wire to pinch the fuel feed line on command. Generally speaking, this item would not be needed, since the fuel tank is designed for only about two and one-half to three min. flying time. (Assuming 30-45 sec. ground running during starting and launching.)

The location of the fuel tank is somewhat critical. Best results in RC models have been obtained by keeping the top of the fuel tank within ¼" from the level of the engine metering jet. If the fuel tank is mounted too high, the fuel will gravity feed into the engine, resulting in a potential fire hazard. On the other hand, too low a fuel level will result in difficult starting.

Stabilator: The hinge assembly for the stabilator (all-moving horizontal tailplane) is constructed from aluminum and plastic. Particular care should be exercised to achieve a smoothly operating, slop-free unit. It is spring-loaded to the neutral position. (See fuselage side-view drawing.)

The stabilator is shown true size on the top-view drawing, and it is constructed from balsa and plywood, sandwiched over the actuator plate. The two stab sides must be added after the hinge assembly has been installed in the fuselage. The bolts and nuts are inserted and epoxied prior to adding the upper and lower balsa sheets. Final shaping and sanding is done on the aircraft.

Fin and Rudder: The fin is made from 3/8" medium hard balsa, sanded to shape, while the rudder is cut from ¼" hard balsa. Use your favorite brand of hinges and control horn.

Miscellaneous: A few items remain to be installed on the fuselage. The rudder and elevator servos are mounted on .020 aluminum mounts, bent to shape as indicated. The remainder of the electronics components may be installed at this time. Caution: All electronics hook-up wiring should be located at least an inch away from the engine heat shield to protect the insulation from melting!

The ailerons are both actuated via Nyrods from a single servo mounted in the port wing, as indicated in the top-view drawing. This servo is mounted to an aluminum angle bracket with grommets in the mounting holes. The bracket is mounted atop a piece of 1/16" plywood, fitted with two pieces of 3/16 x 5/8" pine which accept the bracket mounting screws. The receiver antenna should **not** be placed parallel with the jet engine, but rather at right angles to it. In other words, it should run from the receiver out to a wing tip, rather than the usual receiver-to-fin setup.

Engine: My jet engine installation techniques have been developed over a period of years, and the basic principles thoroughly tested in a number of different models. Certain important considerations deserve special attention. Perhaps most significant is the matter of assuring adequate cooling to protect not only the engine itself, but also the potentially flammable structure of the model. The drawings indicate the relative locations of the air intakes and the engine heat shield, which also serves as a passage for cooling air. Regardless of the provisions made for proper cooling of the engine and insulation of the model structure, it still is important to confine ground running time to a minimum. Since the engine does not require any sort of warm up, it is pointless to operate it for any extended period while stationary. Correct cooling can best be assured by getting the model into the air as soon as possible.

When installing the engine, the thrust line is inclined two and one-half degrees with respect to the fuselage reference line. This corresponds to downthrust in a conventional reciprocating engine.

Note that the entire engine and heat shield may be removed, if necessary, after the model has been completed, since the forward hatch allows sufficient room. Other items, unique to jet installations, such as the fuel tank are described separately.

Planking: After all the internal components have been installed and tested to satisfaction, begin planking. A good place to start is the top of the wings, which are covered with sections of sheet balsa, rather than strips. The grain is arranged parallel to the wing leading edges. Ambroid glue is used for this operation, and straight pins hold the sheets in place while the glue is drying. Next, invert the model and install the aileron ribs, actuating Nyrods, and control horns. Carefully mark the top skin to indicate where the ailerons will be cut, and proceed to cover the bottom of the wings. The ailerons then may be cut free, and their hinges installed.

The remaining carpentry work involves cutting out the fuselage tail block, nose block, and air intake baffles. Note that the lower rear portion of the fuselage, featuring the dummy afterburner outlets, is just for appearance and is removed for flying. The entire fuselage is planked, mostly with 3/8 x 1/8" balsa strips. In some locations, such as the relatively flat fuselage bottom, wider sections of 1/8" sheet balsa can be used. Planking is tedious business at best, but the model soon begins to take on an exciting appearance.

Wherever a hatch is to be provided, such as over the servos and the entire cockpit area, provisions must be made in advance of planking. Short balsa wood members are installed at the parting lines, with waxed paper inserted between them. As the planking proceeds, mark on the outside where the incisions will be made to free the hatches. Forget this and you'll find yourself having to do a lot of guesswork (and probably patching) trying to locate the hatch parting lines. The hatches may be hinged or completely removable, at the discretion of the builder. An effective type of latch is detailed near the nose-gear drawing, but any dependable system may be employed. A small bulkhead should be added at the forward portion of the cockpit hatch.

When all the planking is in place, carve and sand the nose and tail blocks to blend in properly. After planking, the underside of the fuselage will not be quite flush with the lower wing skin. Fill in this area with 1/8 x 1/2" balsa strips and blend in with sandpaper.

A suitable opening must be made in the upper fuselage rear to accommodate the rudder-actuating pushrod. Finally, a thorough overall sanding should reduce the thickness of the planking to approximately 3/32" and prepare the model for finishing. The entire wood portion is treated with enough thick coats of a talcum powder/dope mixture to fill the balsa grain. Sand well, then add two more coats. Sand again, and apply two or more coats final color.

Cockpit Canopies: Since no standard commercially-made canopies will fit correctly, make your own! This may seem a tough challenge, but persistence will see the job through! Obtain some 1/16" clear plexiglass. Ours was purchased from a local sign shop, where the material is used to fabricate displays. Carve a male mold from balsa (see plans). Sand it to a smooth finish and glue it onto a hardwood board. The female mold is cut from hardwood or plywood, allowing about 1/16" clearance around the male mold, in the center opening. Apply wax to the male mold so that the plastic will not stick to it.

Now is a good time to be sure that your wife isn't in the kitchen, since she may mistrust your use of her stove! Heat the oven to 350°, allowing about ten minutes for it to reach a stable temperature. Place the male mold in the oven so that it may be evenly heated also. Lay the plexiglass sheet over the male mold inside the oven and watch it carefully through the oven window. Five to ten minutes may be required to properly soften the plastic, depending upon a variety of unpredictable conditions. At this point, call your wife back in or, better yet, get another model builder to help, and be quick about it. You must act fast! In fact, the first plastic sheet may melt before you realize that it is ready. Next time, be prepared. Using gloves to protect the hands, whip the male mold and plastic out of the oven. Have your assistant force the female mold down over the plastic. Put the whole thing on the floor and place a foot on each side to hold the female mold down firmly for about three minutes.

After the plastic cools, remove the molds and trim the plastic into the required three sections. Next, cut out and add the thin aluminum canopy framing, which may be held in place with tiny countersunk screws, available from any model railroad shop. Do not try to rivet on the frames, as the plexiglass is very apt to crack. Various internal cockpit details are left to your discretion. Since I feel this sort of detail really adds to the charm of any model, mine is complete with cockpit hinges, latches, instruments, seats, and pilots. The extra time required to add these features is repaid many times over by compliments.

Decor and External Detailing: Phantom aircraft are used by the U.S. Navy, Air Force, and Marines, as well as by some foreign nations. Thus, any of a wide choice of color schemes is appropriate. My model was patterned after a VF-121, since the machines are based at N.A.S. Miramar, convenient to my home. Thanks to the splendid cooperation of Chief Ed Mangel and various VF-121 personnel, I was able to examine the full-size aircraft at close range.

Those who do not have ready access to the real thing should obtain as many photos of Phantoms as possible to use as guides. Such photos have been published in **Air Progress, Aviation Week,** and other magazines. Another hint: take a good look at some of the Air Force, Navy, and Marine recruiting literature, free at many Post Offices!

Most of the external details such as landing gear components, air scoops, etc., can be made from scrap aluminum and balsa. Panel lines, rivets, and the like are added with india ink and a draftsman's pen. Squadron markings are made from decal paper, such as Trimfilm. Thanks to the use of mild (white gas) fuel, no fuel-proofing or exotic paint is required.

The indicated equipment locations allowed my model to balance correctly without additional ballast. It was equipped with Heathkit components, so the use of other brands may bring about the need for slight weight additions to arrive at the correct CG. The model should balance at a point one inch aft of fuselage former F-5.

Dyna-Jet Engine Operation

External Equipment: I used a Dyna-Jet engine which requires only air and fuel supply once it is running. However, it must be started with the aid of outside air and electrical sources. The air can be provided by a heavy-duty tire pump or by a small compressed air tank, which can be filled at any automotive service station.

A regular spark plug, rather than a glow plug, is fitted to the engine, thus, a spark source must be provided. It generally takes the form of a vibrator spark coil of the type employed in the old Ford Model T and Fordson tractors. These items still may be obtained from some large chain stores which deal in auto supplies. Another possible source is automotive wrecking yards. In addition, a 6V battery and a switch are required.

Fuel Supply: Although some speed merchants advocate the use of special fuels, the Dyna-Jet factory specifies unleaded automotive gasoline or, if that is not conveniently available, regular grade. The use of ethyl gasoline is not recommended.

Flying: When you finally have mustered up enough nerve to attempt a flight test, find a couple of brave cohorts and head for the field. Quite a few U-Control flyers have had the necessary experience, since jet engines are quite commonly used for Ukie speed flying. If you can locate one or more of these fellows, so much the better! Needless to say, a long smooth runway is essential, since hand-launching this type of model is out of the question!

The threats of fire hazards are greatly exaggerated. Even a few glow-engined models have gone up in smoke for lack of a handy extinguisher, so take one along—as insurance. Perform the usual pre-flight tests to be certain that everything is operating correctly. (This provides plenty of time to think up good excuses for delaying the test flight!) As a final check, be certain that the stabilator is in its correct neutral position, prior to takeoff. The fuel tank should be filled at the last moment before starting the engine.

Starting: Ground running of the Dyna-Jet engine should be for very short periods, since proper cooling is provided only while the engine is in motion. Thirty seconds is the suggested limit for stationary operation.

The ground wire and high tension spark plug lead are attached, the tank is filled with fuel. The air source is attached by screwing the air supply tube onto the engine's blowpipe. Next, the switch is closed, actuating the spark coil system. The resulting sparking action can easily be heard.

At this point, operate the tire pump, using deliberate, full length strokes. If an air tank is being employed, allow the air to enter the engine intermittently. Usually the engine will send popping sounds from the tail pipe; shortly thereafter it will run continuously. (Note how quickly the spectators back away!)

When the engine is running, air and spark sources may be removed. As mentioned before, the engine should **not** be operated for extended periods on the ground. Once in motion, however, the Dyna-Jet can be operated for indefinite lengths of time with no harmful results to the engine.

Waste no time getting the model airborne. A jet engine does not receive proper cooling while stationary. The wing incidence is such that **no** up control should be required to get the aircraft off the ground. Since the model is exceedingly fast, it is sensitive to control movements, particularly in respect to the ailerons. When the model is in the air, gain altitude as rapidly as possible, in order to gain familiarity with the control response at a safe height. All maneuvers should be performed as smoothly as possible. It is a must to think ahead of the model; very little reaction time is available at these speeds!

Stopping: The engine may be stopped by cutting off either its fuel or air supply. For remote control stopping, as might be desired in a U-Control or radio-control installation, it usually is easiest to arrange a simple mechanism to pinch the fuel supply line. Needless to say, the engine generates intense heat, and common sense dictates keeping hands away from the engine until it has cooled.

When the engine stops, apply slight down control to retain airspeed. If your model is not equipped with a fuel shut-off, be prepared to land at any time. There are no touch and goes with this bird, and when the fuel has been consumed the plane is committed to a landing—period! Landings should be performed in such a manner as to allow a nose-high attitude at touch-down so that the main gear will absorb the initial landing loads.

As a crowd-pleaser and attention-getter, a true jet scale model has no equal.