PRECISION PATTERN

SSN 594 PERMIT

1/96 Scale Model Submarine Kit
THE KIT

1. Below are the contents of the Permit kit. Included is a sheet of 1/96 scale Permit class hull plans (hang them over your work area for quick reference), two epoxy hull halves, cast polyurethane appendage set and sail, a white metal fittings set with propeller, stainless steel drive shaft, stainless steel photo etched MBT vent detail set, and running gear linkage set. Upon receipt of any kit be sure to inventory the contents with the enclosed parts sheet prior to assembly. Notify the manufacturer immediately of any damaged or missing parts.

2. Shown is the resin sail with brass diesel exhaust diffuser molded into the upper trailing edge. Mounting bolts with nuts extend from the bottom of the part. To the right of the sail, and below, are the resin masts and sail mounted diving planes. To the left of the sail is the white metal fittings set with bollards, cleats, zins, periscopes and other mast parts. Below them is the white metal propeller (a stainless steel set screw is provided).
3. Here are, beginning at left, the drive train resin parts (thrust bearing bulkhead and two WTC saddles). Next at top are the control linkage jumpers, thrust bearings, universal coupler and allen wrench. Below them are the stainless steel photo-etched MBT vents and cast resin mushroom anchor. Continuing to the right are, first, the rudders, then the stern planes. If everything is present and accounted for, proceed with assembly.

**PREPARATION - Parts Washing**

1. Prior to assembly, care must be taken to prepare each part to ensure that glue and/or paint will properly adhere to it's surface. Using warm soapy water and a scotch-brite pad, scrub and wash each part thoroughly to remove any remaining mold release agent. Dry the parts and set them in a container to ensure they will not be misplaced.
2. Certain essential tools and raw materials will be required to complete the kit. They include:

3/8" electric drill
Drill bit set
Dremel moto-tool & bits
Needle file set
2 hour cure epoxy
Micro-balloons
CA adhesive
1/2" fiberglass tape
1/8" o.d. brass tubing
Tubing cutter
X-acto knife
Razor saw (small)
Ruler & drafting compass
Sand paper (assorted)
Masking tape
Dixie cups
Disposable brushes
Baking soda
1/4" closed cell foam
10-15 ozs. lead weight
1 tube Nitro-Stan putty

PREPARATION - Parts Trimming

1. Before actual assembly begins, care should be taken to trim up any access flash, or rough edges, on the resin parts. This can be accomplished with an Xacto knife. Gently whittle away any excess resin, making sure that you don't damage the part itself. Take your time and work with each part carefully.
2. Once the parts are trimmed, use 600 grit sandpaper and sand the hull and the parts. This will provide the "tooth" necessary for proper paint and glue adhesion. Take care not to sand away any of the scribing or other detail on the hull and/or parts. Sand enough to make the surface uniformly dull. Resin parts can be sanded further to provide a smooth finished appearance.

3. Now is the time to trim the indexing lip. First, a cutting line must be marked. I improvised a simple marking tool. Place the lower hull on a flat surface and find a flat object on which you can place a sharpie. This object must be tall enough so that the point of the sharpie touches the hull approximately a 1/2" above the boat's centerline. In this case a small cup and ruler were used. Holding the hull steady, slide the object with the sharpie around the hull, marking a line on the indexing lip.

Trimming of the indexing lip on other Thor kits is not required. Matt recommended it on his Permits as the lip was a little longer than normal. Cutting it down improves the hull fit.
4. Using a Dremel Moto-tool with a cutoff wheel, cut along the marked line and removed the excess material. Use a file to knock down any rough edges along the cut. REMEMBER: always use eye protection and a dust mask when using the Dremel. And use the Dremel outdoors or in the garage - the dust is very messy!

With parts preparation completed it is now time to proceed to Hull Assembly.

HULL ASSEMBLY - Cut the Stern

1. Place the upper hull on an appropriate work area and locate the scribed cutting line. It is an arc approximately 3.5 inches from the stern of the hull. Utilize a razor saw for the cutting process. The thinner the blade, the less material will be lost during the cutting process. This will allow for a tight fit between the two parts once the hull is assembled.

Webster's dictionary defines kerf as: "the channel made by a saw, or the width of such channel". When sawing on models remember: the thinner the saw blade, the narrower the kerf!

NOTE: I don't use a Dremel and cut off wheel for this procedure. While some do, my hands aren't steady enough.
2. Place the razor saw on the scribed line. Gently draw the saw across the line to ensure that the blade is following the scribing perfectly. Continue to saw until the stern is separated.

3. If done carefully, you should have two parts with a perfectly matched seam. This will enhance the appearance of the hull when the stern piece is joined to the bottom of the hull -- which is done next.

HULL ASSEMBLY - Gluing the Stern

1. Test fit the two upper hull pieces onto the lower hull. File the stern of the lower hull if necessary to ensure the upper stern piece fits snugly. All parts should seat completely with minimal gaps between parts.

The following raw materials (left to right) are recommended to glue the stern pieces together: disposable epoxy brush, micro-balloons, dixie cups (for mixing), and two hour cure epoxy (for maximum bond strength). WARNING: Never use 5 minute epoxy on joints which will be exposed to water. It is NOT waterproof.
Please note there are a wide variety of adhesives for the modeler to choose from. Optimum results can be obtained by observing several rules:

Epoxy resin can be used to bond epoxy and polyester hulls and parts.
Polyester resin should only be used on polyester hulls.
Quick cure epoxies (5 minute) are **NOT** waterproof.
The less resin used when bonding a joint, the better. Excess resin actually decreases joint strength.
Adding micro-balloons to an epoxy will significantly increase it's cure time.

2. In 2 dixie cups, fill the bottom of each with approximately 1/8" of epoxy parts A & B respectively. Be sure to observe the proper mixing ratio as stated on the epoxy label (such as 1:1, part A to part B). Add to each cup an equal amount of micro-balloons and stir until the liquid and micro-balloons are mixed thoroughly.

3. Add the two mixtures together in one cup and blend them together thoroughly with an epoxy brush. When completed, the mixture should have the consistency of toothpaste. If it is too thin, add more micro-balloons. If it is too thick, add more epoxy (be sure to add both parts in the proper ratio).
4. Brush the epoxy/micro-balloon mixture onto the lower hull where the upper stern half will be joined. NOTE: Be careful not to apply any epoxy to the indexing lip in areas where the forward half of the upper hull will seat.

5. Place the upper stern piece in position on the lower hull. Allow the epoxy/micro-balloons to work into the seam. Wipe away any excess resin with a paper towel. Use strips of masking tape to hold the upper stern piece in place.

The inside of this crucial seam should be reinforced at this time. Continue to the next post for the procedure.
HULL ASSEMBLY - Gluing the Stern (continued)

1. In order to reinforce the inside seam of the stern piece, 1" heavy weave fiberglass tape will be epoxied over the inside joint. With scissors, cut two strips of fiberglass tape three inches long.

2. While working on a sheet of wax paper, brush the remaining epoxy/micro-balloon mix onto the strips of fiberglass tape. Wet both sides of the tape, then remove excess resin with the brush.

3. Inside the hull, place a piece of wetted tape over the stern seam on each side. Wick out any excess resin with the brush.
4. Making sure there is no epoxy on the exposed indexing lip, place the upper forward hull onto the lower and make any adjustments in the position of the upper stern piece that is necessary. What's a sure fire way to keep an adjacent part from being bonded while you use it to align another part that is being glued? When working with epoxy, spread a thin film of petroleum jelly on the surface you want to remain free from glue.

Once everything is lined up, secure the pieces with tape. Dispose of epoxy mixing cup and brush. Set the hull aside and allow the epoxy to cure overnight.

HULL ASSEMBLY - Hull Openings

1. With the stern piece completely cured, it is now time to open the many holes necessary to correctly model a Permit class SSN. Using the supplied plans as a reference, locate the dimple in the hull where the mushroom anchor is mounted just forward of the lower rudder. Using an electric drill and a 7/32 bit, drill out the dimple to receive the cast resin mushroom anchor. Use a round file to widen the hole to fit if necessary.

NOTE: Following the curing of the stern pieces, I painted the Permit hull with primer. This allowed the scribed hull opening lines to be more clearly seen during the drilling process. Details on how to prime and paint the boat will be outlined later.
2. Switch to a 1/8 bit and drill one or two holes in each Main Ballast Tank flood hole. The MBT floods are rectangular in shape and there are 5 grouped just forward of the anchor. These holes will allow the use of a Dremel grinding bit to further cleanout the opening. To prevent mistakes, take the time to mark each flood to be opened with a pencil or marker prior to drilling.

3. Moving forward, locate the next set of floods amidships and drill similar holes in them as well. There are 20 MBT floods in this section.

NOTE: Do not drill in the T-shaped area scribed in between the flood groups. This is the cover for the Secondary Propulsion Motor (SPM) and should be left intact.
4. Locate the forward group of floods near the sonar dome demarcation line. There are 14 scribed rectangles. Drill pilot holes in each of the floods.

5. With the floods completed, switch to a 7/32 bit and drill pilot holes in the two Main Sea Water openings on either side of the hull. The lower hull opening pilot holes are now complete.
6. On the upper hull you will notice dimples representing the Main Ballast Tank vent openings. A set of stainless steel photoetched parts will accurately depict the MBT vents and will be installed in a later section. However, holes must be drilled in the hull to allow trapped air to escape through each vent during r/c operations. Using a 3/32 bit, drill a single hole in the center of each of the 6 MBT vent dimples in the forward section.

7. Moving amidships, drill holes in each of these 6 MBT vent dimples.
8. Finally, locate and drill the single MBT vent in the upper stern section of the lower hull. It is located slightly forward and to starboard of the upper rudder.

Don't be alarmed. Though your model may look more like Swiss cheese than a submarine at this point, it will soon take on a scale appearance. And if you’re curious as to what all those holes do on the real boat, check the following short hull opening glossary:

Main Ballast Tank (MBT) vent: Round, stainless steel vent valve in the top of main ballast tanks that open to allow air to escape for diving and close to trap air for surfacing.

Main Ballast Tank flood/drain: Rectangular opening in the bottom of main ballast tanks that allow the free flow of water into, and out of, the tank during diving and surfacing.

Secondary Propulsion Motor (SPM): A small retractable electric motor mounted in the lower hull amidships. Used for maneuvering the boat in close quarters such as pierside.

Main Sea Water (MSW) intake/discharge: Large round hull openings through which reactor coolant water is taken into,
HULL ASSEMBLY - Hull Openings (Pt. II)

1. With all the pilot holes drilled out it is now time to change tools. For the next phase you will need a Dremel moto tool and several needle files. Small needle files can be bought in sets with varying shapes.

2. The Dremel tool should be used first to grind out the flood holes. A steel grinding bit is preferred. Shown are the two bits. The larger cylindrical grinding bit in the tool was used for the majority of the holes. The smaller round bit to right was used on the smaller floods (the object to the right of the second bit is the mandrel needed for the smaller bit).

3. Moving outside, insert the Dremel in each pilot hole and grind out the hull material. You want to get close to the scribed lines but not actually to it. Use two hands as the epoxy hull is tough and the tool can wander if your grip isn’t firm. Switch to the smaller bit and do the same thing in the smaller flood holes. Be sure to clean the dust off your clothes before going back inside. NOTE: Always wear safety glasses or goggles and a dust mask when grinding with a moto tool.
4. With the grinding completed, pick up your needle file set and file out each opening to the scribed outline. Flat and square files work best and new, clean files make the job go quicker. A thicker square file is good for bringing the hole out to the scribed line. Use wider flat files to make the sides smooth and straight. Then, go back with the square file and true up the corners.

5. One down, forty-two more to go! The upper right hand flood hole is what you should work for. The edges are straight, the corners true and the scribed line is no longer visible. With sharp files and some practice the average time per hole should be about five to ten minutes. But don't rush. The effort and care you put into the process will yield a better looking model.
Once your floods are filed out and looking good, there is one more step to the hull assembly section.

HULL ASSEMBLY - Mushroom Anchor

1. Permit class boats carried a single, mushroom shaped anchor mounted under the stern on the starboard side. This anchor is represented in your kit by a cast resin part. Notice the contour of the part at left. The curve follows the contour of the outer hull. Placed in its mounting hole and properly positioned, the anchor sits flush against the outer hull. Locate the anchor mounting hole and check the part for fit. Familiarize yourself with the anchor’s proper orientation in the hole.

2. Rough the surface to be glued around the hole with some sandpaper.
3. Apply Cyanoacrylate glue to the anchor's underside...

4. Place the mushroom anchor into position in the hole. Hold or tape the part in place until the glue is completely cured.
Initial assembly of your Permit hull is now complete. Soon we will be adding rudders, stern planes and propeller. But first let's turn our attention to the Sail...

SAIL - Assembly & Mounting

During the design stage, it was proposed to completely remove the sail on the Permit class boats to reduce underwater drag. However, the impracticality of having to tow the submarine out to sea at the beginning of each patrol due to the near zero freeboard quickly negated the proposal. Instead, the sail was designed with a minimum height. The sail planes were mounted as high as possible in an attempt to increase depth control close to the surface. The final design was so narrow, one could almost reach through the sail via the maintenance access plates.

1. For radio controlled operations, it is necessary to open up a hole in the top of the sail to allow trapped air to escape during diving. Study the plans, then choose an area to open such as a mast or the bridge clamshells. For this project, the VLF loop antenna opening was selected.

2. Using a very small grinding bit, grind out the VLF loop opening with the Dremel. NOTE: periscope and mast assembly/installation will be outlined later.
3. Using round and half-round needle files, file out the VLF opening to the scribed lines.

4. Here you can see the opening through the sail top. It is important that the hole accesses the interior void of the sail otherwise air will remain trapped inside. By working files at an angle, the interior side of the hole can be beveled wider.

With the VLF opening complete, we can turn our attention to the sail planes. Because of their small size in 1/96 scale, the kit's sail planes afford minimal control influence during r/c operations. Therefore I mounted them in a fixed position. However, if active sail planes are desired, skip steps 5 - 7 and use the plane connecting rod as your control shaft. By mounting a bellcrank on the shaft and running the linkage through the sail and into the hull, you can effectively animate them.
5. Locate the planes and test fit them in the pre-drilled mounting holes. They should fit snugly against the sail and protrude from either side of the sail at a 90° angle. Both port and starboard planes should be aligned with one another through the sail. Slight filing of the mounting holes can correct any variations in alignment.

Apply cyanoacrylate to a plane with the supplied connecting rod inserted. Apply glue only to the surface which will rest against the sail side.

6. Slide the connecting rod into the pre-drilled hole and glue the plane to the sail. Slip the other plane on the opposite side in order to check the alignment of the two planes as the one dries.
7. Apply glue to the opposite plane and slide it onto the connecting rod and against the sail. Hold it in place until the CA dries, then set it aside.

8. Moving to the upper hull, locate the two sail mounting bolt dimples in the upper hull. They are at the forward and after end of the scribed sail outline in the hull. Use a 7/64 bit and drill out the mounting hole hull dimples.
9. Switch to a 3/16 bit and drill two drain holes on center between the mounting holes. Be sure to keep the holes within the scribed outline of the sail. The holes will allow air to escape more quickly from the lower hull during dives and will quickly drain the sail during surfacing. NOTE: there is no scribing or dimples to indicate placement of the holes. Just select a spot within the sail outline on the centerline of the boat.

10. Slip the mounting bolts of the assembled sail into the holes in the upper hull. Don't apply glue to the sail or upper hull. Install the nuts on the mounting bolts and tighten until snug. Be careful not to overtighten. NOTE: using the mounting bolts without applying glue enables the sail to be removed for transportation and greatly reduces the risk of accidental damage during trips to the pond.
11. Turn the upper hull over. The sail should be firmly mounted and rising vertically from the hull. If the sail leans to port or starboard, unfasten it and gently sand the underside of the sail to remove the high spot and bring it into proper alignment. As always, be careful not to remove too much material at one time.

It's now time to work on the essential hull appendages used in radio controlled operations. First, the rudders...

RUDDERS - Bearing Fabrication and Alignment

1. With a 3/32" bit in the chuck, drill the mounting hole for the upper rudder bearing. It's exact location is the dimple in the upper stern.
2. Turn the hull over and drill the hole for the lower rudder bearing. Again, a dimple in the hull indicates the exact drill point.

3. Insert a length of 1/8" o.d. (3/32" i.d.) brass tubing into the upper rudder bearing hole. Extend the end of the tubing through the bottom rudder bearing hole until it is flush with the exterior of the hull. Then mark the tubing with a sharpie at the upper rudder hole so the mark is flush with the exterior of the hull.
4. Using a K&S, or other similar, tubing cutter, cut the tubing on the sharpie mark.

5. Deburr the freshly cut end of the tubing with a small round needle file or deburring tool. The control shaft of the rudder pieces should be able to slip into each end of the tube and rotate without binding.
6. Slip the tube back into the holes in the hull and insert the rudders in the top and bottom.

7. Make marks on the tube with a sharpie approximately 1/8 inch from the hull on both ends.
8. Cut the tube on each mark with the tubing cutter. The two small pieces will be used as the upper and lower rudder bearings. Do not discard the center section of the tube. It will be used in the gluing process. Deburr all three pieces of tubing with a round needle file to ensure that the rudder control shafts do not bind.

9. Place the bottom rudder in the hull with the small bearing on the shaft. Slip the longer, middle tubing piece over the shaft. With the small upper bearing on the control shaft, insert the upper rudder into the hull and the middle connecting tubing.

The middle brass tubing piece, though it won't be used in the final operational rudder setup, serves to keep the bearings properly located in the hull holes for gluing and also keeps the upper and lower rudder control shafts properly aligned. NOTE: the image below depicts how the rudders and bearing/tubing pieces will be arranged in the hull during the gluing process.
10. Visually check the rudder alignment at this time. When viewed from astern, the rudders' trailing edge should form a vertical line through the center of the hull. If any correction needs to be made, use a round needle file on the hull holes. NOTE: a little filing goes a long way on the alignment of these holes. Work carefully.

Once everything checks out, it is time to glue the bearings in place...
RUDDERS - Bearing Installation

1. At left are the necessary raw materials for installing the rudder bearings: 2 hour epoxy (not shown), tape, mixing cup, Vaseline, 5 minute epoxy. NOTE: While 5 minute epoxy is not to be used for joining materials to be exposed to water, because of its rapid drying properties it can be used to tack pieces in place prior to gluing with more suitable adhesives.

2. First, apply a thin film of Vaseline to each rudder shaft to prevent gluing it to the bearings. Place the bearings on the rudder shafts. Prepare a small batch of 5 minute epoxy in a cup. Using a toothpick, place a small drop of 5 minute epoxy on each bearing and insert it into the hull (be sure to use the middle tubing piece to connect the rudder shafts as depicted in step 9 of the previous section).

3. Secure the rudders in place with masking tape. It is best to support the lower rudder. Use the sail’s trailing edge as a sight guide to help ensure proper alignment. Allow the 5 minute epoxy to cure completely.
4. Carefully remove the tape and rudders. Mix a batch of 2 hour cure epoxy and micro-balloons (see section 2 "Hull Assembly" for mixing instructions). Using a Q-tip, apply a bead of epoxy/micro-balloons around each bearing. Be sure to fill any gaps between the hull and bearing. Avoid getting epoxy in the bearing itself.

It is best to reinstall the rudders (don't forget a thin film of Vaseline) and shaft connecting tubing and re-tape the rudders to ensure accurate final alignment. Set the hull aside and allow to cure overnight.

5. With the epoxy completely cured and the bearings bonded firmly to the hull, a small flat file can be used to shape any part of the bearing which is exposed above the hull contour.
6. Slip the rudders in their respective bearings and check for fit and movement. They should rest snugly and evenly against the hull. Each rudder should freely turn at least 35° past the centerline both to port and starboard. If either rudder piece is found to bind against the hull during movement (binding usually occurs when passing center), use a small flat file and shape it until the necessary freedom of travel is achieved. NOTE: setting up the rudder control linkages will be covered later.

By now the model is beginning to take shape. The next section will combine the techniques already mastered and will cover the installation of the stern diving planes.
STERN PLANES - Plane & Appendage Location

1. The first step in installing the stern planes is to locate and mark their position on your model's hull. Using a ruler and your Permit plans, measure the distance from the end of the hull to the trailing edge of the stern planes (7/8”).

2. On your model, measure the same distance from the end of the hull along the hull's side seam. Place a mark in pencil on the seam to indicate the point of the stern plane's trailing edge. NOTE: the trailing edges of both rudders and stern planes should be the same distance from the end of the hull.
3. Remove the hinge pin from the assembled stern planes.

4. Using the plane itself, align it's trailing edge with the mark placed on the hull. Mark the point where the control shaft touches the hull seam with a sharpie. Repeat steps 2 - 4 on the opposite side of the hull for the starboard stern planes.
5. Drill a hole for the control shafts on the sharpie mark using a 3/32 bit. Make sure the hole is centered on the hull's side seam.

NOTE: bearings will be installed in the holes for the stern plane control shafts as was done for the rudders. However, at this point we only want a hole sized for the control shaft itself.

6. Slip both stern plane control shafts into the holes and check for fit. Their trailing edges should form a straight line across the hull and should be in line with the rudder trailing edge.
7. Reassemble the stern plane appendages with the hinge pins and reinsert the stern plane control shafts in the holes. Line the appendage mounting tab up with the hull side seam and mark where it touches the hull. Do this for both sides.

8. With the Dremel tool and cut off wheel, cut a slot along the hull side seam where the stern plane mounting tab was marked. NOTE: do this procedure outdoors or in the shop observing proper safety and health precautions.
9. With a flat file, open up the slot to fit the stern plane mounting tab.

10. Reinstall the stern planes into the holes and mounting tab slots. Visually check for alignment and fit. Make any necessary adjustments by further filing out the mounting tab slot. Carefully file the forward stern plane appendage where it meets the hull to ensure a close, accurate fit. Once everything looks good, it is time to install the stern plane bearings.
STERN PLANES - Bearing Fabrication and Alignment

1. Using the existing control shaft holes as pilots, drill out the mounting holes for the stern plane bearings with a 3/32" bit.

2. Insert a length of 1/8" o.d. (3/32" i.d.) brass tubing into the starboard stern plane bearing hole. Extend the end of the tubing through the port stern plane bearing hole until it is flush with the exterior of the hull. Then mark the tubing with a sharpie at the starboard stern plane hole so the mark is flush with the exterior of the hull.
3. Cut the tubing on the sharpie mark and deburr the freshly cut end with a round needle file. The control shaft of the stern planes should slip into each end of the tube and rotate without binding.

4. Slip the tube back into the holes in the hull. Make marks on the tube with a sharpie approximately 1/8 inch from the hull on both ends.
5. Cut the tube on each mark. The two small pieces will be used as the port and starboard stern plane bearings. Do not discard the center section of the tube. It will be used in the gluing process. Deburr all three pieces of tubing to ensure that the control shafts do not bind.

6. Place the port stern plane assembly in the hull with the bearing on the control shaft. Slip the longer, middle tubing piece over the shaft. With the bearing on the control shaft, insert the starboard stern plane assembly into the hull and the middle connecting tubing.

NOTE: The middle brass tubing piece, though it won't be used in the final operational rudder setup, serves to keep the bearings properly located in the hull holes for gluing and keeps the control shafts properly aligned.
7. Recheck the stern plane alignment at this time. When viewed from astern, the trailing edges should form a horizontal line through the center of the hull. If any correction needs to be made, use a round needle file on the hull holes. REMEMBER: a little filing goes a long way on the alignment of these holes. Work carefully.

Once everything checks out, it is time to glue the bearings in place...

STERN PLANES - Bearing Installation

A Suggestion: a good time to pay a little attention to the hull seam around the bearings and stern planes is prior to their permanent installation. Use a file, sandpaper and putty to smooth out this seam. Once the stern planes are bonded to the hull it gets much harder to work on the area with the planes in the way.
1. First, apply a thin film of Vaseline to each stern plane shaft to prevent gluing it to the bearings. Place the bearings on the control shafts. Prepare a small batch of 5 minute epoxy in a cup. Using a toothpick, place a small drop of 5 minute epoxy on each bearing. 

REMEMBER: While 5 minute epoxy is not to be used for joining materials to be exposed to water, because of its rapid drying properties it can be used to tack pieces in place prior to gluing with more suitable adhesives.

2. Insert the stern planes into the hull. Be sure to use the middle tubing piece to connect the stern plane control shafts as shown at left.

3. Secure the stern planes in place with masking tape. Use the horizontal hull seam, rudder trailing edge and sail planes as sight guides to help ensure proper alignment. Allow the 5 minute epoxy to cure completely.
4. Carefully remove the tape and planes. Mix a batch of 2 hour cure epoxy and micro-balloons. Using a Q-tip, apply a bead of epoxy/micro-balloons around each bearing. Be sure to fill any gaps between the hull and bearing. Avoid getting epoxy in the bearing itself.

NOTE: It's best to reinstall the stern planes (don't forget a thin film of Vaseline) and shaft connecting tubing and re-tape to ensure accurate final alignment. Set the hull aside and allow to cure overnight.

5. With the epoxy completely cured and the bearings bonded firmly to the hull, a small flat file can be used to shape any part of the bearing which is exposed above the hull contour.
6. Slip the stern planes and appendages in their respective bearings/slots and check for fit and movement. The forward appendage should rest snugly against the hull. Each stern plane should freely move at least 30° past the centerline both up and down. If either plane is found to bind during movement (binding usually occurs when passing center), use a small flat file and shape it until the necessary freedom of travel is achieved.

NOTE: setting up the stern plane control linkages will be covered in a later section.

Next, the stern plane appendages will be installed.
STERN PLANES - Appendage Installation

Permit class boats were the first SSNs to have hulls made completely of HY80 steel. Their stern planes steered them to operational depths of over 1200 feet -- unheard of in prior classes of US submarines.

1. Prior to installing the stern planes and appendages, care must be taken to ensure proper clearance of the propeller shaft between the stern plane control shafts. Here one can see that the control shafts are almost touching. This would prevent passage of the prop shaft down the center of the boat. Thus, the control shafts must be shortened.

2. Working with one stern plane set at a time, mount a control collar on the fully inserted control shaft. Leave about 1/32 between the collar and the installed bearing. With a sharpie, mark the exposed end of the control shaft.

NOTE: If necessary, file down the control arm on the collar for proper hull clearance.

3. Using a Dremel and cutoff wheel, remove the excess control shaft at the sharpie mark. File the new control shaft ends smooth.
4. With the shortened control shafts installed, insert the propeller shaft to test fit. Plenty of clearance is available now. It is time to permanently install the stern planes and affix the appendages to the hull.

5. Mix a 50/50 batch of epoxy and micro-balloons. Apply the epoxy with a brush to the appendage mounting tab.

WARNING: Do not allow epoxy to encounter the stern plane or control shaft, only the hull end of the appendage and the mounting tab.
6. Insert the stern plane control shaft into the bearing and slide the mounting tab into the hull. Do the same for the opposite side.

IMPORTANT: Do not use the brass control shaft connecting tube used during bearing installation. Once the appendages are cured, the tube cannot be removed and will prevent installation of the propeller shaft and stern plane control collars.

7. Secure the stern plane appendages in their proper location with masking tape. Double check for proper alignment. Set aside and allow to cure overnight.
DRIVE TRAIN - WTC Saddle Installation

To equip the Permit for R/C operations, you have to either build or purchase a watertight cylinder (WTC). These units house all the necessary electronics and gear while keeping the water out. Given the Permit’s dimensions in 1/96 scale, a 3” diameter cylinder is the best size to use. In this build-up a WTC-3 from D&E Miniatures was installed.

1. First, the location of the WTC and its mounting saddles must be established. Locate the WTC as far forward in the hull as possible without hitting the indexing lip. The saddles should be spaced far enough apart to evenly support the WTC. Take care that the saddles do not interfere with the flood/drain holes in the lower hull or the ballast tank flood/drain holes in the WTC. Once the proper saddle locations are determined, mark the edge of the indexing lip on the lower hull.
2. Test fit the kit supplied saddles in the hull. Sand and file down the high spots until you achieve a good, close fit. Make sure the saddles just meet the hull and are not wedged in.

NOTE: A fit that is too snug can cause the hull to distort slightly, interfering with the mating of the upper hull over the indexing lip. Double check the fit of the upper and lower hull with the saddles in place before proceeding.

3. To ensure the proper operation of the automatic pitch controller in your WTC, the cylinder must be properly oriented in the hull with a zero bubble. Begin by using a vial level to make sure your Permit hull is perfectly level on its stand.
4. Place the saddles in the hull and lay your WTC in the saddles. Check the WTC's attitude with the vial level. It should be perfectly level, along the hull's longitudinal axis. If it is out of level, carefully sand down the outside of the high saddle until the WTC is level.

Be sure to check the attitude of the WTC's drive shaft. It should rest level at the hull's horizontal center line and be centered on the hull's longitudinal axis. One should be able to draw a straight, imaginary line down the center of the hull, from the drive shaft to the center of the stern where the prop shaft will exit. Making this alignment true minimizes drive train vibration during operations.

5. Sand the hull interior and saddles to rough up the surface where they will be joined. Place the saddles in the hull and install the WTC. Check the WTC's attitude with the level. If it is at zero bubble, apply a drop of CA between the top of each saddle and the hull. Capillary action will draw the CA into the space and tack the saddles in place.
6. Remove the WTC. Brush a batch of 50/50 epoxy & micro-balloons into the seams between the saddles and the hull. Build a fillet around the base of each saddle with the epoxy. Set the hull aside and allow the epoxy to cure completely.

DRIVE TRAIN - WTC Locating Pin Installation

The WTC locating pin ensures proper registration of the WTC within the hull each time it is installed. This is critical in maintaining the proper alignment of the drive train and control linkages.

1. In order to position your WTC in the same location within the hull every time it is installed, a locating pin should be installed. The piece consists of a cast resin base contoured to fit the inner hull and a 1/8" brass pin.
2. Using a 1/8” bit, drill a hole in the lower horizontal centerline of the WTC's ballast tank. WARNING: Do not drill the hole in the dry compartments of your WTC - only the ballast tank.

3. Test fit the locating pin in the hole. Lay the WTC in position in the hull and check it's clearance and attitude. The WTC should sit properly in the saddles and should remain level in the boat. If the locating pin's base is too high, slide it next to a WTC saddle and mark it. Grind down the high area with a belt sander or Dremel sanding drum until the base is the same height as the saddle.
4. Rough sand the bottom of the locating pin foundation and the inner hull where it will be glued. Mix a batch of 2 hour epoxy. Brush epoxy onto the bottom of the WTC locating pin foundation. Reinstall the WTC in the hull with the pin in place. Allow the epoxy to cure completely. Once the glue is dry, remove the WTC. It can be installed correctly, and identically, every time.

DRIVE TRAIN - Stern Bearing Installation

1. With a ruler or calipers, measure the hull width across the centerline at the stern.
2. Divide the measurement by two and mark the hull. Repeat the measuring and marking for the vertical axis of the stern.

3. Using a 3/32” drill bit, drill a hole at the center of the stern where the two marks intersect. Using the hole as a pilot, replace the bit with the next higher size and re-drill the hole. Work your way up to a 1/4” bit, then drill out the hole. The opening should now allow the drive shaft bearing to pass through.
4. Place the WTC in the saddles and install the universal coupling joint (UC-2 type) on the drive shaft. Place the drive shaft bearing in the rear of the hull and slide the stainless steel propeller shaft through it. Install the other universal coupling joint (UC-2 type) to the forward end of the prop shaft. Insert the dog bone coupler between the two universal couplers and push the prop shaft as far forward as possible to ensure a good positive connection. Hold the shaft in line with the WTC drive shaft. At the stern, mark the prop shaft leaving enough to properly mount the propeller (approximately 5/16”).

5. With a cutoff wheel, cut the shaft and file off the rough edges.
6. Cut a piece of 3/16" i.d. tubing approximately 1 3/4" long and deburr the ends with a file.

7. Remove the universal coupling and place the tubing on the WTC drive shaft. Slide the prop shaft into the tubing. NOTE: using the tubing in place of the universal joint helps to ensure that the shaft alignment is as close to the WTC drive shaft in attitude as possible.

Place the stern bearing on the shaft and slide it into the hull. Place the propeller in position on the shaft and check that it is properly centered in the stern. If the prop is off center, remove the shaft and true up the hole with a round file.
8. With the tubing and shaft in place on the WTC drive shaft, mix a small batch of 5 minute epoxy and apply it to the stern bearing. Slip the bearing onto the shaft and into the stern.

9. Apply a film of Vaseline to the propeller and place it on the shaft. Tape the prop in correct position, centered in the stern of the hull. Allow to cure.
With the bearing tacked in place, mix a batch of 50/50 epoxy and micro-balloons. With a brush, apply epoxy around the base of the stern bearing inside the hull. Build up a fillet around the bearing, carefully avoiding getting epoxy in contact with the prop shaft. Leave the prop in the correct position, centered in the stern of the hull. Allow to cure overnight.

DRIVE TRAIN - Thrust Bearing Bulkhead Installation

Even with a perfectly aligned shaft, an unsupported drive train can vibrate excessively. If transferred directly to the hull, this vibration can cause significant structural damage. By installing a bulkhead mounted thrust bearing, your drive train is strengthened significantly and the hull should suffer no ill effects from continued operation.

1. In order to mount the thrust bearing, the thrust bearing bulkhead must first be installed. It is best to locate the thrust bearing bulkhead as close to the WTC as possible.

IMPORTANT: At least 2 inches must be left between the bulkhead and the end of the WTC drive shaft to allow room for the UC-2 universal coupling set-up and prop shaft wheel collar retainer.

Once the proper thrust bearing bulkhead location is determined, mark the hull.
2. Test fit the bulkhead in the hull. Sand and file down high spots until you achieve a good, close fit. Make sure the edges just meet the hull and are not wedged in. Sand the interior of the hull underneath the bulkhead to roughen it up. NOTE: Double check the fit of the upper and lower hull with the bulkhead in place before proceeding.

3. Tack the hull in place with a few drops of CA. Secure it to the hull using a 50/50 batch of epoxy and micro-balloons. Apply the epoxy with a brush to the bulkhead/hull joint and build a small fillet along the seam. Set the hull aside and allow the bulkhead to cure completely.
DRIVE TRAIN - Thrust Bearing Installation

1. Install the WTC and place the 3/16” i.d. tubing used in the stern bearing installation on the WTC drive shaft. Slide it aft on the drive shaft until it meets the thrust bearing bulkhead. Make sure the tubing doesn’t droop as it slides, but stays inline with the shaft. With a sharpie, draw a circle around the tubing on the bulkhead.

2. Remove the WTC. With a 5/16” bit, drill a hole for the thrust bearing through the circle mark on the bulkhead.
3. Place the thrust bearing into the hole from the stern side as shown. Slide the propeller shaft into the stern bearing and forward through the thrust bearing. Reinstall the 3/16" tubing on the WTC drive shaft. Slide the prop shaft into the tubing. When coupled, the WTC drive shaft and prop shaft should form a straight line through the thrust bearing bulkhead to the stern bearing. If necessary, widen the thrust bearing hole with a round file to ensure a non-binding fit.

4. Mix a batch of 50/50 epoxy and micro-balloons. Slide the thrust bearing out of the bulkhead. With a brush, apply epoxy around the bearing. Slip the thrust bearing into the bulkhead. Avoid getting epoxy in contact with the prop shaft. Allow to cure overnight.
The bearings supplied with the kit are oil impregnated "oilite" bearings. As the shaft heats the bearing during operation, oil is released to assist in lubrication. It is recommended, however, to apply a good, waterproof bearing grease to the shaft where it contacts both the stern and thrust bearings.

LINKAGES - Rudder

The following items will need to be purchased to complete the control linkages:

Threaded rod with clevis (2)
1/8" Brass Tube (12")
1/8" Wheel Collars (2)
Du-Bro 1/16" Threaded Ball Link sets (2)

1. Your Permit kit supplies a drawing of the most effective linkage arrangement for your boat. The supplied parts eliminate most of the fabrication required. From left to right are the rudder jumper, two stern plane control links, a wheel collar for joining the two stern plane control rods and an allen wrench for tightening the set screws.
2. Because the propeller shaft runs down the center of the boat, and the control axis of the tandem rudders crosses the centerline as well, a jumper is used to connect the rudders and prevent binding against the shaft. Insert the rudders in their bearings and slide their control shafts into the collars at each end of the jumper. Tighten the set screws with the allen wrench. Check the control horn for movement. If it binds against the hull, remove the jumper and trim the control horn to ensure proper clearance.

3. Remove the rudder jumper. Drill a 1/16" hole in the center of the control horn.
4. Insert a clevis in the hole in the control horn. Thread a length of rod into the clevis. Most hobby stores sell prefabbed Du-Bro rod & clevis sets. However, they can be purchased separately and assembled. NOTE: While a steel rod and clevis are pictured, they are highly susceptible to corrosion beginning with your first run. To minimize maintenance, use brass, stainless steel or plastic parts whenever possible.

5. Reinstall the rudder jumper as shown. Work the control rod to make sure the rudders move together and do not bind. With the rudders centered, mark the control rod approximately 2" from the WTC control rods. Cut the rod at the mark.
6. Cut a 3” length of brass tube. Flatten 1/4” of one end of the tube with a hammer. Drill a 1/16” hole in the flattened area and insert a ball link.

7. Drill a 3/32” hole in the top of the tube at the open end as shown.
8. Place a wheel collar over the open end of the tube and tighten the set screw until it enters the hole (the wheel collar can be soldered in position on the rod if desired). Slide the brass tube onto the rudder control rod. Snap the ball connector into the plastic quick connect threaded onto the WTC control rod. Center the rudders and tighten the wheel collar until it secures the rudder control rod to the brass control tube. Power up your radio & WTC and check the rudder operation. They should respond in tandem without binding.

LINKAGES - Stern Planes

The following items will need to be purchased to complete the control linkages:

Threaded rod with clevis (2)

1/8" Brass Tube (12")

1/8" Wheel Collars (2)

Du-Bro 1/16" Threaded Ball Link sets (2)

1. To avoid the propeller shaft, the stern plane linkage will use split control collars and linked control rods. Insert the control collars onto the stern plane control shafts and tighten the set screws. Check the control horns for movement. If they bind against the hull, remove them and trim the control horn to ensure proper clearance.
2. Remove the stern plane control collars. Drill a 1/16" hole in the center of each control horn as shown. Insert a clevis in the hole in each control horn. Thread a length of rod into the clevis. NOTE: Most hobby stores sell prefabbed Du-Bro rod & clevis sets. However, they can be purchased separately and assembled. Again, brass, stainless or plastic parts will resist corrosion infinitely better than the steel ones shown.

3. Reinstall the control collars. Work the control rods to make sure the stern planes do not bind. Bend the port control rod forward of the wheel collar up at approximately 45°. With the lower part of the control rods parallel to the boat's longitudinal axis, bend the port rod back down until it is parallel with the WTC control rod. Mark the port stern plane rod 2" from the WTC control rods. Cut the port rod at the mark.
4. To join the control rods, bend the starboard rod with pliers 45° so that it crosses the port rod. Bend the starboard rod back parallel to the port rod where they cross. Mark off 1/2" of overlap on the starboard rod. Cut the starboard rod at the mark. Slip the supplied wheel collar onto the two control rods. Center the stern planes and tighten the collar. Manipulate the stern planes via the control rods. They should operate in tandem without binding. Adjust the rods in the wheel collar as necessary until the stern planes operate correctly, then tighten the set screw.

5. NOTE: The combined control rods should come together below the prop shaft. The port rod is bent so that it will rise and meet the WTC control rod. At no time should the contact the shaft.
6. Cut a 3" length of brass tube. Flatten 1/4" of one end of the tube with a hammer. Drill a 1/16" hole in the flattened area and insert a ball link.

7. Drill a 3/32" hole in the top of the tube at the open end as shown. Place a wheel collar over the open end of the tube and tighten the set screw until it enters the hole. NOTE: the wheel collar can be soldered in place on the brass tube if desired.
8. Slide the brass tube onto the port stern plane control rod. Snap the ball connector into the plastic quick connect threaded onto the WTC control rod. Center the stern planes and tighten the wheel collar until it secures the stern plane control rod to the brass control tube. Power up your radio and WTC and check stern plane operation. They should respond in tandem without binding.

With the boat almost completely assembled, the only task remaining prior to getting her wet is to batten down the hatches...

HULL FASTENER

The clean lines of the Permit class are elegant but they don’t provide a discreet means for hiding fasteners for the upper and lower hull halves. Traditionally, a standard Phillips head screw is countersunk in the side, or upper stern, and threaded through a nut fastened to the underside of the lower hull. It’s effective to be sure, but has always offended my sense of scale realism.

While building the Permit kit, I sought a hull fastening method that was equally robust, mechanically simple, yet as near to invisible as possible. After wracking my brain through most of the kit’s construction process I finally hit upon an idea that worked (please note the following images were taken after the boat was completed).

1. A brass rod was mounted inside the Permit’s upper hull approximately 1/2” abaft the bow sonar dome demarcation
line. Care was taken to align the rod so it was affixed below the height of the lower hull indexing lip’s overlap 1/4". Holes were drilled in the upper hull, but not through the upper hull, and the rod was glued in place.

2. Next, a vertical slot was filed in the indexing lip, one on each side, into which the rod would fit once the hull halves were put together. Note: the slots are approximately 1/8” forward of where the upper hull would normally sit in its properly registered position. With the vertical slots completed, a horizontal niche was filed at the bottom of each slot to allow the upper hull, and brass rod, to slide back the necessary 1/8” to mate perfectly.
3. With the two hull halves aligned, I needed something to hold them in place against hydrodynamic forces while underway. Many ideas were explored, but the final solution was something already used in the boat: a rubber band. Prior to installing the WTC (which I secure with rubber bands) I slipped an extra band around the WTC. The band is then stretched up through a hook cut and bent out of flat brass stock.

4. A hole drilled in the hook allows it to be fastened firmly against the upper hull using a sail attachment point. Once taut, the band provides the necessary tension to keep the upper hull from sliding forward. NOTE: upper hull is removed in the image to show the internal arrangement.
5. For extra stability, a small tab of brass was glued to the underside of the upper hull at the stern cut. It slides under the upper section of the lower hull, keeping the rear of the upper hull in place.

The arrangement has stood the test of time beautifully on many patrols.
BALLAST & TRIM

1. To ensure proper R/C performance, the boat will need two things: ballast weights and flotation foam. The D&E WTC-3's ballast tank provides ample volume to float a Permit. Lead weight must be added to the bottom of the hull, underneath the tank, to both keep the boat upright on the surface and properly offset the buoyancy in the WTC dry spaces when the ballast tank is flooded. In addition, closed cell flotation foam should be added below the surfaced waterline to establish the boat's level trim when submerged (image courtesy D&E Miniatures).

Which kind of foam? Most of us have an old styrofoam pool float laying around somewhere. Unfortunately, the large cell styrofoam it contains is unsuitable for r/c submarine use. Closed cell foam insulation used in home construction, such as Dow BlueCor, works well and comes in thicknesses as small as 1/4".

What about surfaced trim? The upper hull of the Permit has a scribed line depicting the scale surfaced waterline. However, trimming the boat to ride exactly at this line is secondary to establishing the correct submerged trim. Establishing the proper submerged trim is essential for safe underwater operations and will usually result in a surfaced trim close to the scale waterline.

However, unless a Permit boat is at rest, it is virtually impossible to determine if a model is riding at it's scale surfaced waterline due to the minimal freeboard these SSNs possessed. Once underway, waves will wash over the hull and even if the surfaced waterline is off, the model will look quite realistic.

2. To begin, cut two strips of 3/16" closed cell foam 1" wide and 25" long. With an X-acto knife, slice half way through the foam down each strip's length (this enables it to match the hull contour more easily). Using waterproof silicone adhesive, glue the strips to the inside of the upper hull, port and starboard, just below the surfaced waterline (start at the bow sonar dome demarcation line and work aft). Once the adhesive dries, place the upper hull on the lower hull and check the fit. Trim or sand down any high spots on the foam that prevent the proper mating of the two hull pieces.
3. Affix 12 ozs of lead to the inside of the hull on the bottom beneath the ballast tank. Self-adhesive 3oz bars can be found in most hobby stores, or silicone adhesive can be used. Button up the boat with everything needed for a patrol including WTC, linkages, running gear and battery.

4. Fill your bathtub or test tank. Place rubber bands around the hull near the bow, stern and ballast tank area. Put the boat in the water and turn it over to fill the ballast tank. Gently rock the hull to ensure all trapped air bubbles are released. Turn the boat back over, keeping it submerged.

5. Proper submerged waterline is 1/4" of sail showing with the boat in level trim. This provides slightly positive buoyancy for patrols. If the boat rides too high, slip weights under the rubber bands at the ballast tank area until the proper waterline is achieved. The boat depicted is close to the proper height with 12 ounces of lead. NOTE: If your boat is too heavy, add foam to bring it up rather than removing weight. For stable, upright running, 10-12 ozs. are needed to counteract the torque from the prop.
6. With the boat at the proper submerged waterline, level trim must be obtained. Here the boat is down by the stern. Place small pieces of foam under the rubber bands aft below the surfaced waterline until the boat is level.

7. Remove the boat from the water. Note where the foam and lead was placed on the hull under the rubber bands. Remove the pieces and set them aside. Dry the hull interior. Use silicone adhesive and affix the foam and lead pieces to the inside of the hull in their respective locations. Make sure the foam is below the surfaced waterline, yet as high in the hull as possible.
8. Once the adhesive cures, return to the bathtub and flood your boat until all air is out of the ballast tank and hull. Leave the boat in the water for several minutes more then return and check your work. This allows water to fill every nook and cranny. The trim may still require some fine tuning. Add weight and/or foam until it rides correctly (level with 1/4” of sail above water). Repeat steps 7-8 until proper trim is achieved. Be patient and take your time.

DETAIL & PAINT - Detailing The Boat

The PIKE MODELS Permit kit depicts USS Permit (SSN-594) in it’s as-built condition circa 1962. However, the boats of this class served well into the 1990’s and underwent many modifications. To properly detail your model, chose the specific boat and service period you wish to depict and research her thoroughly. For the purpose of this build, I chose to model USS Thresher (SSN-593) at the time of her loss on April 10, 1963.
Deck Fittings - Permit kits come with a selection of white metal parts to represent all the major deck fittings such as cleats, windlasses, etc. The hull is molded to represent these fittings in their retracted, at-sea positions. To depict them in their extended positions, drill a pilot hole for each fitting in the upper hull and file out the opening. Clean the flash from the white metal part and insert it in the proper hole. From the back side, apply epoxy to glue it in place. On this build, I chose to leave the in-port details off.

Stern Light - 1. Drill a hole in the upper rudder to accept the white metal part depicting the stern light beacon. I shaved off the resin housing molded into the top of the rudder for a more accurate appearance.
2. Apply a drop of CA to the bottom of the stern light part and insert it in the hole.

Periscopes & Masts - An assortment of resin and metal parts are included to depict the various periscopes and masts. Using the plans, drill and file out holes in the sail top for the masts you wish to install.

1. For this project only the single attack periscope was used. Cut a length of brass tube to represent the periscope barrel. Clean the white metal periscope top and glue it in one end with CA.
2. Next, drill a hole in the sail top. Insert the periscope. Friction will hold it in place during patrols. For other masts, insert a small threaded rod in the bottom of the mast. A washer and nut can then be applied from the inside of the sail to hold it in place.

MBT Vents - A tree of stainless steel photo-etched Main Ballast Tank vents are supplied with the kit.

1. Cut or twist a vent from its tree. File off any rough edges. Due to their tiny size, it is best to hold the part with a pair of needle nosed pliers. To increase grip and avoid scratching the part, wrap masking tape around each half of the pliers.
2. To countersink the part in the hull, I beveled the hole out with a small rat tail file. Masking tape was put around the area to prevent scratching the hull. The photoetched part was the placed in position and held in place with masking tape. The tape was sealed tightly around the mating surface and MBT opening.

From the back side, a drop of CA was placed in the joint between the hull and part. Capillary action draws it into the gap and secures it. Once dry, the tape can be removed and the outer seam between part and hull should be clean and glue free.

Early Permits had their stainless steel vents painted black, but at sea the paint would quickly wear off. As a result, they were left unpainted starting in the mid 1960's.

Zincs - Once the final paint job is finished, the zinscs should be affixed to the stern. Their location is indicated on the plans and scribed in the hull. Place masking tape on either side of the scribe mark, apply CA to the underside of the metal part and lay it between the tape in the proper location. This prevents the glue from damaging the adjacent paint. As full scale zinscs were unpainted, leave these parts in their raw, white metal condition.

Strainers - A 1/96 scale set of photoetched SSN vents and strainers was purchased from Jeff LaRue. The 637 MSW suction and discharge strainers were used in the Permit hull. They dressed out the big round holes very nicely. Installation was accomplished in the same manner as the MBT vents.
DETAIL & PAINT - Primer

1. The key to any paint job is preparation and attention to detail. Patience during the primer stage will yield excellent results. Like David Merriman, I’m a firm believer in using industrial grade coatings for epoxy hulls. For this project, an industrial grade epoxy primer manufactured by a local plant was used. NOTE: When spraying solvent based paint be sure to observe all necessary safety precautions such as proper breathing protection and ventilation of flammable solvent fumes.
Don't own an airbrush and don't want to? Applying paint from aerosol spray cans is your alternative. Hardware and automotive supply stores carry a good selection of products which can produce a finish that is quite respectable.

2. Sand the entire hull with 600 grit sandpaper. The goal is to remove any of the shine from the surface. Cast resin parts should be sanded as well with 400 grit to remove any remaining flash or mold imperfections.

3. Lay out the hull halves and resin parts in a well lit work space which will not be damaged by overspray. Wipe down the hull and parts with thinner to remove any residual oil or grease. Prepare the primer per manufacturer instructions. Spray with a double action air brush (a Paasche VL was used for this project) in long, even strokes. Apply a thin coat of primer to avoid sags or runs. The intricate scribed detail in the hull and sail should begin to really pop out. Avoiding heavy applications of paint to these areas will keep them sharp.
4. Once the primer has dried sufficiently (consult manufacturer's recommendations), wet sand the primer with 800 grit. Be careful not to sand back down to the epoxy hull itself or remove any scribed detail. As the boat becomes smooth, the paint dust slurry will fill in any tiny pin holes in the hull.

5. For larger gaps and imperfections, such as seams and joints around the stern planes, apply automotive grade body putty. I used NitroStan 9001 on my project. It is quick drying and waterproof, exhibiting little or no shrinkage over time. Once the putty dries in the seam, wet sand the area smooth with 800 grit.
6. Clean excess dust from the parts and run a small pointed object, such as a scribing tool or thumbtack, through any scribed detail that is filled with dust. Air brush another light layer of primer over the entire surface of each part. Repeat steps 3 - 5 until all surfaces are smooth and blemish free.

DETAIL & PAINT - Finish Coats

Great effort goes into an outstanding paint job on any boat. If you're a novice r/c sub driver, consider postponing the final finish painting until you've run your boat several times in primer. The water won't hurt the primer and it could save having to repair assorted dings and scrapes generated during the initial shakedown period at the pond.
1. For the finish coats, automotive grade coatings or enamel hobby paints are recommended. NOTE: if hobby paints are used, a tough industrial clear coat should be used to seal them and protect the finish.

The paint scheme for Permit boats' was as follows: upper hull to midline - flat black; lower hull from midline down - red oxide. The propeller should be painted gold to simulate the bronze color of the original.

Wipe down the entire hull with a lint free rag and be sure to remove all dust from the scribed detail. Lay out parts on the work space. Observe all safety precautions when working with solvent based paint including breathing mask and proper ventilation.

2. Before you begin, make sure all objects to be sprayed are dry and clean of all dirt, grease or fingerprint oil. Spray the lower hull and rudder with red oxide. Mix the paint per instructions. Here, a double action air brush was utilized. Long thin strokes should be used until the entire surface is covered. Allow the hull to dry.
3. Wet sand hull with 1200 grit paper. Avoid sanding down to primer. Repeat steps 3 - 4 for two more applications.

4. Mask off the lower hull down the midline and stern planes (use 3M 1/4" or 1/8" tape). Prepare the flat black for spraying per manufacturer's instructions. Spray a thin coat to lower & upper hulls, sail and upper rudder.

When masking off an area, shoot a thin coat of clear over the seam prior to shooting the new color. This will prevent bleed-through under the tape.
5. Wet sand the hull and pieces with 1200 grit paper. Avoid sanding down to primer. Repeat steps 3 - 4 for two more applications or until the desired finish is achieved.

6. Place the propeller in a small cup and spray the back side with gold. Once it is dry, place it on a rod and shoot the top side. Use a fine tip to get good coverage around the hub between the blades. Buff with 0000 steel wool.

7. With the boat painted, protect the finish with an application of clear flat lacquer or polyurethane. Spray a thin coat over the entire model and let it dry. Then, rub with 0000 steel wool to further buff the finish. Repeat 2 - 3 times to build a good tough barrier.
DETAIL & PAINT - Hull Markings

1. The best way to depict the standard markings on a Permit boat is to apply dry transfers. The main hull markings were located on the bow, sail, flank and upper rudder. Use the plan sheet as a reference when mapping out the precise locations on your model. For best results, transfers should be applied to surfaces that have been clear coated.

To get the proper numeral sizes and font to depict U.S. Navy markings in 1/96 scale, use Woodland Scenics dry transfer sheet #MG740 for the letters and #MG747 for the numbers (45° USA Gothic).

2. Hull numbers were located under the sail planes. Cut out the appropriate dry transfer from the master sheet. A Post-It note makes for a convenient, self-adhesive straight edge.
3. Select the appropriate marking and align it on the model. The plastic sheet should be up, with the transfer on the back side, against the model.

4. With a burnishing tool or other firm, blunt instrument, rub the face of the transfer. The number will adhere to the model.
5. Peal away the plastic sheet to reveal a sharp, crisp number. Repeat, making sure to keep adjacent numbers properly aligned.

Once all markings are applied, spray the entire model with a final coat of flat clear to seal and protect the transfers from damage.

The same steps were followed to add the draft markings to the bow and upper rudder.
With the boat assembled, trimmed and painted, it's now time to put her through her paces on patrol.

ON PATROL

The first run of a new model sub is always a heady thing. All the time, work, and money invested, not to mention the expectations of the crowd, can all lead to disaster if you're not careful. If at all possible, take an experienced r/c sub vet with you to double check your preparations. One missed item on your pre-run checklist can ruin your day. Pick a spot with clear water and bottom features you are familiar with.

A good plan is to commence with surface running first. Get the feel of how she handles, the response you can expect from rudder and throttle commands. When you're comfortable, bring the boat in and park it for a static dive next to the shore. Command a vent and check the trim. Adjust as necessary. Often different water densities will require minor ballast adjustments.

With a good final trim, blow to the surface, make a circuit and aim the boat towards you. Command a dive. As she dips under observe her behavior. She should level off at periscope depth. If so, you're on your way (if the worst happens, she'll be heading to shore at your feet and the recovery will be easy). As you get to know your new command, keep an eye on run time. Don't want to end on the low note of a flat battery (with a standard 1500mah NiCad I can get a run time of approximately 1 hour -- your results may vary).

My own Permit proved to be a wonderful performer. Docile underway, she turns smartly and has gobs of power in reserve for getting out of trouble. With the planes mounted high in the sail she has a tendency to be drawn upward by surface capture at periscope depth -- just like the real thing. I always run with the attack scope extended to help gauge my depth. As idiosyncrasies go it proved to be minor. Every boat has them.
The above images were taken of Thresher several seasons ago. She is still running strong, and despite other projects, retains a special place in my modeling heart.