



## Chesapeake Tartan 30 Association

### HEAD & HOLDING TANK SYSTEM

Brad Armendt, T-30 #282, *Emprise*, May 1998\*

As part of the preparations for a cruise down the Intracoastal Waterway from Annapolis, MD to Florida, we decided to install a proper holding tank system to replace the minimal-compliance system which had been in place on our boat since about 1980, but never used. An additional motivation was Maryland's crackdown on overboard discharge, commenced in July 1997.

First we read everything we could find on the subject, which turned out to be surprisingly little. While lots of ink has been spent on this, most of it presents generalities and platitudes, but very little hard data or convincing guidance on what to buy and how to install it. The most essential technical information for planning this project came from two articles in the September 1993 issue of *Practical Sailor*: "Holding Tank Blowout," page 12, and "The Cure for a Smelly Head Starts with the Hose," page 14. Before starting on a holding tank project, I strongly recommend that you obtain copies of these articles.

The layout we used is shown in Figure 1, and is essentially what West Marine describes in their catalog as "Our Favorite Method" of installing a sanitation system. This provides that all waste goes from the head into the holding tank, from which it can be either sucked out through the deck at a pumpout station, or pumped "overboard when legal and logical to do so." A Y-valve (normally kept locked in the no-overboard-discharge position) controls which way the waste goes. If the boat is taken offshore, you must have a way to dispose of holding tank waste. And in some coastal cruising areas, pumpout stations simply don't exist.

**THE PLAN.** We had lived with the original Wilcox Crittenden Head-Mate for 25 years, during which time it had required at least two major overhauls — and it was time for another one. Instead, contemplating living aboard this boat for an extended period, we decided to replace the old head with an ITT Jabsco Electric Marine Toilet, Model 37010-0000, which provided several advantages (in addition to the convenience of electric vs. manual operation). This electric head has a macerator pump incorporated in its base (easily accessible for service), which both pumps in the water for flushing and macerates the waste as it pumps it out to the holding tank. It just seemed better to inject a fine slurry into the holding tank instead of mixed liquid and solids. Further, because the head *pumps* in the flush water, it becomes feasible to eliminate the old problem of inadvertent flooding of the head — remember, if you forgot to put the little lever back down on the Head-Mate? That could get serious if you were sailing on starboard tack. This problem is eliminated by running the seawater intake up higher than the heeled (i.e., starboard tack) waterline, to a vented loop, before it comes back to the new head. An electric solenoid valve on the vented loop allows it to be open at all times except when actually flushing the head. The vented loop is located inside the fiberglass cowling (just forward of the mast) in the head. The solenoid valve is wired directly to the pushbutton flush switch, so you don't even have to think about it. When you flush, the solenoid valve automatically closes, allowing intake of seawater to the toilet.

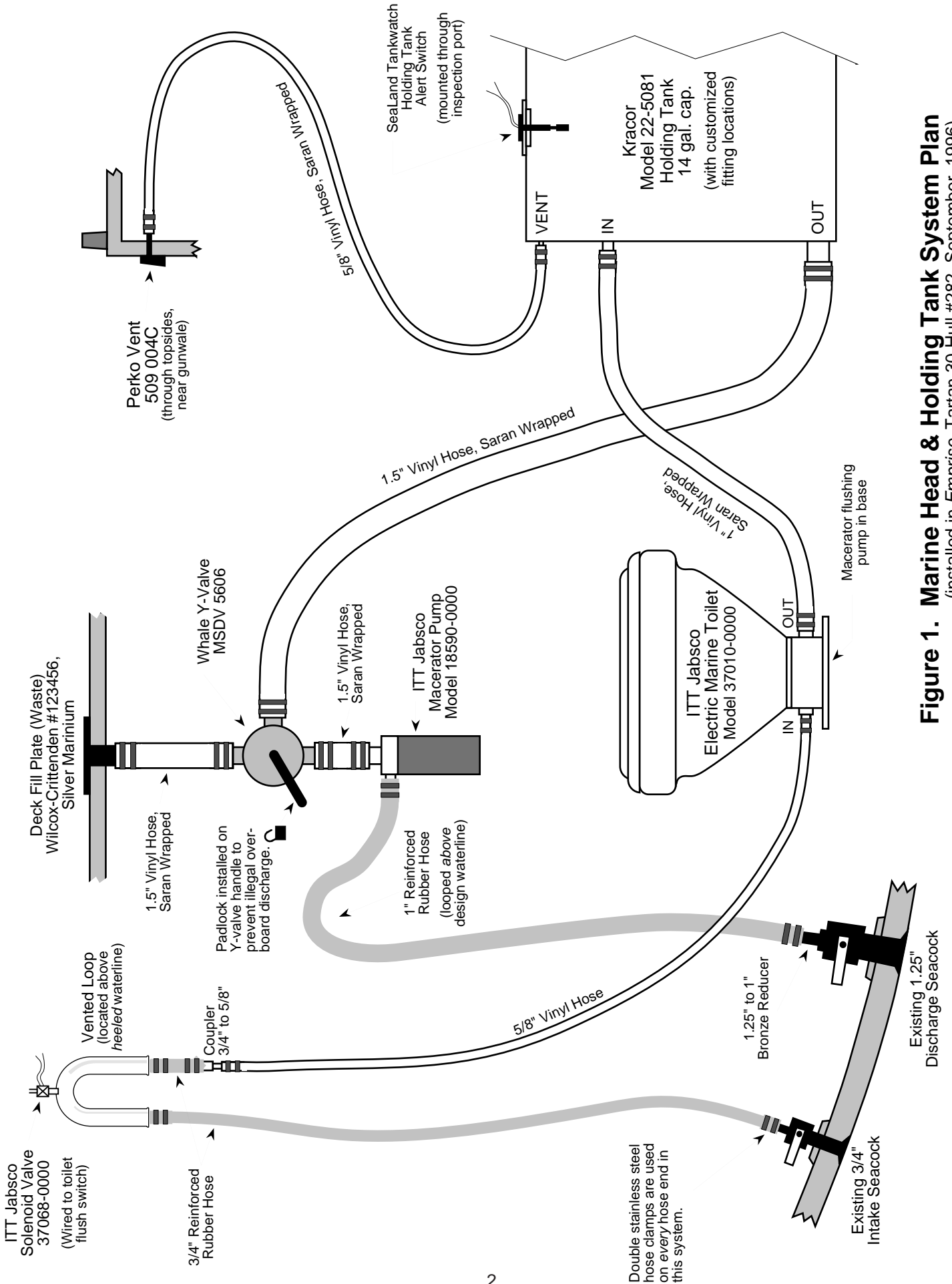
Since it's already been macerated into a slurry, the output from the head goes through a hose only one inch in diameter, which is a lot easier to route around through the boat than the larger 1½ inch hose normally used for head output.

The holding tank outlet is connected to a Whale Y-valve which is normally kept in the pumpout-from-the-deck position, so there is nothing to do below to have the holding tank pumped out. All that is necessary is to remove the cap from the deck plate (located amidships, next to the toerail) and suck out the waste. On arrival in Daytona Beach, FL, our ultimate destination in 1996, we found a simply great place — Halifax Harbor Marina— where we took a slip for the winter. They provided *free* pumpouts any time at their pumpout dock, and (if you simply signed up for it) *free* pumpouts by a pumpout boat that came around to your slip once a week, whether you were aboard or not! Not having to be there to throw valves or something down below was a convenience.

If necessary to discharge waste overboard, the Y-valve is unlocked and turned to the other position, routing waste from the holding tank to the overboard discharge pump. While designing this system I

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**Figure 1. Marine Head & Holding Tank System Plan**  
 (installed in *Emprise*, Tartan 30 Hull #282, September, 1996)

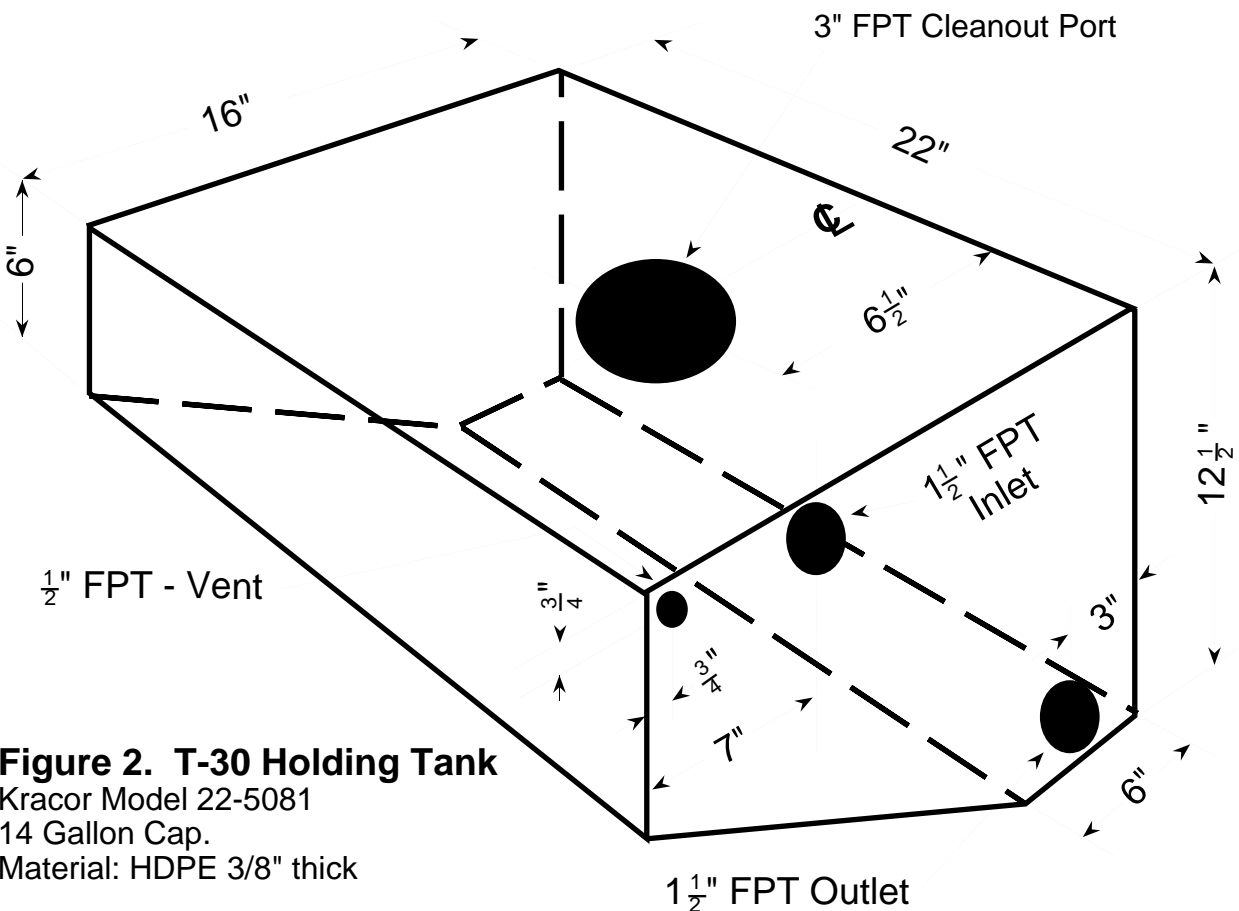
looked at various discharge pumps, but finally settled on an ITT Jabsco Macerator Pump, Model 18590-0000. Why a *second* macerator? Well, I don't think it *needs* to be a macerator, but this pump is considerably smaller and less expensive than other waste discharge pumps I could find. Also, it was possible to partially disassemble the pump and rotate its outlet port to the best direction, and to mount the pump inlet almost butting against the outlet port of the Y-valve, making a very compact assembly on a base of  $\frac{3}{4}$  inch marine plywood. This plywood base is epoxied to the inside of the hull outboard of the toilet, behind the removeable door in the head, so it is also reasonably easy to access when service is required. One real disadvantage of using a macerator pump is that in addition to the chopper plate that does the macerating, it includes an impeller pump to move the waste along. And impeller pumps don't like to be run dry, so it's necessary to pay attention while doing an overboard discharge. When overboard discharge is necessary, you first open the big seacock (which is kept closed at all other times), turn the Y-valve to O/B discharge position, flip the macerator pump circuit breaker (mounted inside the head cabinet) to "on," then hold down the momentary-contact pushbutton switch to run the discharge pump. It takes about a minute or less to empty a full holding tank, and the pumping sound changes very obviously when all the waste has been pumped, so you release the pushbutton switch to stop pumping. Usually, we flush the toilet a bit to push a couple of gallons of "clean" seawater into the holding tank, then pump that overboard, too. Afterwards, flip the pump circuit breaker "off," close the big seacock, turn the Y-valve to deck-pumpout position and lock it, and you're done. Because people forget things (even *me*, sometimes!), a small checklist next to the switches is good insurance.

Another advantage of using a macerator pump for overboard discharge is that the outlet is only one inch hose. This is looped up above the design waterline of the boat (i.e., sitting level), so that even if you leave the big seacock open, flooding is less likely from malfunction of upstream components which are *below* the design waterline. Also, in the event of some kind of clog in the discharge hose or seacock, it's possible to remove the discharge hose from the macerator pump, pull it out of the head cabinet, then run a "snake" down the hose and out the seacock to clear the problem.

**HOLDING TANK.** For some time I searched for holding tanks and agonized over where to put one in our boat. Ultimately, I found that Joe Palmer at The Customer Service Company could supply one that fit under the port V-berth. Joe faxed me a drawing and I built a cardboard replica to see if I could fit it in. It appeared that the tank would fit the space under the V-berth, but that the fiberglass bunk would have to be cut to get it there. Finally accepting this, I ordered a tank from Joe, but asked that the locations of the outlet fitting and the inspection port be changed to fit my needs (Joe can do this). I think this tank design was made to fit in the later T-30s that were equipped with holding tanks, so the waste outlet fitting normally was on the forward end, because Tartan located the pumpout deck plate up near the bow. As mentioned earlier, we had installed a minimal system in 1980, using a flexible Nauta tank under the port V-berth. I needed all tank fittings located on the aft end to use the existing deck pumpout plate located amidships (see Figure 2). The tank arrived 3 $\frac{1}{2}$  weeks later direct from Kracor, but it had been made wrong. Joe had it picked up and another one, built correctly, sent to me. Kracor marked my tank "Model 22-5081," but I'm not sure whether that number is for their *basic* design of this shape, or for my order with the special fitting locations. If you get a tank from Joe, he can keep it straight if you tell him what you need.

The first thing I did with the new holding tank was to run a test on it like *Practical Sailor* described in the "Holding Tank Blowout" article cited above, and I recommend you do the same on whatever holding tank you buy. You plug up all the holes but the vent, connect a plastic hose to the vent fitting and run it up vertically for about eight feet, then fill the tank completely with water (no air bubbles) and fill up the hose to a height of seven feet. Let it sit for at least an hour. If no leaks occur with this seven foot head of water, it has met the most important U.S. Coast Guard standard (other standards deal with fill-and-drain fifty times, etc.). Partly I did this because the *PS* holding tank article had mentioned leaking around the inspection port when the Kracor tank bulged under pressure. My tank had no leaks, but it was *very* educational to see how the tank bulged under a seven foot head of water pressure. And you learn how tight to turn in the fittings — enough to prevent leaking, but not enough to break the tank. Incidentally, you *must* use plastic fittings (I used nylon); if you use metal fittings you void Kracor's warranty, because it's so *easy* to break the tank by overtightening them.

Satisfied that the tank would hold its contents, I took it to the boat to see how much fiberglass cutting it would take to make it fit. Amazingly, I found that it would *almost* go through the hatch under the port V-berth. All I had to do to get the tank through was to trim away less than an inch from the



**Figure 2. T-30 Holding Tank**

Kracor Model 22-5081

14 Gallon Cap.

Material: HDPE 3/8" thick

edge of the hatch opening in three places. That wasn't even enough to require a patch job; it was all covered when the bunk hatch was replaced over the tank! Hooray!

Next was the problem of building a support for the tank. By phone, Kracor's Customer Service man said to support the tank with 3/4 inch plywood. So, I built a platform inside the volume under the port V-berth. A length of 2x4 lumber was bolted to the inside of the fiberglass liner on the inboard side of the space. A piece of 3/4 inch marine plywood was cut to fit and was screwed to the top of the 2x4 on the inside edge. The outboard edge of the plywood was beveled to rest against the inside of the hull. In view of the weight of a full holding tank, *big* bolts and *big* screws were used in this construction. After putting the tank into the compartment to sit atop the platform, I found that it could be slid forward, under the forward edge of the bunk hatch and against a bulkhead there, and then wedged securely in place using only one block of wood bolted at the top, inboard, aft corner of the tank. It's difficult to describe, but if you get the tank into the space, you will see what I mean.

Now keep in mind that (a) all the tank fittings are on the aft end, (b) the tank intake and vent fittings are at the top, reachable with difficulty through the bunk hatch, but (c) the tank outlet is at the very bottom, aft corner, impossible to reach if service (like, having to replace the outlet hose — ugh!) is ever required. Therefore, before putting the tank in place, an access port was cut through the fiberglass liner next to the tank outlet; a small cover of 1/4 inch teak plywood was screwed over it. Also, because of the difficulty of attaching the hoses and their hose clamps inside the tiny space aft of the holding tank, all hoses were cut to length, fitted and clamped to the holding tank before it was finally put in its hole, hopefully for good. Of course this meant that most of the rest of the sanitation system had to be installed first, so the lengths and routes of the tank hoses could be established.

On request, Kracor sent me (gratis) an extra inspection port cap, which I used to mount a SeaLand Tankwatch Holding Tank Alert Switch, as shown on Figure 1. We thought this was necessary, to warn us when the tank was nearly full. You don't want the waste slurry to fill the tank

and be pumped up the vent hose — and maybe even squirt out the vent. Aside from the unpleasantness, some of the waste would remain inside the vent hose even after the tank was pumped out, hardening there and perhaps eventually clogging the vent. Better to know the tank is almost full and take action to empty it. The Tankwatch connects to a warning light located in the head compartment right next to the flush switch over the toilet. When it comes on, you can't miss it.

Incidentally, a problem we sometimes have in the Chesapeake Bay area is with dirt-dauber wasps, who delight in finding a holding tank vent outlet hole in the side of a boat sitting unattended in a slip. The dirt-dauber happily builds himself a mud nest in the hole, thereby totally closing it up. Sometimes it's hard to see that it's been done, leading to much agonizing by skippers trying to figure out why the holding tank system won't work right. Moral: be sure to buy a vent fitting with a screen inside, preferably close to the opening. And if the system acts like the vent is clogged, check the outside end first — it may be very easy to fix.

**HOSE.** Based on the findings in the *Practical Sailor* article on hoses, we used Shields' Series 148 Heavy-Duty Vinyl Hose for all but two sections: the head intake line and the overboard discharge line (both running to seacocks) which must withstand below-waterline pressure of the sea. For these latter lines, we used Shields' Series 135 Heavy Duty Water Hose ( $3/4$ "") and Series 101 No-Odor Super Head Hose (1") respectively; both of these are heavily reinforced rubber hoses. All hose of all types was bought from West Marine.

The toughest thing about using the Shields Series 148 Heavy-Duty Vinyl Hose was getting it onto the plumbing fittings. We found it worthwhile to buy an extra fitting of each size used to attach hose (they're plastic, and cheap). After everything was in place and a piece of hose was measured and cut to length, we dipped each end in boiling water and then forced it onto a spare fitting of the size to be connected. Sometimes it took more than one dip-and-force to form the plastic hose to the shape needed. But afterwards, installing the hose was easy. Without this hot pre-forming, getting that tough plastic hose onto the fittings is virtually impossible.

In the article cited above, *Practical Sailor* described their discussions with the president of SeaLand Technology, which has done extensive testing "to determine the compounds in waste causing odors, and what materials, if any, might successfully contain them." Besides discussion of materials used in hoses, etc., *Practical Sailor* reported that "One material that does appear impermeable to these virulent waste odors is Saran® wrap ... owners with severe problems might try wrapping the offending hose tightly with several layers of Saran Wrap. The key word here is *Saran* — other food wraps are not made of the same material, and are not impermeable to vapor and odor transmission."

Therefore, being firm believers in the belt-and-suspenders approach, after each of our plastic hoses that might ever contain waste were cut to length and the ends formed to fittings, we wrapped them with three layers of Saran Wrap, then overwrapped that with one layer of 3M Super Strength Mailing Tape (2" wide, clear plastic) to protect the Saran Wrap and keep it in place. Did we need the Saran Wrap? We don't know. It seemed like a good idea, for good technical reasons, and it was quick and cheap to add during the initial construction, so we did it. I didn't want to think about trying to apply it to hoses *after* we had an odor problem (Ugh!).

In running the hoses between the system components, great care was taken to see that the path of each hose ran monotonically down from higher end to lower end — that is, no *dips* were allowed that would pool waste in one location for a long time. Sometimes eliminating dips took some imagination. Strong nylon cable ties frequently were useful to support a hose in the desired position.

**OTHER COMMENTS.** When you go to buy "stainless steel" hose clamps for this (or any other) boat project, take a magnet. Disregard what the store clerk, the catalog or the sign on the bin says — *put your magnet on it* — not just the band, but especially the clamp screw. Parts attracted by a magnet *will* rust ... sometimes catastrophically. You may be surprised how often you find magnetic parts on "SS" hose clamps. If the hose clamps you find are magnetic, look further. Usually you can find non-magnetic ones for only a bit more. Remember, some of the hose clamps used on this system will end up in hard-to-reach locations, so you don't want to have to replace them prematurely.

One thing to think about when living with a holding tank system is the calcium-type deposit that builds up inside the hoses. While living aboard in Florida last winter we read a book titled: *The*

*Liveaboard Report*, by Charlie Wing, International Marine, Camden, ME, 1993. The author interviewed a number of liveaboards about what worked and what didn't. One interesting item on pages 63-64, regarding holding tank systems: "A sailing doctor explained that the mineral deposit inside the discharge hose (which can totally block a hose in a year or two) is calcium carbonate, precipitated from sea water by urine. Many cruisers found that a weekly cup of vinegar flushed down the head and left to reside in the hose overnight will prevent the accumulation."

Well, vinegar (5% acetic acid) is cheap. So we used a cup about once a week. Six months later I had to rebuild the macerator pump at the bottom of our electric head. When I took it apart, there was very little mineral deposit inside the pump and as far as I could see up the hoses attached to it. Perhaps the vinegar helped.

**RESULTS.** As I said, we installed the system in the summer of 1996, then left in October 1996 for Florida. We lived aboard for most of eight months, returning to Annapolis, Maryland on Memorial Day, 1997. Throughout all this long cruise to Florida, and the following 1997 season back on Chesapeake Bay, we have never had any bad odors from our holding tank system. (That is, except what comes out the holding tank vent hose when you flush, but that's outside, and momentary.) So something is working for us, either the good Shields hose, or the Saran Wrap, or both. I don't know if we will ever know for sure. But so far I can't think of anything I would change if I had to do the head & holding tank system over again.

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**P.S.** *We repeated our trip from Annapolis, MD down the ICW to Florida during October 1998 to May 1999, again living aboard most of the time we were in Florida. During this second trip, and again back home on the Chesapeake Bay during the 1999 and 2000 seasons, we still have had no problem with odors from the holding tank system (except briefly outside when the head is flushed, as mentioned above). — B. Armendt, October 2000*