

# 1 WATER TANK CASE STUDY-CANOE COVE 53

## 1.1 THE CANOE COVE 53

In way of background and introduction, a short description of the Canoe Cove 53 (CC53) is provided here. My boat, M/V RENDEZVOUS, is hull number 44 of 62 (see Figure 1). She was built by Canoe Cove Manufacturing, located in Canoe Cove, British Columbia. She was launched in 1984 and first registered in 1985. I bought her well-used but not abused in 2002. M/V RENDEZVOUS is an aft-cabin “yachtfisher” (Canoe Cove’s moniker-not mine!), with a queen-sized walkaround berth centered longitudinally against the salon bulkhead in the aft cabin master stateroom. In this configuration, the water tank is installed under the berth below the deck in the aft cabin.



Figure 1. M/V RENDEZVOUS

## 1.2 THE FIX OR REPLACE CONNUNDRUM

If you are reading this, you have (presumably) discovered a significant leak in your water tank. Finding myself in that selfsame situation not long ago, I spent many hours trying to assess the cause of my leakage, and then trying to fix it without removing the tank. I finally reconciled myself to removal and replacement of the existing tank. If yours is leaking, I heartily suggest you save yourself much time, anguish, and heartache and simply jump past the “fix” thought, directly to the “replace” thought. You’ll be happier in the long run. It’s really not that tough of a job, given that someone (me!) has gone there before. Hopefully, this roadmap will ease your way.

# 2 WATER TANK REMOVAL

## 2.1 CARPET AND PAD

My particular CC53 is carpeted, with padding stapled to a plywood deck, and the carpet attached via tack strips nailed to the deck along the perimeter of the cabin. So, the first task is to remove the carpet. If you wish to retain the carpet, some judicious tugging on the edges will remove the carpet without damage. However, it is virtually impossible to remove the carpet padding without damaging it. Have no fear-it’s cheap to replace. Go ahead and pull it up with impunity, and remove the staple remnants at the same time. Then, pry up and remove

the tack strips that surround the berth. You only have to kneel on one once to understand the merit to this suggestion.

## **2.2 MATRESS**

The mattress is a full-sized (60" x 80") queen, and is too large to be removed through the aft cabin door. So it must be removed from the platform, and leaned up against the port hull side.

## **2.3 BUNK PLATFORM**

The platform bed is constructed as a raised pedestal with solid teak sides and ends, similar to a Danish Modern platform bed, but with a solid plywood bottom vice slats supporting the mattress. At the foot of the platform are two clothing drawers, while under the main body of the mattress is a large storage area accessed via a removable hatch under the mattress. The platform is flanked to port by a bedside cabinet sandwiched between the platform and the hull and attached to the forward bulkhead, while the starboard bedside cabinet is attached to the platform and the forward bulkhead as well. The platform base is cleated and screwed to the plywood cabin deck and forward bulkhead. Access to the cleating is from the outside at the base of the platform via plugged screws into the cleats. And herein lays the most vexing issue with removal of the water tank. The cleats are not only screwed to the deck, but they are glued to the deck as well. As are the platform sides. So, even though each cleat screw can be accessed by un-plugging and removing the bronze screws, the platform remains firmly attached to the cleats. And by firmly, I mean FIRMLY. No amount of jacking, tugging, swearing, wedging, etc. could be found to release the berth platform from the deck cleats.

After much head scratching, a FEIN Multitool was purchased, which provided the key to removal of the platform. By using the oscillating blade of the Multitool flat against the deck and under the platform all around the perimeter of the platform, the platform could eventually be persuaded to free itself from the deck with minimal damage. Some of the cleats come off with the platform. As this platform is a beautiful piece of solid teak furniture, every effort must be made to remove this platform intact with minimal damage. Use of the Multitool was the key to achieving this goal.

Once the starboard bedside cabinet (the port bedside cabinet may be left attached) and the platform is freed from the deck, the platform (which is also obviously too large to be removed from the cabin) must be leaned up against the mattress, as far out of the way as possible.

## **2.4 DECK**

Immediately under the platform is a 4' wide section of decking. This decking is 5/8 fir marine plywood, screwed but (fortunately!) not glued down to the 2" x 4" fir deck beams. Unscrewing a plethora of deck screws allows this section of plywood to be removed in one piece, once again leaning it up against the platform against the port hull, and out of the way.

## **2.5 DECK BEAMS**

This provides access to the deck beams, which must be sawed off at the edges of the deck plate and removed to allow the tank to be removed.

## **2.6 TANK**

The aluminum 200 gallon water tank (see Figure 2) is installed immediately under the deck beams, in between the two large fiberglass-encased fir longitudinal hull stringers that form the engine beds. The tank is a rectangular solid, and fabricated from ~1/8" welded aluminum alloy. It contains one transverse slosh baffle, midway between the front and back of the tank. The tank is held in place via two 2" x 2" aluminum angles welded to the sides of the tank, and lag bolted to the longitudinal stringers. Both the existing plumbing and lag bolts are easily accessed for removal from above. However, even though the tank is ready for removal from its resting place, it will be apparent that the tank is too large to be removed through the aft cabin door. So the 1<sup>st</sup> conundrum presents itself: to butcher the aft cabin door or cabin overhead to remove the tank intact, or to cut up the tank and remove it in pieces. My choice was to cut up the tank with a Sawzall (an easy task), and

remove it in pieces through the aft cabin door. While that choice was easy, it then presented an unintended consequence of this action: the new tank won't fit back into the boat! So, inevitably two new tanks small enough to fit through the cabin door must be designed to replace the single existing one.



Figure 2. OEM Water Tank

### 3 DESIGN OF A NEW TANK(S)

#### 3.1 MATERIAL

After significant head-scratching, two (2) replacement water tanks were designed and fabricated to fit. I chose to fabricate these tanks from 10-gauge (0.135") 316L stainless steel. The choice of material is subject to discussion (see Steve D'Antonio's article <http://www.passagemaker.com/MagazineandEvents/TheMagazine/ReadArticle/tabid/277/articleID/1011/Default.aspx>) but it is this author's opinion that as the material is a minor cost of the entire operation, why not choose the very best? No stock polypropylene tanks could be found that would fit, custom rotomolded polypropylene tanks were not cost effective, and I did not trust a custom welded polypropylene tank in the long run. Welded aluminum tanks, while somewhat less expensive to manufacture than stainless, were absolutely unacceptable to me after witnessing the interior of the failed tank that was removed. Figure 3 is a picture of the interior of the existing tank, showing the numerous oxide precipitates ("crusticles") that formed sometime during the life of the aluminum tank. These precipitates clung tenaciously to the sides and bottom of the tank, and formed corrosion pits under each. It was one of these corrosion pits that led to the ultimate demise of the original tank. While I didn't bother to determine the chemical composition of these precipitates, the thought of drinking water from a tank in contact with these precipitates was not pleasant. Monel has been priced out of cost-effective

consideration, and mild steel was not even considered due to its propensity to rust, even if coated with epoxy. So stainless steel it became!



**Figure 3. Old Water Tank "Crusticles"**

### **3.2 DESIGN CONSIDERATIONS**

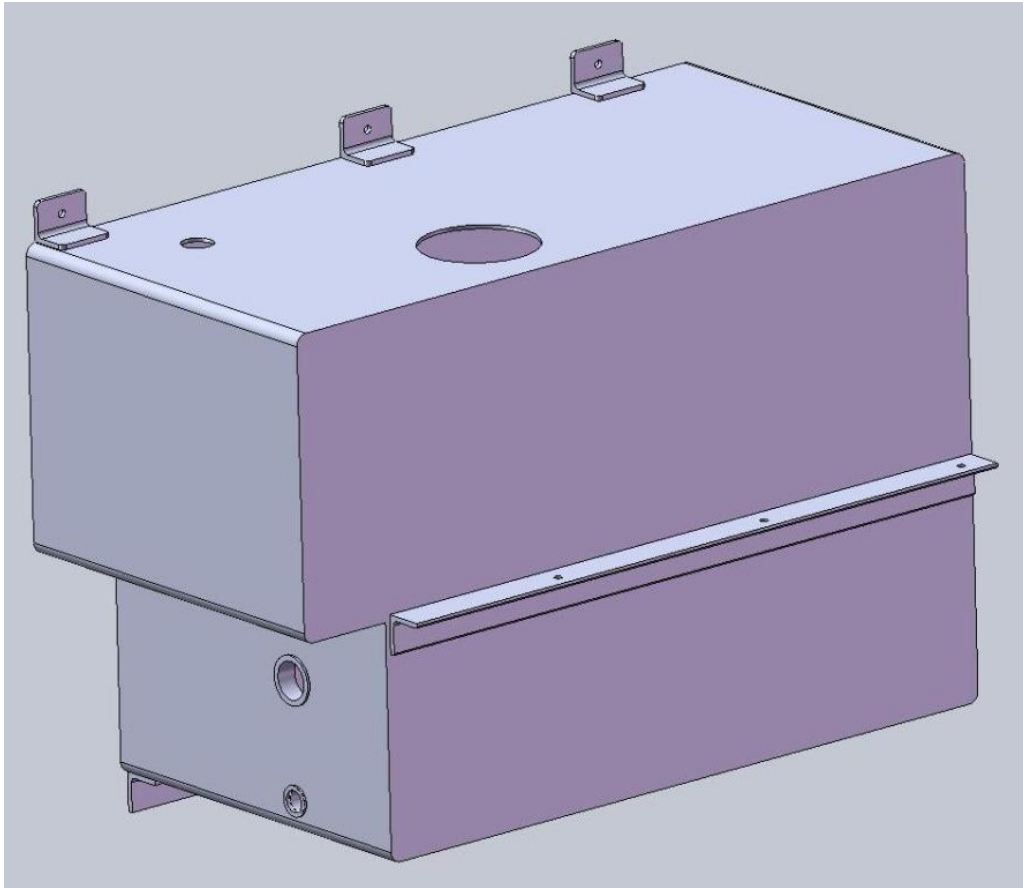
As I am a competent mechanical engineer with extensive machine design experience and access to various Computer Aided Design softwares, I decided to tackle the design and drafting tasks myself. The replacement tanks were designed to be inserted into the aft cabin singly, then bolted together, and installed into the existing void as a unit. Figure 4 is a solid model of the starboard tank. The port tank is a mirror image. Design of two tanks that function as a single unit was not entirely straight forward. Unless you are content to have two water fills, two vents, and two drain lines, some method of ganging the tanks together must be devised. In this installation, this was accomplished via a “spill pipe” that interconnects both tanks, and tee-ing the individual vent fittings into a common vent. The spill pipe was sized so as not to limit the transfer of water from one tank to the other during either filling or draining. The major difficulty with this concept was that the bulkhead that forms the aft limit to the tank cavity cannot be easily or prudently removed to provide space or access to the spill pipe. Hence, the tanks were designed with a step that accommodates the spill pipe. The tank dimensions were increased wherever possible to recover the lost volume from the step; the dual tanks have a 196 gallon capacity vice 200 gallons for the original. Note: reflection on the design some years later revealed the now-obvious point that the drain ports could have been enlarged and plumbed as the spill ports as well, saving one penetration per tank. Doh...

An inspection port was installed in the aft bulkhead to allow inspection and service of the spill pipe and drain ports without removal of the tanks, should leakage in this area ever occur. Every effort to prevent such leakage was accomplished by the use of 316L stainless steel pipe fittings, top-of-the-line Trident brand flexible water hose rated for food service, and double hose clamps on each connection.

In addition to the necessary spill pipe, vent, and fill fittings, a port was provided for a gauge fitting. A 6” access port was provided in the top of each tank, accessible through matching access plates in the deck under the



platform bed. Should it be necessary to inspect or clean the interior of the tanks, it is possible to remove the mattress, remove the lid over the storage area, remove the access plates, and reach the interior of the tanks. A feature this owner fervently wishes was provided in the initial installation! It might have prevented this entire evolution by allowing routine inspection and cleaning of the potable water system.



**Figure 4. Starboard Tank (Port Side Mirror Image)**

### **3.3 FABRICATION**

Internet inquiries, discussions with local boatyards and marine professionals, and telephone calls to potential tank suppliers should yield numerous candidate tank vendors. Due to the size of the replacement tanks, shipping costs need to be factored into your choice of vendor. In my situation, a highly recommended tank manufacturer (Coastline Equipment Inc.- <http://coastline-tanks.com/index.html>) was located in Bellingham, WA. Coastline was extremely helpful during the design process, were happy to build to my drawings, and promptly delivered the tanks within three weeks of receipt of the drawings. A three psi pressure check was provided by the vendor, which is essential to guaranteeing a quality product.

## **4 INSTALLATION**

### **4.1 ASSEMBLY**

Once the new tanks are landed in the aft cabin, they were simply bolted together, using stainless steel hardware through the bolting tabs top and bottom on the tank, marine board spacers to fine-tune the width between the tanks, and nylok locking nuts to ensure the fasteners stay fastened.

### **4.2 DROP IN PLACE**

Each tank is approximately 100 lbs empty. Once the tanks are bolted together, it takes several persons to manhandle the tanks into place in the tank void. Once the tanks are dropped in place as a unit, they are then lag screwed in place through the angle brackets to the longitudinal stringers, just as was the stock tank. Once in

place, the tanks can be plumbed. For galvanic compatibility, I chose to use 316L pipe fittings, which can be ordered at a substantial discount on line. Make sure and use either Teflon tape or a liquid thread sealer to facilitate the fitting installation.

Once plumbed, the tanks filled with water, and a final leak check made, it is time to replace the furniture. Celebration with a fine liquor of choice, diluted by a wee splash from your new-found water supply is in order at this time!

#### **4.3 DECK BEAMS**

Replacement of the deck beams is quite straight forward. Assuming the original deck beams were carefully removed, they can be re-used by sistering them in place at each end. Use of carriage bolts through the sisters into the native deck beams is encouraged. As the tank height was increased over one inch to retain tank volume, the beams must be notched accordingly to fit. Make sure there is clearance under the beams; do not rest them on the tank itself.

#### **4.4 DECK**

The plywood deck can then be re-installed (I used stainless steel flathead screws instead of bronze), with little carpentry required.

#### **4.5 BUNK PLATFORM**

With the deck successfully re-installed, the berth platform can be replaced. I gave significant thought to simply screwing the cleats back to the deck, without glue. However, I was very anxious to preserve the squeak-free, rigid construction techniques employed by the original Canoe Cove boatwrights, so I chose to use Sikaflex adhesive between the cleats and the deck, and between the platform and the cleats. Hopefully, this adhesive will be removable in the future by any subsequent owner that cares to repeat this tank replacement exercise without use of TOO many bad words. I, hopefully, will not be that person.

#### **4.6 CARPET AND PAD**

Lastly, new carpet padding can be installed, with new tack strips as necessary, and the carpet re-installed. Some stapling around the aft cabin deck access hatches must be accomplished. Make sure to use either Monel or stainless steel staples. A pneumatic or electric staple gun greatly eases this stapling task.

CONGRATULATIONS-YOU'RE DONE! These replacement tanks should last at least as long as the original equipment, and provide hygienic and taste-free water for years to come.