Cummins wet-exhaust elbow issues on early NT37s

This article is a postscript to Cameron Sharpe and Jim West’s great 2008 SENTOA article on high-temp exhaust issues they corrected on their early NT32’s (www.sentoa.org/maintenance_tips/wet_exhaust.html) and describes different exhaust issues we encountered on our early NT37.

If you recognize the white Cummins wet-exhaust elbow in this picture (it’s bolted directly to the turbocharger at the back of the engine) and you’ve never had your wet-exhaust elbow off to inspect it, this article is for you.

Sandpiper is a 2001 NT37-042 with the analog Cummins 6BTA5.9. After 8000 hours (and 16 Seattle-Alaska-Seattle summer cruises). Finding Cameron and Jim’s article on SENTOA motivated us to do a full IR temperature scan of our NT37 exhaust system. We didn’t find any of the high temperature exhaust issues Cameron and Jim reported encountering on their NT32’s, but we put a full R&R exhaust inspection on our annual maintenance to-do list anyway because further research indicated that these Cummins wet-exhaust elbows were a potential problem. Good thing we did because we learned a lot.

First of all, a few important details about these Cummins wet-exhaust elbows because they’re not obvious from just looking at one while it’s still bolted on the engine.

Just like the air that flows through the radiator of your car, your boat’s ‘raw water’ system cools your engine by pumping sea-water through the heat exchanger that cools the closed antifreeze coolant system which actually keeps the engine from overheating. After the raw water (saltwater in our case) finishes its job in the heat exchanger, it exits the boat through the wet-exhaust elbow where it sprays into the exhaust stream cooling the exhaust gases so they don’t overheat the fiberglass exhaust components downstream.

The stock Cummins wet-exhaust elbow on our early NT37 is really two elbows, one welded inside the other separated by a ½” water jacket. The only place to actually see the inner elbow is the short 1” section that is welded to the flange bolted to the turbo. The two elbows are joined at the aft end with a ‘shower ring’. This shower ring portion of the wet-elbow is hidden inside the 6” exhaust hose that goes down to the wet-lift muffler in the salon bilge. All the now warm raw water sprays thru this shower ring into the hot exhaust gas stream cooling the 800-1000F diesel combustion gases down ideally to less than the 150F that is suitable for all the fiberglass exhaust components downstream.
It turns out these robust looking stainless-steel wet-exhaust elbows are actually consumable items. They will likely need to be replaced during the life of your boat. And if you wait too long, it could get expensive. Some claim that low-use boats are perhaps at higher risk than boats that are run regularly. You won’t know when your wet-exhaust elbow is failing because you probably won’t see it starting to leak. The inner elbow is going to leak first because it’s being degraded from both sides by corrosive diesel exhaust byproducts (i.e., sulphuric acid) on the inside and ‘hot’ raw water (salt water in our case) on the outside.

A leaking Cummins wet-exhaust elbow can allow raw water to drain back towards the turbo just as the engine is turned off while the raw water system is still pressurized but there is no exhaust gas to force the raw water down the exhaust piping. Members of www.BoatDiesel.com have posted pictures of hundreds of turbos ruined by leaking Cummins wet-exhaust elbows – and too often with stories of expensive engine rebuilds because raw water had leaked back from the elbow into the engine through turbo housing and exhaust manifold.

After inspection, Sandpiper’s 15 year old stock wet-exhaust elbow was deemed ‘reusable’. There were no leaks and no indications of salt water damage to our turbo. But the large black exhaust hose connected to the wet-exhaust elbow was a serious problem. Our original black 6" Trident exhaust hose that connects the wet-exhaust elbow to the wet-lift muffler thru the engine room bulkhead had entirely delaminated internally. There were bubbles and ruptures throughout the laminations down the entire internal surface of the hose. Had our exhaust hose fully ruptured, diesel exhaust and some of the associated hot raw water would have ended up in the engine room.

The remaining outer layer of exhaust hose was ‘softer’ in the fully delaminated areas, but still stiff enough we had no real indication that the internal high-temp layers were useless. We had hotter spots (115-135F) along the upper axis of the hose but we expected those after reading Cameron and Ken’s article, so weren’t alarmed until we looked inside.

Even though we could probably have re-installed Sandpiper’s stock Cummins wet-exhaust elbow, we upgraded Sandpiper’s exhaust elbow at the turbo because we wanted to add some ‘insurance’ in our exhaust system. We did a lot of reading on www.boatdiesel.com, the trawler forums and www.sbmar.com to educate ourselves to issues others have faced with inadequate and marginal marine exhaust designs. Replacing our wet-exhaust elbow with a dry-riser elbow of some form was clearly the direction to go.
The new exhaust elbow moves the raw water injection point - and any possible future leak - downstream from the turbo because the only water jacketed portion is the last few inches in the section with the shower ring. It’s the short silver part in the left edge of the photo between the blue exhaust hose and insulation blanket. More importantly, the new dry-riser elbow adds critical ‘freeboard’ to Sandpiper’s wet exhaust system design similar to the exhaust systems NT incorporated on the later 37’s. Based on pictures folks have posted of their unfinished NT37’s still on the production floor, at some point in the mid-2000’s, NT37’s using the QSB Cummins began being delivered with insulated dry riser exhaust elbows instead of the Cummins wet-exhaust elbow Sandpiper came with in 2001. You can see a similar insulated dry-riser exhaust elbow on a NT32 in Cameron and Jim’s article.

Design guidelines from Cummins Marine recommends the turbo outlet for marine uses of the 6BTA be at least 12” above the waterline. That’s a nice goal but lots of marine diesels end up far below the boats waterline (i.e., many larger sailboats) so it comes down to the integrity of the exhaust design to keep water from backing up the exhaust and ruining the engine. When loaded for cruising, the lower edge of Sandpiper’s turbo outlet is just at the waterline. Our stock wet-exhaust elbow connected to the exhaust hose, drops aft exactly at Cummins’ minimum recommended 15 degree angle to the wet-lift muffler. Farther aft in our exhaust system, we determined Sandpiper’s loaded waterline was within 2” of the top of the wet-lift muffler drum, so the only part of Sandpiper’s stock exhaust system that was actually above the water line was the dip-tube elbow coming out of the wet-lift and about half of the aft FRP exhaust piping. We measured that ‘dry’ section of exhaust FRP piping to have about 3” of ‘freeboard’ when fully loaded. The aft FRP exhaust piping descends aft from the dip-tube elbow at 3.5 - 4 degree towards the underwater exit just forward of the transom. With the air gap in this aft exhaust piping, Sandpiper’s wet-lift muffler ends up acting like a ‘sink trap’ in reverse and is pretty much the only thing keeping the bay out of our engine.

We modeled possible dry-riser elbows using plastic piping with the goal of using the existing bulkhead penetration for the exhaust hose. We then made a full dimensionally correct mock-up of the entire starboard aft corner of the engine room including all the overhead restrictions. There was never going to be enough room in Sandpiper’s engine room for Cummins’ recommended 12” of freeboard at the turbo, but Scott Conahan at National Marine Exhaust in Marysville WA (www.nationalmarineexhaust.com) was able to fabricate a custom S/S insulated dry-riser exhaust elbow for us within our
constraints that resulted in about 8” of freeboard over the water line at the turbo while still maintaining sufficient thermal clearance to the engine room insulation overhead.

Our dry-riser exhaust elbow freeboard has about 5” over the freeboard of the aft exhaust piping. ‘Diesel Guru’ Tony Athens at Seaboard Marine indicates that if you can’t get the 12” freeboard minimum target at the turbo, you go for the maximum exhaust elbow freeboard as your boat limitations will allow. He claims that as long as the ‘spillover’ height of the resulting exhaust elbow is above the next highest point in the exhaust system after the wet-lift muffler, the resulting marine exhaust system is likely to be ‘inherently safe’ with respect to avoiding the possibility of drowning your engine with water backing up the exhaust system. (www.sbmar.com/articles/designing-a-marine-exhaust-system). This additional freeboard height at the turbo also reduces the risk of slopping water out of the wet-lift muffler towards the engine if pitching in rough seas with the engine off, or even from a rough ride in the straps on the way to a dry-dock. Seaboard Marine also makes great custom exhaust elbows, we decided to spend our boat bucks locally.

We could probably have had a dry-riser elbow with one less elbow if we had been willing to move the penetration for the exhaust hose in the engine room bulkhead and reorient the wet-lift muffler inlet. We felt we could accommodate any additional exhaust backpressure as long as we avoided reducing the piping diameter and minimized the total bend complexity. Before we started the project, Sandpiper’s exhaust backpressure at the turbo pyro port measured at 12.9” H2O @ 1200 RPM to 23.5” H2O @ 2000 RPM (against one max recommendation of 41” H2O @ WOT). We haven’t measured backpressure with the new dry-riser elbow yet.

Alternatively, National Marine Exhaust makes a vertical ‘shower can’ style of S/S exhaust elbow which also moves any possible leak points safely downstream from the turbo while adding the critical exhaust freeboard at the turbo. Their shower can style elbow is essentially a water jacketed design so it doesn’t need an insulation blanket either. This picture of a shower can elbow from National Marine Exhaust on Jackson Union’s Cummins 6BTA, another early NT37 that upgraded their stock Cummins wet-exhaust elbow. Even though our insulated dry-riser elbow approach was perhaps more convoluted than a shower can elbow, we went with the dry-riser in order to have the larger diameter piping components over those used in the original stock Cummins wet-elbow or the vertical shower can elbow. We boat entirely in the pacific NW, western Canada and SE Alaska with 45F-55F water, so any extra engine room heat load from the insulated exhaust piping of our dry-riser elbow is of little concern for us.

We did all the on-board wrench work ourselves so the final project cost less than $2.5K including glassing in a new high-temp vinyl-ester FRP inlet elbow in the wet-lift muffler to replace the original cracked inlet which had been a warranty item left over when Sandpiper was delivered in 2001.
We connected our new dry-riser elbow to the wet-lift muffler with blue 300F rated high-temp silicon exhaust hose similar to that shown in Cameron and Ken’s NT32 exhaust system article. Our exhaust system temperatures were fine (highest measured temp throughout the exhaust system was 120F when running at 1800-2000 RPM at the FRP wet-lift inlet elbow). As a result, we didn’t feel we would benefit from adding the Vetus exhaust mixer ring described in Cameron and Ken’s article.

We had also already planned to upgrade Sandpiper’s raw water pump to Seaboard Marine’s completely redesigned SMX pump because we’d gotten tired of the inadequate and unpredictable life of the Sherwood 1730 raw water pumps sold by Cummins for the 6BTA so increasing raw water flow wasn’t a targeted objective either. We have a 190F high-temp alarm sensor mounted on the blue silicon hose to alert us to possible raw-water flow restrictions.

For further reading, there is a detailed article on ‘Exhaust Inspection and Maintenance’ published by Nordic Tug back in 2007 that strongly recommends inspecting this wet-exhaust elbow. Check out Nordic Tug's Waypoints Newsletter #11 at www.glantoa.net. This NT article advises its boat owners that the life expectancy of a wet-exhaust elbow is about 12 years. Seaboard Marine also has lots of information on their website about important design considerations for marine exhaust systems (www.sbmar.com/tonys-tips), it’s primarily targeted at re-powering boats but still really good stuff to understand about this critical boating system.

Exhaust elbows come off the turbo quite easily - just 4 bolts along with a few hose clamps on the raw water supply hose and exhaust hose. If you’ve got one of these Cummins wet-elbows, it might be a really good idea to check yours. And be sure to take a good look down that exhaust hose too. Infrared non-contact gun style temperature measuring devices are pretty inexpensive and quite useful for checking the health of lots of systems on your boat.