Original Call for Feedback:

From: Marc Willis
Subject: [RVTEC] Uncontaminated seawater piping - need a quick hit
Date: Thu, 11 Mar 2010 09:04:27 -0600

All,

I'm in the middle of a furball over uncontaminated seawater piping ("clean seawater" system). I'm doing a quick (as in today) survey of clean seawater piping. If you have the time, please send a one-liner describing your system(s), especially piping material. PVC? Lined pipe? Lined with what? Stainless? Whatever else?

I'd appreciate any info you can provide on your system(s), any ship, anywhere.

Thanks,
Marc

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RVTEC RESPONSES ON UNCONTAMINATED SEAWATER SYSTEMS
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Mike Webb, NOAA PMEL

stainless lined with teflon for piping is preferred, but not in
everywhere yet.  debubbler, of course, but that's a problem, unless
tom can farm it out.

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Dale Chayes, LDEO and HEALY

Most of Healy's new system is GRP (glass reinforced plastic, aka
fiberglass.)  I'll see what I can find on the actual material.
I know that the original system installed on the Ewing was designed to
be able to "slip" a liner inside the pipe (stainless perhaps.)

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Tim Deering, UDel (SHARP)

For our ship water pick ups we come out of a science ship's sea chest
with a Teflon steel reinforced tubing. Matt Hawkins would know the
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full details of the sea chest design. It goes to a centrifugal pump for regular applications (temp, salinity, bucket fill). We also run a line from this science sea chest to a Teflon diaphragm pump for a clean water source. If the water needs to be cleaner then that we can tow a pickup hose off the bow. To do this we have a boom and tow fish which take the hose outside of the ship's wake.

Dave Nelson, URI (ENDEAVOR)

The Endeavor is currently using all PVC piping for the uncontaminated seawater from the magnetically coupled pump onward. The intake is off the main engine sea chest and travels through one steel valve immediately after the chest. then through a seabird remote sensor for the TSAL and on to the intake of the pump with PVC.

Dave Forcucci, HEALY

Here is a link to some 2003 RVTEC comments on pumps and piping related to Healy's seawater system.
http://www.icefloe.net/docs/rvtec_comments.htm
Here is the engineering plan for Healy for the 2003 drydock to install a new science seawater chest
http://www.icefloe.net/docs/science_seawater_scientist.pdf
They used Hastelloy C for the pipes and the pumps and GRP where possible.

The requirements laid out at on the UNOLS site are very helpful.
http://www.unols.org/committees/fic/smr/regional/rcsmr_version1.html#_Lab_-_Water

Key words are: "made from materials acceptable to the majority of science users"

Here is the paragraph from that link:
"This water must be collected as close as possible to the bow and piping must be made from materials acceptable to the majority of science users. Provisions for keeping piping clear and clean should be included in the design. Provisions for changing pumps, valves, and piping when necessary should be included in the design. Provisions for connecting multiple users in addition to semi-permanent equipment should be provided. A backup or alternate system should be considered. Provision of space and connections as close to the intake as possible are desired."

John Calderwood, SIO

You could take a look at the Harvel website for PVC and plastic piping ideas. <http://www.harvellxt.com/> for instance.

The SIO ships use PVC for the UCW system. A concern with ordinary PVC is the "weathering" period as the volital and soluble components leach out. After the initial break-in period, they are fairly clean.

John Bichy, Skidway (SAVANNAH)

The RV Savannah "clean water" system is all PVC. We have two pumps installed in line, one for continous use and the second as a backup. this water is pumped to the ship surface flow-thru system and is available on deck and the wetlab.

Ben Jokinen, MLML (PT SUR)

SS debubbler (home grown?) on top of seachest, all PVC ..75" from there to the main lab debubbler (SUNY style) and instrumentation.

Mark Wiggins, SUNY Stony Brook

The system we've used has a steel pipe running out of a seacock forward on the boat. It sticks out a foot or 2 and the user supplied teflon tubing which we ran through it. The tubing stuck out a couple of inches from the pipe.

Chris Griner, WHOI

Here is a drawing of the system on Atlantis. I have worked on it in the past but I am now at sea on Knorr (Long Core crew) and do not have access to my files in the office. I remember the valves being lined (German manufacturer I think) and much that I saw in our bow thruster room just downstream of the strainers is schedule 80 PVC. Make sure the yard uses 316 SS hardware! If I have time later I can probably send some pictures to you and they may show the valves as well. Hope this helps in your crunch time. [nb: if you want to see the drawing, or the pictures of the ATLANTIS system that Chris sent me later, let me know. Marc Willis]

Barrie Walden, WHOI

We have a number of different system arrangements - none are perfect but we don't get complaints (I'm not sure what this means). I don't believe its possible to select a piping material that will suit all potential users. We have lined pipe on Atlantis (Dow Chemical product?), PVC on Oceanus, and primarily PVC on Knorr. In all cases, there is PVC at the "user" end because of the required degree of configuration flexibility (and repair ability).

In my opinion, the tricky parts are devising a means for keeping the system clean/free of growth, and providing a flexible interface for use with science supplied instruments. We don't run our systems close to shore and, when the pumps are off, the piping will drain down to the waterline. Unfortunately, this is not enough to prevent problems. I've heard of ships that empty their pipes down to the hull valves using drains into the bilge (which we can't do easily) and some actually have two parallel systems to allow each in turn to remain empty for long time periods (or perhaps they are rotated daily). Another method which we routinely use on Atlantis is to shut the pump off and then fill the system with fresh water before closing the hull valve. Even if the hull valve remains open, the fresh water tends to remain in the pipes below the waterline due to the density difference. The trick here is to make sure the fresh water connection cannot result in seawater entering the fresh water system (we use a garden hose connection with an adapter that prevents flow unless the fresh water pressure is some substantial amount above that in the seawater piping), and to ensure that the pressure of the fresh water is not too much for the clean seawater pump , piping, etc. (in case the hull valves are closed).

The problem with the instrument connections is the usual requirement for a drain designed for continuous flowing seawater. Laboratory sink drains have been used in the past but for environmental reasons, those days are pretty much gone (it wasn't a good solution anyway). We have used dedicated non-corroding overboarding drain lines with the equivalent of a "stand pipe" connection system (stick your hose in the pipe as is done with your washing machine). We have also used supply valve arrangements that can split the flow and then re-join it after one leg passes through an instrument. The first method is far superior but the second can work.

One final thought - we have had a lot of trouble with air bound pumps even though they have been well below the waterline. Use self-priming pumps and give some thought to what changes you might need to make if you have problems (particularly if you decide on lined pipe). I believe all of our systems require vent lines on the suction side of the pump, leading to up to well above the waterline (hard to believe).

Bob Kluckhohn, USAP (PALMER and GOULD)

When the NBP was built we used a chemically inert pipe called Red Thread that changed to Green thread. It is Fiberglass and was allowed below the water line. The LMG has stainless steel, automated ball valves at the intakes and has been built with PVC. Stainless steel was not considered a good material because it will release iron and rust which is prohibitive to growth experiments. The Teflon lined Stainless steel was considered but it is weak and will scar when ice is pumped from the southern oceans. PVC was finally accepted with Stainless at the
bulkheads.

The pump we use is called a food grade Mono pump out of England. It is variable, positive pressure pump that is very smooth and does not cavitate. It can pump gravel and ice cream just as easily as it can pump seawater.

Dave Fisichella, WHOI

I think Chris Griner sent you something from WHOI. Just don't allow any clear tubing or piping in the UCSW system - remember, out of sight, out of mind. Seriously though, I recently had a PI who was going on three WHOI cruises this year ask us to clean all the UCSW piping. I was about to dismiss his request as unreasonable when I cam e up with the idea of placing chlorine tablets in the sea strainer for a few days prior to his cruises. I have not heard if made a noticeable difference or not, but have not received any complaints.

Phil McGillivary, USCG POLAR-class icebreakers

I am pretty sure we actually went with titanium piping for some very good reasons (stainless doesn't cut it as I am told, as metals interfere with chla fluorescence potentially). The other key thing is putting in a backflush capability, using freshwater and having the ability to backflush with some strength of at least freshwater, and periodically HCl. The key other component re your concerns: we have a pressure sensor at the intake which senses when things are clogging with ice, and can backflush there too. And our backflush can use HOT water too. I am not 100% certain that all these did get incorporated in both Polar breakers, but these are what you need regardless (my opinion).

Tim McGovern, UHawaii (KILO MOANA)

Here’s the info I have on the KM’s USSW (uncontaminated scientific seawater system):

1-1/2” & below diameter piping: Steel, polypropylene lined, schedule 40, ASTM A587, w/ ASTM D2146 liner. Edlon-PSI or equal.
Fittings: Steel, flanged, polypropylene lined, schedule 40, ASTM A587, with ASTM D2146 liner. Edlon-PSI or equal.
2” Sea Suction: Stainless steel; ASTM A213 or A249, Type 316L, Schedule 80 ANSI B36.10. PTFE liner.

Fittings: Stainless steel, buttweld, ASTM A403, Schedule 80, ANSI B16.9 & B16.11.
Strainer: 1-1/2” & smaller: Hayward p/c basket strainer w/ 1/8” perforated plastic basket.
Pump: Centrifugal, close coupled, CPVC housing, mechanical seal. Capacity: 17.3 GPM @ 85 ft. TDH. Motor: 1740 RPM, 460V/3PH/60Hz, 1.5HP, TEFC. Manufacturer: Jabsco. Model: 30520-1011 (or equal).

Ballvalve: McMaster-Carr 46125K45 (or equal), 2”, ductile iron, TFE lined, ASTM A395, 150# WOG. Stainless steel ball & stem, TFE coated. Seat is TFE, integral with liner.

Diaphragm: 1-1/2” & below; body is ductile iron, polypropylene lined, ASTM A395, 150#, WOG. EDPM diaphragm. Seat is polypropylene, integral with liner.
Gate & Check: 1-1/2” & below; Body is Bronze ASTM B61, CL150.

I know you asked for a one-liner, but I already had this info on-hand. I took all this info off our as-builts. I know we've changed the pumps since then (possibly the strainers too), but the rest of the material is the same. Hope this helps!

Geraint West, NOC, Southampton UK

Please take a look at:
http://www.noc.soton.ac.uk/nmf/discovery_replacement_project/Technical%20Requirements%20for%20Science/Volume%201%20%20SOR/Statement%20of%20Requirements%20Volume%201%20Version%205.0.pdf
which outlines our statement of requirements for the RRS Discovery replacement - go to para 7.1.34 for the clean seawater supply requirement.

For more general interest you may want to look at:
http://www.noc.soton.ac.uk/nmf/discovery_replacement_project/Technical%20Requirements%20Science.html

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Steve Poulos, UHawaii

Tim gave you a great summary. Could I add that the system have taps into it for a fresh water flush. I would even add some scheme to have a gas flush ability. Note some of the replacement piping and re-arranged piping over the years - we spec'd teflon lined pipe. So perhaps a mix of below and/or teflon. We had a great analysis of trace metals contamination at one point (by trace metals folk) - but even though the figures looked very good - still those trace metal guys don't
trust...... you know the rest

Bruce Huber, LDEO

A recent paper in GRL may be of interest if you are building or refurbishing a system:

Juranek, L. W., R. C. Hamme, et al. (2010). "Evidence of O2 consumption in underway seawater lines: Implications for air-sea O2 and CO2 fluxes." Geophys. Res. Lett. 37(1): L01601.

Tonya Watson, NOAA Ship KA'IMIMOANA (Hawaii)

On NOAA Ship Ka'imimoana we have an old system and use PVC and copper piping, maybe some nickel piping too (I'm asking the chief marine engineer at the moment), and we don't have any fresh water back flush available for the line, so we just fresh water flush the main SBE21 sensor between cruises and use anti foulant pellets on the main SBE21 sensor and Clorox the main SBE21 housing every so often. We have often wondered about how our system would hold up to scrutiny with regard to the the issue of trace metals and biological growth problems.We are a blue water boat, so we basically just try not to run our pumps too close to shore to avoid pumping too much crud through the system. I'm very thankful you asked this question because I'm receiving a lot of information that I've been looking for over the years.

Lynne Butler, URI (ENDEAVOR)

The Endeavor has the system as Dave Nelson stated. One wish I have for scientific seawater system is to have it duplicated, either complete duplicate PVC piping (not likely, just a dream) and/or duplicate pumps where a turn of a valve could bypass a faulty pump.

Our current pump is strong enough for most cruises, however we've had a couple times over the last 10 years where it would have been useful to have more pressure/flow. So if the scis want to wash down nets with the "clean" water on the back deck, it doesn't affect the pressure/ flow to the TSal/TSG system.

There were big problems on the Healy with having the system full of ice and therefore not flowing. Not sure if that's been resolved. Ability to heat some of the pipe to just above freezing could be critical up there in the ice, but perhaps that's only applicable for icebreakers.
