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Subject:	New TSG & PCO <sub>2</sub> Location ECR supporting document
Project:	Healy Science Support
Created:	August 29, 2007
Updated:	September 5, 2007: incorporate feedback from the ship September 6, 2007: add gas bottle details November 20, 2008:
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Doc No.:	n/a
Revision:	-

## 1 Background

The ThermoSalinoGraph (TSG) and associated instrumentation (including flourometer) installed in the Bio-Chem lab on USCGC Healy does not receive adequate water flow due to freezing of super-cooled water in the Science Sea Water (SSW) piping aft of Frame 80. Freezing occurs due to the small diameter and tight bend radii of the original piping in the presence of sub-freezing water with ice chips. This condition is a common occurrence when operating in heavy ice and results in significant loss of data.

The new SSW system installed in the 2003-4 drydock has been a significant improvement with respect to successful operation in heavy ice conditions in part due to the larger diameter piping and to some extent, the ice separator arrangement. Unfortunately, the new plumbing does not extend aft to the labs including the Biochem Lab where the TSG is located.

Very large variations in flow through the current sensors are frequently observed and are attributed to a range of issues including icing, variable water use on the foredeck for incubators and sea water use in the lab spaces. Even relatively small variations in flow have significant impact on the measured values. The new system will address this problem.

An additional significant issue with TSG and Fluorometer data taken in the Biochem Lab is the very large time latency (often as much as 20 minutes) of water from the intake to the lab. This latency is due to the volume of water in the plumbing, including the ice separator and the long pipe run aft to the Biochem Lab.

Finally, there is a well-defined need from the science community to measure the partial pressure of CO<sub>2</sub> (PCO<sub>2</sub>) in the high latitude oceans. There is not enough room in the Biochem Lab or other lab spaces to add the PCO<sub>2</sub> system and allow installation of the normal complement analytical equipment such as auto-analyzers and oxygen titration systems that are typical of many cruises.

The workaround to freezing of the plumbing when operating in the heaviest ice conditions has historically been a second TSG installed in the Aft Fuel Hose Handling Room that draws water from the wake using a hose lowered through the breach of the through hull XBT launcher. There are a number of problems with this arrangement including the remoteness of the location, the fact that the sampled seawater has been thoroughly mixed by the props and the passage of the ship, and the fact that the space is not intended for laboratory use.

To address the latency and freezing issues a new TSG/PCO<sub>2</sub> location should be implemented that is substantially closer to the intake and connected directly to the new large-diameter SSW piping forward of the traditional lab spaces. Several locations were evaluated with the intent to provide substantially more reliable service with equipment installed in a readily serviceable location.

To address the highly variable flow rates observed in the current system, a separate pump is included in this plan to insure constant flow through the new sensors.

The new location will support the traditional 'TSG' system plus the new PCO<sub>2</sub> system.

Potable water (hot and cold) is required at the new location for cleaning sensors and plumbing during periodic service of the system, and to allow for thawing of frozen plumbing. Although sampling may be done at this site, no chemical analysis will be done at the new location.

The existing TSG system will not be removed as part of this ECR. After the new system is working well, we will evaluate the need to continue to retain the current system in the Biochem Lab. In the mean time we intend to operate both systems.

Independent of this ECR, we expect to eventually evaluate the possibility of a change to re-do the SSW piping to extend the large diameter, large bend radius plumbing aft through the lab spaces.

## 2 Scope of Work

The following section outlines the detailed scope of anticipated work.

### 2.1 Removals:

No significant removals are anticipated. There will be some removal of lagging to accommodate Unistrut installation. It is possible that some relocations may be necessary to accommodate the additional pump and/or piping.

### 2.2 Installations:

The location of the new installation shall be between frames 93 and 84 on the outboard bulkhead in Passageway 1-84-4-L.

This space is not separated from the port engine room by watertight doors so it is subject to CO<sub>2</sub> flooding in the event of a fire. There is currently no audible or visual CO<sub>2</sub> alert system in this space. This should be addressed, perhaps by either changing to water tight doors, or adding appropriate alarms and appropriate signage inside the space.

One option would be to install an alarm panel on the inboard bulkhead of the passageway with a visual alarm remoted to the TSG/PCO<sub>2</sub> instrument location. The remote should be mounted to the (new) Unistrut™ to maximize visibility and minimize impact on the science systems.

Install vertical galvanized Unistrut™ from the deck to overhead on evenly spaced centers between all of the major frames. Unistrut™ to be galvanized, 1 5/8" slotted, type: P1000. Unistrut™ will be mounted to the horizontal stringers with stand-offs sufficient to allow the outboard face of the Unistrut to be flush with the uncompressed lagging.

Connections from the Unistrut™ to the standoffs shall be bolted (with locking nuts) so that rusted or corroded Unistrut™ can be easily replaced in the future.

All new piping, valves, sensors, drip pans, gas bottle racks, cable runs, and electronics will be mounted to the Unistrut™ to maximize future flexibility.

Approximately 24"x48" stainless steel or synthetic sink/drip pans for sensor cleaning, salt water leak and drip containment will be installed between frames 87 and 90 beneath all of the plumbing and sensors. Dual "sinks" will allow maximum flexibility for future sensor desires. The drip pan/sink will be mounted to the Unistrut™.

Provide faucets for potable water to one of the drip-pan/sink with appropriate plumbing. The drip pan/sink will drain to the ship's grey water system with

appropriate plumbing. A connection for back flushing (perhaps garden hose) should be provided for backlashing.

Provide drains capable of handling the flow from the potable water source for the drip-pan/sinks to the existing grey water system with appropriate plumbing.

Seawater from the new pump provided via appropriately sized Glass Reinforced Pipe routed near the overhead between Frame 88 and 89. An isolation valve shall be provided in the vicinity of Frame 88/89.

Install industrial grade flow meter, temperature sensor, and a pressure sensor for MPCMS. Provide local readouts for these three sensors in the vicinity of Frame 88/89. Electronics and readouts shall be mounted on the Unistrut.

Provide an oversized (perhaps 4") drain with appropriate isolation valve(s) to an existing (or new if necessary) overboard in the Motor Room. The drain has to be sized to insure that at full flow from the new pump there is no back pressure for the instrument drains from the TSG or PCO<sub>2</sub> systems.

Provide service and cabling for one 115 VAC 15 Amp duplex receptacle that will be mounted on the Unistrut™ near the overhead in the vicinity of Frame 93. Electrical service should be from the Ships Sensitive bus on an independent circuit breaker.

Appropriate UPS(s) will be provided as part of the science equipment and will be mounted in the cabinets that will be provided as part of the science equipment.

If it does not exist already or is not big enough, provide a junction box in the Motor Room to re-route the existing SBE38 Remote Temperature Probe cabling up to the new TSG/PCO<sub>2</sub> location.

Provide a deck transit with kick pipe to route a cable from the junction box for the existing SBE Remote Temperature sensor in the Motor Room up to the vicinity of Frame 93. The output of the Remote temperature sensor will be shared with the existing TSG in the Biochem Lab as well as the new TSG thorough electronics to be provided as part of the science equipment.

Test and verify the performance of the existing fiberoptic cable from the Radio Room to the existing fiber drop box (CGSW Data Port 02-09.) Replace fiber if necessary.

Relocate the existing fiber drop box with ST connectors (CGSW Data Port 02-09) from the inboard side of the passageway near Frame 90 to the Unistrut™ above the electronics cabinet near Frame 91. If splicing is necessary to extend the fibers, hotsplice and then certify the fiber and connectors.

Connect the relocated fiber Data Port to the existing Science Ethernet through the Radio Room patch panels.

Renew and restore all disturbed insulation and decking.

Science technical support personnel will do the mounting, plumbing and wiring of the seawater, sensors, network, and electronics and will provide the necessary equipment and generate the as-installed documentation.

### 2.3 TSG Instrumentation:

The new TSG location will be instrumented with the following:

- Seabird Electronics model SBE 45 MicroTSG. A new SBE45 and a spare will be provided by science technical support.
- Seabird Remote hull temperature sensor. The existing SBE38 remote temperature sensor already installed in the new SSW system will be used.
- Fluorometer: A Turner SCUFA fluorometer will be installed.
- Dissolved Oxygen Sensor: A Seabird Electronics SBE43 dissolved oxygen sensor will be installed.
- Debubbler: A suitably sized debubbler will be installed in the plumbing system to eliminate gas from the seawater that goes to the TSG, DO, and fluorometer. Water going to the PCO<sub>2</sub> system will not pass through a the debubbler.
- Flow and pressure: Pressure sensors and flow meters installed in the science-provided plumbing will measure the flow rate of seawater through the system and report data to the science data logging system.
- Interface: Data acquisition and conversion interfaces will be installed in the Electronics Cabinet.
- Electronics cabinet: A dual hinged electronics cabinet will be mounted on the Unistrut™ to house and protect the necessary electronics.
- UPS: Appropriate dual conversion UPS(s) will be installed in the Electronics Cabinets.
- Ethernet Switch: An SNMP managed Ethernet switch with direct fiber connection to the relocated science network junction box will be installed in the Electronics Cabinet.
- Computer/display: a small rack mounted display computer will be installed in one of the Electronics rack. This computer will be used to configure

sensors, to verify the installation and to run local diagnostics during troubleshooting.

#### 2.4 The new PCO<sub>2</sub> system will include:

- Analyzer: CO<sub>2</sub> gas analyzer components will be housed in the PCO<sub>2</sub> Electronics enclosure that will be mounted on the Unistrut™.
- Air pump: The air pump will also be housed in the PCO<sub>2</sub> Electronics Enclosure
- Equilibrator: The seawater equilibrator is made from 11-inch clear Lexan pipe with PVC top and bottom plates and is about 25 inches tall and 16 inches wide and 16 inches deep. The long dimension oriented vertically. Air tubing is plumbed from the equilibrator to the pump box and from the pump box to the analyzer box. The seawater equilibrator needs to be located near a seawater source and requires a flow rate of about 10 liters/min. A drain to carry this amount of water over board will be needed as well. The drainpipe diameter must be large enough to not allow water to back up to the equilibrator. The PCO<sub>2</sub> system will share a common source and over-sized drain with the TSG system.
- Calibration Standards: The calibration gasses are contained in DOT specification 3AL2015 (150 cubic foot) aluminum cylinders that are about 52 inches tall and 7.5 inches in diameter. They contain ultra-pure air with small (precisely measured) amounts of carbon dioxide. In typical operation five bottles will be installed. Bottle racks will be mounted to the Unistrut to secure the gas bottles. Each active bottle will have a regulator and will be plumbed to the selector valve in the gas analyzer by stainless steel tubing.
- Flushing gas: The system will consumes about one large (steel 300) cylinder of Nitrogen gas per month of operation to flush standards and samples through the analyzer. Flushing gas is provided in DOT (Department of Transportation) specification of 3AA2400 steel bottles. One bottle is active at a time. The active and at least one spare N<sub>2</sub> cylinder will be mounted in standard bottle racks secured to the Unistrut.
- Computer: A small computer will be installed in the electronics cabinet. It controls the gas analyzer components and collects data through a serial port. This computer provides an ASCII data message that will be logged by the science data logging system over the science network by way of the Ethernet switch in the TSG system cabinet.
- PCO<sub>2</sub> Electronics Cabinet: A dual hinged electronics cabinet will be mounted on the Unistrut™ to house and protect the necessary electronics.

This cabinet will be identical to the one that houses the TSG system components.

Associated documents:

- Rendering of the general arrangement of the new TSG & PCO<sub>2</sub> system
- Plumbing one-line diagram
- PCO<sub>2</sub> system one-line diagram
- TSG system one-line diagram
- Photographs of the proposed installation location
- Weight distribution table