

Ship Tower Setup and Gas Inlet Sector Control

System Components and Function

The sampling system on the ship's bow crane consists of in-situ sensors for wind and water vapor and gas inlet tubing for both mean concentration and turbulent flux. The tower is deployed from the crane by winch and cable and can be tilted back for easy access to the installed sensors and inlets. Arrange with the bridge watch and ship's crew to lower the tower when required.

The Metek uSonic anemometer is mounted to the top of the tower, the Licor 7500DS is mounted just below that, and the RM Young 2D sonic is just below the Licor. The vertical separation between the sensors is about 1 m. We have a spare Metek sonic and a spare RM Young sonic, but no spares for the Licor.

Sampling inlets for the fast trace gas analyzers (DMS, ozone, CO₂/CH₄) are positioned at the base of the Metek sonic. A valve box for the nitrogen pulse injection is at the top of the tower with short lines running to each of the fast measurement inlets. Inlet tubes for the fast measurements are insulated and heated to 15°C down to the point where the lines go into the steel pipe and below deck to the container lab.

An enclosure for 24V power and serial/network devices is mounted to the bow crane railing just behind the tower on the starboard side. A 4-wire RTD temperature sensor is also installed on the tower but as of leg 1 this sensor is not functional.

Cables from the tower box down to the container lab include 120 V power, ethernet, power for the N₂ valve, and the 4-wire RTD signal cable. There are connectors for each of these cables at the point where the pipe comes above deck, so the exterior inlet and cables can be disconnected at this point without pulling out the tubes and cables running below deck.

The NO_y converter box and inlets for slow ozone/Hg, NO_x, and the GCMS are on the bow crane railing just aft of the tower electronics box on the port side. These inlets are enclosed in a separate insulated and heated bundle.

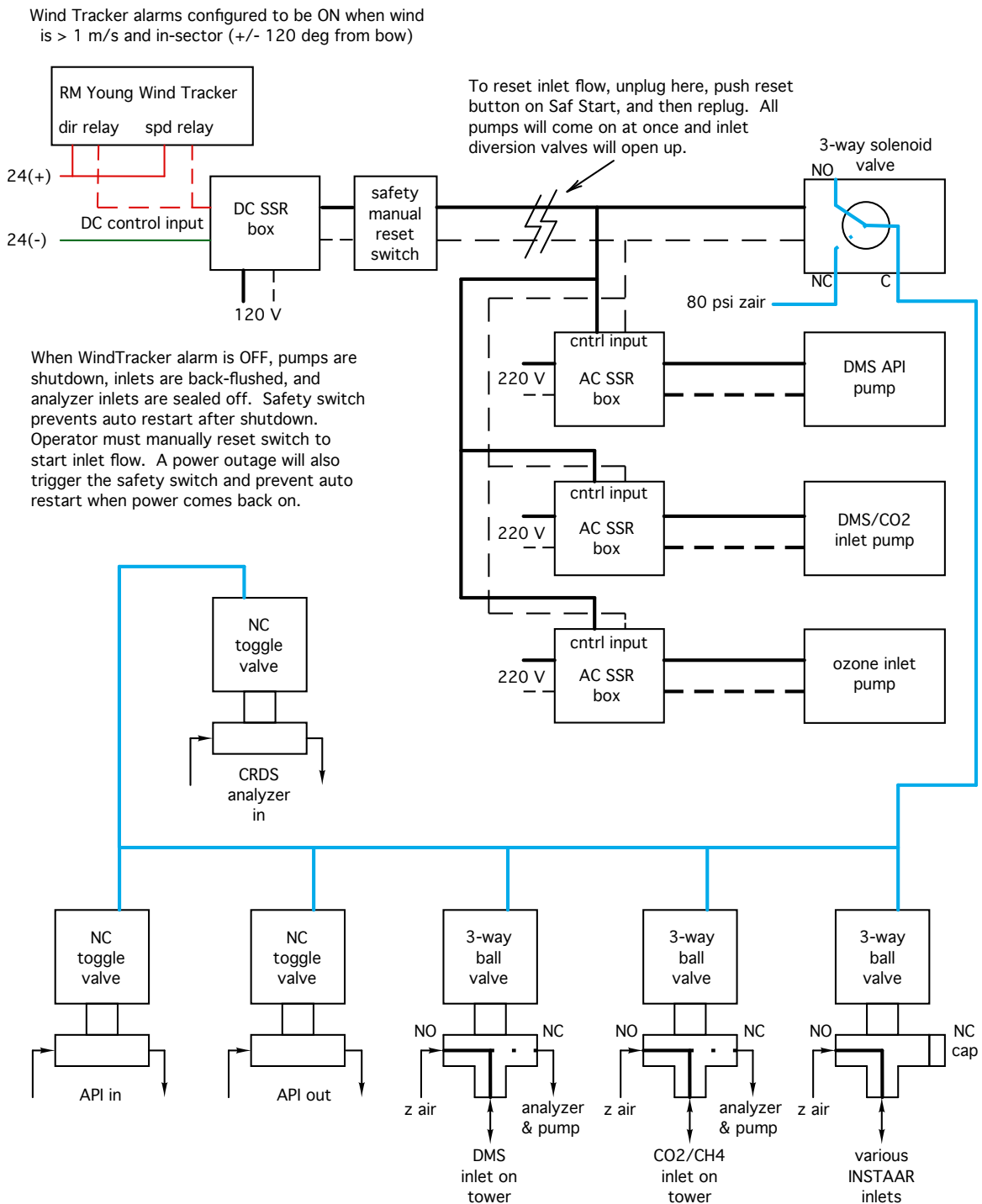
Plumbing and inlet flow control system

Relative wind direction and speed measured by the RM Young sonic are used to determine when we are in danger of sampling polluted air from the ship. In that condition, the air sampling pumps are stopped and clean air is flushed back through the inlets to prevent

contamination. The alarm limits are set on the RM Young WindTracker display in the van. The current limits for good wind are +/- 130° relative direction from the bow and >1 m/s wind speed. The diagram below shows the main components of the wind sector inlet control system.

Note that the WindTracker alarm state is set to be ON when wind is good, so the logic is reversed, but the alarm relays are closed when the alarm is activated, and that is the state we needed to trigger the SSR and turn on air sampling. So, the WindTracker is set to activate the

Ship Sector Control System for Flux Analyzers



alarm relay when wind is in the +/- 130° sector or when it is > 1 m/s, and this activates the sampling pumps and inlet diversion valves.

Adjusting sector control for sampling system

See the WindTracker manual for instructions on how to set the various readout and alarm options. The anemometer sends data at a 1 Hz rate. Based on conditions during leg 1, a 10 sec averaging time on the readout and a 1 minute alarm delay seems sufficient to detect bad wind conditions without being too sensitive in marginal conditions. Note that when you enter the setting adjustment mode on the WindTracker this clears the alarm and shuts down sampling, so it's best to make adjustments to the alarm triggers when the sampling is already shut down.

User actions when inlets are in shutdown mode

When wind conditions trigger an inlet shutdown, the Picarro, DMS APIMS, GCMS and Tekran analyzers should be put in standby mode until wind conditions improve. The fast ozone and NOx analyzers could also be shut down, but Jacques indicated they are often better left running, so that's what we've done on leg 1. However, if it's necessary to conserve compressed oxygen the NOx analyzer should be shut down as well. Leaving the TEI ozone system running is a good way to show exactly when the inlets are in backflush mode since the ozone concentration measured by the TEI goes to zero. The operating instructions for each instrument give details on shutdown/startup procedures, but here is a brief synopsis:

- 1) **Picarro:** click the 'shutdown' button on the Picarro main interface window. This will stop the analyzer and shut down the Windows OS. Then, turn off the Picarro vacuum pump on the high shelf to the left of the rack and remove the DC power plug to the CO2 inlet mass flowmeter on top of the rack (otherwise it just overheats). You can boot the Picarro computer again if you want access to the Windows OS or data files.
- 2) **DMS APIMS:** turn the detector high voltage to zero and turn off the detector HV switch; close the manual toggle valves and the entrance and exit ports of the APIMS source; turn off the two inlet and source temperature controllers (400°C and 150°C) by putting them in 'park' mode (hold down both up/down buttons for a few seconds until you get a flashing 'tune' display, hold the * button and use one of the up/down buttons to select 'park' mode from the 'tune' menu; hold both up/down buttons for a few seconds again until the flashing display clears and you see the temperature alternating with 'park' on the display). See the instruction manual for the temperature controller if this is unclear.
- 3) **GCMS:** on the LabVIEW sample controller, click the autosample button (on the autosample tab) to turn off the sampling sequence (button color goes from bright to dull green). The current sample will continue to finish, then the system will pause in standby mode.

4) **Tekran:** tap the ESC button twice to halt sampling.

User actions for system restart

The inlet system will not restart automatically. The operator must restart manually. When wind conditions are suitable, unplug the power cord to the solenoid air valve on the top left rear corner of the APIMS rack, then push the reset button on the SafStart switch, then plug the solenoid cord back together. The pumps will start instantly and the ball valves mounted to the ceiling will open for air sampling.

When sample air flow is reestablished, the analyzers can be restarted. In brief:

- 1) **Picarro:** turn on the vacuum pump and boot the analyzer; select the 'start instrument' shortcut on the desktop; remove the power plug from the MOXA serial interface for a few seconds and then reinsert it; the analyzer will go through the warmup process and should begin showing gas concentration data when temperatures and pressure have stabilized. Check the DAS system to be sure the Picarro serial stream is being logged.
- 2) **DMS APIMS:** See the operator instructions for specific details.
- 3) **GCMS:** If the sampling system and gems are in standby for the current sequence, just click the 'autosample' button on the LabVIEW sampling interface to restart sample collection. See GCMS instructions for more details.
- 4) **Tekran:** select 'CONTINUOUS' from the 'RUN' menu to restart sampling.

Bypassing the sector control system

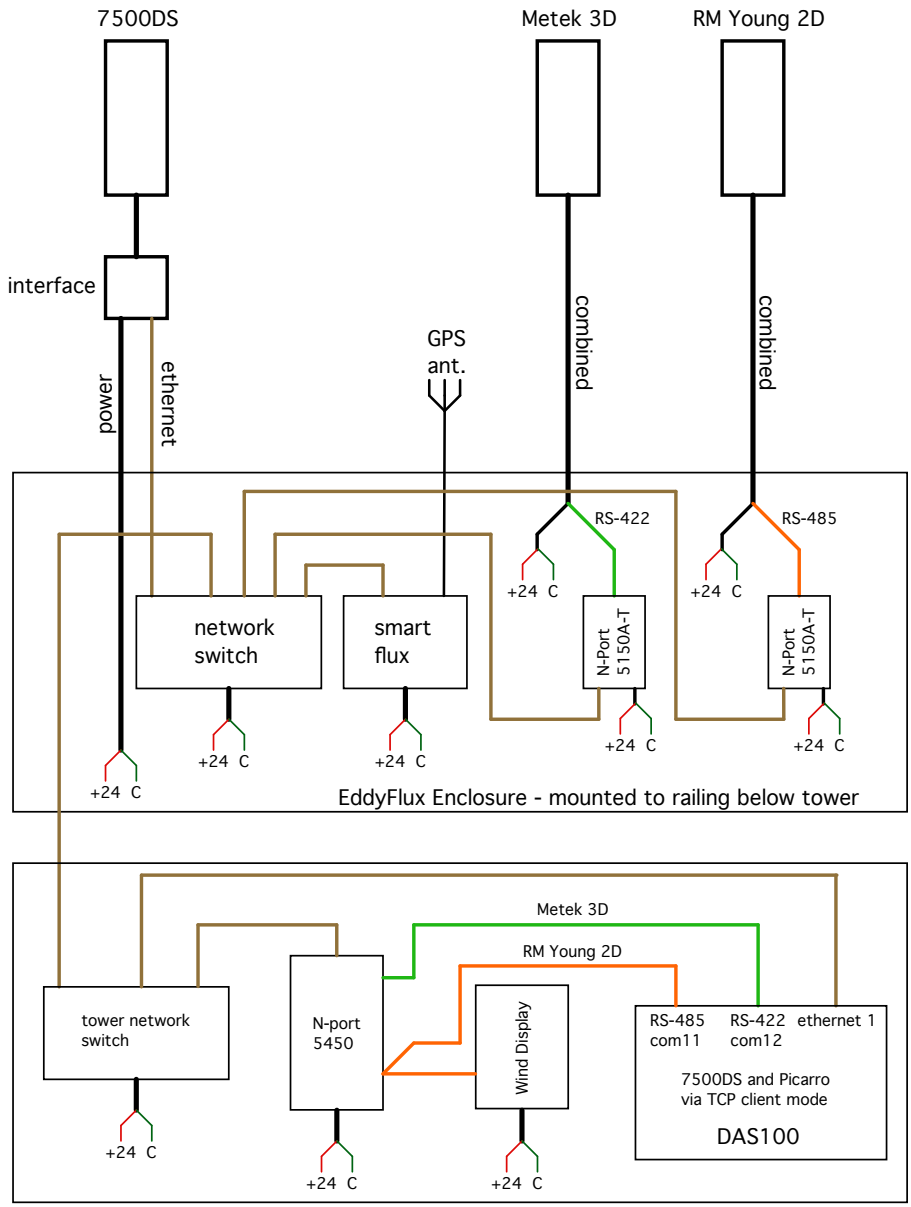
If you need to bypass the inlet control system and keep the inlets running, remove the alarm relay input cable from the Backflush Valve Control SSR box on the top right front corner of the rack and replace it with the 24V 'test' cable. This forces the SSR to remain in the 'ON' state and inlets will run without sector control.

This was done once during leg 1 when icing from freezing fog led to a malfunction of RM Young sonic. If it occurs again have the crew lower the tower and thaw the sonic transducers manually. Avoid using alcohol on the sonic transducers - I'm not sure the sonic is compatible with alcohol. You might just warm them with your fingers or a hand warmer hot pack.

Sensor wiring and network communication

Data from the tower sensors is transmitted via the ethernet cable. Serial streams from all sensors are connected to the ethernet switch in the box at the base of the tower. The 24V

supply in the tower box powers all the network components and sensors on the bow crane, including heaters. This diagram shows the cabling set up for power and signals between the tower and lab van.



The Metek and RM Young sonic anemometers communicate by RS-422 and RS-485, respectively. For each of these, a MOXA serial device server is configured to convert the serial stream to TCP/IP, which is transmitted on the ethernet cable via the switch in the tower box. In the lab van, a MOXA 4-port device server translates the serial streams back to RS-485 and RS-422. The COM11 and COM12 serial ports on DAS100 are configured to log each of these. For the RM Young sonic, the RS-485 signal is split, with a second cable running to the WindTracker display.

Communication with the Licor 7500 is by TCP/IP between DAS100 and a network port in the Licor SmartFlux module, which is itself connect to the Licor sensor head through the network switch.

The utility programs on DAS100 for the sonics and Licor can be used to remotely access all these sensors for configuration and diagnosis, but stop the serial acquisition process before using any of these utilities. Configuration files for both sonics are saved on the DAS100 desktop in case you ever need to upload the configuration to a replacement sonic (best done in the lab van before mounting the sonic, just to be sure things are working). The MOXA device servers can be remotely configured from DAS100 with the NPort Admin utility. Ludo has written a short description of the wiring and setup for serial communications with the two sonics, including specifics on the MOXA configurations.

IP addresses on the tower subnet are given below. Note, these use the same base address as the ship (192.168.) so there is a possibility of confusion and network issues because DAS100 is connected to both the tower and ship networks. So far it hasn't been a problem, but if DAS100 ever has network problems it may be wise to change the tower IP addresses to something other than 192.168...

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DAS100:      192.168.127.1
NPort 5450:  192.168.127.2    (4 port in lab van)
NPort 5150A: 192.168.127.10  (RM Young, RS-485, tower box)
NPort 5150A: 192.168.127.11  (Metek uSonic, RS-422, tower box)
Licor 7500:  192.168.127.12
Picarro MOXA:192.168.127.13
    
```

The following screenshot shows the result of a **Search** for MOXA devices with the NPort Admin utility. Any MOXA connected to the tower ethernet switch will appear on this list, no matter the IP address in it's network tab. So, you can use this app on DAS100 to configure a MOXA to be used at other sites (for example at Met City).

