NOAA/ESRL/GMD AEROSOL SYSTEM
ANNUAL MAINTENANCE MANUAL

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Location: /aer/doc/stn_maintenance/stn_maint.doc

1. List of Supplies for Annual Maintenance

The lists of supplies below are split into category and are based on the assumption that the site being visited doesn't have any supplies. Before packing, check what is already at the site either by talking to the station technicians or looking at the station inventory from a previous maintenance visit.

1.1 General

- Check station inventory for available on-site supplies
- Check with site manager for site access (keys, contact phone numbers, directions, helper)
- Documents from previous station visit (inventory, maintenance log, calibration file)
- Station flow diagram (in /aer/doc/drawings/stn/)
- List of basic computer commands – e.g., for making back-up of USB, calculating neph stats, etc.
- Daily/weekly checklist form (hard-copy and electronic copy) and/or IPOD update info
- Return shipping labels
- Hard copy of stn config file or channel assignments (useful, but not necessary)
- Most recent version of operations manual – hard copy for station techs; check that it matches most recent version at: *http://ftp.cmdl.noaa.gov/aerosol/doc/operations/oper_man_gen_cpd2.pdf*
- Spare cables (RS232, instrument power)
- Tools, including: large adjustable wrench, allen wrench set (for the splitter), assorted screwdrivers and wrenches (7/16", 1/2", 9/16" and 7/8"). Screwdriver for blower adjustment during pitot tube calibration.
- Electrical kit: contact renewer (Jim's magic drops), chip puller, anti-static mat and/or grounding strap.
- Assortment of tubing, fittings and ferrules (1/4", 1/2", 3/4"). ¼" nylon ferrules are especially useful!
- Tape: duct, packing, labeling
- Climbing harness and helmet
- Camera (NOTE: take lots of photos to document station and instrument configuration and status)
- Cleaning: denatured ethanol, shop rags, paper towels, cotton swabs, dish scrubbers, thin bottle brush for splitter, thick bottle brush for 2" inlet tube
- Silicone sealant
- Cable ties: long (pump filter), medium (tubing), short (wiring)
- Plastic bags: Garbage, Ziplock
- Computer: 2 USB sticks with latest version of LiveCPD
- Multi-meter (useful for troubleshooting, also for T sensor calibration)

1.2 Windbird

- Compass, with magnetic variation for station
- Walkie-talkies (with batteries, 4xAAA each) or cell phones + helper

1.3 Flows

- Flow calibrator (with tubing and some ¼” and ½” connections). Need capability to calibrate low (~1 lpm (e.g., PSAP)), medium (8 lpm (e.g., CN drier)) and high (30 lpm (e.g., impactor box)) flows

1.4 System Filters

- HEPA filters (e.g., Gelman Sciences product#12144)
    - 1 for each nephelometer (use HEPA filters removed from nephelometer for 30-lpm mass flow controller (MFC))
- Inline filters (1/4” tube ends, Parker finite filter IDN-4G or Balston DFU Grade AQ)
    - 1 for CN drier line (with ¼” nylon ferrules)
    - 1 for CN flow line (with ¼” nylon ferrules)
    - 1 for CO2 span check line (with ¼” nylon ferrules)
    - 1 for each nephelometer, (with ¼” nylon ferrules)
    - 1 for dilution system (if exists)
- Fiberglass filter mat for pump exhaust filter (36” wide) (if station has old homemade filter mat type filter) or replacement filter for new style pumpbox (pump box filter: RU-1200; pump box wrap: 22-8029PK, purchased from http://www.knfilters.com/)
- Also need HEPA filter with correct fittings and inline filters for overnight zero measurements on neph and psap (section 2.2). Don’t assume site will have correct fittings to attach HEPA filter to nephelometer inlet unless specifically stated!

1.5 T/RH sensor calibration

- RH calibration
    - Salt solutions with lids for Vaisaila and neph sensor or RH generator suitcase and calibrated reference RH sensor
    - extension cables for RH sensors (neph and vaisala)
    - spare Vaisala RH sensor
    - sleeve for RH sensors that allow you to put them in ¾” fittings
- Handheld digital thermometer or multi-meter+appropriate thermocouple. Bottle for warm and cold water calibration with appropriate lids for sensors.

1.6 Pressure calibration

- Magnehelic vacuum gauge for pitot tube calibration (0-0.5” H_2O; if not on pumpbox)
- Magnehelic vacuum gauge for neph impactor (0-15” H_2O)
- Magnehelic vaccum gauge for system vacuum (0-10 psi)
- Manifold for pressure sensor calibration, with tubing, plugs
- Handheld vacuum pump, with tee fitting

1.7 Pumpbox

- Pump repair kits (Check the manufacturer and model numbers of your pumps to determine the appropriate repair kit)
    - Gast carbon vane pump series#0823 and series#1023 both take kit# K479

    - Gast diaphragm pump #DOA/DAA takes kit#K294A and diaphragm #AF818B
- Pitot tube and acrylic tube (in case replacements are needed)
- No repair kits for blowers (we use Ametek Windjammer blowers model#116636 (120 VAC) and model#117636-51 (240 VAC))

1.8 CN Counter

- Reference CPC for overnight comparison (with power and serial cables)
- Pulse counter (with power adapter, serial cable, BNC cable) if using CPC 3760
- Mixing chamber + power for mixing chamber fan + conductive tubing
- Replacement drier tube (Permapure MD-110-12E-S)
- Stuff for BMI CPC?

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1.9 Nephelometers

- spare bulbs (GE EYC/CG)
- zero check HEPA filter, with ¾" Swagelok fitting for inlet of Neph

1.10 PSAP

- zero check filter
- spare o-rings
- spare supply of silicone grease (for o-rings)
- PSAP sample filters (Pallflex E70-2075W, reorder #7186, 10 mm dia.)
- Filter bags (2"x3"/5cmx7.5cm, e.g., part#MGRL2W0203, from www.minigrip.com)

1.11 CLAP

- zero check filter
- CLAP sample filters (Pallflex E70-2075W, reorder #7192, 47 mm dia.)
- Filter bags (2"x3"/5cmx7.5cm, e.g., part#MGRL2W0203, from www.minigrip.com)

2 Annual Maintenance Tasks

The tasks below are described in no particular order, although it's good to do a system overview check and overnight filtered air test at the beginning of the site visit. The rest of the tasks can be done in an order dictated by priorities or weather or whim.

2.1 Initial on-site tasks

<u>(0) Begin and keep an electronic maintenance log document</u>. This is helpful for looking back at what you did at the site as well as noting tasks to follow up on. There is an example maintenance log document in the back of this document (section 7)

(1) Look at current system parameters displayed on cpdclient screen - look for anything that seems like it might need further work (i.e., if it seems too high or too low or too noisy)

(2) Visually check system for proper operation – it's good to do this early so parts can be requested from NOAA and perhaps arrive during maintenance visit. Check for:

- no loose/cracked tubes or wires
- all front panel readings normal
- all manual valves in proper position

(3) Check station flow diagram against existing diagram and/or make new flow diagram. Station flow diagrams are located under help menu (question mark icon in lower right) of station laptop and at /aer/doc/drawings/stn/.

(4) Make an image and/or backup of the override device – this is useful if something crashes during station maintenance. For a cpd1 system go into the root menu <control><alt><F11> and type:*backup_override <enter>*. To get back to the normal blue screen desktop press <control><alt><F7>. For a cpd2 system, open a terminal window and type: *sudo livecpd2.sendbackup <enter>*. When you are done with annual maintenance and everything appears to be working you will want to repeat this task to ensure a current override image is stored at NOAA.

2.2 Overnight filtered air check and CN comparison

The overnight filtered air test provides an indication of instrument noise. Place a HEPA filter with the appropriate ¾" fittings on the inlet of the nephelometer. Place an in-line filter on the inlet line of the PSAP. Place an in-line filter on the inlet line of the CLAP. Put a note into the message log with the start of the filtered air check. When the filtered air check is finished put a note into the message log with the end time. Remove filters and return inlet lines to normal sampling configuration. To analyze the neph noise, use the db system program '*nephstat2*' (you'll need to wait until the data are processed), for example,

```
nephstat2 bnd "2011-11-25 01:30" "2011-11-25 15:30"
```

See documentation at *http://www.esrl.noaa.gov/gmd/aero/software/aerosols/nephstat2.html*
To analyze the PSAP and CLAP noise, extract the data over the filtered air time period and calculate the average and standard deviation (if the extracted data are in 'stn,year,doy' format the averaging code 'ave.pl' can be used. If this is the file format you've extracted, run ave.pl twice:

ave.pl all=1 psap_data > psap_filtair_ave

ave.pl all=1 stdev=1 psap_data > psap_filtair_std

Alternatively, you can use these commands to analyze the raw data stored locally. The example assumes that the station is BND, the nephelometer is S11, the PSAP is A11 and the CLAP is A12.

```
data.get –localdata bnd A11a,A12a,S11a "2011-11-25 01:30" "2011-
11-25 15:30" raw | \
data.avg --cut=off --count=off --stddev=on --contam --decimal-
format=%9.4f,9999.9999 --interval=forever | \
data.consolidate --source=- 'Bs*' 'Bbs*' 'Ba*' |  \
data.export –mode=csv | transpose > noise_test.csv
```

Note: it is useful to make a time series plot of the filtered air to see if there are obvious issues.

The overnight CN comparison allows you to compare the CN counter at the site with a CN counter that is comparable to the NOAA lab standard. Connect the transfer standard CN counter to the data system and connect the inlet for the transfer standard CN and the rack system CN to a mixing chamber (or at least make sure that the inlet tubing to both CN counters is of similar length and bendiness.) Measure the sample flows for both instruments and update the configuration file. Collect the data overnight and evaluate the next day after the data have been processed to determine whether the site CN counter needs to be worked on.

2.3 Filter replacements

There are several filters that need to be replaced in the aerosol system on an annual basis.

Nephelometer filters	HEPA filter and inline filter for each neph
A filter in front of each mass flow controller and mass flow meter	Analyzer flow = HEPA CN flow = inline filter CN drier flow = inline filter Filter rack =HEPA (not all stations) Dilution flow=HEPA (not all stations)
CO2 flow (for span check)	Inline filter

General notes for filter replacement:

- put the date on the filter - that way you know how long it's been in operation
- Make sure the filters are installed in the proper direction
- The old neph HEPA filter can be re-used as the filter upstream of the analyzer MFC. Likewise, the old neph inline filter can be re-used upstream of the CN flowmeter.

Notes for Neph filter replacement

- The neph filter replacements are described on pages 8-15 thru 8-18 of TSI neph manual.
- Just to repeat - make sure the filters are installed going the right directions! The manual has details on that if you pull them out and can't remember (Betsy learned the hard way (see below)!).
- Make sure that the 'blade' for the zero valve doesn't touch the HEPA filter when it rotates. This shouldn't happen if the filter is installed properly and facing the right direction. If this does happen it can cause a leak in the zeroing system (at best) or destroy the zero valve motor (at worst)

- The neph manual suggests using RTV silicone sealer on the HEPA filter fittings. We use teflon tape instead and that seems to be fine.
- It is possible to replace the neph HEPA filter without removing the end plate on some of the older nephs, but it's SO much easier to do the replacement by removing the end plate.
- Do a neph zero after the filters are replaced to make sure the background values haven't shifted (a shift in background values could indicate a leak).
- Check the integrity of the silicone tube (the squishy tubing) that holds the small inline filter. The end of this tube can degrade where you push the filter into the tubing and so is another potential source of a nephelometer leak. Usually there's enough extra tubing that you can snip off the degraded end and still install the filter.

2.4 Pump Box

(1) Unplug pumps (turn off stack heater, impactor box heater, and any other system heaters while pumps are unplugged!)
(2) Check carbon vanes – replace if necessary (cracked, really short). It helps to measure vanes and record the length in the maintenance log so you can track approximately how much they wear down over time.
(3) Remove, clean and adjust pitot tube – described at: ftp://ftp.cmdl.noaa.gov/aerosol/doc/maint_docs/pumpbox_pitot_clean.ppt
(4) Calibrate pressure transmitter (described in section 6.2)
(5) Clean/replace carbon vane pump filter. Change fiberglass filter material in pump exhaust (if you have old style long tube filter) <u>or</u> filter and filter cover (if you have new style filter). For the new filter – the filter starts out pale pink. Filter cone points toward incoming air.
(6) Replace diaphragm in diaphragm pump (most sites no longer have diaphragm pumps)
(7) Clean/replace rotameters as needed. It's helpful to have a supply of cotton swabs and alcohol to do this. You can remove the adjustment knob and insert a swab into the flow volume of the rotameter to scrub out any deposits.
(8) Clean pumpbox (i.e., vacuum up the detritus that collected since it was last cleaned)
(9) Check that pumpbox ventilation fan is working

2.5 Stack and Inlet

(1) Inspect all tubing for cracks or other problems (8" PVC, spare line tubing, sample tubing)
(2) Inspect tower, guy wires, and anchors for rust or other problems
(3) Climb tower and inspect rainhat and screen on rainhat. Look for anything that might block flow of sample down stack (i.e., slipped rainhat or clogged screen).
(4) Perform leak check with HEPA filter as described in operations manual before and after taking apart flow splitter
(5) Remove flow splitter and clean with water and then alcohol. A small bottle brush is helpful for this.
(6) Clean 2" stack with water, rope and scrubber - we tie a dish scrubber in the middle of a 20-foot long rope and pull it back and forth through the 2" inlet tube to clean it. Finish with an alcohol scrub.
(7) Calibrate stack RH and temperature sensors (section 3)
(8) Insulate tubing exposed to sunlight against UV (use aluminum tape or foil+duct tape?)

(9) Clean inlet tubing from splitter to instruments. This is probably easiest to do with an appropriately sized bottle brush, string and tiny sponge. Pull the bottle brush through the tube using the string to abrade off deposited particles. Follow that with the sponge on a string with water then alcohol. Note: you want the tubing to be relatively dry before re-installing on system.

2.6 Nephelometer

(1) Overnight filtered air test (section 2.2)
(2) Replace filters (section 2.3)
(3) Inspect neph tubing for any cracks or degradation
(4) Clean neph light trap
ftp://ftp.cmdl.noaa.gov/aerosol/doc/maint_docs/Neph_cleaning_lighttrap.ppt
(5) Perform a span check. If span check looks good you can make calibrating the neph lower priority to other tasks
(6) Check voltages and counts to determine if any neph parameters need to be changed. (can do this with dosneph or with cpd software). Review the long-term nephelometer status plots at http://www.esrl.noaa.gov/gmd/aero/net/mlo/Neph.status.mlo.html (replace 'mlo' with your station ID in the URL).

Neph raw photon counts depend on lamp intensity, light pipe transmission, calibrator properties, air density, presence or absence of particles in the optical path, color filter properties, photomultiplier (PMT) alignment, and PMT sensitivity. For a neph in good working condition with a new lamp, raw photon counts on filtered air should be at least B=80000 Hz, G=100000 Hz and R=100000 Hz for the TS (total scatter)-CAL values. The TS_CAL values track the brightness of the chopper calibrator sector. Lower count rates in any channels may suggest one or more of several possible problems, including an aging light pipe, a dirty calibrator surface, a dirty or hazy color bandpass filter, a misaligned PMT, or an old PMT with reduced sensitivity. If you have questions regarding likely problems and how to handle them, please contact one of the NOAA aerosol scientists for assistance.

The TSI neph apportions photon counts between the three sectors of the chopper wheel. The ‘CAL’ sector is the shiny silver sector that lights up to a fixed brightness when illuminated by the lamp. The ‘MEAS’ sector is the open sector of the chopper wheel, and the ‘DARK’ sector is the black sector. If the neph interior gets dirty over time, the calibrator could get dirty and its brightness could change, resulting in the need for a new calibration. The ‘DARK’ counts are measured when the black light block is in the optical path and blocking all scattered light from reaching the detectors. The ‘MEAS’ photon counts reflect the scattering from whatever is in the scattering volume at the time. To gauge neph performance, filtered (i.e., particle-free) air should be in the neph. The difference between ‘MEAS’ and ‘DARK’ counts is a measure of the count rate based on the light scattering of filtered air A properly working neph should show ‘MEAS – DARK’ count rates of at least a few hundred Hz (400 Hz is typical). The BLUE and GREEN channels should have very low DARK counts (< ~30 Hz). The RED channel always shows higher DARK counts (100-400 Hz) because the RED PMT is sensitive into the near–IR and detects heat. Therefore, if the TS-RED DARK counts are 300 Hz, you would want to see the TS-RED MEAS counts at or above 700 Hz.

Here is an example showing typical values for photon counts for a working neph.

Total Scatter

	CAL	MEAS	DARK
BLUE	82562	540	8
GREEN	125731	614	5
RED	140689	936	278

Higher counts are better, but lower count rates than those listed above do not necessarily mean that the scattering measurement is invalid. Often, perfectly good span checks are obtained with lower count rates. The problem is really one of instrument noise and how much of that you are willing to live with. At sites with high aerosol loadings this is less important because photon counts (and scattering coefficients) are typically higher there. At very clean sites, however, noisy channels due to low photon counts can lead to negative scattering coefficients. At some point the noise will dominate the measurement, and at that point it becomes unacceptable. For example, a neph may measure aerosol scattering at 450 nm fine with a TS-CAL photon count of B=60,000 Hz. But at B=20,000 Hz there is just too much noise in the signal for a neph to measure scattering reliably. Again, if you have questions on what count rates are preferable or acceptable, please contact a NOAA scientist.

(7) Calibrate neph (if needed) *ftp://ftp.cmdl.noaa.gov/aerosol/doc/maint_docs/Neph_cal_using_cpd.doc*
(8) Calibrate neph RH, T and pressure (section 3)

2.7 PSAP

(1) PSAP filtered air test (section 2.2)
(2) Take top lid off PSAP and check tubing and connectors. Note whether PSAP has a heater installed or not.
(3) Clean internal tubing and tubing from pickoff at back of impactor box to PSAP sample inlet
(4) Check that filter holder o-rings are in place (This is a good time to check that the site has spare o-rings)
(5) Calibrate PSAP flow (section 5); update station configuration file. Note: at most stations we would like the PSAP flow to be the same as the CLAP flow (e.g., 1 VLPM). The exceptions are sites like AMY and KPS where the absorption is so high that PSAP filter needs to be changed multiple times/day. At those sites a value of 0.5 VLPM (or perhaps even less) is acceptable. Just make sure the flow calibration is centered around where you set the PSAP flow.
(6) Check that PSAP settings are the setting used by NOAA: *http://www.esrl.noaa.gov/gmd/aero/about/faq.html#1-17*

2.8 CLAP

(1) CLAP filtered air test (section 2.2)
(2) Check CLAP flow (section 5) – note: we want the flow to be 1 VLPM to to keep the face velocity comparable with all the other sites in the network. Once you've done the flow cals in SLPM you'll need to figure out what SLPM flowrate corresponds to a 1 VLPM flow rate. $VLPM=SLPM*(T_{amb}/273.15)*(1013/P_{amb})$ so SLPM value to set to will be: $SLPM=(1\ VLPM)/(T_{amb}/273.15)*(1013/P_{amb})$. SLPM value should be lower than VLPM value.
(3) Inspect blower block – ¼" tube for clap pickoff should be recessed approximately 1/8" and pickoff should be on column side of blower block.

2.9 Impactor Box

(1) Inspect impactors for rust
(2) check o-rings in impactors – are they all there and what is their condition?
(3) Clean tubing
(4) Check impactor valve switching by switching size cuts and looking at position of ball in Whitey valve
(5) Replace HEPA filter upstream of mass flow controller (section 2.3)
(6) Calibrate mass flow controller (section 5) and enter calibration into configuration file. We want the flow through the impactors to be 30 VLPM to get the proper size cut. Once you've done the flow cals in SLPM you'll need to figure out what SLPM flowrate corresponds to a 30 VLPM flowrate: You will also have to subtract off the flows of other instruments that are pulling flow through impactors (e.g., PSAP, CLAP, etc), but not through the MFM in the impactor box and adjust the final impactor flow rate accordingly.$VLPM=SLPM*(T_{amb}/273.15)*(1013/P_{amb})$ so SLPM value to set to will be: $SLPM=(30\ VLPM)/(T_{amb}/273.15)*(1013/P_{amb})$. SLPM value should be lower than VLPM value.
(7) Calibrate temperature and RH sensor at inlet to impactor box (section 3)

2.10 CN BOX

(1) Replace drier tube *ftp://ftp.cmdl.noaa.gov/aerosol/doc/maint_docs/CN_nafion_drier_replace.ppt*
(2) Clean CN orifice and focusing nozzle (applies to TSI#3010 and TSI#3760): *ftp://ftp.cmdl.noaa.gov/aerosol/doc/maint_docs/CN_cleaning_CO_and_focusing_nozzle.ppt*
(3) measure CN flow at inlet of CN counter (section 5) and enter into configuration file
(4) replace in-line filters upstream of mass flow meters in CN box
(5) calibrate mass flow meters (CN flow and CN dryer flow) (section 5) and enter calibrations into configuration file
(6) Flush CN sample line with denatured ethanol (not butanol!)
(7) Perform overnight side-by-side comparison (section 2.2) with a 'reference' counter (do at same time as filtered air test on neph and psap). Expected flow rates for 3760 is 1.4 lpm and for 3010 is 1 lpm so would expect 3760 to be 40% higher than 3010. Note: if you put calibrated flow rates for two instruments into configuration file before starting comparison you won't need to worry about flow differences.
(8) STUFF for BMI CPC?

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2.11 uMac

(1) Check that the cooling fans on the sides of the uMac are working
(2) Calibrate the pressure sensor array (section 6.1)

2.12 PID

(1) Check that the cooling fans in the PID are working
(2) Replace any PID controllers that have issues

2.13 UPS

Do a battery runtime test by unplugging the UPS from wall power. The UPS should run for at least 5 minutes. If it runs for less then new batteries should be ordered.

2.14 Spare USB sticks and system backup

After the config file is completely updated with new calibrations/flows etc, clone a few spare usb sticks to leave at the site.
Install a second usb stick into the system (now you have both the working usb stick and the second usb stick that will be your new spare both connected to the aerosol system). You can put the second usb stick into a spare port on the Edgeport serial hub (it has 4 usb ports) or onto a spare port on the laptop - that doesn't matter.

Open a terminal window and type:

```
sudo livecpd2.installusb
```

Answer yes to prompts. This process could take 10-30 min. Once it is done, remove the second usb stick and put it somewhere safe and obvious so you have it if you need it.

Send backup of system to NOAA.
In a terminal window type:

```
sudo livecpd2.sendbackup
```

Only do this once at the end of maintenance – it's a big file.

2.15 Inventory

Update the station inventory file. The inventory is an electronic document that lists instrument serial numbers, NOAA CD tags (where applicable), and general supplies. It can be useful for tracking instruments after the fact and for figuring out what supplies you need to bring. It can also help tell a station tech where to look for something or for someone else visiting station where to find something. There is an example inventory document in section 8.

2.16 Miscellaneous

1. Fix and/or add labels where needed on cables, tubing, readouts, etc.
2. Check wind vane against compass and/or other windbird
3. Disassemble and clean impactor box solenoids if they are making a buzzing noise.

2.17 Back in Boulder

(1) Download pictures to /aer/{stn}/photos/maintYYYY/
(2) Put maintenance docs (cals, inventory etc) in /aer/{stn}/doc/maintYYYY/

(3) Put updated flow diagram in correct directory
/aer/doc/drawings/stn/STN_yyyymmdd.odg and provide to station collaborators
(4) Follow up on tasks that need completion

3 Using saturated salt solutions for RH sensor calibration

There are several Vaisala temperature/relative humidity sensors (Model#HMP50) incorporated into the GMD-style aerosol rack. The nephelometer also has a relative humidity sensor that measures the RH of the nephelometer sampling volume. These sensors should be calibrated annually to maintain optimal performance of the aerosol system. The sensor calibrations are entered into the cpd.ini file so that the recorded relative humidity data reflects the calibrated value.

Experience has shown that the factory calibration of new RH sensor modules for the Vaisala sensors is very good, and annual replacement of the sensor is an acceptable alternative to the calibration described below. However, this approach does not work for the RH sensor in the TSI nephelometer.

One relatively simple way to calibrate relative humidity sensors is to use saturated salt solutions. Some details on this technique can be found at:
http://www.npl.co.uk/thermal/faqs_humidity.html#values
http://www.natmus.dk/cons/tp/satslt/satsol.htm

Briefly, one can generate a known relative humidity in an enclosed volume by making a saturated salt solution. The relative humidity depends on the composition of the salt and the temperature of the solution. The table below gives approximate relative humidity values for several salt solutions as a function of temperature (from the water activity links at http://faculty.che.umn.edu/fscn/Ted_Labuza/default.html).

Salt	RH%@20 C	RH%@25 C	RH%@30C
LiCl	12.4	12.0	11.8
K_2CO_3	44.0	43.8	43.5
NaCl	75.5	75.8	75.6
$(NH_4)_2SO_4$	80.6	80.3	80.0

There are multiple companies that will sell you a salt solution calibration kit (two examples):
http://store.newadventures.com/kehucakit.html
www.kele.com/archive/hy-cal/hc-60-ser-hy.pdf

You can also build your own kit (much less expensive!). You will need:

- High purity salts (99+%) that cover a range of relative humidities (we use the salts in the table above)
- Distilled water
- Small (~50 ml) bottles with caps to hold the saturated salt solutions
- Extra cap(s)
- O-rings that snugly fit around the vaisala sensor
- Bottle holder (something to prevent bottles from tipping sideways)

Unfortunately we've found that it is difficult to get the expected RH from salt solutions, perhaps due to impurities introduced from the bottles, water and/or from the air when the bottles are open. One way around this is to have a brand new, unused Vaisala sensor designated as your calibration standard and assume that the sensor measurements are correct within the range suggested by Vaisala. You would then use this designated RH sensor to determine the RH generated by each salt solution and then calibrate the sensors in the system utilizing the values determined by the designated RH sensor.

	Picture of bottle used for salt calibration

	The extra caps are used for calibration – they need to have a hole in them that is approximately the diameter of the Vaisala probe (~12 mm).
	The o-ring is used to prevent the probe from slipping all the way through the cap.
	Note: it is easier to screw the sample cap onto the bottle and then insert the probe into the hole in the cap. The blue styrofoam in this picture prevents the bottle of solution from tipping over and provides some thermal insulation.

Making a saturated salt solution

1) put a small amount of salt (~10 g) into the bottle
2) SLOWLY add distilled water and stir/shake until about ½ the salt crystals are dissolved. You are really making a slush or a slurry rather than a solution. There must be undissolved salt crystals in the liquid, but they should not poke out above the top of the liquid.
3) Wait for the salt/water mixture to come to room temperature (the LiCl and K_2CO_3 solutions are exothermic and the bottle will be warm to the touch.

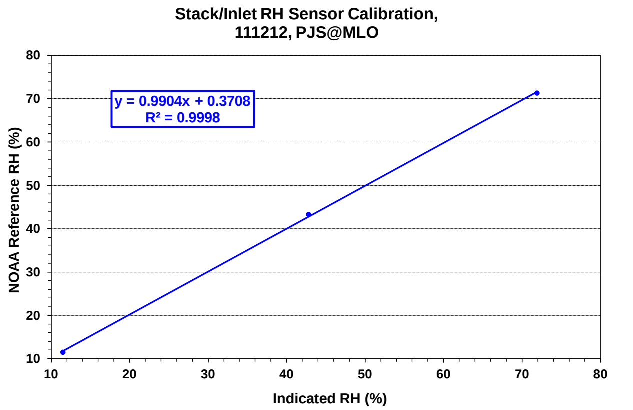
3.1 *Doing a Vaisala RH sensor calibration*

1) Make salt solutions for each of your calibration salts and allow them to come to room temperature.

2) Measure the temperature of the room.
3) Put the sample cap (with the hole in it) on the first bottle.
4) Put an o-ring around the designated calibration sensor and measure the RH of air above the solution. Place the o-ring so the sensor will NOT touch the salt solution when inserted in the bottle.
5) Insert designated calibration sensor into bottle and wait for the relative humidity to equilibrate (~20 minutes)
6) Record the sensor voltage (or PID readout)
7) Repeat for each of the salt solutions you are using.
8) Next follow the same procedure with each of the sensors in the system.
9) Fit a line to the points (system sensor RH on x-axis, designated calibration sensor RH on y-axis)

Note: we've found that it appears to make a difference how high the RH sensors are held above the surface of the salt solution. You want to try to get the sensors located as similarly as possible to the position you used for the designated calibration sensor.

Below is an example of a sensor calibrated using salt solutions for the Mauna Loa, Hawaii aerosol system.

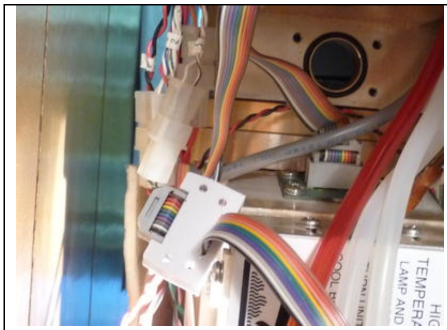
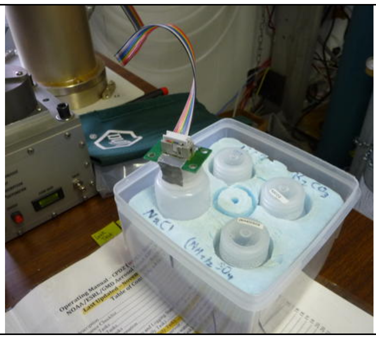
<table>
<tr><td>
</td><td>This is an example of an RH sensor calibration using the 3 of the salts listed above ((NH4)2SO4 was not used).</td></tr>
<tr><td colspan="2">The entry for the sensor in cpd.config would be:
Instruments;X2;!var;U_V11;cal,0.3708;0.9904 # 111212/pjs
The entry for this sensor in cpd.ini would be:
Cal_Inlet_RH=0.3708,0.9904; 111212/pjs

Notes: Intercept is entered first, then slope.</td></tr>
</table>

3.2 Doing a Neph RH sensor calibration

You will use the same general procedure as described above to calibrate the nephelometer RH sensor. Some key differences are:

(0) you need to know where the RH sensor is located on the neph. It will require a special extension cable so that the sensor can reach the calibrated salt solutions
(1) the RH sensor is located on a small circuit board. Rather than push the sensor through a hole in the salt solution bottle lid, lay the circuit board on top of the lip of the bottle and tape it down so that ambient air can't leak into the salt solution bottle.
(2) There are two different ways to determine what RH is being measured by the RH sensor. The first is to look in the neph window on the cpdclient blue screen and use the RH reported there. If you use this method then you will add a line to cpd.config with the calibration equation. The calibration equations will be derived from the fit to neph RH on the x-axis and designated calibration sensor RH on the y-axis.
(3) The second way to calibrate the neph RH sensor is to set the bit values for the RH sensor from the neph using either dosneph (NOAA's version of the TSI software) or the TSI software in terminal mode. You would adjust the bit values based on calibration points for 2 salt solutions. First you would read what the bit values were for the 2 salt solution measurements. To read bit values for RH you type: RA. The neph will echo back 4 numbers – the last number is the bit value for the RH being measured. This value will be between 0-1023. Write down the bit value and the corresponding RH from the designated calibration sensor. Repeat with a second salt solution. Once you have bit values numbers for two different salt solutions you will update the RH calibration in the neph using the SC command. For example if you measured 613 bits for a salt solution giving 71.3% RH and 261 for a salt solution giving 11.5% RH then you would update the calibration string in the neph using the SCR command: SCR261,115,613,713. (Before updating the calibration string it's a good idea to read and record the existing calibration string which you can do by typing the command SCR not followed by any numbers.)

	
The hole in the picture above is the location of Neph RH sensor. The cable is identified as 'J18'. It is helpful to have a magnetic tipped screwdriver to remove the sensor as the screws holding the circuit board onto the neph have star washers attached and it's easy to drop the screw and star washer and lose one or the other. Also, be sure that the o-ring is in place.	Neph RH sensor taped onto top of salt solution bottle. The rainbow cable extension connects up to the connector close to where the RH sensor enters the neph sampling volume.

4 Temperature calibrations

4.1 Vaisala probe temperature calibration

Need to add

4.2 Nephelometer temperature sensor calibration

Need to add

5 Flow calibrations

For the basic aerosol system there are several flows that need to be calibrated or checked. Most flows are reported in terms of standard temperature and pressure where T=273.15 K and P=1013.35 mb. The CN sample flow is the exception – that flow is controlled by a critical orifice and is measured in terms of volumetric flow.

(1) CN sample flow (volumetric flow) – measure this at the inlet of the CN counter. This is a single point measurement rather than a calibration. You will need to convert the measured flow (probably in lpm) to cc/s before entering it into the configuration file in the CN module.
For example, in cpd.conf: Instruments;N71;Q_cnc_cc_s,24.9 #091510eja #24.0;

(2) CN drier flow and CN sample flow – mass flow meters in CN box (standard flow). For the CN drier flow: connect your flow calibration device to the inlet of the mass flow meter. For the CN sample flow connect your flow calibration device to the inlet of the CPC. These flows are controlled by a homemade critical orifice for the CN drier flow and the critical orifice in the CPC for the CN sample flow. For both of these flow meters you can do a 2 point calibration: (a) record the mass flow meter reading when flow is off; (b) record the mass flow meter reading when flow is on. Note: where you observe the mass flow meter reading will differ depending on what type of flow meters the CN box has. If the CN box has Brooks mass flow meters (black and silver, ~5 inch tall, 1 inch wide, 3 inch deep) you will need to figure out what uMac channel each flow meter is assigned in the configuration file. You will then make a plot of the voltage from the flow meter (found in the uMac window) on the x-axis and the flow from your flow calibration device on the y-axis. If the CN box has TSI mass flow meters (white or beige, 2 inch tall, 1 inch wide, 5 inch deep) then you will first need to put the default calibration into the TSI flow meter module in the configuration file and restart cpd. Then you will read the flow values in the TSI flow meter window and plot those on the x-axis and plot the flow from your flow calibration device on the y-axis. The flow calibrations entered in cpd.conf will look like this for the Brooks flow meters:
Instruments;X1;!var;Q_Q72;cal,0.0171;1.4382#110902/PJS
and like this for the TSI flow meters:
Instruments;Q72;!var;Q_Q72;Cal,0.454;1.08#100919/eja;

(3) BMI Mixing CPC place holder **Need to add when get info from Fred.**

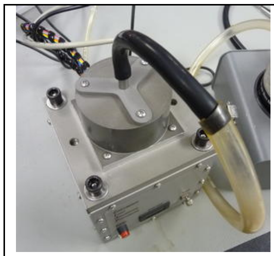
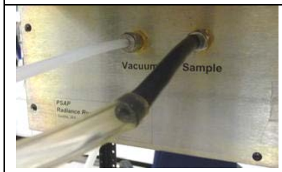
(4) CLAP flow (standard flow) – There are two flow cals for the CLAP in the cpd.conf file. The first is a polynomial fit of flow to voltage done at NOAA. The actual flow calibration for the CLAP is complicated – please talk to a NOAA scientist if you think this is needed. The second flow cal is a tweak to the flow calibration to account for departure of the polynomial fit from the desired flow rate. The tweak value in cpd.conf is the ratio of the measured flow (e.g., using a BIOS flow meter) to the CLAP reported flow. To get this number: (i) change the tweak value in cpd.conf to 1.0 (i.e., no tweak is being applied and restart cpd (ii) set the CLAP flow to the desired operating flow using the valve on front of the CLAP and measure the flow at the inlet of the CLAP (iii) Calculate the ratio of measured flow to the CLAP flow on the cpdclient screen. If XXX>

ratio <XXX then no change is necessary – restore the tweak value in cpd.config. If XXX>ratio<XXX or XXX>ratio<XXX then apply the new tweak. If the ratio<XXX or ratio>XXX then a new calibration is needed. Please contact a NOAA scientist. More details are also available in the CLAP manual. Note: This instrumented is calibrated in SLPM but we want the flow rate set to 1 VLPM to keep the face velocity across the filter consistent across the NOAA network.

(5) PSAP flow (standard flow) – this is a multi-point calibration. Connect your flow calibration device to the PSAP sample port on the back of the PSAP. Use the PSAP flow knob on the front of the PSAP to adjust the flow over a range of values centered around the typical flow rate used for the PSAP. Record the flow on the screen of the PSAP and the flow measured using your flow calibration device (e.g., BIOS, Gilibrator, etc). Make a plot with the PSAP screen flow on the x-axis and the flow calibration flow on the y-axis. Do a linear regression to find the slope and offset. Typically we want the PSAP flow rate to be the same as the CLAP flow rate (i.e., 1 VLPM), although at some polluted sites (e.g. KPS, AMY) this is not true. The calibration will be entered in the configuration file in the PSAP module and will look like this: Instruments;A11;!Cal;Q,0.2757;1.0175#110902/PJS

(6) Impactor box flow (standard flow) – this is a multi-point calibration. Connect your flow calibration device to the ½ inch fitting on the back of the impactor box labeled 'return flow from neph'. Use the PID setpoint control to adjust the flow over a range of values centered around the typical flow rate for the impactor box (30 vlpm). Note: the desired flow rate is 30 vlpm, but the calibration is done in SLPM, so you'll need to figure out the proper SLPM flow rate to get 30 VLPM – the SLPM will be lower than the VLPM (at see level 27.2 SLPM is ~ 30 VLPM assuming standard temperature of 0 C. You will then make a plot of PID flow value on the x-axis and the flow from your flow calibration device on the y-axis. The entry for the MFC flow cal in cpd.conf will look like this: Instruments;X2;!var;Q_Q11;cal,0.517;1.0527#110831/PJS

 Flow calibration device is attached to inlet of TSI mass flow meter in CN box.	 Top view of CN box with Brooks mass flow meters.

 Flow calibration device is attached to inlet of CLAP.	 Flow calibration device is attached to back of impactor at port labeled ‘return flow from neph’. You are calibrating the mass flow controller in the impactor box.
 Flow calibration device is attached to inlet (sample) of PSAP.	 Top view of impactor box – mass flow controller is to left of HEPA filter at rear of impactor box.

6 Pressure calibrations

6.1 uMac dp sensor calibrations

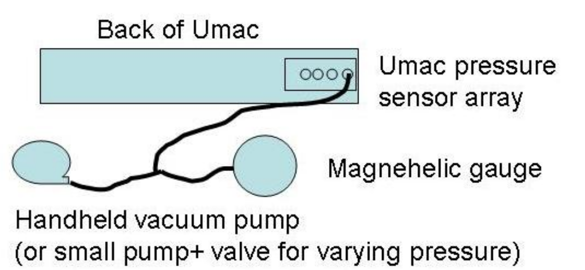
(1) Label dP tubing at back of uMac then disconnect
(2) Connect pressure calibration manifold tubing (see picture below) to uMac sensor array
(3) Look in configuration file to identify which uMac channel is associated with which pressure sensor
(4) Open uMac window on cpdclient screen so the pressure channel voltages can be seen
(5) Change pressure using handheld vacuum pump
(6) record range of uMac voltage and pressure from magnehelic and develop calibration for pressure sensors

Typical maximum values for various dP sensors and appropriate gauge for calibration

Sensor	hPa	Psi	inches H2O	Appropriate magnehelic gauge
Filter rack sensors	150	1.5	60	0-2 psi
Neph impactor	15	0.15	6	0-8" H2O
System/CN vacuum	600	6	240	0-10 psi

Conversion values: 1 hPa = 0.01 psi; 1 hPa = 0.40" H2O

Picture of pressure calibration setup



Notes on uMac pressure sensor calibration

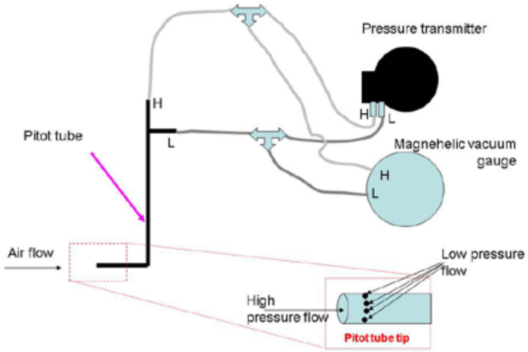
- Face of magnehelic should be vertical to get correct reading
- If pressure value on magnahelic drifts lower then there is a leak in pressure calibration manifold.
- Need to convert pressure from units on magnehelic to hPa for calibration equation. Conversion values: 1 hPa = 0.0145 psi = 0.401" H_2O
- Pressure cals for uMac pressure sensor in cpd.conf will look like this: Instruments;X1;!var;Pd_P12;cal,-207.41;328.66#110902/PJS

6.2 Neph pressure sensor calibration

Need to add description

6.3 Calibration of pumpbox pressure transducer (pitot tube calib.)

The excess (stack) air flow pulled by the blower is determined using the pressure difference across a pitot tube. The theory of getting a flow measurement using a pitot tube is described here: http://www.engineeringtoolbox.com/pitot-tubes-d_612.html . The standard pitot tube setup in the pumpbox is shown in the figure below.



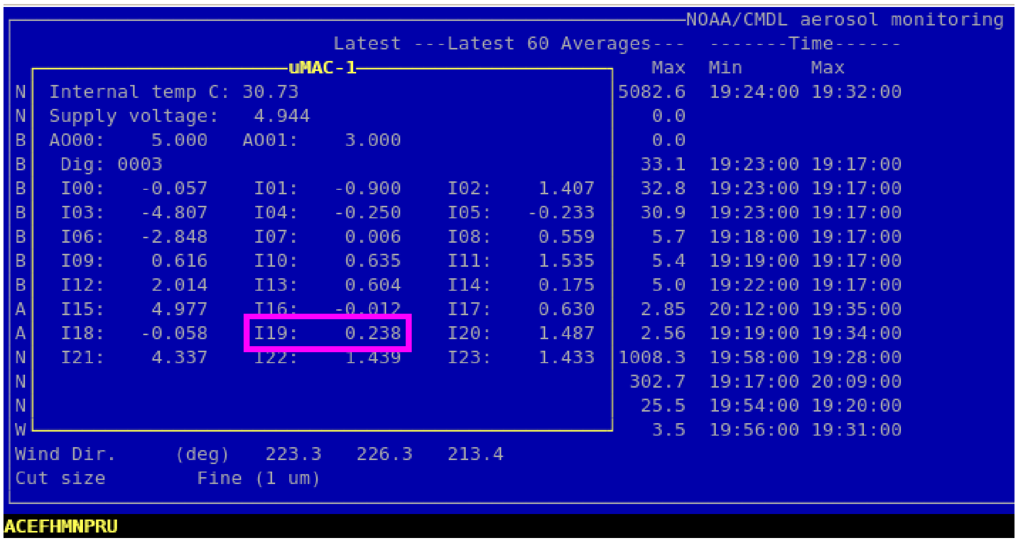
We have redundant pressure difference readouts for the pumpbox. First, the magnehelic gauge (0-0.5" H_2O) is used to give a visual reading of the pressure difference. Typically, for a sea level site, the magnehelic should read ~0.25" H_2O to give a flow of ~850 lpm. Second, the pressure transducer sends a voltage to the uMac that is related to the pressure difference – this way we have a value in the data files indicative of the stack air flow. The pressure transducer is calibrated using the magnehelic gauge so that the analog and digital information are consistent.

(0) Figure out which umac channel the pressure transducer voltage is recorded on (pressure transmitter is typically (but not always) on channel 19). You will need to look in cpd.conf to determine the channel assignment for your station. To look in cpd.conf, double click on the cpd.config icon on the bottom of the desktop. Scroll down until you see a set of lines that look like:

```
Instruments;X1;!var;Pd_P01;chan,19
Instruments;X1;!var;Pd_P01;cal,-0.195;7.74 #090317/EJA;-0.36;4.08;081006/EJA
Instruments;X1;!var;Pd_P01;FieldDesc,Stack pitot tube dP (hPa)
```

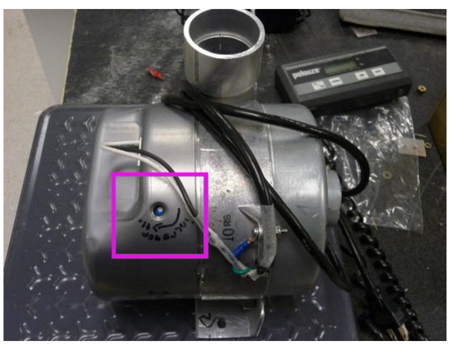
The third line tells you that Pd_P01 is the pitot tube delta pressure (dP); the first line tells you that Pd_P01 is assigned to channel 19 and the second line contains the most recent calibrations.

(1) open the uMac window on the aerosol system blue screen by typing <enter><u>. Open the uMac menu by typing <m> and choose option <v> to display the channels. This will bring up a screen showing the voltages for each channel.
Identify the voltage readout of the pressure transmitter channel. There is a pink box drawn around channel#19 in the picture below.



(2) Record the voltage (in this case 0.238) and then the pressure reading on the magnehelic gauge on the pump box (for example, 0.25" H2O).

(3) Adjust the blower flow by turning the blower set screw. You should hear the blower change speed and see the magnehelic gauge value change. (note: there can be a slight lag time (~30s) between adjustment of the blower flow and response of the magnehelic. See picture below for picture of where the flow adjustment screw is on the blower. Write down the new magnehelic pressure reading and the corresponding new uMac voltage reading.



Repeat this several more times so you have a table that looks something like this:

Voltage	Magnehelic_dP
0.345	0.41
0.285	0.31
0.254	0.26
0.222	0.22

0.186	0.15
0.135	0.075

You basically want to cover the range of the magnehelic gauge and have several readings close to the typical value of 0.25" H2O (at sea level) or whatever the appropriate value is for your station.

(4) Convert the Magnehelic_dP reading from 'Inches of water' to 'hPa' using the relationship 1" H2O = 2.491 hPa.

(5) Calculate the linear fit equation between voltage and hPa. For the example above it would be: deltaP_hPa = 3.969*voltage-0.352. The values you would enter into cpd.ini for the pitot tube calibration would then be: -0.352 and 3.969.

(6) Enter the new calibration in the configuration file.
The entry in cpd.conf would look something like:
Instruments;X1;!var;Pd_P01;cal,-0.352;3.969 #YYYYMMDD/nnn
The entry in cpd.ini would be:
Cal_dP_Pitot=-0.352,3.969;YYMMDD/nnn
YYMMDD is the year, month and day of the calibration and nnn is the initials of the person doing the calibration. Once you've entered the new calibration, save the configuration file and restart cpd.

Note: you can also use the pitot tube equations to derive the flow. The equations are described in Dwyer's bulletin# H-11 available at http://www.dwyer-inst.com/PDF_files/160_IOM.pdf
The inner diameter of the tube that the pitot sits in is 1.75".
You can do the calculations yourself or ask us for an excel spreadsheet template which you can enter the measured voltages and pressures and get the calculated flow rate.

7 Example of a Maintenance Log Document

	Action	Description
2010-10-31		Betsy arrives in Song-shan Taipei City airport after United changes logistics because of typhoon. Staying in Gloria Prince Hotel in Zhongshan district in Taipei, near Shuanglian MRT station.
2010-11-1		Sleep in and hike in Yangmianshan NP and check out Danshui via MRT and bus
2010-11-2		Betsy takes MRT to HSR in main Taipei station and takes HSR to Taoyuan. Josh meets at Taoyuan around 9am. We drive to NCU to deal with packing logistics. There is also a short IOP that will occur at LLN while I'm there.
		Drive drive drive. Arrive at LLN ~ 4pm (5.5 hr drive + stop for lunch+groceries)
	Done	*Inspect Outside Stuff:* Pumpbox rotameters could use cleaning - done ½" Tubing (quick glance) looks ok
	Done	Need to inspect PVC pipe and tubing more closely -done
		Did quick zero on CNC – put parker filter upstream and let counts go to zero while I took pictures of sunset. CNC did indeed count zero with filter on
		Put filters upstream of neph and PSAP for overnight zero check
		Did instrument inventory – everything appears to be same as last time except for PSAP. PSAP is serial number 71, PMEL#2.
		Noted PSAP settings (in message log). I believe they are all correct.
		Took some system pictures (inside only)
	GMD	FE want to know if they are starting an AER_VM system from scratch if there is anything they can save on a file to speed up the synchronization. How necessary to update aer_vm software? Ferret has, but eric hasn't because he says he can still edit. They are using august 2009 aer_vm. *Emailed david*
	GMD	Laptop appears dead sometimes when they get to station so they reboot. Also, to get uMac to reset sometimes they have to restart entire system – pushing restart button doesn't help
	GMD	I suggested they clean impactors more often, esp. when it is polluted. Currently they only clean them 1/month. They expressed interest in maintaining same ops schedule as MLO as that is their 'model' station. MLO does impactor service every 2-3 weeks and span check every 2 weeks according to PJS.
		Got them most recent version of editing manual 'Using_CPX2_20100504.doc and also the powerpoints from the workshop describing editing mechanics and strategies.
	GMD	Lulin folks would like more feedback on data editing I went over the data editing stuff we put together for the workshop and suggested that they do their editing as best they can and then rather than asking the general question 'did we edit ok' to ask questions about specific edits they are not sure about.
2010-11-3		Ended zero test, send data
		Results from neph and psap zero pasted at end of file. Both look good (great!) Sub1um psap possibly slightly noisier than sub10um psap
	GMD	How do neph stats for zero test with system in new data format? Can psap stats be added? Old data format ran perlscript nephstats on h__ and nc_ files
		Check bios version and memory, install new memory if necessary Bios version was 1.21 (1YET60WW) Old memory amount was 256 with two 128 cards. Removed one of the 128 cards and put in a 256 card bringing memory up to 384. (BIOS noted change of memory)
		Installed new software and see if it looks ok. Analyzer flow oscillated when installed futzed with PID and put to manual and oscillations. All instruments are talking (except clap as it's not here yet) Derek says add this line to cpd.conf: Instruments;X2;34;ManualOutput,TRUE

		Added this line and now the oscillation is gone – yay!
		Trained on new software – see entries below
		Noted that PSAP is now on 'L' instead of 'R' Showed cpx2 display.
		Did span check to show differences in old and new span check.
		Cleaned impactors. Went through new software for that. They are using vacuum grease for impactor plates
		SS block supporting electronic ball valve is not connected to floor of impactor box. Doesn't look like it ever was. It can tilt which suggests a loose fitting somewhere between electronic ball valve and fitting in back of impactor box. →is this related to later problem that acrylic box not actually attached to metal shelf in imp box?
		Did leak check – showed them that Pd_P11 is Neph_imp_dp
		Sent link to flow diagram
	TODO	Check if they can log in remotely to LLN blue screen. I can from vortex so I assume they can from aer_vm… Derek says ssh cpd@210.69.102.188 cNC password then cpd –c I asked Derek about SVNC too…
	Done	Noted aethalometer has no comms. Full memory card or something- they fixed…
		Pumpbox – cleaned rotameters – they had amazing amounts of black gunk in them, although appeared still functional; cleaned pitot tube, vacuumed insides, washed filter cover and filter holder.
	NCU	Piece of tubing connecting outlet of all 4 rotameters to blower cracked during dismantling. They have no spare Swagelok pieces other than caps and a few ¼" ferrules. Advised them to get some spare Swagelok pieces.
	GMD	What is part number for pumpbox filter?
		Inspected spareline tubing from splitter. It looks fine (not cracked or degraded) probably because on north side of building and protected from sun. it is not covered with foam or anything.
		Inspected pvc pipe (4" and 8") joints all looked good except where 4" tees out of 8" for excess air. That was loose (again – same as last year, although not all the way popped out this time). Applied more silicon goop and use tiewraps to help hold it in place. (see picture). →apparently roof joint was not so good!
		Pretty cool (in a disturbing way) can see pollution coming up valley from population centers. This morning it was tamped down low in the valleys and now it's lifted a lot, although we are still above it here (10:30 am)
		Check carbon vanes – they look almost brand new – they are only ~2 mm shorter than brand new vanes and have been running since the system was installed (with time off for bad weather).
		Calibrated pitot tube (channel 19 on uMac, Pd_P01 in cpd.conf) Note: when blower potentiometer is connected can't get pressure above 0.185" h2o Calibration equation: deltaP=-4.4*volts + 0.706
		Changed both nephelometer filters (HEPA and parker)
		replaced co2 filter. Note: it's at co2 inlet on neph, not down by co2 tank on 1st floor. Used filter removed from nephelometer.
		Checked drier flow filter (it was changed june 2010). it was missing a ferrule so we added that.
		Changed CN flow filter
		Changed analyzer flow filter (used filter from neph). Note the filter removed from upstream of the MFC was obviously dirty – it was dark when held up to the light compared to a new filter.
		Changing permapure drier tube for CN box.

		Note: pat bought MD-110-12E-S (stainless tips) They have: MD-110-12E-P (plastic tips) The permapure color is different too: the stainless tips one is clear, the plastic tips one is amber. Emailed PJS about this Replacing permapure drier tube requires removing CN box. Lots of things to detach. Pat says: The only difference is the end tubes. Stainless vs. plastic. The stainless inserts are for the stainless driers, while the plastic ones are for the plastic driers. Putting a plastic insert into a stainless drier can work fine, but you have to be careful that you do not compress the plastic end tubes way down when tightening the connections. The ferrules in the stainless driers are metal, so they will choke off the tube if you are not careful. If you watch for this, the plastic inerts will be fine. The color of the nafion tubes don't matter. Brand new ones are clear, but they age to a brown color. The brown ones still seem to work OK though.
	NCU	Buy HEPA filters and parker filters for replacing filters in system. Note: can use filters removed from neph at other places in system. They have parts information from my trip last year.
	GMD	Acrylic base of impactor box not attached to steel shelf it sits on – is that normal? We figured this out because front and back of impactor box were sticking out from rack. We took out impactors and pulled bottom of impactor box all the way out. Found ¼" ss ferrules, 2 ¼" caps and a loose screw – the loose screw was what was preventing the impactor box to sit all the way back on the shelf. Pulled that out and fixed, but acrylic is still not attached to metal shelf. Emailed RCA about this. Rob says: The acrylic (normally now it is polycarbonate) is only attached to the shelf via 2 bolts fastening the Whitey ball valve. normally is the pillar that the electronic ball valve sits on attached to the metal shelf so the acrylic bottom is sandwiched between pillar and metal shelf? If I understand your question correctly, YES. So.. this means that the imp box at lln is missing the 2 bolts fastening the whitey ball valve. Not an easy thing to fix and hasn't been an issue till I was here so will continue as is.
2010-11-04		Inspect splitter RH sensor Looks good – they dealt with earlier this year. In the RH spare line there is a 2" ½" stainless connector (I took a picture) that doesn't seal well – it is stainless nuts connecting to nylon tee on one side and brass tee on the other side and the ferrules are poorly placed so the piece spins even when the nuts are tight.
	NCU	They will get replacement for connector piece with appropriate nuts and ferrules They will also get spare vaisala. They have the info from last year.
		Clean splitter. Used small bottle brush to scrub and washed with water then alcohol and dried.
		Clean 2" pipe Used large bottle brush to scrub then wrapped with towel and cleaned loose stuff out. It seemed to be quite clean. Surprising since rotameters were so dirty
		Did leak check to make sure system ok after splitter removal. Looks good. It is really clean here today – we are possibly in cloud and could see top of boundary layer this morning a bit below us.
		Inspected inlet RH sample. has paper cap/dust filter and paper looks fine – clean no dirt on paper.
		Spot check RH sensors Splitter RH sensor within 3% of reference. At ~40% Sample RH sensor within 1% of reference at ~45%

		Note sample RH sensor is on PID#1, splitter RH sensor on PID#3 Be sure to turn off correct heater while RH sensors are out of line.
		CN, Psap and edgeport were on raw power strip. Moved cn and psap power to UPS, turned off power and moved edgeport to UPS.
		Calibrate PSAP flow using tetracal Flow(slpm)=0.9962*psap_screen+0.1907
		Calibrate analyzer flow using tetracal. Flow(slpm)=0.9645*PID-0.1896 If assume pressure=720 and temp=298 then to get 30 VLPM need to have mass flow of 19.5 slpm for analyzer
		Check CPC, drier flow using tetracal CN_flow=0.978 vlpm = 16.3 cc/sec CN_flow(SLPM)=0.3716*volts+0.0305 (channel 12) CN_drier_flow(SLPM)=1.7215*volts+0.0344 (channel 13)
		Calibrate pressure sensors (used magnehelics psi 0-10 range) Dp_neph_imp(hPa)=327.11*volts-202.82 (channel 20) Pd_P11 Dp_pump_vac(hPa)=334.72*volts-204.73 (channel 21) Pd_P12 1 pound/square inch = 68.947 hectopascal oops – I grabbed the wrong gauge for the neph_imp_dP cal. I should've gotten 0-15" h2o but grabbed 0-15 psi. will not enter the cal we did for neph_imp_dp
		Did inventory
		Sent them preliminary doc describing annual maintenance and link to ftp page with all the maintenance procedures.
		Update cals in cpd.conf
		Noticed that spot size in cpd.conf is different the spot size on psap which is different than spot size on filter holder. Need to figure out which one is right. Psap has sticker that says spotsize is 19.37 mm2, filter holder says 17.31 mm2 and in cpd.conf the spot size is 1.834e-5 m2. LLN doesn't save filters so we will run a filter for a long time and see if we can get a dark spot. Unfortunately it is very clean right now so probably won't get one before I leave.
		Explain CLAP setup – told them we would send clap maybe in dec/jan. showed software and cpx2 plots. Explained that clap will sample from neph blower plug so they would need to send us their neph blower plug when we send them our modified blower plug.
	GMD	Station diagram under help menu on laptop is hard to read (can't see any of flow lines only boxes) on laptop screen
	GMD	Need to change system diagram for CPX2 to add clap (when clap comes) betsy wants to make system diagram pretty like she did for some other stations.
	GMD	When send clap need to explain how calibrate clap flow, and also take picture of back of instrument for clap manual. Need to send serial cable, cb tubing, filters along with clap.
		The joint where their stack goes into the roof sprung a leak while I was here. They are covering with plastic and will silicone when it gets dry out. Doesn't seem to be coming from inside the stack, but the joint where the 8" goes into the roof. We did a temporary patch while it was raining with silicon goop that appears to be working, but we will check frequently.
		LLN switches size cuts every 30 min. I am surprised it is not every 6 min since not a humidograph station.
		Check aeth sample flow Measured aethalometer flow : 4.63Vlpm, 3.03 Slpm, screen says 2.99
		Check remote login using putty – doesn't work needs to be from aer_vm or vortex because of firewall
		Went over flow chart with them – much easier to explain after working on system for two days!
2010-11-05		Finished inventory

		Did some more leak sealing
		Assured myself that flow was actually going through system because numbers of all extensives were so low.

LLN stuff
5-6 hour drive from NCU to lulin station (with stop for lunch)
bring towel if staying at site

computer stuff
<control><alt><f11> goes to root screen
<control><alt><f7> goes back to normal desktop

Making 800# calls to gmd:1-800-579-5383
put in your extension number followed by # key, put in your voicemail password xxxxxxxx followed by # key
put 0 and the extension you want to call followed by # key. For example 06120# will get you john
jim wendell:x6994
pat sheridan:x6672
john ogren:x6120
josh wen ph#886-938950356
ferret ph#886-922246838

Neph zero test results from running perlscript nephstat (need h_. nc_ , and need to be in a station directory to run cnvt* and nephstat)
Total Filtered Air Mean Blue -0.060 1/Mm
Total Filtered Air Mean Green 0.000 1/Mm
Total Filtered Air Mean Red 0.050 1/Mm
Back Filtered Air Mean Blue 0.020 1/Mm
Back Filtered Air Mean Green 0.000 1/Mm
Back Filtered Air Mean Red 0.020 1/Mm
Total Filtered Air StdDev Blue 0.280 1/Mm
Total Filtered Air StdDev Green 0.170 1/Mm
Total Filtered Air StdDev Red 0.180 1/Mm
Back Filtered Air StdDev Blue 0.200 1/Mm
Back Filtered Air StdDev Green 0.110 1/Mm
Back Filtered Air StdDev Red 0.150 1/Mm
Total Background Mean Blue 4.517 1/Mm
Total Background Mean Green 4.495 1/Mm
Total Background Mean Red 10.040 1/Mm
Back Background Mean Blue 1.685 1/Mm
Back Background Mean Green 1.863 1/Mm
Back Background Mean Red 5.505 1/Mm
Total Background StdDev Blue 0.053 1/Mm
Total Background StdDev Green 0.053 1/Mm
Total Background StdDev Red 0.036 1/Mm
Back Background StdDev Blue 0.057 1/Mm
Back Background StdDev Green 0.018 1/Mm
Back Background StdDev Red 0.034 1/Mm
~
psap zero tests
==> bap_10um_ave <==
LLN,2010,306.41667,0000.03,0000.03,0000.03
==> bap_10um_sd <==
LLN,2010,306.41667,0000.23,0000.24,0000.23
==> bap_1um_ave <==
LLN,2010,306.40000,0000.04,0000.04,0000.04
==> bap_1um_sd <==
LLN,2010,306.40000,0000.26,0000.26,0000.24

8 Example of an Inventory document

LLN Nov 2010 Maintenance Visit

Item	Quantity	Serial number	Comments
TSI 3563 Nephelometer	1	70638013	has spancheck mod, CD0001610674
Radiance Research PSAP	1	71	PMEL #2 (not sure if has heater mod – will check)
TSI 3010 CPC	1	2028	No CD#, new laser 3/2007
UPS Ferrups FE power ware	1		
Brooks 5851 E Series 0-50 LPM	1		Analyzer flow, in impactor box
Brooks 5860 Series 0-10 lpm	2		in CN box
Edgeport	1		
uMac 1050 data logger	1	1001	Standard uMac
Laptop	1	78-B5790	CD0001075597
PID	1	06/21/06	Standard PID
Manuals Neph MFM PSAP PID CPC	1		In drawers on aerosol system desk
Binder with ops manuals and other info from GMD	1		Includes emails/info from GMD
Pump box			
Gast Carbon vane pump 0823-V103-G608X	1		Needs repair kit k479A
Ametek blower	2		Pulls excess stack flow and 30lpm each through 3 spare lines+stack T/RH line
Pitot tube assembly	1		Includes pitot tube, pressure transducer and magnehelic gauge
Carbon vane pump filter	1		Small, clear version with automotive filter
Other stuff around trailer			
HEPA filter	1		Neph suitcase
Serial cables (9-9pin)	1		Neph suitcase
Assorted tools			Nothing special, but good assortment of screwdrives, wrenches, grippers, cutters
Tiewraps			Lots of different sizes.
Bottom desk drawer			
Leak check filter assembly	1		For neph zero check
Pump repair kit K-479A For 0823 Carbon vane pump	1		
Used parker/balston filters	3		For psap zero check and spare if necessary
BuOH drain bottle	1		
BuOH	1 gal		1 gallon
neph lamps	Box		At least 8 lamps
Ethanol	1 liter		For cleaning
Small bottle brush	1		For cleaning splitter tubes
Tubing ¼”	2		1 piece nylon ~2’, 1 piece conductive black ~2’
Leak test filter assembly	1		
Small baggie of swagelok			Mostly caps, and a few ¼” ferrules. Not very useful
Middle drawer			
manuals			
Top drawer			
permapure drier tubes	2		New one has plastic ends, but pat says is still ok to use

			Used one has metal ends, probably still ok to use
Spare quick connects for CPC	3		Plastic ones for buOH lines and CPC didn't check which specific ones
English socket set	1		¼" through ½", useful for removing pumps from pumpbox and opening carbon vane pump
wrenches	3		2 ½" wrenches, 1 #11 wrench, →no 9/16" wrench
Metal tubing cutter	1		
Adjustable wrenches up to ¾"	2		These are the standard typically red-handled wrenches
Computer discs	Box		For aethalometer(?)
Tape	2		Teflon and electrical
Qtips			
Psap o-rings	Several		Both kinds (red and black)
Psap filters	2 boxes		
Vacuum grease	tube		