

Attachment 1

Meeting of the NADP Network Operations Subcommittee: Spring 2007 Agenda

Wednesday, April 11, 2007 – Lake Champlain A

- 1:30 Approval of minutes from Fall 2006 meeting in Norfolk, VA, Marty Risch
- 1:40 MDN report, David Gay
- 1:50 NED report, David Gay
- 2:00 New collector engineering and deployment update, David Gay
- 2:30 USGS External Quality Assurance Report, Natalie Latysh, Greg Wetherbee
 - Results for the collocated sampler program
 - Interlaboratory comparisons
 - MDN system blanks
 - Blind audit program
 - High altitude rain gage comparison
- 3:00 Third party site audit program, Mike Kolian
- 3:30 Break – Mezzanine
- 4:00 High altitude monitoring update, David Gay, Greg Wetherbee
- 4:15 NADP siting criteria, Chris Lehmann
- 4:25 New site information worksheet, Chris Lehmann
- 4:35 Site operations manuals and new generation operator training, Chris Lehmann
- 4:55 MDN Atmospheric Initiative, Eric Prestbo, David Schmeltz
- 5:25 Preview of Thursday agenda
- 5:30 Adjourn

Thursday, April 12, 2007 – Montpelier AB

- 8:00 HAL report, Bob Brunette
- 8:30 HAL Review report, Greg Wetherbee, Bob Brunette
- 8:45 CAL issues, Karen Harlin
- 9:15 CAL audit response and NOS approval, Chris Lehman
- 9:30 Policy for wind shields for rain gages, Greg Wetherbee, Chris Lehmann
- 10:00 Break –Mezzanine
- 10:30 Policy for wind shields for samplers, Greg Wetherbee, Chris Lehmann
- 10:45 Policy for co-location of new N-CON samplers with ACM samplers, David Gay
- 11:00 Retrofit of ACM samplers with N-CON sensors, David Gay
- 11:10 Slaving ACM samplers to ETI precipitation decision, David Gay
- 11:15 Ammonia monitoring network, Gary Lear, Van Bowersox
- 11:45 NADP Quality Management Plan review, Van Bowersox
- 12:00 Adjourn

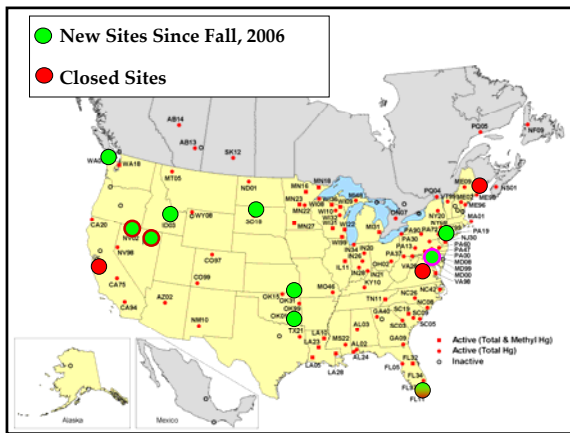
Mercury Deposition Network Update

David Gay
Program Office

Spring 2007

Current Network

- **101** Active Sites Total Mercury Sites
 - 21 Methyl Mercury Sites
 - 5 weekly (LA, WI)
 - 16 four-week composite
 - 3 Inter-comparison Sites
 - WA18, VT99, WI36
 - 6 Urban Sites
 - Reno, Portland, Milwaukee, Orlando, Jersey, Indianapolis
 - 47 Co-located with NTN Sites
 - Reno, Portland, Milwaukee, Orlando, Jersey, Indianapolis



Interesting Possibility

- Large Addition in Florida,
 - "daily" sampling possible
- State of Kansas
 - Up to six across the state
- Two, three in Nebraska
 - 1 for sure, 2 likely

Web Data Update

- I have said this before, but the Methyl Data
 - Really really really almost there
 - For 2002 and beyond, attend DMAS for last motion, then turn it on when we get home
 - Delay with HAL audit requirement
- <2002 data is being processed at PO now
- 2006 data
 - Coming in now with total mercury data
 - Incorporated into the same data base
 - Larson is happy with format.
 - All is well

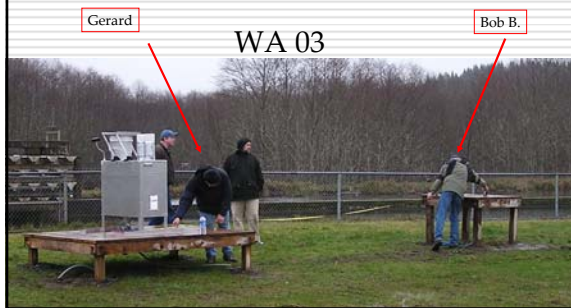
Data To Program Office

- HAL is processing data much faster than required
 - i.e. January data at PO by the end of March
 - Since Jan 2006 measurements
 - With fewer problems and in correct format

QC Highlights

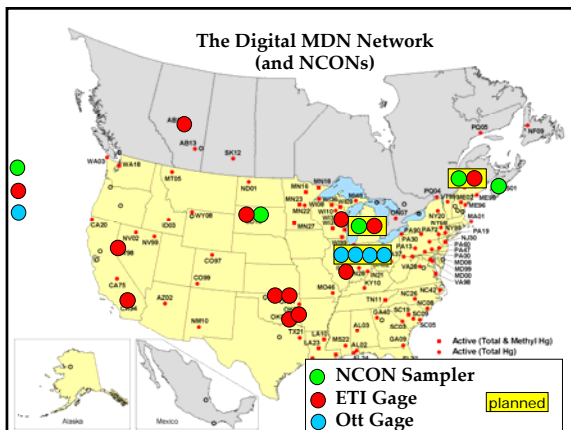
- 2006 HAL Audit Complete
 - Report here at the Spring Meeting

Other: Service Above and Beyond



News

- LODA Sampler Cost Decrease
 - LODA Price decrease
 - MDN Sampler is now \$4545 (NTN= \$3145)
- Digital Precipitation Gages in the Network
 - CA94 on Thursday
 - ETI=\$5600
 - 2 more in OK coming soon



News

- Monthly Turn Over of Data
 - HAL moves data to PO after two months
 - Example: January data to PO by March 31

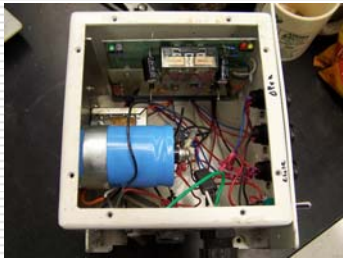
News

- 2nd MDN Site Operator's Training
 - Seattle, Oct 12 and 13th.
 - 15 Operators

Network Equipment Depot Update

David Gay
Program Office

Spring 2007



Outline

- Equipment
 - What have we fixed
 - How much have we spent
 - Increasing decreasing
 - Aerochem is now \$40 cheaper
- ACM retro-fit
 - 1 History slide (what we did and what we wanted to do)
 - No Action
- Intercomparison between NCON and ACM collectors
- Waiting for response from Marty on this one

What is Getting Fixed These Days?

- Several wide spread ice storms this year
 - Eats motor boxes
 - Lots of these problems cannot be distinguished, so motor boxes go out with sensors

How much have we spent?

- Income (approximate)
 - \$2*350 sites*24weeks (since fall) ≈ \$16,800
- Expenses
 - Salary: Tim*24 weeks
 - Sum Expenses

Increasing? Decreasing?

Aerochem Price Change

- Aerochem NTN
 - Was \$3,185
 - Now \$3,145 (-\$40)
- Aerochem MDN
 - Was \$4,585
 - Now \$4,545 (-\$40)



Equipment

Summary of ALL Ongoing Collector Modifications....

1. Aerochem Retro-fit ("LO Sampler")
 - Save \$ & samples, more reliable
 - Testing, Field Deployment
2. New Collector ("Loda 2005")
 - more reliable
 - Development & Testing now
3. New MDN -NCON Collector
 - Approved
4. Deep Bucket NTN Collector
 - Better NTN collection during snow
 - operating in field
5. Second Chimney Modification
 - Better MDN collection during snow
 - Sample built
6. Combined LO Drive, Deep Bucket NTN Collector

Aerochemetric Retrofit

i.e. "LO Sampler"

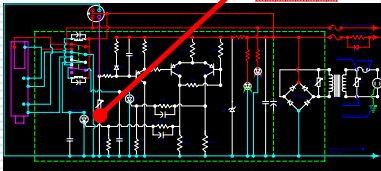
History.....

- Goal of the new drive mechanism...
 - To save money at the PO
 - To same money/time on site
 - reliability

In the Fall....

- We were stuck....

we had fooled it into opening...



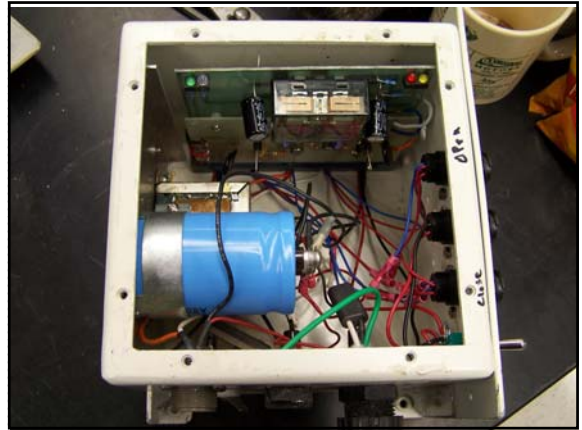
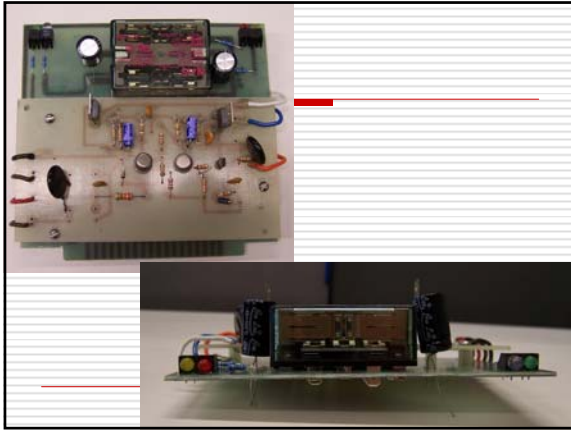
- now we are not....

Problem Corrected

- And it works
 - Freezer test, no problems
 - Outside since about 12/1/06
 - Survived a blizzard just fine
 - (30 hours, winds 30 to 40 mph, gusts to 50, temperatures to -2°F)
 - Blew a fuse once
 - increased the size to 3 amp fuse
 - Board was not water sealed, nor was the box
 - Will not go out as such

(Pass Around Example) JIM?

Attachment 3



Change A Knuckle End

- Easier to unhook
- 1 extra inch of "throw"



Change Position Lights

- @@@@@@@@@@@@@@@@

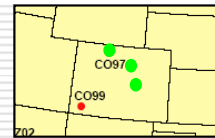
PICTURE

Cost

- Parts
 - \$@@@@@@@@@@@


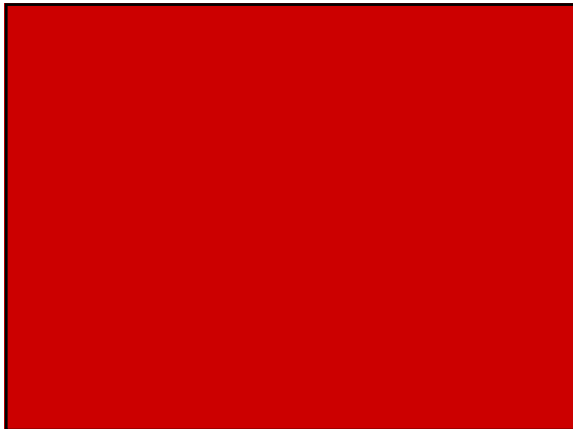
Future Plans

- One installed (or waiting) at VT99
 - USGS/Natalie & Greg
- Aiming for three in Colorado
 - CO98
 - CO97
 - CO02



Brains Behind this Design

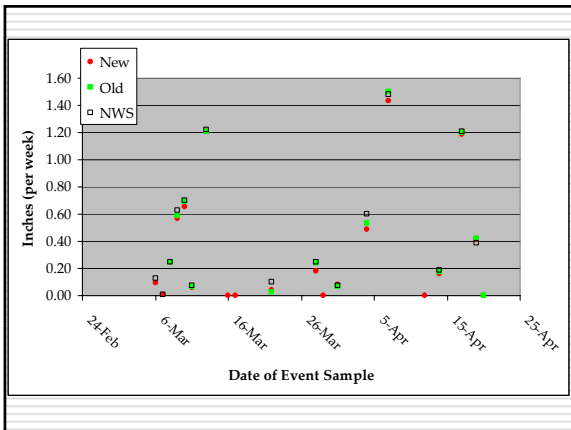
"L" "O"

New Collector "Loda 2005"

Brief History....

- Earlier In the Spring
 - Ran great for 3 weeks in my hallway
 - Ran fine in our backyard
 - 19 Precipitation events compared to Aerochem and stick gage
 - Difference to Old Collector
 - Mean= -0.01 inches
 - Context: Many small rain events
 - Difference to Stick Gage
 - Mean= -0.02 inches
 - Context: Old Collector is -0.01 inch
 - so no difference
 - Put Into Freezer
 - Would only open so far.....



Then?

- Loda Repaired, back into the Fridge:
 - Same problem. Open two inches and froze
- Called Loda to come fix.

Attachment 3

We waited.....

.....And we waited.....

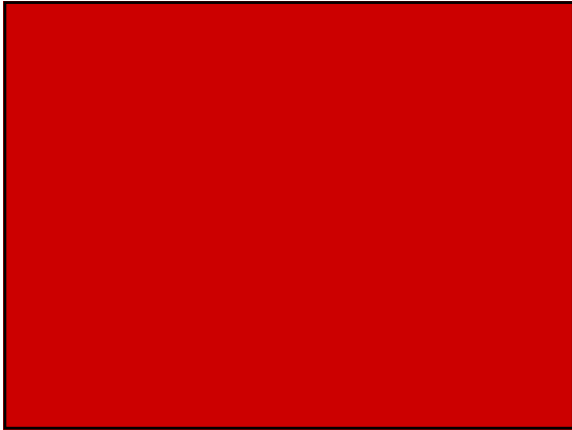
.....And we waited.....

.....We're still waiting.

So?

- Therefore, not much to report
- About where it was
 - Seems to work fine at normal temperatures
 - Does not seem to work at cold temperatures
- Loda has to show me...
 - Works at cold temperatures and at warm temperatures
 - With the same unit
 - And that it will perform for a period of time without fail (into our backyard)

I'll get back
to you.....



NCON & ACM Comparison



Deep Bucket Collector

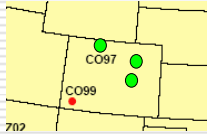
Some now,
Some *later in NOS*
"High Measurement
Experiments"

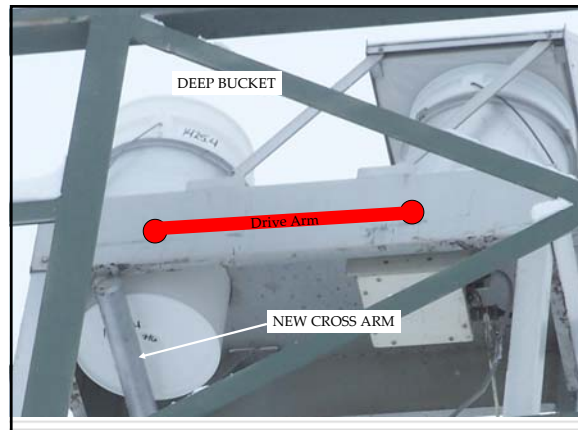
Two white plastic buckets are shown in a laboratory setting. One is larger and taller, while the other is smaller and wider. They are both sitting on a dark surface.

DAG3

What's Going On Here?

- Deployed three deep buckets in CO, October 2006
 - CO97 replacement
 - CO02 co-located and slaved
 - CO98 co-located and independent

A map of Colorado showing the locations of three deep bucket collectors. CO97 is marked with a green dot, CO02 with a red dot, and CO98 with a green dot. The number 702 is written at the bottom left of the map.



Attachment 3

Slide 35

DAG3 label the sites better
DGay, 4/2/2007


Attachment 3



DAG4

Mechanics?

- All seems to be working
 - A few power problems at CO98 (solar)
 - No mechanical failures that we know of
 - (new cross members, etc)
 - Site difficulties?
 - Heavy buckets, loading?
 - Twice as heavy
- Do not have LO Drive motors though (May, 07)



Results

- Later in NOS

“High Altitude Monitoring Update”

Cost To Build?

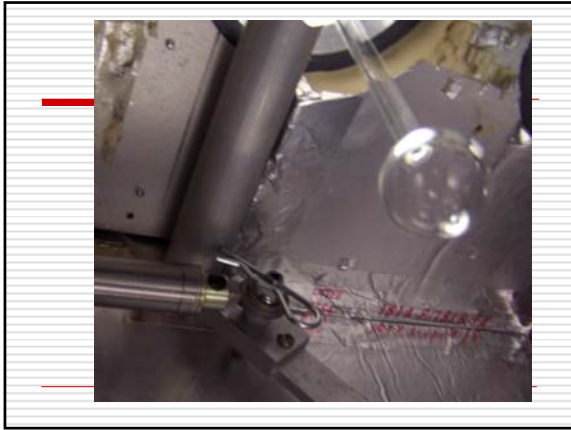
- Parts
 - \$@@@@@@@@@@
- Time To Build
 - Estimated at @@@@

Attachment 3

Slide 40

DAG4 label the sites better
DGay, 4/2/2007

Attachment 3



New Sampler Development

A Brief Report

D. Gay, April 2007, NOS



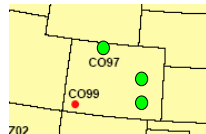
Ongoing Equipment Changes....

1. New Collector (LO)
 - Development and Testing**NOW**
2. New Collector (LODA)
 - Development and Testing now**NOW**
3. New MDN Collector (NCON)
 - Results, and Decision**LATER IN JOINT**
4. Better Collection (Deep Bucket)
 - Results**Joint**
5. Digital Gages
 - Results and Decision**Joint**
6. Wind Shields
 - Discussion

What's Going On Here?

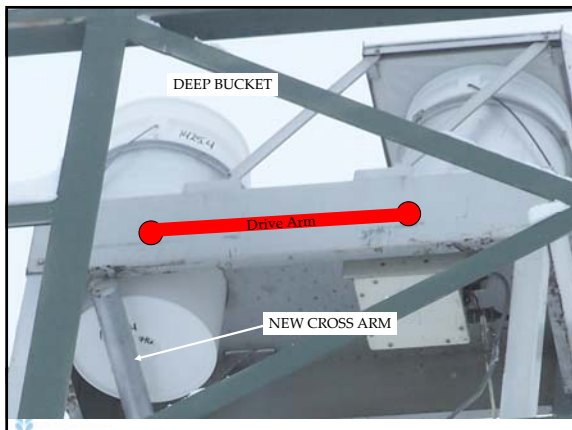
- Successfully developed, built and deployed three samplers with deeper buckets

- CO97 replacement
- CO02 collocated and slaved
- CO98 collocated and independent



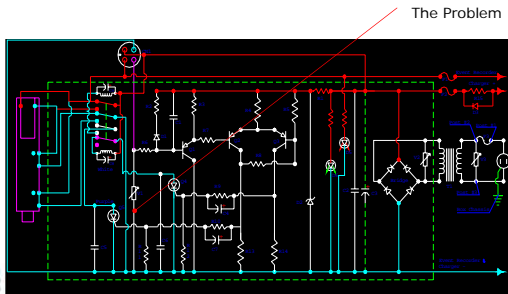
- What we did not do?

- New drive arm
- The solution is escaping us (More here)



Solving the Drive Arm Problem in the LO Sampler

What's Wrong?.....



Really.....

- Manipulating the older system into a digital system without changing the sensor sensitivity
- Sensor has to signals and two directions (but not 0 and 1, amperage)
- We have to have bi-directional system

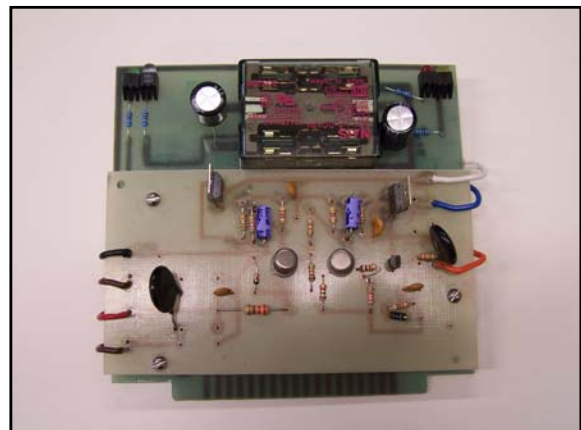
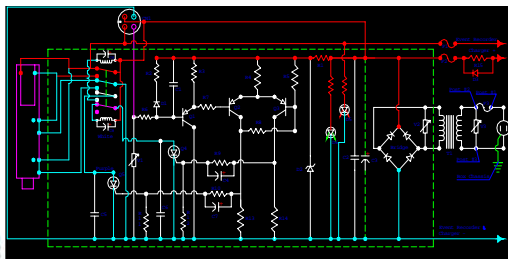
What we have done.....

- LO Design was designed and built
 - Worked wonderfully in the freezer
 - 3 weeks, open and closed every 3 minutes
 - Never missed
 - With all of the new parts
 - Linear actuator, Pull out board, warning lights
 - About \$350 retro fit
 - Put it into a deep bucket with plans to go to CO
- then we fooled it.....

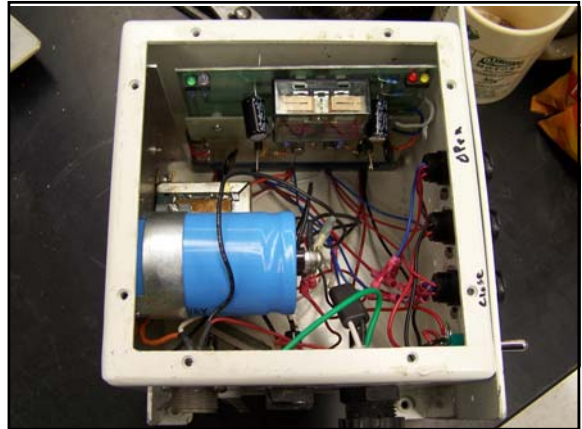
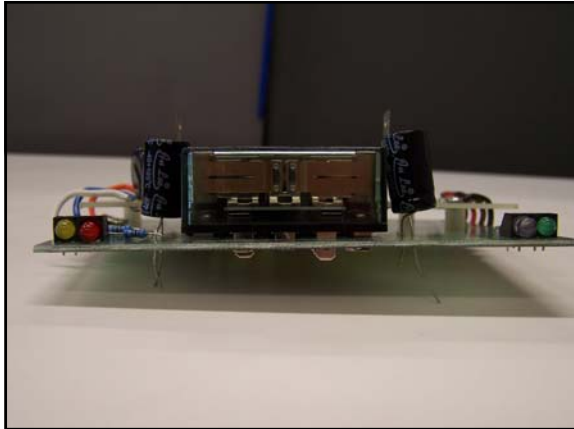
What we have done.....

- We got it to cycle with light precipitation
- Determined the problem and have made 3 more designs since then
- But now we think we know what the answer is

This is actually the answer.... Model F



Attachment 3



So what are we going to do

- Make the design work
 - Next month I hope to have one built
 - Test it in the freezer

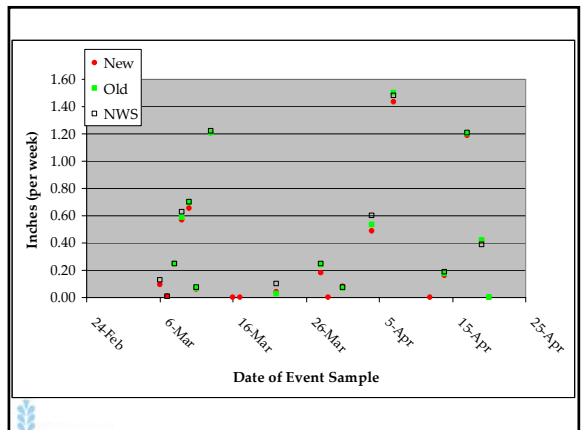
- If and when we are ready
 - Incorporate with the deep bucket
 - Put out in CO or other snow site



What is Going On With the new LODA?

- Earlier In the Spring
 - Ran great for 3 weeks in my hallway

 - Ran fine in our backyard
 - 19 Precipitation events compared to Aerochem and stick gage
 - Difference to Old Collector
 - Mean = -0.01 inches
 - Context: Many small rain events
 - Difference to Stick Gage
 - Mean = -0.02 inches
 - Context: Old Collector is -0.01 inch
 - so no difference



Attachment 3

What is Going On With the new LODA?

- Put it in the Freezer
 - Didn't run so well at 4°F
 - Open and closed it every 3 minutes
 - Would only open about 2 inches
 - Close on cue fine
 - Could push it after opening, and it would move another 2 inches
 - Tried to adjust it, but no success
 - LODA showed up Thursday to adjust it, pulled the electronics and are attempting to figure out what is going on
-



What is Going On With the new LODA?

- Therefore, not much to report
 - About where it was
 - Seems to work fine at normal temperatures
 - Reworking the flow of electricity at low temperatures
 - Attempted to call one of his customers (in Canada), but never got him
 - Needs
 - More testing
 - Fixed price
-



What's Next

- Priority
 - Back to the freezer
 - Out in the "backyard" or Bondville (M. Snider)
-



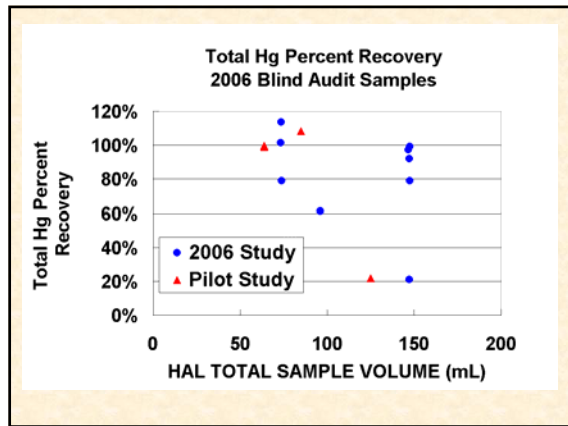
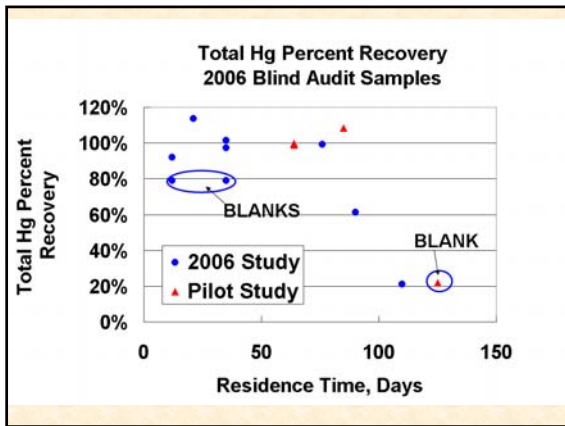
USGS EXTERNAL QUALITY ASSURANCE PROJECT

2006 PRELIMINARY RESULTS

Greg Wetherbee and Natalie Latysh

2006 MDN QA

- MDN Blind Audit
 - Shipped 20 samples
 - 75 mL and 150 mL
 - 18 samples analyzed
 - 0.76 (DI), 5.72, 14.3 ng/L



2006 BLIND AUDIT

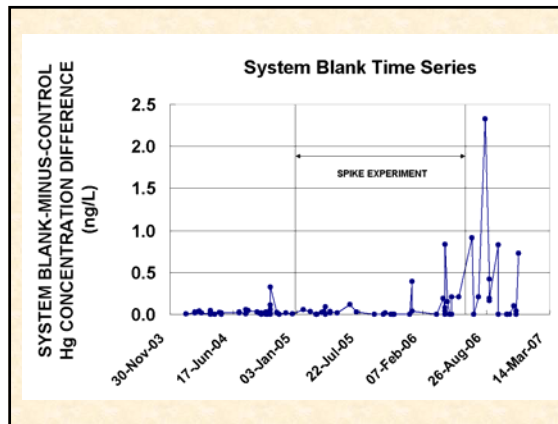
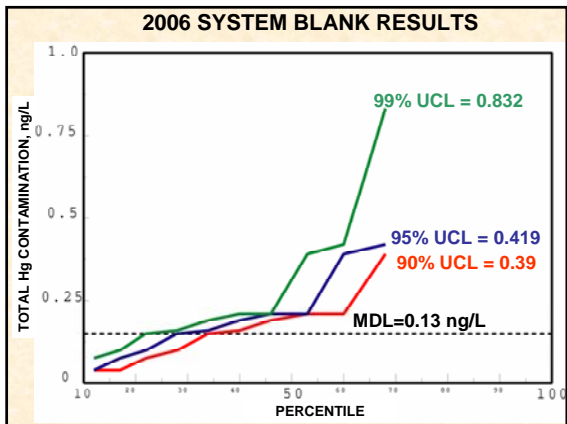
| Solution | Sample_Volume | Date_On | Target [Hg] | Total [Hg] ng/L | HAL_PC TRECOV |
|----------|---------------|-----------|-------------|-----------------|---------------|
| DI | 150 | 2/21/2006 | 0.76 | 0.700 | 92% |
| DI | 75 | 3/14/2006 | 0.76 | 0.600 | 79% |
| DI | 150 | 2/21/2006 | 0.76 | 0.600 | 79% |

BLIND AUDIT LTMDL = 0.169 ng/L

HAL MDL = 0.05 ng/L
MRL = 0.150 ng/L


2006 MDN QA


- MDN System Blank
 - Shipped 91 samples
 - 62 sites participated (68%)
 - 41 pairs of samples analyzed
 - 30 samples acceptable = not spiked
 - Of 30 samples, 15 not suspected of contamination by unknown source(s)



2006 Field Audit

- Shipped 255 samples
- 169 sites (66%) participated
- 164 sample pairs analyzed



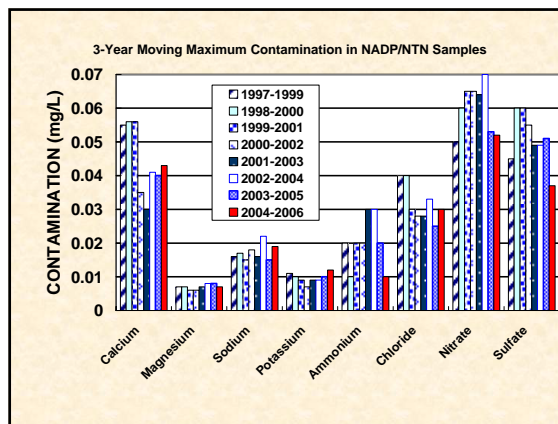
2006 Field Audit 

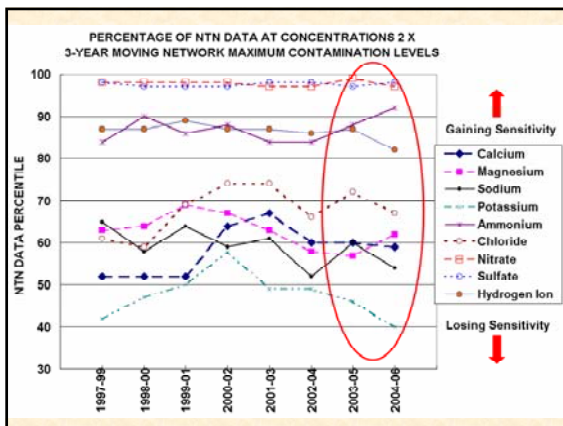
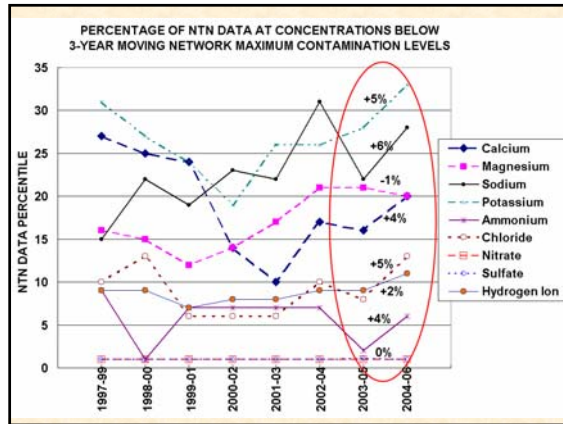
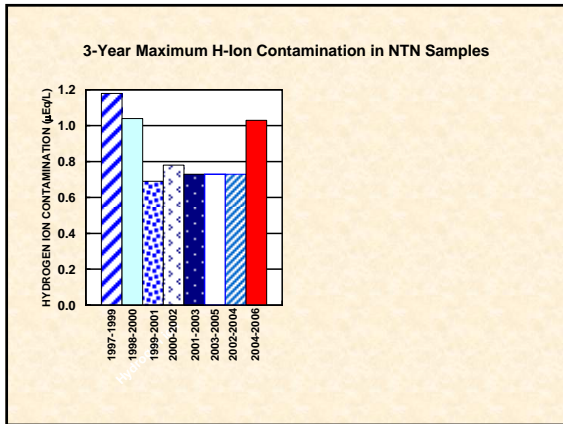
Site ops pour 75% FA sample into dry bucket that was in field for week.

Site ops submit 2 samples:
75% that rinses the bucket +
25% that remains in the original bottle

[Contamination or Loss]=[bucket]-[bottle]
+ or -

NMCL=90% UCL on 90th Ptile [Contam]





3-YR MOVING FIELD-AUDIT ANALYTE LOSS

| 3-Year Period | Calcium | Magnesium | Sodium | Potassium |
|----------------|--------------|--------------|--------------|--------------|
| 1997-99 | 0.008 | 0.001 | 0.009 | 0.003 |
| 1998-00 | 0.005 | 0.001 | 0.003 | 0.003 |
| 1999-01 | 0.002 | 0.001 | 0.002 | 0.002 |
| 2000-02 | 0.004 | 0.001 | 0.003 | 0.002 |
| 2001-03 | 0.007 | 0.001 | 0.003 | 0.003 |
| 2002-04 | 0.007 | 0.001 | 0.003 | 0.003 |
| 2003-05 | 0.008 | 0.001 | 0.003 | 0.002 |
| 2004-06 | 0.001 | 0.001 | 0.003 | 0.001 |

| 3-Year Period | Ammonium | Chloride | Nitrate | Sulfate | H |
|----------------|-------------|----------|--------------|--------------|------------|
| 1997-99 | 0.06 | 0 | 0.010 | 0.020 | 3.9 |
| 1998-00 | 0.05 | 0 | 0.010 | 0.013 | 4.3 |
| 1999-01 | 0.03 | 0 | 0.010 | 0.015 | 4.2 |
| 2000-02 | 0.02 | 0 | 0.010 | 0.016 | 3.4 |
| 2001-03 | 0.02 | 0 | 0.013 | 0.016 | 3.9 |
| 2002-04 | 0.02 | 0.002 | 0.013 | 0.018 | 3.9 |
| 2003-05 | 0.03 | 0.003 | 0.019 | 0.029 | 3.6 |
| 2004-06 | 0.04 | 0 | 0.012 | 0.008 | 3.1 |

2006 NTN TRIPLE BLIND AUDIT


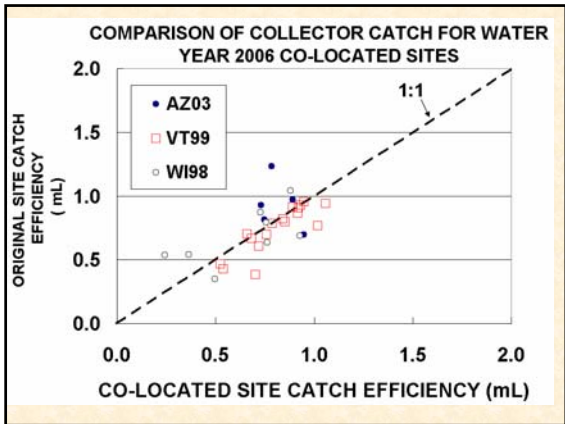
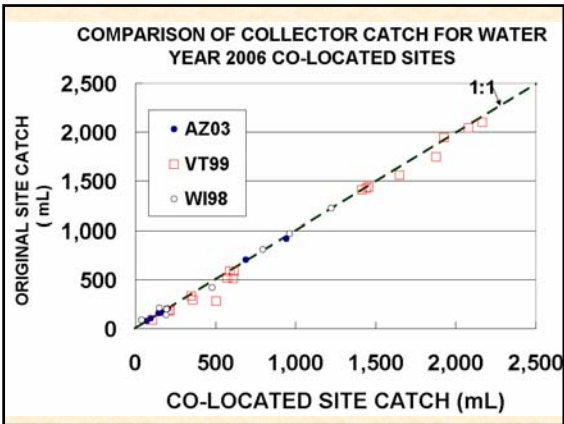
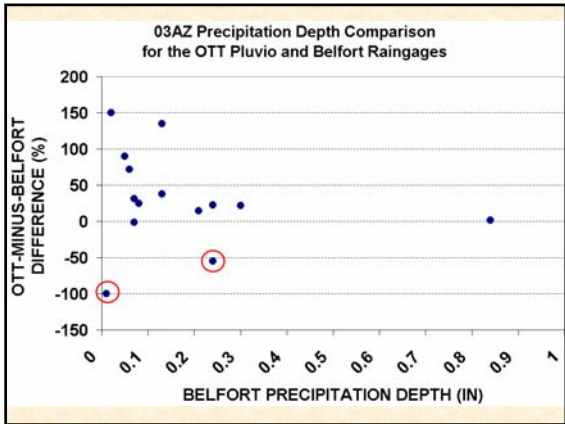
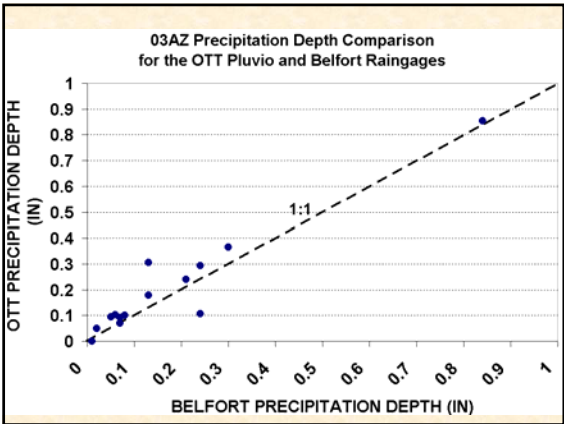
- CAL does not know samples are QC – unless...
CAL does not know sample concentrations
CAL does not know why we're doing study!
- 20 DI SAMPLES SHIPPED, 19 SUBMIT TO CAL,
1 SAMPLE RUN AS A DUPLICATE, N=20
- OUTLIERS REMOVED BY GRUB'S TEST
- OBJECTIVE:
LTMDL = $t_{n,df} \times \text{Std. Dev. of concentrations}$

2006 NTN TRIPLE BLIND AUDIT

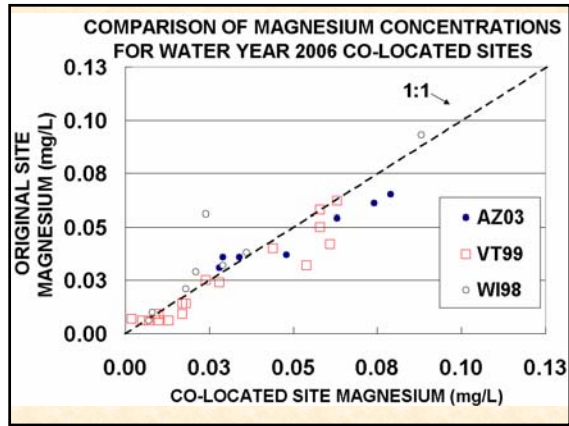
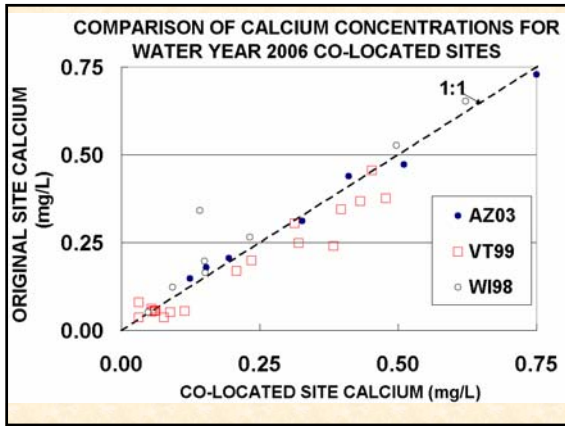
| Analyte | 2006 NTN Blind Audit Long-Term | |
|----------------------|--------------------------------------|--------------------------------|
| | CAL Reported Detection Limits (mg/L) | Method Detection Limits (mg/L) |
| Calcium | 0.002 | 0.002 |
| Magnesium | 0.001 | 0.001 |
| Sodium | 0.002 | 0.005 |
| Potassium | 0.001 | 0.001 |
| Ammonium | 0.003 | 0.003 |
| Chloride | 0.003 | 0.004 |
| Nitrate | 0.013 | <0.001 |
| Sulfate | 0.012 | <0.001 |
| Phosphate | 0.004 | 0.001 |
| Specific Conductance | | 0.300 |

2006 Co-located Sites

- Co-located Sites AZ03, WI98, VT99
- Duplicate sets of instruments at each site.
- Estimate overall variability in NTN measurements
- Algorithms for new instrumentation

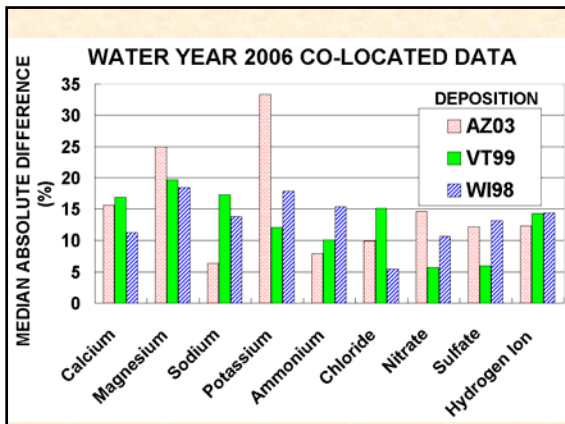
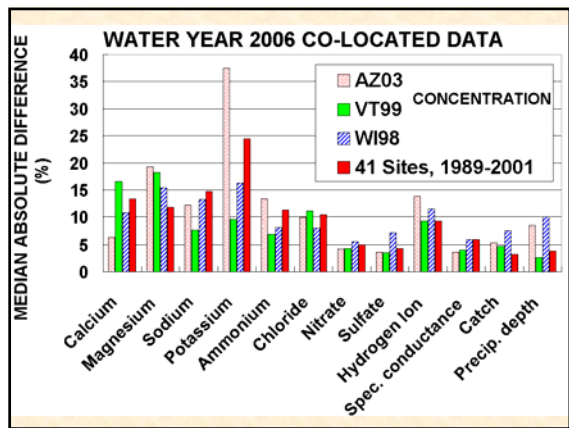
Attachment 4



WI98 / 98WI = BIRD HEAVEN!!

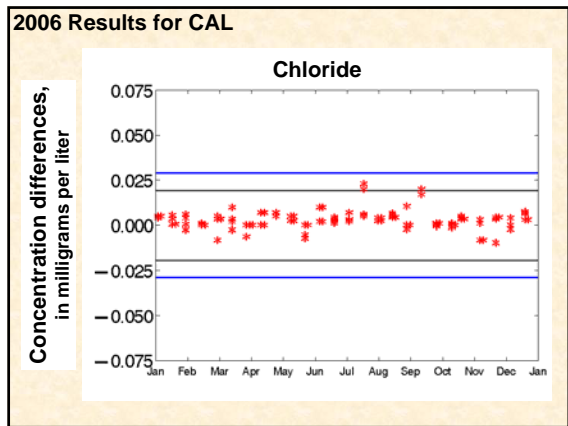
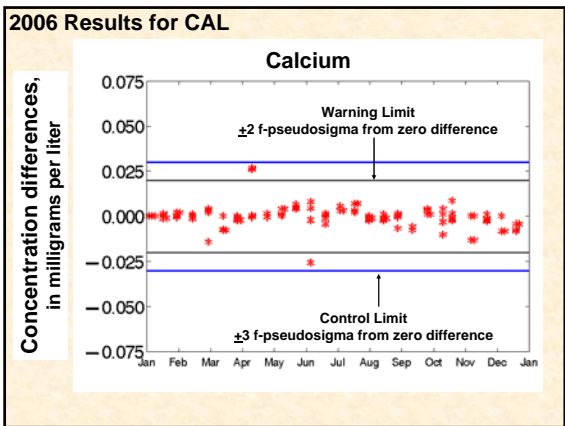
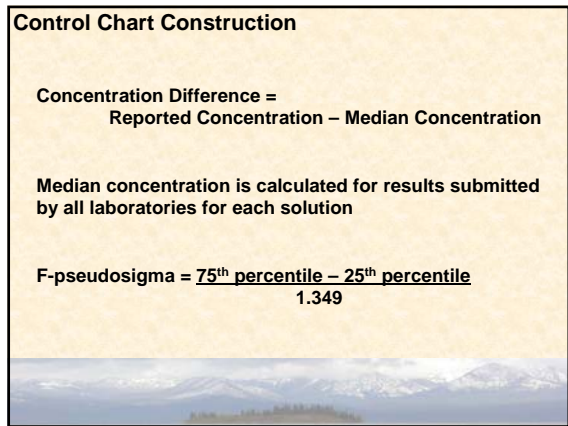
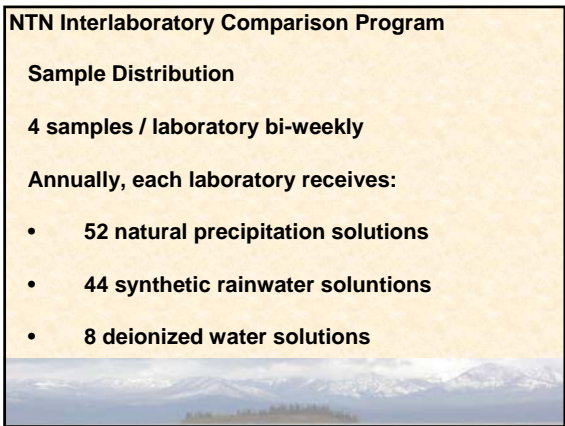
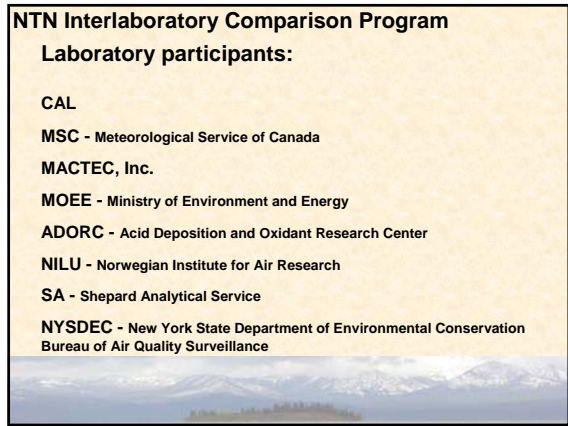
Of 52 pairs of samples,
Only 8 were "W" coded
with NO contamination!

SOLUTION
→
NADP OFFICIAL
INFLATABLE
MARK NILLES
BIRD
ELIMINATOR!!

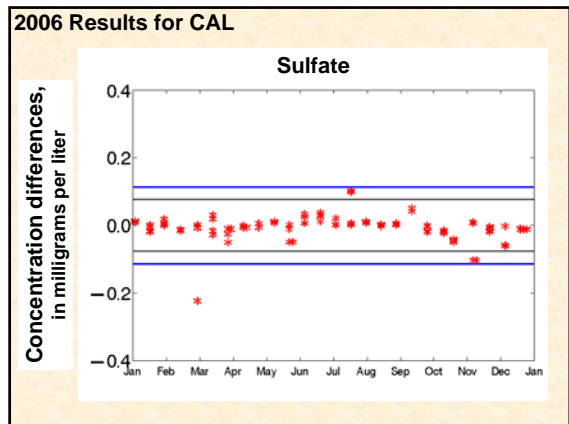
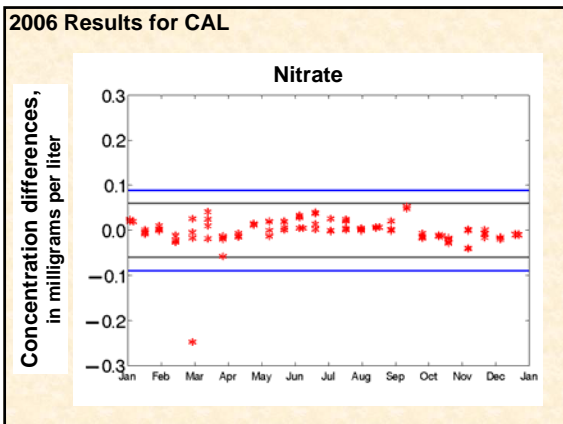
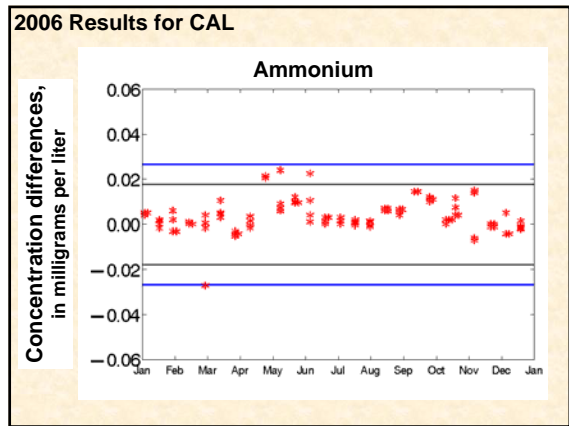
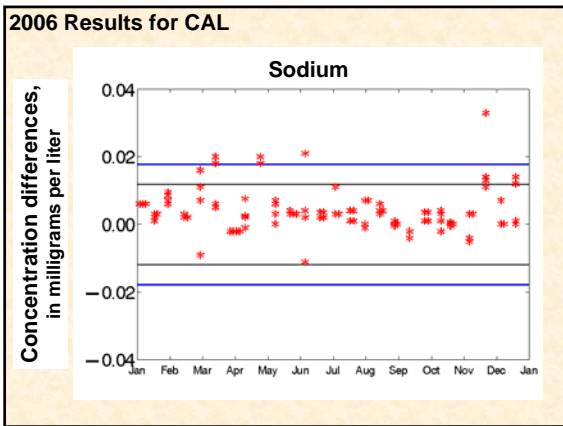
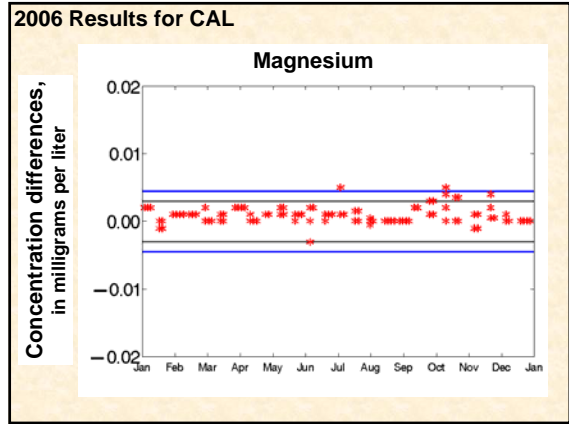
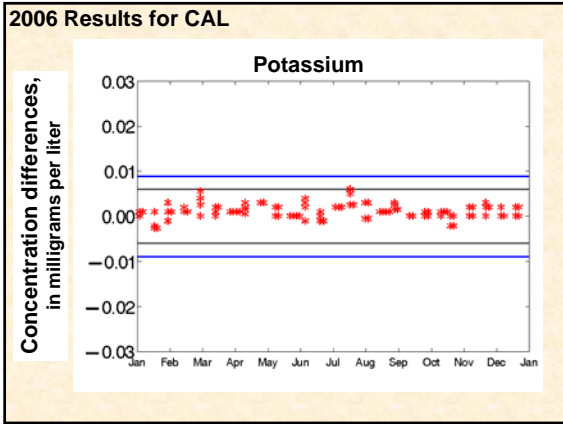


| Analyte | f-pseudosigma ² 41 Co-located Sites 1989-2001 | 2006 f- pseudosigma | f-pseudosigma ratio (2006 fps/41 Sites fps) |
|----------------------|--|------------------------|--|
| Calcium | 0.095 | 0.028 | 0.30 |
| Magnesium | 0.004 | 0.005 | 1.30 |
| Sodium | 0.019 | 0.012 | 0.62 |
| Potassium | 0.006 | 0.003 | 0.49 |
| Ammonium | 0.044 | 0.022 | 0.51 |
| Chloride | 0.022 | 0.016 | 0.74 |
| Nitrate | 0.111 | 0.079 | 0.71 |
| Sulfate | 0.089 | 0.050 | 0.57 |
| Hydrogen Ion | 2.45 | 1.89 | 0.77 |
| Specific Conductance | 1.26 | 0.741 | 0.59 |
| Collector Catch | 30.1 | 38.7 | 1.29 |
| Precipitation Depth | 0.907 | 0.377 | 0.4 |

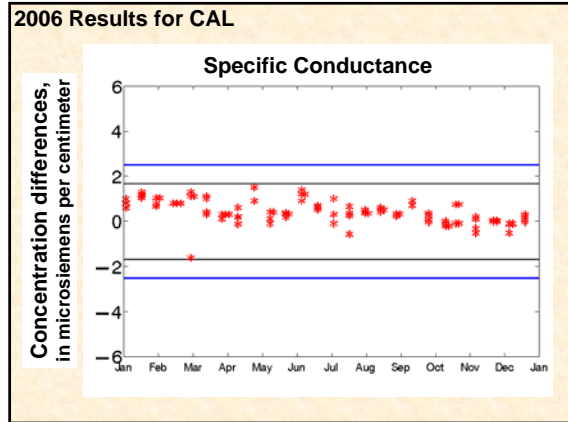
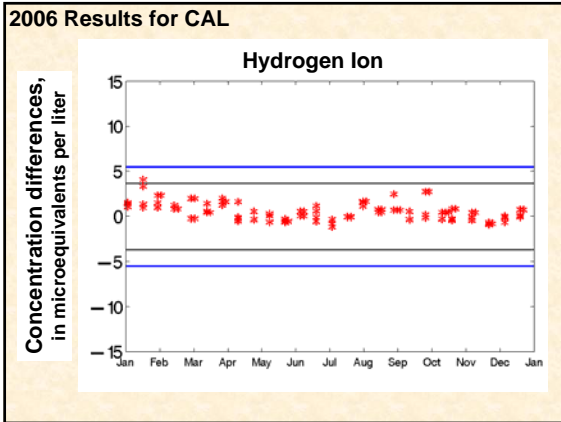
Attachment 4



Attachment 4



Attachment 4



2006 Deionized Water Results
Number of analyte determinations > MDL

Ultrapure DI (8 samples/year)

| Lab | NH ₄ | Ca | Cl | Mg | NO ₃ | K | Na | SO ₄ |
|--------|-----------------|----|----|----|-----------------|---|----|-----------------|
| CAL | 3 | | | | | 1 | | 1 |
| MSC | 1 | | | | | | | |
| MACTEC | | | | | | | | |
| MOEE | 3 | | | | 4 | | | |
| NILU | 1 | | | | 1 | | | 1 |
| ADORC | | | | | | | 2 | |
| SA | | | | | | | | |
| NYSDEC | 1 | 2 | 1 | | | | | |

MDN Interlaboratory Comparison Program

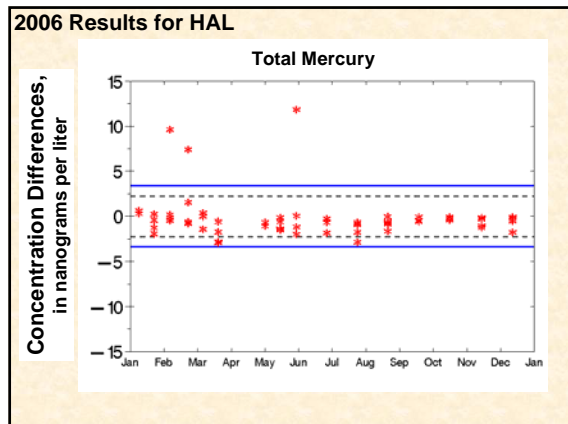
HAL - Mercury Analytical Laboratory
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MDN Interlaboratory Comparison Program

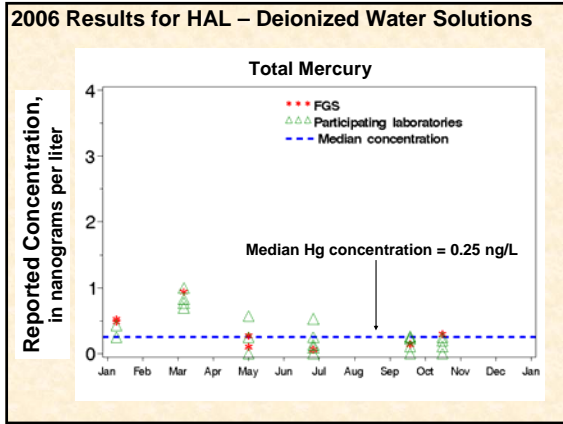
Mailing Schedule

4 samples mailed monthly to FGS, NSA, NLS
(52 samples/year)

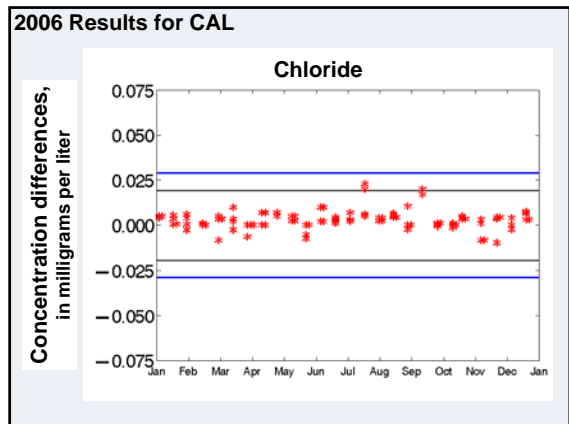
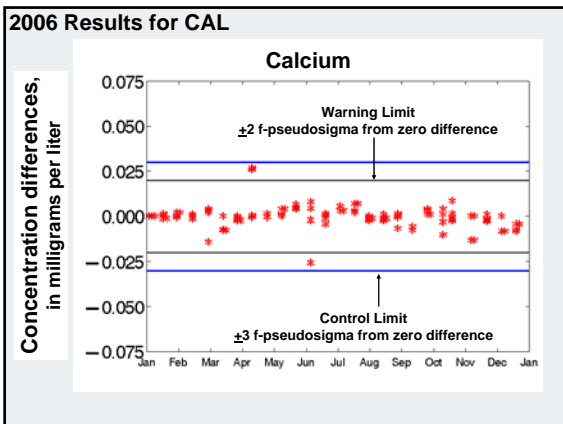
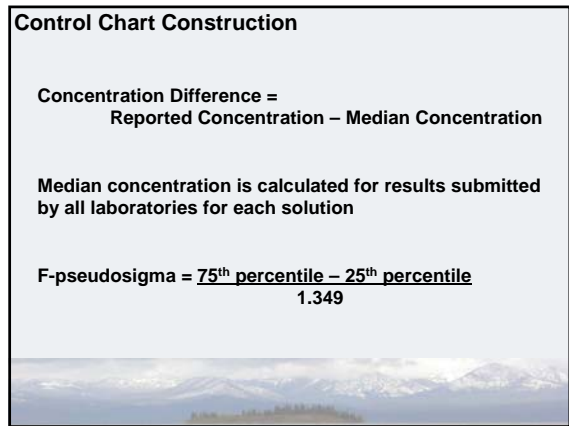
2 samples mailed monthly to ACZ, WML, IVL
(26 samples/year)



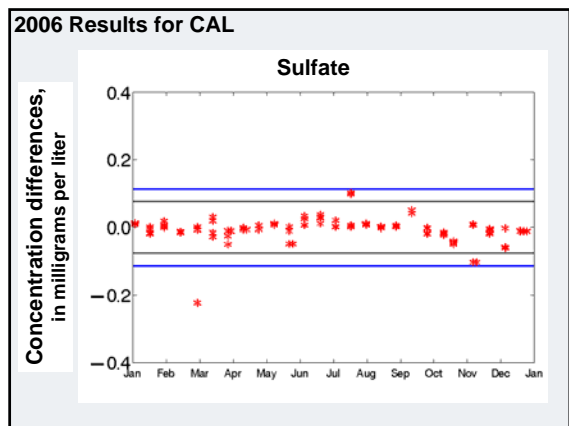
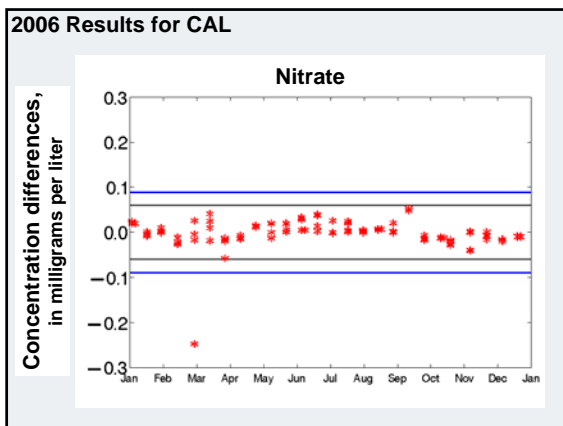
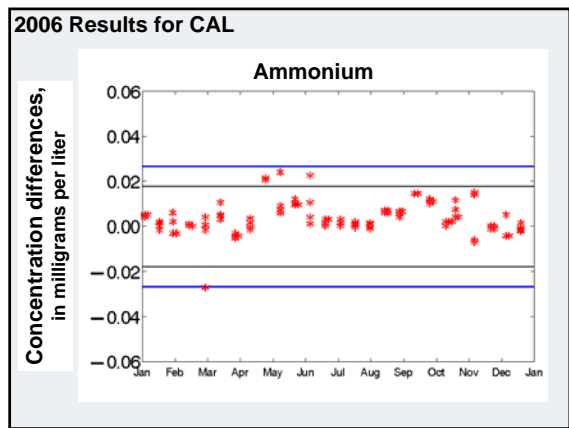
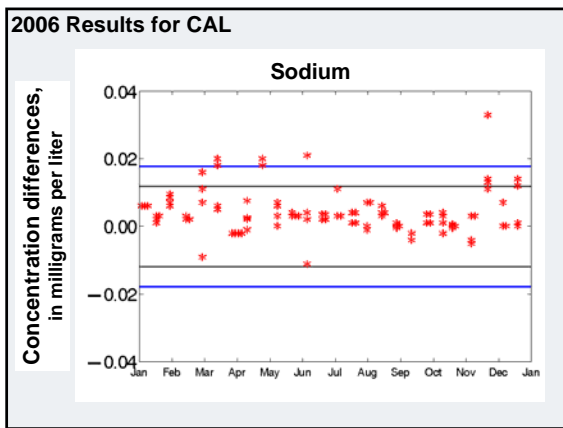
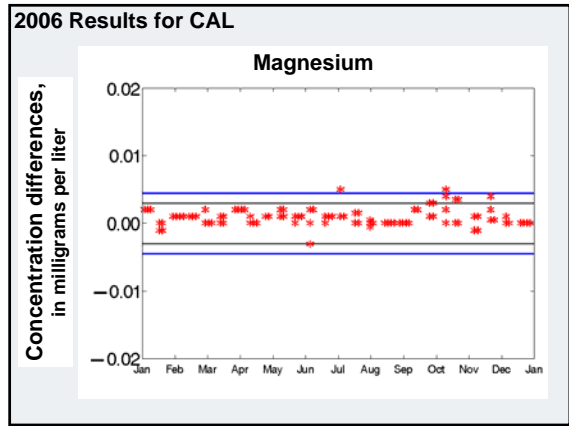
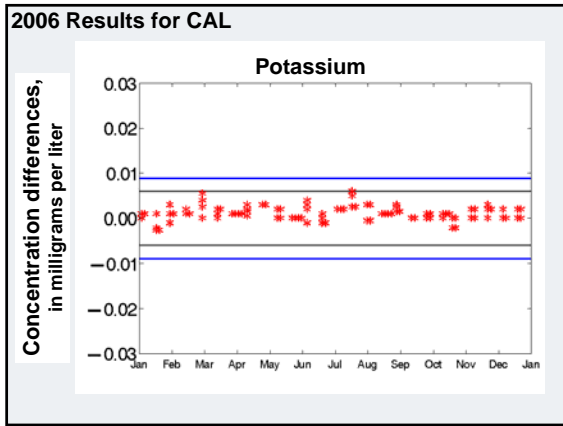
Attachment 4



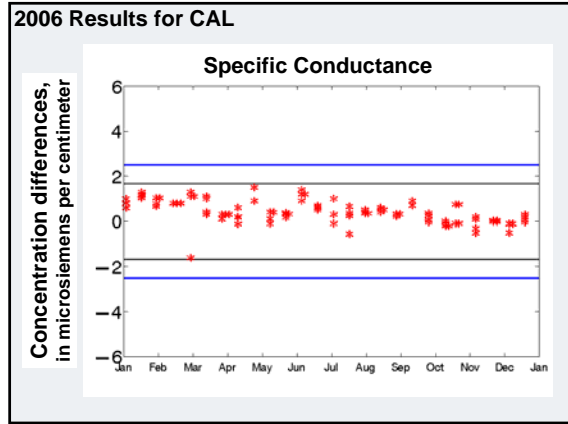
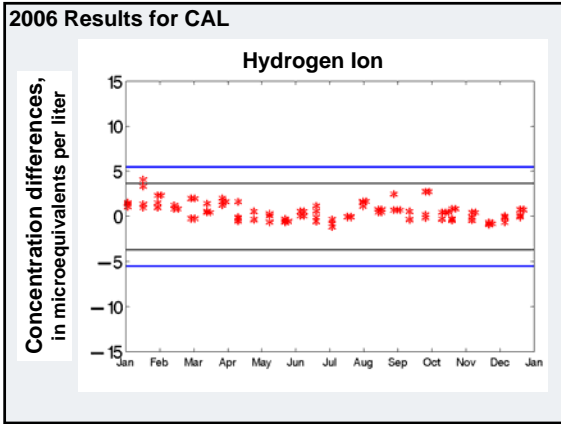
Attachment 4



Attachment 4



Attachment 4



2006 Deionized Water Results
Number of analyte determinations > MDL

Ultrapure DI (8 samples/year)

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| MSC | 1 | | | | | | | |
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| MOEE | 3 | | | | 4 | | | |
| NILU | 1 | | | | 1 | | | 1 |
| ADORC | | | | | | | 2 | |
| SA | | | | | | | | |
| NYSDEC | 1 | 2 | 1 | | | | | |

MDN Interlaboratory Comparison Program

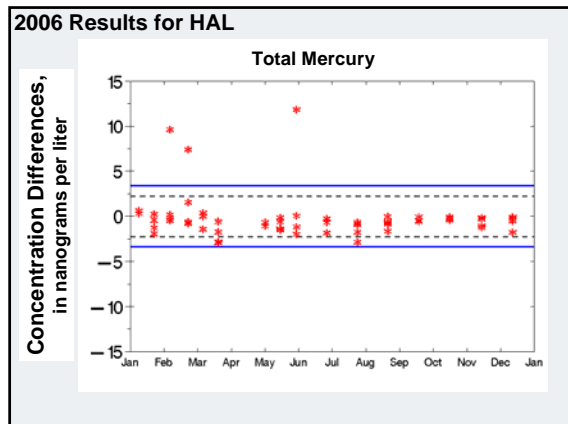
HAL - Mercury Analytical Laboratory
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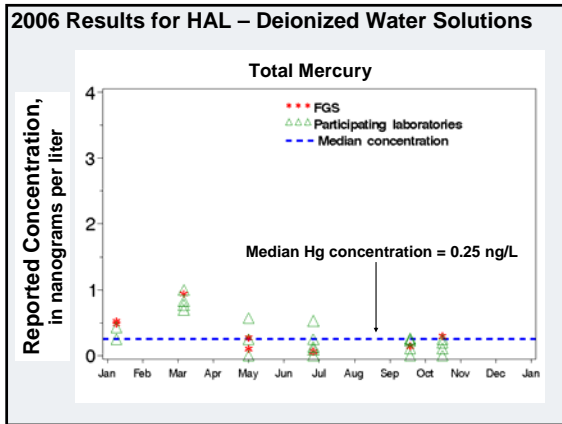
MDN Interlaboratory Comparison Program

Mailing Schedule

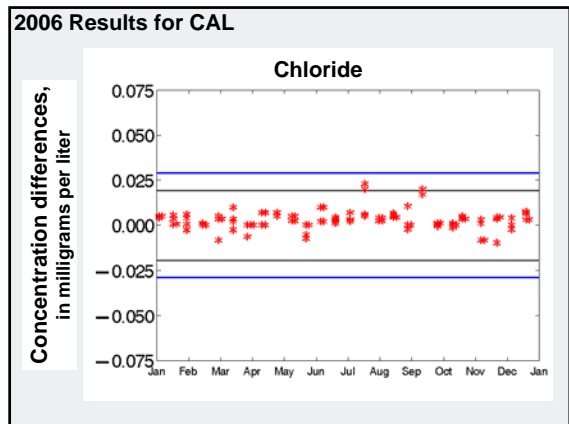
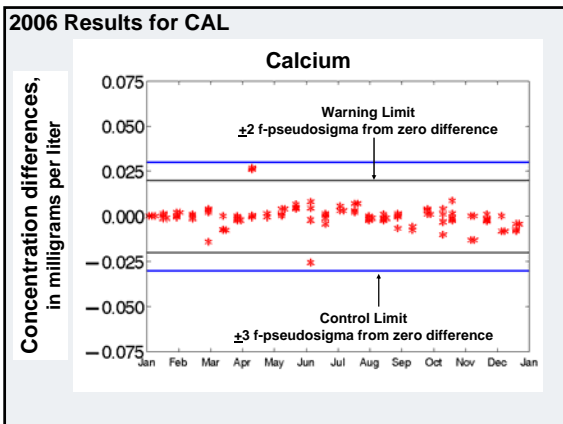
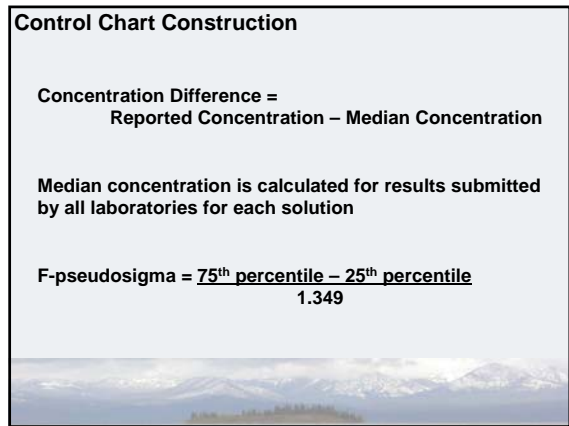
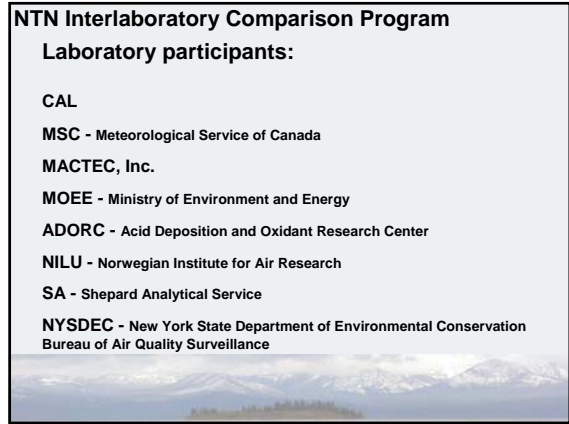
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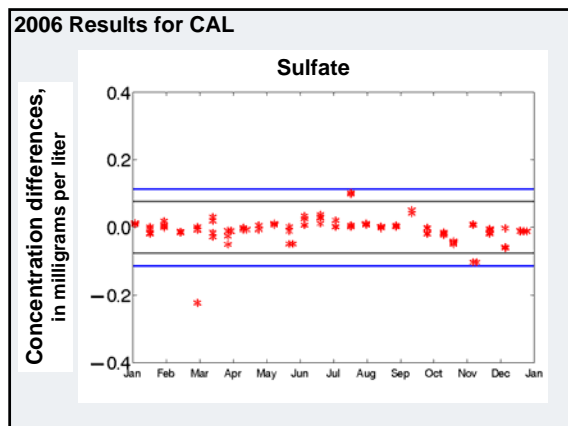
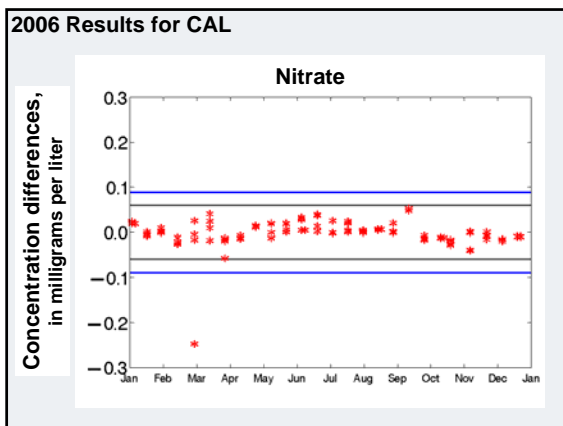
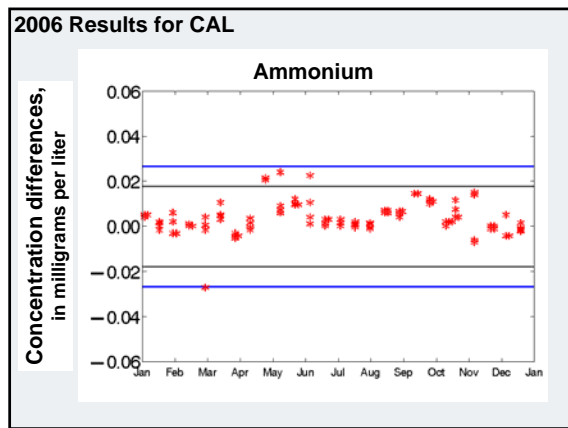
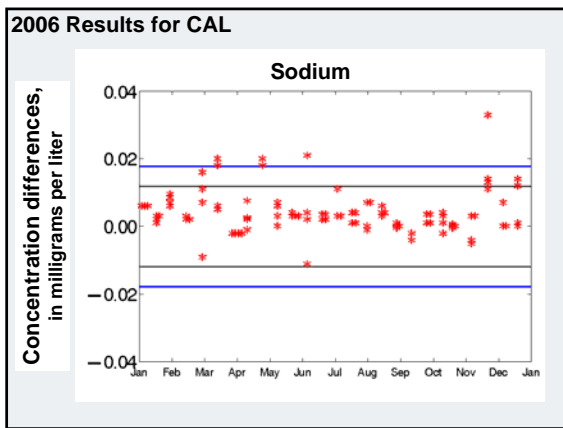
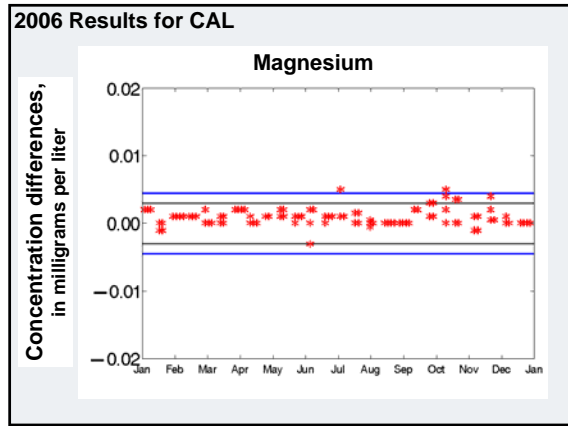
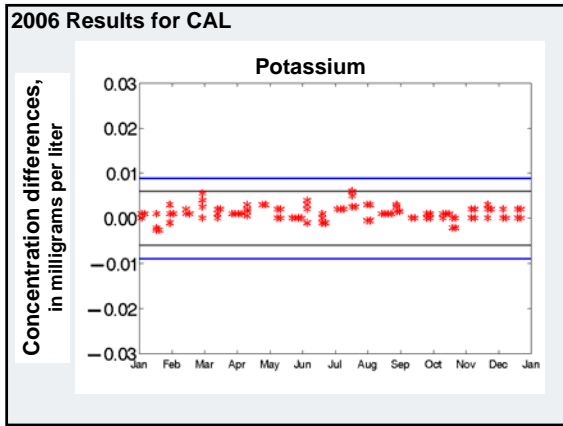




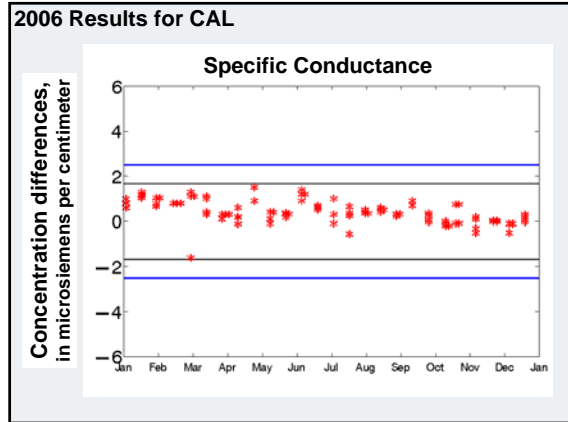
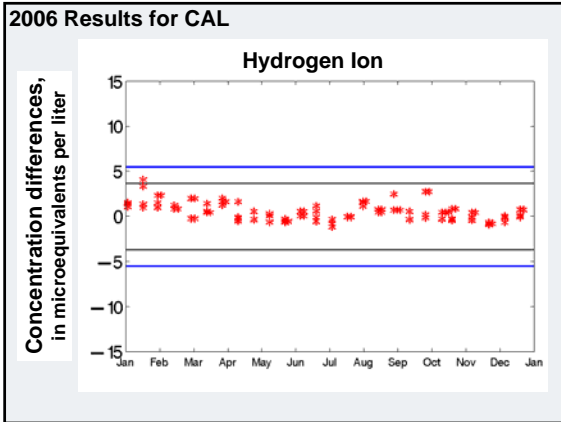
Attachment 4



Attachment 4



Attachment 4



2006 Deionized Water Results
Number of analyte determinations > MDL

Ultrapure DI (8 samples/year)

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| NILU | 1 | | | | 1 | | | 1 |
| ADORC | | | | | | | 2 | |
| SA | | | | | | | | |
| NYSDEC | 1 | 2 | 1 | | | | | |

MDN Interlaboratory Comparison Program

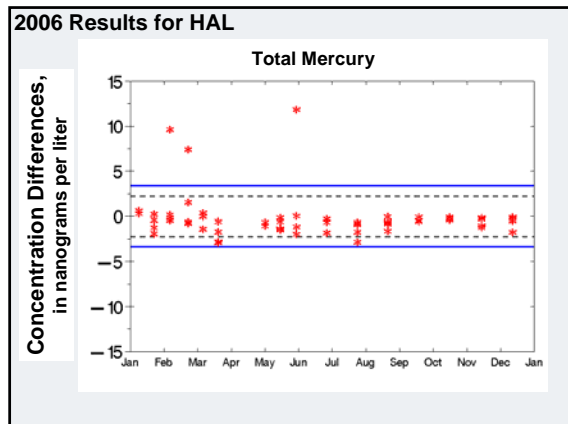
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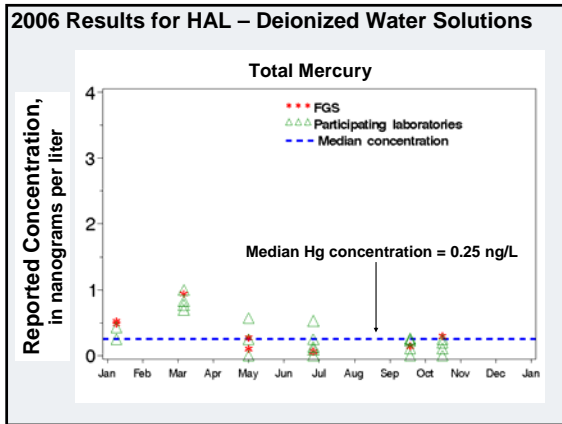
MDN Interlaboratory Comparison Program

Mailing Schedule

4 samples mailed monthly to FGS, NSA, NLS (52 samples/year)


2 samples mailed monthly to ACZ, WML, IVL (26 samples/year)





High Altitude Test "Colorado Experiment"

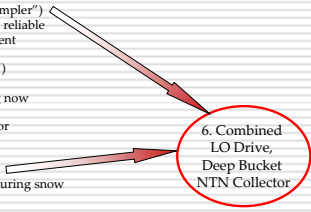
Greg Wetherbee
USGS
David Gay
P.O.
Spring 2007



Summary of ALL Ongoing Collector Modifications....

1. Aerochem Retro-fit ("LO Sampler")
 - Save \$ & samples, more reliable
 - Testing, Field Deployment
2. New Collector ("Loda 2005")
 - more reliable
 - Development & Testing now
3. New MDN -NCON Collector
 - Approved
4. Deep Bucket NTN Collector
 - Better NTN collection during snow
 - operating in field
5. Second Chimney Modification
 - Better MDN collection during snow
 - Sample built

6. Combined
LO Drive,
Deep Bucket
NTN Collector



Two Part Experiment

- Install both a "LO" Drive, Deep Bucket Sampler at multiple locations
- Install a Sampler opened by a Raingage



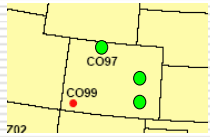
Deep Bucket Collector

Later in NOS
"Colorado Experiment"

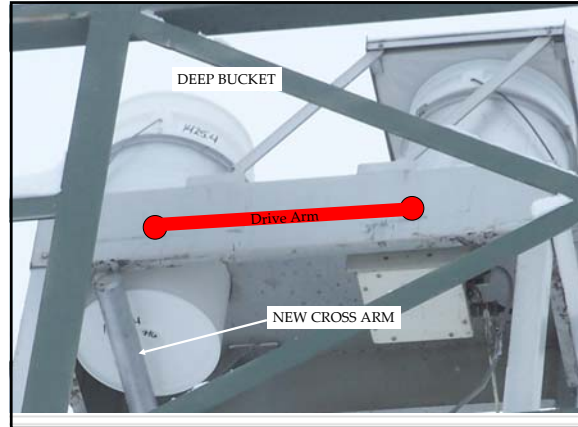


What's Going On Here?

- Successfully developed, built and deployed three samplers with deeper buckets
 - CO97 replacement
 - CO02 collocated and slaved
 - CO98 collocated and independent
- What we did not do?
 - New drive arm
 - The solution is escaping us (More here)



Attachment 5



-
- Planning document
 - Summarize here

 - Go in May
 - Do x at CO02
 - Do y at CO98
 - Do z at CO97
-


-
- Figure'
 - Set up (including Power, wind breaks) of regular NTN at CO98
 - Set up (including Power, wind breaks) of ETI Driven NTN at 98CO
-

Attachment 5

Results

- What is van seeing
 - Does van like what he is seeing

 - See van's email to Kristi
-




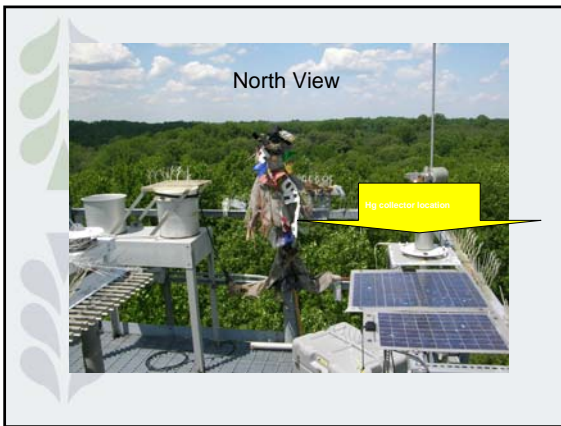
**NADP Siting Criteria
Follow-up**

Network Operations
Subcommittee
April 2007



NOS Fall 2006

- MDN-MD00 (Smithsonian Research) approved by NOS. "The site has too many siting criteria issues to be an ordinary MDN site..."
- NOS approved "Special Purpose Site" classification for MD00 and similar sites.
 - Data from sites would be available on NADP web site
 - Isopleth maps would not include data from these sites
- Site approval committee should create guidelines
 - NOS Chair
 - NOS Vice Chair
 - QA Manager



Siting Criteria Revisions...

- PULL UP WORD FILE



Motions....

- Move to accept the revisions we just worked out
- Motion to refer data issues to DMAS?

Lake Dubai (WI28) Move

- NTN-WI28 (Lake Dubai) moved 10.6 km northwest of its previous location on January 31, 2006.
 - The Lake DuBay reservoir to the north of the old WI28 NTN site could provide for wind swept snow during winter months to be carried from the frozen surface of the reservoir behind the Lake DuBay dam to the NTN sampler. Collection of wind driven snow off the surface of the reservoir would not be representative of actual snowfall events but of the snow on the ice cover.
 - The security chain-link fence to the west of the previous WI28 site was too close to the Belfort recording raingage. Siting criteria for raingage exposure was not met.

Lake Dubai (WI28) Move

- ATS audit prior to 2006 suggested relocating the WI28 NTN site to the WDNR air monitoring station 10.6 km northwest of the old site. This move would collocate the NTN sampling equipment with the WDNR ozone and meteorological station. A USDA UV-B monitoring site is also at the Bergen Road site. Relocation would eliminate the siting concerns mentioned above. The Bergen Road site is much more accessible than the old power dam site and allows the site operator to collect and process NTN samples at the same location and requires much less time to collect and process each sample.

Lake Dubai (WI28) Move


- NADP Site Selection & Installation Manual
 - Sites moving further than 10 km or into a different type of topography, ecoregion, or land use must reapply for admission to the network as a new site. Such a move requires submission of a complete set of siting documents to the coordinator's office for approval. A new site name, CAL code, and station number will be assigned to the new site.





Lake Dubai (WI28) Move

- MOTION: Allow WI28 to retain site ID, even though move of 10.6 km is further than that allowed in the Site Selection & Installation Manual



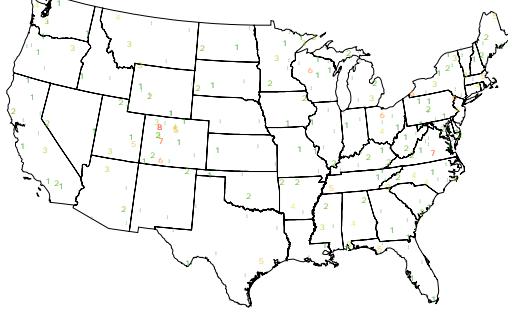
**Site Systems and
Performance Surveys**

NADP Network Operations
Subcommittee
April 2007

Surveys Conducted in 2006/07



NTN Siting Criteria Issues



MDN Siting Criteria Issues



AIRMoN Siting Criteria Issues

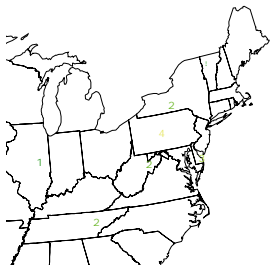


Table 1. Site Survey Reports Received, Reports Issued, and Remedial Actions, January 2004-present

| Network | Reports received from survey team | Summary reports issued to site | Surveys released for internet posting | Sites having siting criteria issues ^a | Number of violations ^b / number of objects in violation ^c | Sites reporting remedial actions | Number of violations corrected / objects removed ^d |
|---------------------------------------|-----------------------------------|--------------------------------|---------------------------------------|--|---|----------------------------------|---|
| 2005 Surveys | | | | | | | |
| NTN | 79 | 79 | 79 | 48 | 124 / 79 | 3 | 8 / 5 |
| MDN | 22 | 22 | 22 | 12 | 23 / 21 | 0 | 0 / 0 |
| AIRMoN | 1 | 1 | 1 | 0 | 0 / 0 | 0 | 0 / 0 |
| Total | 102 | 102 | 102 | 60 | 147 / 100 | 3 | 8 / 5 |
| 2006 Surveys | | | | | | | |
| NTN | 74 | 17 | 1 | 37 | 79 / 33 | 0 | |
| MDN | 28 | 3 | 1 | 10 | 22 / 7 | 0 | |
| AIRMoN | 3 | 1 | 0 | 3 | 6 / 6 | 0 | |
| Total | 103 | 27 | 2 | 50 | 107 / 46 | 0 | |
| 2007 Surveys (through January) | | | | | | | |
| NTN | 4 | 0 | 0 | 2 | 5 / -- | | |
| MDN | 4 | 0 | 0 | 1 | 1 / -- | | |
| AIRMoN | 0 | 0 | 0 | 0 | 0 / -- | | |
| Total | 8 | 0 | 0 | 3 | 6 / -- | | |

Attachment 6




Table 2. Remedial Actions Reported to Program Office, January 2006 – April 1, 2007

| Network | Site ID | Survey Date | Reported Improvement |
|---------|---------|-------------|---|
| NTN | NC03 | 3/23/2005 | Site improvements reported 11/30/2005 as follows: 45 degree obstruction to raingage removed. 5m obstruction to collector removed. 5m obstruction to raingage removed. Collector wet bucket azimuth corrected to be within 270 +/- 45 degrees. |
| NTN | NYS6 | 8/25/2005 | Site improvements reported 1/17/2007 as follows: Vegetation >0.3 m in height removed within 5m of collector and raingage. |
| NTN | UT01 | 9/22/2005 | Site improvements reported 9/26/2006 as follows: 5m obstruction to collector removed. 5m obstruction to raingage removed. Vegetation >0.3 m in height removed within 5m of collector and raingage. |
| MDN | FL34 | 2/14/2006 | Site improvements reported 2/28/2006 as follows: MDN collector moved from lower to ground. |
| MDN | FL04 | | Site improvements reported as follows: MDN collector was relocated to a ground-level location as relocated site FL97. |




Table 3. Siting Criteria Summary for the NTN, MDN, & AIRMoN

| | NTN | MDN | AIRMoN |
|--|-----------|----------|---------|
| Number of records | 246 | 75 | 7 |
| No siting criteria violations | 107 (43%) | 37 (47%) | 1 (14%) |
| Azimuth of wet bucket deviates by more than 45deg. from W | 12 (5%) | 4 (5%) | 1 (14%) |
| Vertical distance raingage-collector > 0.3m | 11 (4%) | 10 (13%) | 1 (14%) |
| Raingage not within 5 – 30m from collector | 28 (11%) | 5 (6%) | 1 (14%) |
| Objects within 5m of collector | 52 (21%) | 12 (15%) | 1 (14%) |
| Objects within 5m of Raingage | 49 (20%) | 14 (18%) | 1 (14%) |
| Vegetation height >0.6m within 5m of collector | 28 (11%) | 9 (10%) | 1 (14%) |
| Objects impeding 45 degree vertical clearance of collector | 32 (13%) | 7 (9%) | 0 (0%) |
| Objects impeding 45 degree vertical clearance of raingage | 37 (15%) | 10 (13%) | 1 (14%) |
| Residential structures impeding 30 degree clearance of collector | 2 (1%) | 1 (1%) | 0 (0%) |
| Pastures within 20m of collector | 21 (9%) | 3 (4%) | 0 (0%) |
| Mobile pollution sources within 100m of collector | 49 (20%) | 14 (18%) | 1 (14%) |
| Feedlots within 500m of collector | 6 (2%) | X | 0 (0%) |





Table 4. Impact of site surveys on the number of siting criteria violations for sites visited more than once since 2002.

| Network | Number of Surveys Compared / Number of Sites with Siting Criteria Violations | Number of Sites with Decreasing Number of Siting Criteria Violations | Number of Sites with No Change in Siting Criteria Violations | Number of Sites with Increasing Number of Siting Criteria Violations |
|--------------|--|--|--|--|
| NTN | 107 / 67 | 32 (47%) | 25 (38%) | 10 ^a (15%) |
| MDN | 33 / 24 | 18 (75%) | 4 (17%) | 2 ^b (8%) |
| AIRMoN | 4 / 4 | 2 (50%) | 1 (25%) | 1 (25%) |
| Total | 144 / 95 | 52 (55%) | 30 (32%) | 13 (13%) |

^a 16 sites gained violations if all NTN surveys considered.
^b 4 sites gained violations if all MDN surveys considered.



2006 HAL REVIEW

POINT

Greg Wetherbee, USGS

COUNTERPOINT

Bob Brunette, Frontier Geosciences, Inc.

2006 HAL REVIEW TEAM

Greg Wetherbee, USGS, Team Leader

Health & Safety, Data Management, Report Prep

Steve Brooks, NOAA

Quality Assurance, Analytical Chemistry, Operations

Sean Lawson, VT Monitoring Cooperative

Site Liaison, Field Operations

Andrew Heyes, Univ. of MD, CBL

Analytical Chemistry, Quality Assurance, Operations

OBSERVATIONS

HAL STAFF

- 18 People
- 7.85 FTE = core HAL operations,
- 0.65 FTE = technical support



- Robert Brunette, HAL Director
- Gerard Van Der Jagt, MDN Project Manager
- Doug Disney, MDN Site Liaison,
- Ryan Nelson, Senior Analyst,
- Andrew Dawson, Technician,
- Adela Blaga, Analyst/Technician, and
- Amber Dichter, Project Management Support.

HAL STAFF



- Employees have good background – most with chemistry, biology, or environmental degrees.
- The three MDN Total Hg Analysts have 2.5 years, 1.5 years, and 3 mo. experience at HAL. **Seems short.**
- Long-term maintenance knowledge? (e.g.: changing gold traps on N₂ and Ar Tekran UV lamps changed when "bad")
- Given that MDN expands 10-15%/yr HAL must work to maintain an adequate staff of experienced Analysts.

HAL Response

Audit Team: The three MDN Total Hg Analysts have 2.5 years, 1.5 years, and 3 mo. experience at HAL. **Seems short.**

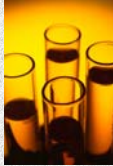
- Frontier Has A Rigorous/Performance Based Training Program
- Staff Are Required To Pass Blind PE Sample Audits
- New Analytical Staff Are Well Supervised By Experts
- Analytical System Configuration Allows Rapid Learning Curve

Brunette - 12 Years Analysis Experience
Prestbo - 16 Years Analysis Experience
Van der Jagt - 6 Years Analysis Experience
Dichter - 9 Years Analysis Experience

- Additional 5 Staff Each With Greater Than 5 Years Analysis Exp

Health and Safety

- Facility is secure
- Overall reasonably safe workplace
- H&S Officer well qualified
- Training records and equipment in good order
- Written policies are required reading for staff
- **Outdoor waste storage vulnerable**



HAL Response

Audit Team: **Outdoor waste storage vulnerable**

HAL Agrees:

- Outdoor Storage Area Not Locked During Audit
- This Area, At Times, Is A Heavily Utilized Area
- Haz Waste Area Should Be Locked When Not in Use

PHYSICAL PLANT

- Get electrical heat in the new building
- HAL Response – No evidence Of Gas Heating System Impact On Trace Metals Analysis or Health and Safety**
- Hg in ambient lab tracked ~monthly, OK.
- Hg controls on water and reagents – OK
- Hoods routinely checked & maintained - OK

HAL NED

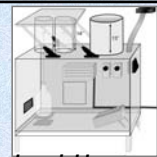
- *Appropriately stocked with most items*
- *Excellent job meeting site operators' needs quickly*

Exception:

Dual pen event recorders – becoming non-issue

HAL Disagrees:

- **There are 40+ MDN/NTN Sites That Need Dual Pen ER's**
- **HAL Typically Has No Dual Pens On Site**
- **HAL Also Needs 5 Replacement Belfort Gauge**



Site Operator Training

- *High-quality site operator training*
- *Training new site operators in person by HAL staff should continue.*




Site Liaison

- *Good records of communications with operators*
- *Sample tracking and NED parts tracking well organized*




Total Hg ANALYSIS



- Analysis of T-Hg consistent with EPA method 1631
- Equipment performance tests adequate & consistent with RFP.
- No significant deviations from the SOP's

THg ANALYSIS


- Instrument calibration - OK.
- Laboratory analytical spaces clean.
- Contamination monitoring -OK (air, acid baths, water quality etc.)
- Lab-monitoring data should be assimilated into the database at a reasonable pace - 1 year behind.



HAL Response

- The HAL Monitors Hg In :
 - Lab Air (For The Past 16 Years)
 - Water
 - Reagents
 - Acid Vats
- Lab Air Monitoring Data Not Summarized
- HAL Will Review Whether:
 - Lab Air Monitoring Data Is Really Needed
 - Submit Response To PO QA Manager

MeHg ANALYSIS




- MeHg analysis generally follows Method 1630.
- Generally good practices, but there are issues to resolve.
- Chart recorders for peak integration are acceptable, but upgrade to electronic data acquisition preferred.

HAL Response

Audit Team: Chart recorders for peak integration are acceptable, but upgrade to electronic data acquisition preferred.

- **HAL Response To Recommendation #30 Above:** The HAL agrees with the Audit Team note that the HAL can modernize our analysis signal measurement. This does require some expense in both time and equipment that the HAL has considered for sometime.
- The HAL however, disagrees with the audit team statement that the chart recorders and integrators "increase the chance of error". Each and every one of the integrator or chart records are read and then peer-reviewed, peak by peak. The chance of error is reduced greatly after this has gone through this process of chart recorder and integrator verification. Further, this process, as documented in FGS SOPS, has been reviewed and audited by NELAP and several federal and state audit organization and has past their audit requirements. Further, this same process is used in litigation level review and found to meet standards needed for much higher QA needs than that of the MDN.
- The HAL will continue to investigate ways of modernizing our analytical peak detection the processing of this signal and will have to weigh the cost/benefit of this effort, prior to implementing a change.


THg and MeHg ANALYSIS



- Bubbler blanks are very low for both T-Hg and MeHg. HAL is doing an excellent job in achieving these blanks.
- Subtraction of mean bubbler blank concentrations is occurring at correct time of sample analysis

QUALITY ASSURANCE


- Detection limits comprehensive & adequate
- Blank data look good
- Internal QA adequate
- External QA comparisons adequate
- Florida state compare for Method 1631 passed and valid until 6/30/07 & Washington state compares for Methods 1630 and 1631 valid until 7/13/07
- Integration of QA programs with analytical operation appears adequate.



HAL RESPONSE

DATA MANAGEMENT

- Paper records and database back-up acceptable
- Monthly reports sent to sites on time.
- **Some data management action items...**



DATA MANAGEMENT

- Procedures are well define
- QC & validation processes well documented
- Every sample receives AMPLE review
- Analysts determine reruns.
- Rarely – High QA IDs reruns.
- Data reporting procedures standardized & consistent RFP Response

RECOMMENDATIONS

RECOMMENDATIONS



- Discuss use of Teflon tape on bottles in NOS.
- Make NED site accounting report more current (< 60 days past the end of month).

HAL Response

Audit Team: All sample bottles should be taped around the bottle cap with Teflon tape to prevent leakage. Currently, HAL tapes some sites that have had frequent leaking of sample preservative when the clean bottle arrives to an MDN site. This should be standardized for all sites and is good QC practice that others (e.g. University of Michigan Air Quality Laboratory) have as standard protocol. Fresh tape should be applied when clean sample bottles are shipped to sites, and fresh tape should be applied after sample collection for return shipment. Implementation of this practice might require NOS review and approval.

HAL Response To Recommendation #17 Above: The Audit Team recommendation, described above, is interpreted to be directed to the Program Office QA Manager and not the HAL as a change in policy is being considered.


The HAL feels that the minor number of slight sample bottle leaks, does not warrant the application of putting tape on each sample bottle

Furthermore, the HAL believes this minor leakage is potentially due to pressure and temperature changes caused by the Air and Ground travel, which, potentially backs the cap slightly off the threads enough to allow a very small (a few droplets) leak. The HAL also sees this phenomena to be very random and minor in magnitude.

HAL Response

RECOMMENDATIONS

- **NADP PO/HAL should produce new training video**
- **NADP PO travel support to site operators for training.**



HAL Response

Audit Team: NADP PO/HAL should produce new training video

HAL Clarification: The HAL thought it prudent to hold off on creating a new training video, as up to the time of the audit, MDN field equipment had been undergoing final intercomparison studies and considerations for official inclusion into the MDN.

- The HAL was originally tasked with this effort back in 2003, however, it was evident that generating a video at this time, could very quickly become obsolete in the next two years.
- It should also be noted that the training video, in the opinion of the HAL, is not a substantial substitute of the Annual HAL training course nor a suitable replacement for the MDN Site Start-Up Program training. The HAL does, however, see a new, updated video, to be a great addition to these existing programs to aid in the training process.
- The HAL will begin working with the MDN Coordinator to investigate if there is room in the budget to pursue this effort.

RECOMMENDATIONS

- **Concentrated HCl on bench in analysis area - Put In Hood!**
- **Keep pets in offices away from labs. Close doors.**
- **NO FOOD IN LABS!!**
Sean carried coffee through labs.
- **Eye protection must be enforced.**
- **Clean up dust on ceiling air vents and lab window ledges.**

HAL COUNTERPOINT

Audit Team: Conc. HCl on bench in analysis area = Put In Hood!

HAL Response: The 2.5 Liter, glass, concentrated HCL bottles, noted above are coated with a heavy plastic sheath by the manufacture, to prevent a spill, should the HCl acid bottle fall over and the glass container break.

- HCl is currently stored near work stations to ensure easy access.
- Storing acid bottles In acid cabinet after every use could increase the chance an accident, transporting, moving, carrying the acid bottles
- The HAL has been audited by the Washington State Department Of Labor and Industries and Department Of Health, which govern laboratory safety practices in Washington State.
- Frontier therefore feels confident in our current practices for keeping 1 – 2.5 Liter HCl bottle in regions where there is the need for the use of these acids.

HAL Response

Audit Team: Keep pets in offices away from labs - Close doors.

HAL Response: Frontier has a strict policy that allows pets in building, but not in laboratories (pets can reside in peoples offices). No threat of pet impact on analytical data. Definitely a perception issue and hence why FGS adopted our strict policy.

Audit Team: NO FOOD IN LABS!! Sean carried coffee through labs.

HAL Response: Frontier does not allow food OR drink in the lab. Auditor walked through hallway adjacent to lab – not proximate to chemical working areas.

Audit Team: Eye protection must be enforced.

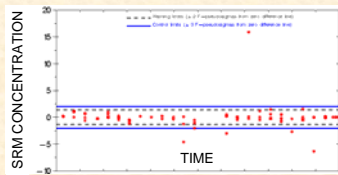
HAL Response: The HAL agrees that enforcing safety glasses in the lab requires vigilance. Frontier has an exemplary safety record as proven by our WISHA record

Audit Team: Clean up dust on ceiling air vents and lab window ledges.

HAL Response: The HAL, prior to the audit, had cleaned and painted our ledges and air vents. Audit note points to observations in MMHg area. FGS has a bi-weekly outside company for general cleaning. The HAL will be sure that the air vents and ledges in the MMHg area are clean. The HAL's real-time QA/QC at the analytical bench would clearly show if dust etc had an impact on our analytical efforts.

RECOMMENDATION

- Calibration curve records & results for SRM's are present but control charts are not available to the analyst.
- Migrate to LIMS and provide analysts with control charts.



HAL Response

Audit Team: Calibration curve records & results for SRM's are present but control charts are not available to the analyst.

HAL Response: The HAL's analysts monitor calibration curve and SRM results in real time at the bench. The HAL has strict QA Criteria, that if the curve, SRM or any other QA/QC parameter fails, requires immediate corrective action.

Audit Team: Migrate to LIMS and provide analysts with control charts.

HAL Response: The HAL is currently using a LIMS (MDN DB) and has built in programs that generate QA/QC control charts. The HAL will increase the frequency of control chart generation to quarterly in order to provide trend related feedback to the analyst.

RECOMMENDATIONS

1. MeHg samples analyzed 2-3 months after collection. Reduce turn-around time - allow faster feedback to the PO and sites.
2. Bar code bottle bags and MOFs
3. Eliminate strip charts & peak area printouts
4. Eliminate typographical errors and handwriting interpretation.

HAL Response

Audit Team: MeHg samples are being analyzed 2-3 months after collection. This lag time should be reduced to allow faster feedback to the PO and sites.

HAL Response To Recommendation #33 Above: The HAL would like to provide a clarification that each MDN site gets monthly feedback on the collection and operation of their weekly samples. Furthermore, the site operation is summarized in our monthly sample accounting record to the PO. The HAL also has weekly conference call meetings with the PO where any and all issues are discussed.

- The MDN MMHg program has grown slowly and the HAL has accommodated this program to match the demand and need by the MDN site sponsors. Currently, there are about 20 of 100 sites measuring MMHg in either a 4-week composite or a weekly split sample.
- The HAL economizes the analysis of the MMHg samples by batching our MMHg samples into groups to ensure that each MMHg analyzer is running a full set of samples. The HAL also urges the Audit Team to note that the very nature of a 4 week composite sample, requires a lag time in the analysis of the composite sample, as it takes at least 4 weeks to take the sample.
- The HAL believes that if the network was to increase the number of MMHg sites, we would easily be able to accommodate a faster, higher frequency of analytical runs to support the need for MMHg data.

HAL Response

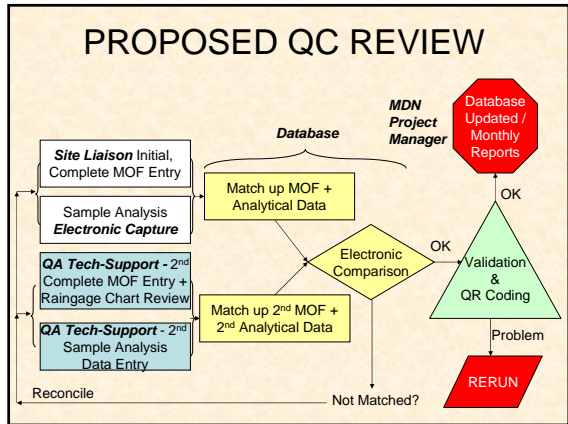
Audit Team: Barcode stickers should be used to label bottles, strip charts, peak area printouts, and sub-sample (split) bottles. This will eliminate most typographical errors and handwriting interpretation.

HAL Response To Recommendation #34 Above: The HAL anticipates barcode stickers on bottles to be a mess and pose a cleaning issue, as these stickers leave a residue on each bottle. Further, barcode stickers can peel off the paper, bottle etc, leaving a potential sample accounting mess.

- Currently, each MDN sample bottle has a unique bottle ID engraved into the glass of the bottle. The HAL has not seen the need to change this system as it has not experienced a problem with identifying bottles properly.
- Further, the HAL employs high level QA peer review of each analytical run and further, performs double data entry for each MOF and analytical lab data sheet, as per PO requirements. The HAL feels confident that all the current practices and measures in place are more than adequate to minimize and or eliminate typographical errors.

RECOMMNDATIONS

- Draw on QA/QC office for support
- QA/QC officers recognize occasional data issues, but flagging left to MDN Project Manager.
- REDUCE / ELIMINATE TDS PEER REVIEW
- FREE UP GERARD BY ELIMINATING "BUSY WORK" – PM spread too thin.



RECOMMENDATIONS

- CHANGE SEQUENCE OF DUAL DATA ENTRY
-SHOULD BE PARALLEL, NOT IN SERIES
- NO NEED FOR DUAL ENTRY OF ANALYTICAL DATA IF ELECTRONICALLY CAPTURED.

HAL Response

Audit Team: All MOF data should be entered at time of sample login to ensure that problems are identified early and relayed back to site operators. This also would provide some warning to the sample analyst that a sample might be contaminated.

HAL Response To Recommendation #38 Above: The HAL enters the basics of the MDN Observer form to create a receipt record for each sample, the day it was received. This initial data entry includes enough of the parameters of the sample MOF to be able to diagnose problems.

The MDN MOF and Rain Gauge chart, however, are then reviewed quickly for notes by the MDN Site Liaison to see if there are any apparent problems or issues present. The HAL has found this system to work quite well. Further, the Rain Gauge Chart holds the essential information to be able to diagnose problems with the sample.

ACTION ITEMS

- Unchecked MOF items default to "No" or "OK" but should default to "Missing".
- All MOF data should be entered at time of sample login

Provides site op feedback and warning to sample analyst that a sample might be contaminated.

- Database should warn of data entry errors

HAL Response

Audit Team: All MOF data should be entered at time of sample login to ensure that problems are identified early and relayed back to site operators. This also would provide some warning to the sample analyst that a sample might be contaminated.

HAL Response To Recommendation #38 Above: The HAL enters the basics of the MDN Observer form to create a receipt record for each sample, the day it was received. The MDN MOF and Rain Gauge chart, are then reviewed quickly for notes by the MDN Site Liaison to see if there are any apparent problems or issues present. The HAL has found this system to work quite well. The Rain Gauge Chart review holds the key to diagnoses of field problems.

- The Audit Team refers above to alerting the MDN analyst to potentially contaminated MDN samples. The HAL understands the Audit Team's note, however, the HAL has only observed a handful of times, since our operations of the MDN in the past 10 years, where a note on an MDN form actually lead us to believe and confirm a sample was/is contaminated.
- The HAL therefore disagrees that entering all of the MOF data into the MDN DB immediately, will help anticipate a contaminated sample and alert the HAL analyst. The HAL maintains that the sample, unless something is observed to be very wrong with the sample (dark color, obvious foreign objects etc), that the samples are introduced to our analysts and analytical system blind. This supports the rigor of our QA/QC the program.
- The HAL is exploring the use of a sample receipt program that will use the power of the MDN LIMS to alert HAL staff to a problem and furthermore, document this problem. This program is currently being explored and is expected to be in place by June of 2007. In the meantime, the HAL is confident that our current system is serving the MDN well.

HAL Response

Audit Team: The database should be modified to provide warnings of data entry errors for extraneous entries (e.g. obviously high/low values, transposed IDs, incorrect dates, etc.).

HAL Response To Recommendation #39 Above: The HAL MDN DB already has many safeguards in place that will not allow the data entry person to make a mistake during the data entry stage of this effort. For example, if an MDN sample start-date is entered that actually occurs after the MDN sample end date, the DB automatically flags this error prompting the data entry person to review the entry from the original document.


- Further, all data entry into the data base, is entered by two, separate staff, independently, at two separate times. The two data entries efforts are then compared by the MDN DB program for consistency and an electronic MDN DB report is generated either confirming the data entry was properly and consistently done or pointing out errors. The errors need to be recorded, resolved and documented prior to the MDN DB allowing the data to be uploaded to the DB.
- The HAL agrees that further improvements can be made to this system and the HAL looks forward to eventually switching the MDN DB to a SQL Server based system that allows for a great deal of additional power to search the DB.

ACTION ITEMS



- Document shipment of winterization correspondence
HAL: Agreed
- Post winterization procedures on the MDN website.
HAL: Agreed

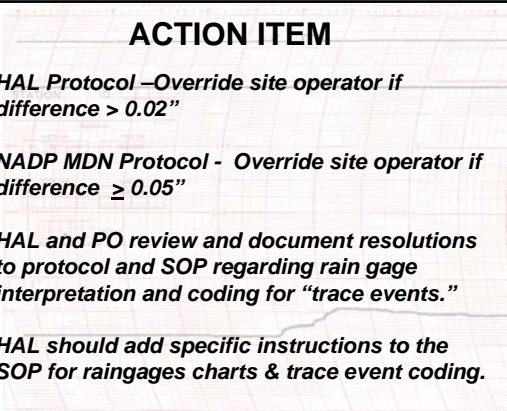
ACTION ITEMS



- New sites need TLC / handholding
- Keep site documentation records up-to-date and consistent with PO database
- Develop HAL protocol for operator follow-up
Example – 4 weeks = reminder sent.
6 weeks = new form.
8 weeks = contact PO for follow-up.

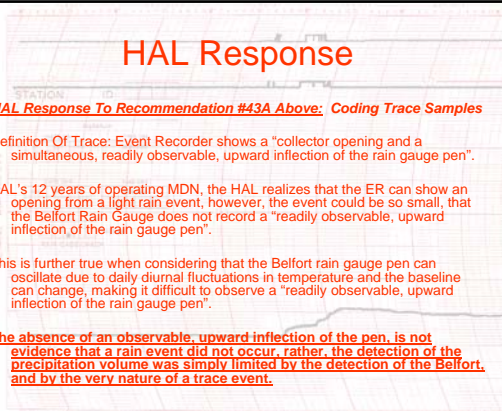
HAL COUNTERPOINT

ACTION ITEM



- HAL Protocol –Override site operator if difference > 0.02”
- NADP MDN Protocol - Override site operator if difference ≥ 0.05”
- HAL and PO review and document resolutions to protocol and SOP regarding rain gauge interpretation and coding for “trace events.”
- HAL should add specific instructions to the SOP for raingages charts & trace event coding.

HAL Response



HAL Response To Recommendation #43A Above: Coding Trace Samples


Definition Of Trace: Event Recorder shows a “collector opening and a simultaneous, readily observable, upward inflection of the rain gauge pen”.

HAL’s 12 years of operating MDN, the HAL realizes that the ER can show an opening from a light rain event, however, the event could be so small, that the Belfort Rain Gauge does not record a “readily observable, upward inflection of the rain gauge pen”.

This is further true when considering that the Belfort rain gauge pen can oscillate due to daily diurnal fluctuations in temperature and the baseline can change, making it difficult to observe a “readily observable, upward inflection of the rain gauge pen”.

The absence of an observable, upward inflection of the pen, is not evidence that a rain event did not occur, rather, the detection of the precipitation volume was simply limited by the detection of the Belfort, and by the very nature of a trace event.

ACTION ITEMS



- MOF date/time overlap checking
- Eliminate "T" and "D" samples with Hg results
- Unofficial Sites – Don't use MOFs, Coordinate IDs
- Watch for gross contamination (e.g. frogs) for QR
- Change SOP for bottle jacking/lid closing sequence, for approval by NADP.

HAL Response


Audit Team: Watch for gross contamination (e.g. frogs) for QR "frog corpse lodged deep in funnel, and wasp nesting on funnel edge." This sample was coded as "B" when it should have been obvious that it had the potential to be grossly contaminated and coded as "C".

HAL Response To Recommendation #43H Above: The HAL believes that the HAL followed the proper protocol for this sample and believes that the Audit Team may not be aware of all of the facts related to this sample:

- 1) Note that a frog was in the funnel (not in the sample).
- 2) There was no discoloration of the sample or debris in the sample.
- 3) There was no indication as to how long the frog was in the funnel and/or if the body of the dead frog actually came in contact with any rain that was collected in the sample bottle.
- 4) The reviewer looked at previous Hg concentrations measured at this site and found that the Hg concentration fell well within the typically range experienced at this site.


The HAL and PO met and clarified in 2006 when the "C" code should be applied as, at that time, the "C" codes was strictly left to the final interpretation of the reviewer. The Protocol that the HAL and PO decided upon, was, whenever a sample was "C" coded, the reviewer is required to write in the "Lab Remarks" section of the EMOF, the detail of their decision. This then could be reviewed by the PO once received and decided if appropriate or not.

ACTION ITEMS



- Complete documentation of HAL database
- Correct leaking bottle corrections with Bob Larson (PO)
- Automate data review
-High concentration flags, Hg results for trace ppt, etc.

ACTION ITEMS



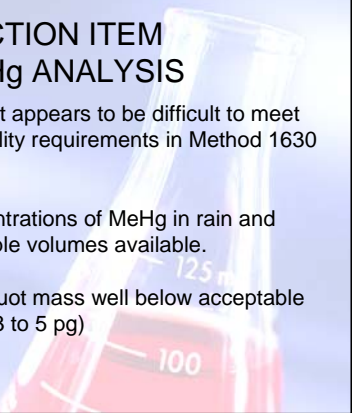
- Complete Draft HAL QAPP
– Chris made me put this in!!

HAL Response: The HAL believes that it is waiting for the PO QA Managers Edits and Review prior to finishing this document (Version 2)

- Update MDN Site Information Manual with PO

HAL Response: The HAL has submitted the v3 of the MDN Site Operations Manual. PO QA Officer recently noted the intention to now integrate the HAL MDN Site Ops Manual with the NTN.

ACTION ITEM MeHg ANALYSIS



For rain samples, it appears to be difficult to meet the data acceptability requirements in Method 1630 due to:

- Low concentrations of MeHg in rain and
- Small sample volumes available.

Result: Using aliquot mass well below acceptable amount. (3 to 5 pg)

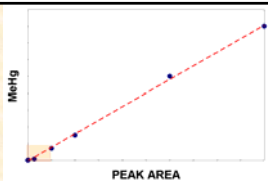
HAL Response

Audit Team: To improve the analysis and validate a greater proportion of the data, introduction of additional standard(s) closer to the MDL could be done. Method 1630 calls for 5 standards above zero but if the majority of the standards are 10 to 100 times the observed concentrations, the validity of the curves' slopes should be questioned. There may be nonlinearity in the standard curves at such low concentrations, and this needs to be investigated. As 1630 was derived from tissue analysis, considerations of such low MeHg concentration as those found in rain are not well addressed. An adjustment of the method to better suite MDN needs should be undertaken, mainly adjusting the structure of the standard curve.

HAL Response To Recommendation #29 Above: The HAL agrees that due to the low level nature of MMHg in general (not just exclusive to the rainwater samples) an appropriate curve is necessary to quantify MMHg in rainwater. The HAL believes that our low standard of 5 pg, is sufficiently low and near the low end capability to pipette accurately to the analytical system. It is evident that some rainwater samples are near or at the blank level of detection. To incorporate an even lower standard than that already currently in place, is a lesson in failure – these systems are low-level (the lowest possible in the industry) however, there are simply low samples that are not possible to accommodate inside the standard curve.

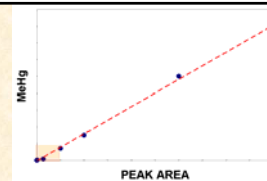
- The HAL believes that the best way to bring the low end MMHg concentration samples (which are also likely low volume samples), up to a more quantifiable level, is through the collection of a sample, in a separate, dedicated MMHg sample train (identical to the Total Hg sample train). This train would be employed in the MDN ACM collectors' 2nd chimney for collection of two simultaneous samples. This practice would maximize the amount of low volume rain sample available for analysis and thus boost the detection of MMHg into a range more acceptable. This will require a modification to the MDN ACM collector to allow the use of the 2nd Sample Collection Chimney. The HAL and PO will be presenting these concepts to NOS during the Spring 2007 meeting.

ACTION ITEM MeHg ANALYSIS



- 1630 - 5 standards > zero
- Majority of standards 10 - 100 X MDN concentrations
- Curve slope validity? (non-linearity)
- Adjust method to better suite MDN - mainly adjust the structure of the standard curve.

ACTION ITEM MeHg ANALYSIS



- Duplicates and Hg recovery performed at appropriate interval, but...
- MeHg spikes are high - typically 10 X MDN concentrations.
- Adjust 1630 spike protocol down to 2X - 5X observed low concentrations - in RFP.

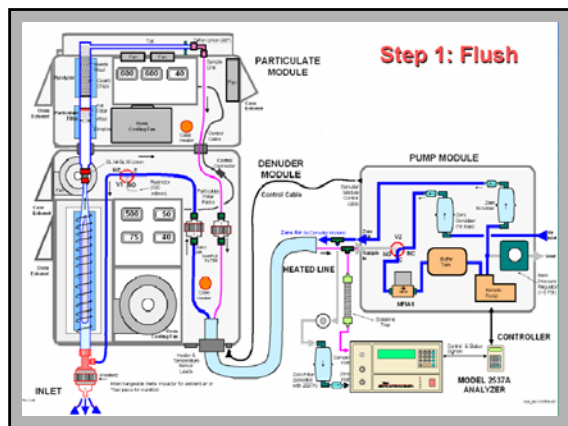
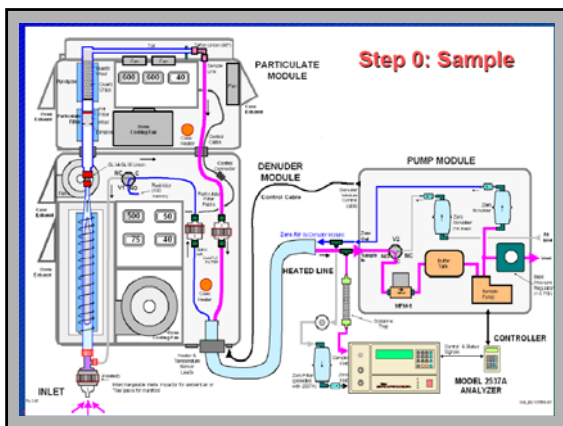
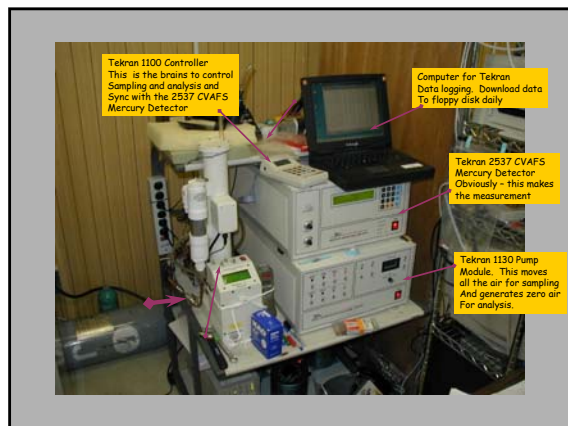
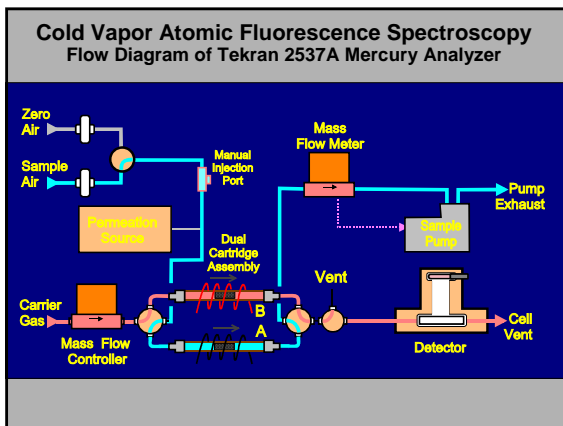
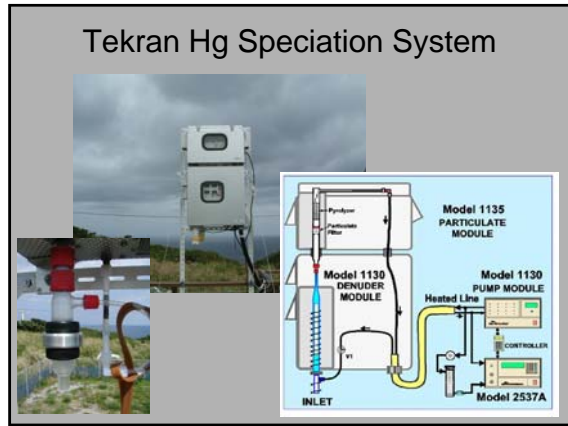
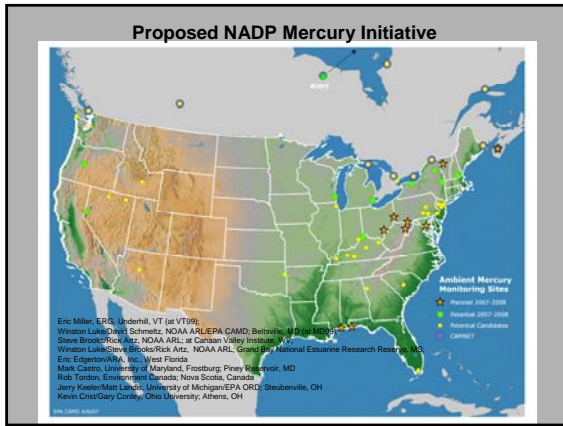
HAL Response

Audit Team: Adjust 1630 spike protocol down to 2X - 5X observed low concentrations - in RFP

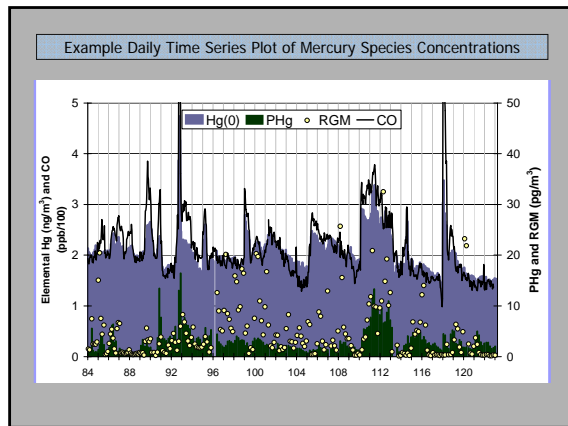
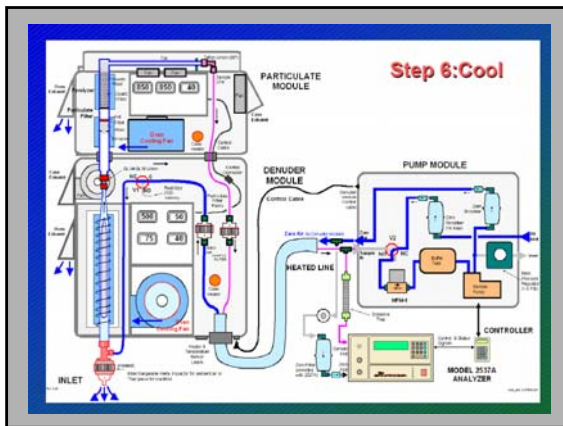
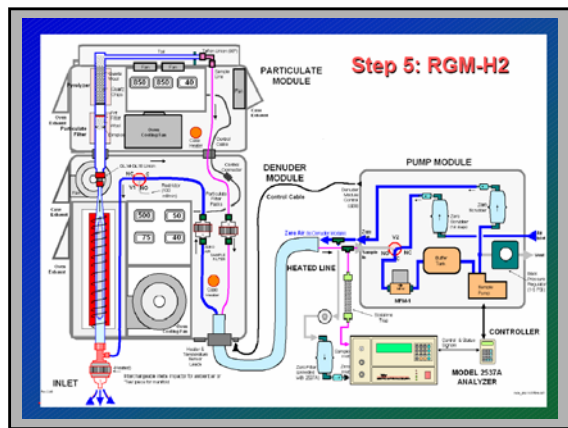
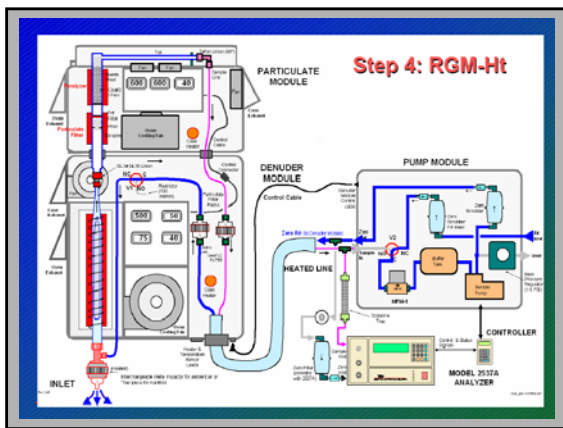
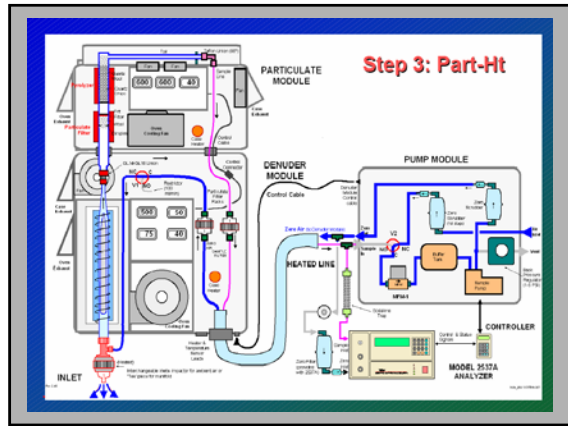
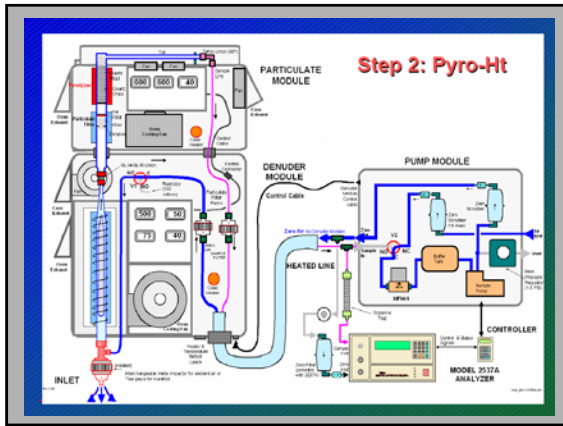
HAL Clarification: The HAL notes that it is relatively impossible to predict the MMHg concentration associated with a rainwater sample.

The many variables that govern the MMHg concentration in wet dep, the science of which is not completely understood (i.e. atmospheric chemical methylation, biological methylation?) is therefore extremely difficult to even attempt to predict. The HAL therefore decided to follow the principles of US EPA 1630.

The HAL urges the Audit Team to consider that a MMHg spike is intended to show a level of accuracy. The concentrations used for a MMHg spike are not critical to demonstrate accuracy and therefore the recovery of the spike should be considered over the spike concentration range. With that said, the HAL will consider a lower spike concentration more appropriate for low-level rainwater.



Attachment 8



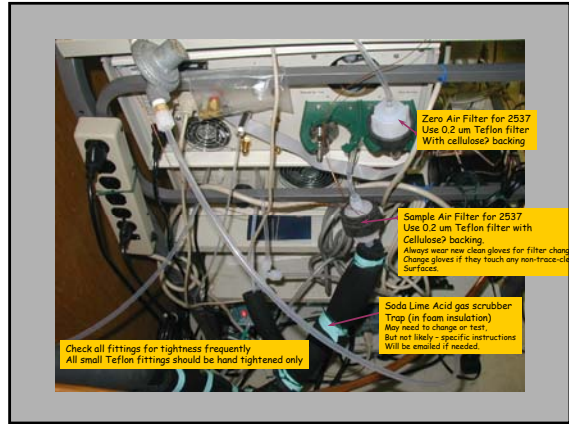
Attachment 8

Tekran Hg Speciation System



Tekran 1135 Particulate Hg Module
This contains the quartz regenerable filter pack (RFP)

Tekran 1130 RGM Module (Reactive Gaseous Mercury)
This contains the quartz denuder



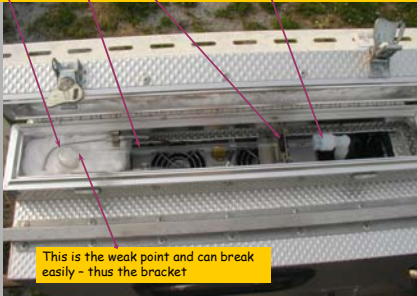
Zero Air Filter for 2537
Use 0.2 um Teflon filter with cellulose² backing

Sample Air Filter for 2537
Use 0.2 um Teflon filter with Cellulose² backing
Always wear new clean gloves for filter change
Change gloves if they touch any non-traceable surfaces

Soda Lime Acid gas scrubber Trap (in foam insulation)
May need to change or test.
But not likely - specific instructions will be emailed if needed.

Check all fittings for tightness frequently
All small Teflon fittings should be hand tightened only

Top Lid of Tekran 1135 Particulate Hg Module
You can see, left to right, the back end of quartz filter pack, quartz tail, bracket and the Teflon compression fitting



This is the weak point and can break easily - thus the bracket

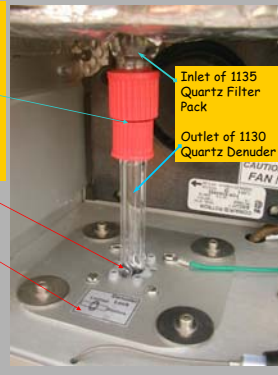
An closer view of the Tekran 1135 Particulate Hg Module quartz tail, bracket and the Teflon compression fitting



Female-to-Female Red-Screw-Cap Union For the 1130 Unit Denuder and 1135 Unit Quartz filter Pack

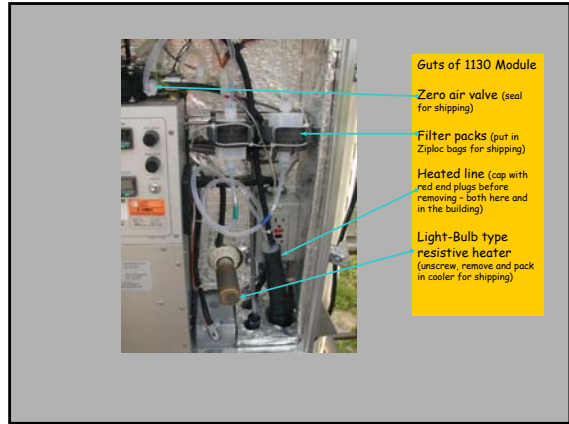
There is a short glass tube between these fittings - easily dropped when detaching (not seen here)

Note - quartz knobs on the denuder. Please don't torque denuder or it may break. Also, to remove the denuder it must be pushed up a few mm and then rotated to get through the holes - note picture description



Inlet of 1135 Quartz Filter Pack

Outlet of 1130 Quartz Denuder



Guts of 1130 Module

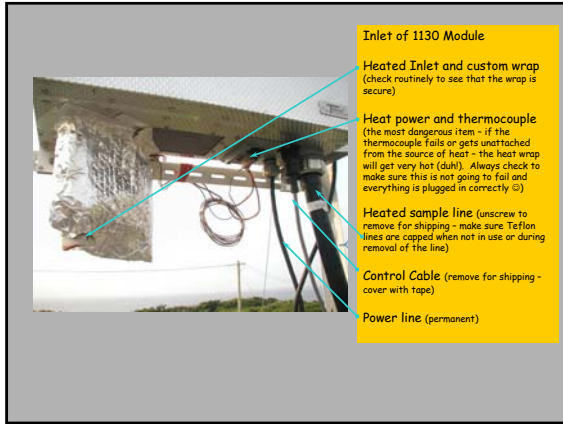
Zero air valve (seal for shipping)

Filter packs (put in Ziploc bags for shipping)

Heated line (cap with red end plugs before removing - both here and in the building)

Light-Bulb type resistive heater (unscrew, remove and pack in cooler for shipping)

Attachment 8



NOS Support - 2008

- Work with Tekran to improve equipment support (similar to Loda, N-CON, Ott)
- Develop system to track and request orders for backup supply status at all sites
- Limited equipment depot for difficult to stock items (e.g., gold cartridges)
- Help design and test new equipment (e.g. heated boot on inlet)
- Help develop site operator training program
- Event-based wet-deposition Hg sampling issues
- Your thoughts and ideas?

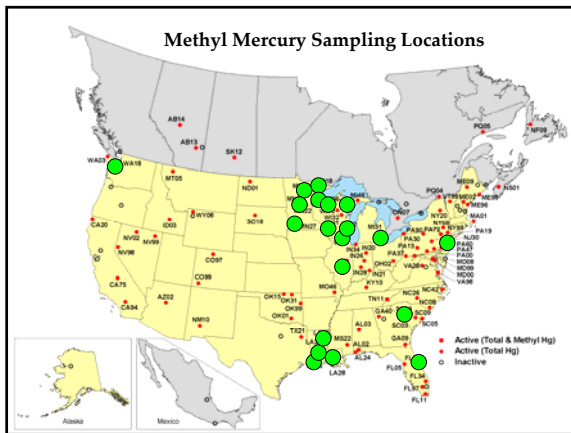
Methyl Mercury Issue

David Gay
Program Office

Spring 2007

What is the Problem?

- Issue brought up in Audit:
 - different amounts of precipitation cause complicated calculations, possible error
 - many samples are very low in either volume or mass (error)



Problem is Easily Fixed

A Separate sample:

- removes all sample splitting;
- maximizes the precipitation volume for the methyl sample;
- maximizes both volume and mass;
- maximizes sample for total mercury also

So what's the problem?

- The 2nd sample train does not allow for a regular sample train

"There's something wrong with the 2nd Chimney?"

Yes, Unfortunately There Is

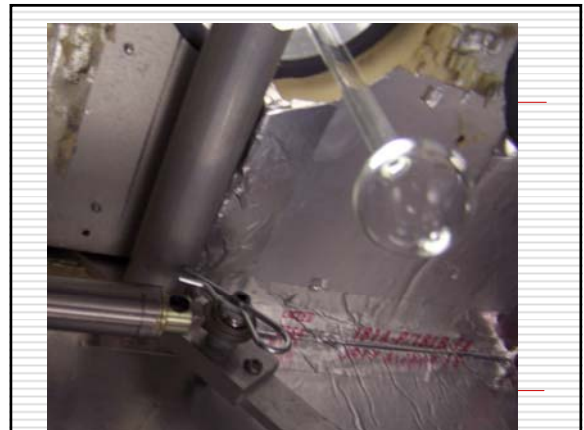
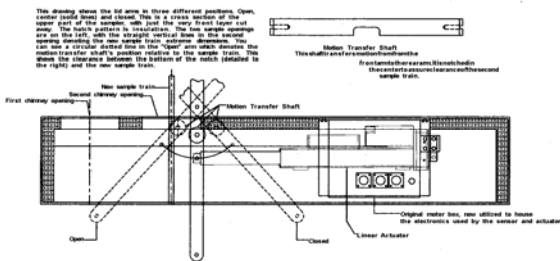
- As the lid closes, the collector cross arm (cylinder of aluminum) crosses under second chimney
- Result = *broken thistle tube*
- Renders that second chimney useless for current sample train
- But can use a different sample train however

5 options to address Audit concerns

1. Do nothing – consistency is a good thing
2. Change the way we split samples
3. Make a sampler that takes the total Sample train
4. Make a sample train with a flexible chimney
5. Use a shorter/different borosilicate bottle that fits

- ☐ Went through all of these options in NOS
 - Pros and cons of all 5 solutions
- ☐ We also built an “Adjusted Chimney” Collector at the Program Office

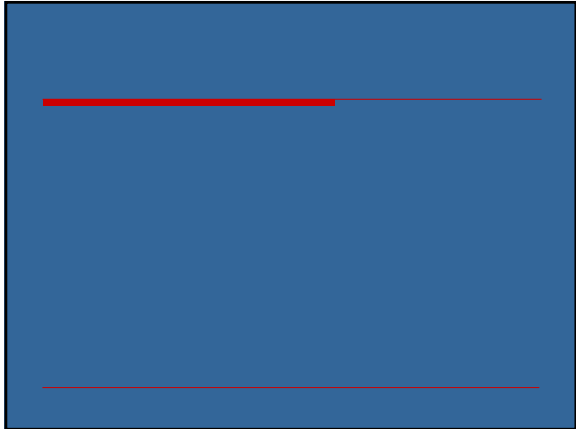
Built an Adjusted Chimney Collector



NOS Action

- Want us to test this new chimney design
 - Run it, and make sure it works
 - Determine the cost of making one
 - Determine if it is a viable solution or not

 - Budgetary implications
-



The “Do Nothing” Option

- follow pending DMAS direction (per potential flagging protocol) and continue to flag values as we would do with no additional changes.

 - Pro:
 - consistency across the data set, we have a solution that works and keep going with the same.
 - It is easy.
 - It costs no added funds.

 - Conn:
 - Not a good solution for our users;
 - possible good data is being flagged and we can do better; i.e. have fewer flagged values.
-

“Change the way we split” Option

- Simply, we now save 25 ml of sample for methyl mercury & use the remaining volume for total mercury analysis.
 - Do the reverse; save 25 ml of volume for total, and then all remaining sample for methyl sample.

 - Pro:
 - Inexpensive;
 - everything is handled at the HAL.
 - No field retrofits or building/design changes required, etc.
 - Second easiest change.

 - Conn:
 - Change in methodology; always a problem in long term sampling.
 - Will QA questions remain, such as does contamination occur while sample is being split, etc?
-

“Sampler retrofit for current sample train” Option

- This is a sampler redesign to move the cross arm so that the current sample train can be used
 - The Program Office has designed a change to the sampler that will open this 2nd chimney for the standard MDN sample train.

 - Pro:
 - Good long term solution, because it actually makes 2nd chimney viable.
 - Elevates any question about splitting samples, QA.
 - This option is favored by the HAL.

 - Conn:
 - Expensive in labor, some parts.
 - Also is not likely a field retrofit; therefore samplers would have to be shipped (at least \$100 each way).
 - Unlikely that the committees would charge the individual sites, but that is a possibility.
 - Added cost of 2nd set glassware to the HAL, although BB says this is minimal.
 - Change the way we split samples
-

“Sample Train with a flexible chimney” Option

- Use the 2nd sampler chimney for the methyl sample, but with a flexible thistle tube of some type. Sampler mechanics remain unchanged.

 - Pro:
 - Inexpensive likely (a function of the materials chosen).
 - It also makes the 2nd chimney viable.
 - No field retrofit questions.
 - Easiest change.

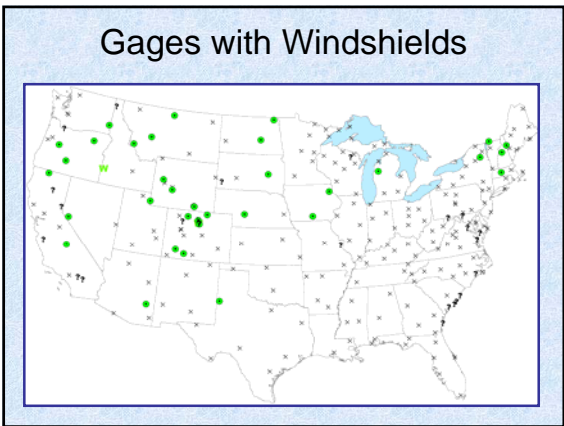
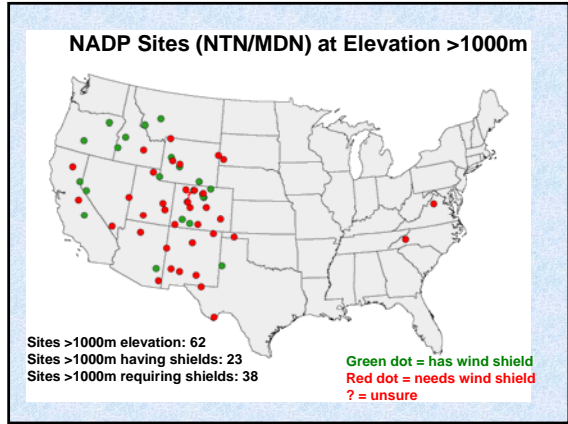
 - Conn:
 - Samples are collected in non-identical sample trains, so QA questions come into play.
 - HAL problem: Can a flexible thistle be cleaned?
-

“A shorter/different borosilicate bottle”

- A different bottle (perhaps like the NCON borosilicate bottle may be designed to stay out to the way of the cross piece, with no mechanical change.

- Pro:
 - Possibly inexpensive (a function of the materials chosen).
 - No field retrofit questions.
 - Easiest change.

- Conn:
 - More bottle types at the HAL (2 currently, shipping, errors, etc.)
 - Can a bottle be found?
 - Would need something to connect the thistle to the bottle



Where We Left Off In Norfolk

- There was considerable discussion on wind shielding rain gages and collectors. Marty Risch (USGS) suggested that the windshield guideline be changed to a rule. Marty then moved that a formal NOS discussion on wind shields be presented at the fall 2007 meeting using information assembled by USGS-BQS and PO. The motion was seconded by Mark Nilles (USGS) and unanimously approved.

Alter vs. Nipher Shielding

From: Laura Hult **Date:** 1/18/00

The latest information I have from Jeff Cole at NCAR is that his Nipher shielded gages typically over-report snowfall by 5-10% depending on snow type. Dry snows do not seem to be a problem, however wet snows can cause snow bridging or build-up that can fall/slide into the gage or get blown in.

NCAR is testing several shielding schemes including a double alter shield and a Wyoming shield. The Wyoming shield (either full-sized or half-size) appears to be much better than even a double alter shield, but takes up more room (about 15-20 feet in diameter).

From: Scott Dossett **Date:** 1/20/00

Laura:
 What gage did Jeff compare the Nipher against? I guess it may always boil down to what baseline you accept. Most people around here still consider the 8" stick gage(daily obs) to be the "best".

From: Laura Hult **Date:** 1/20/00

The Nipher shielded gage at NCAR was a Belfort 3000 (prototype for the Belfort 3200 we have tested at the HIF).

Due to overcatch from the Nipher shield, an alter shield was installed on the 3000. The trade off was that Alter shields typically undercatch by about 10% in wind speed of 3-5 m/s, with undercatch increasing steadily for higher wind speeds (up to as much as 50% undercatch in strong winds).

Of course, Alter shields do not facilitate snow-bridging, etc. by virtue of their construction and proximity to the gages.

From: Jim Lynch Date: 1/20/00

The Nipher shield was developed in 1878 (Nipher, F.E. 1878. On the determination of the true rainfall in elevated gages. Amer. Assoc. Adv. Sci. 27, 103-108)...

I've conducted a similar comparison in PA using shielded (both Alter and Nipher) Belfort gages and an unshielded gage.

The least amount of precipitation for 12 storms occurring January through March was recorded by the unshielded gage. The greatest amount was recorded by the Nipher shielded gage. For some storms (high winds and blowing snow) the Nipher shielded gage captured 50% more precipitation than the unshielded gage and nearly 20% more than the Alter-shielded gage. Regardless, the results were consistent with other published comparisons.

From: Jim Lynch Date: 1/20/00

The point of this discussion is that the least accurate measurement NADP makes is precipitation volumes and that each site should have a shielded stick gage along with a Belfort recording gage.

In most places, the Alter gage will provide very acceptable results. However, at some sites the Nipher gage would be superior (e.g., mountainous terrain where snow is likely or at sites exposed to high winds).

In my nearly 22 years with NADP, I can remember having these very same discussions before. Perhaps this time NOS can reach a consensus on how we are to measure precipitation.

Best Regards,
Jim

From: Jim Lynch Date: 1/20/00

In another study using shielded and unshielded gages at 15 sites in PA for three years I found that in all cases, standard stick gages collected the greatest amount of precipitation regardless of the presence or absence of a shield.

With no shield, the stick gage captured 0.04" to 0.14" more precipitation per week than the Belfort; with a shield...

The Belfort recording gage without a shield underestimated precipitation by 8-10% and that the Aerochem Metric sampler captured 11-15% less precipitation.

From: Rick Artz Date: 1/20/00

Jim, Your conclusion makes the assumption that more ppt in the gage is better. I think you are correct -- but has there ever been any evidence of overcatch in some situations with either a Nipher or an Alter shield? (I doubt it.)

Regardless, I put stick gages at all of the AIRMoN sites because I am absolutely convinced that they give a truer catch of ppt. than any of the automated gages. On the other hand, with a weekly sample, can we ignore evaporation from a stick gage? I have no data to suggest this is a problem, **but I'm nervous.**

Rick Artz

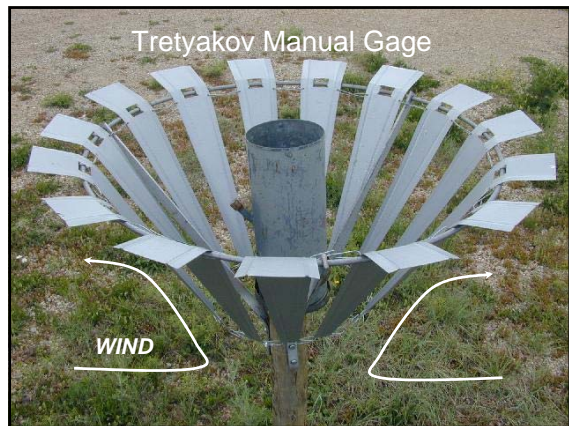
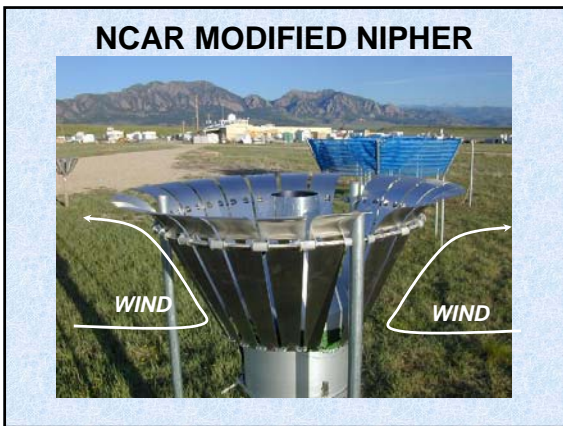
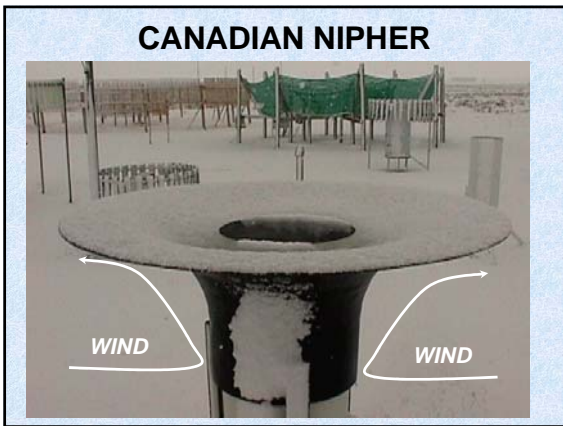
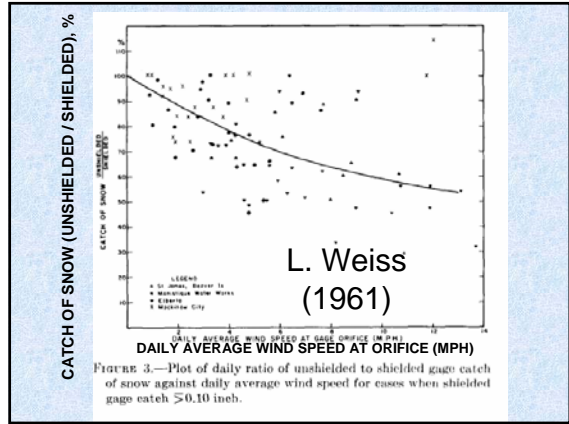
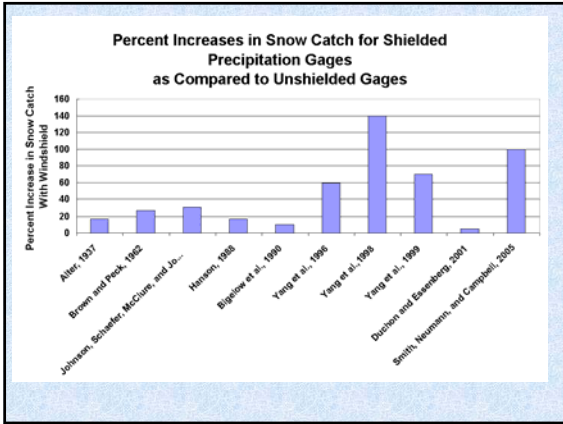
1937?

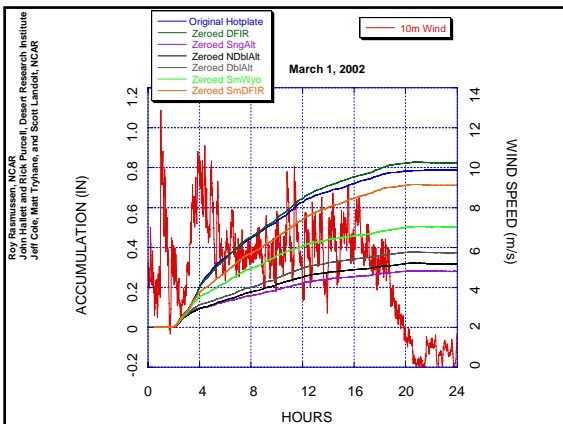
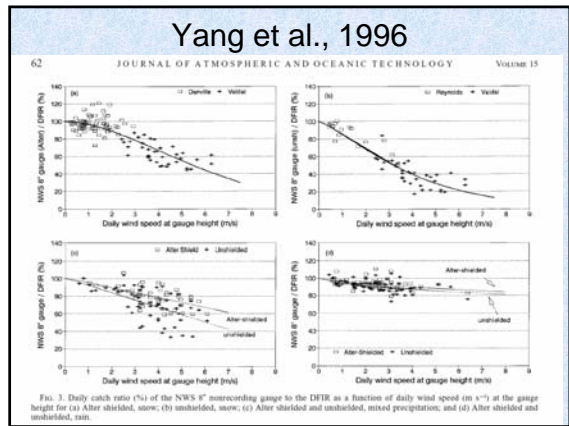
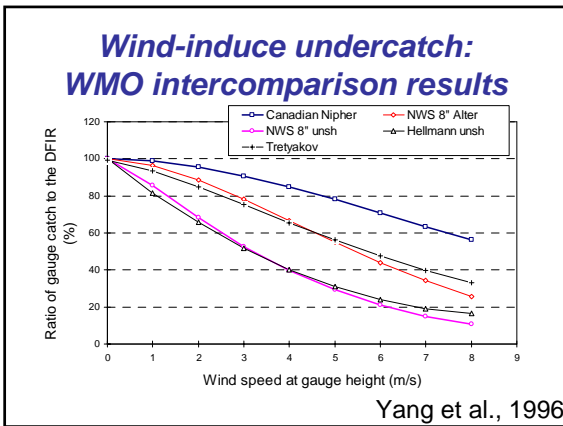
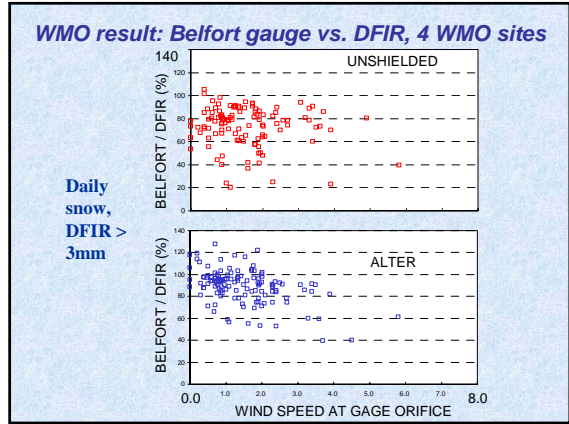
SHIELDED STORAGE PRECIPITATION GAGES
By J. CECIL ALTER

... the precipitation gage, like any other isolated object or structure, becomes a disturbing obstacle around which and over the top of which, the immediately adjacent air passes with increased speed. Thus in strong winds the fabric of falling snow is expanded over the-gage where the wind runs fastest and the snow pattern is condensed in a spot immediately to the lee of the gage where the wind slows up. As a result, a deficiency of snow is deposited over the gage, and an equal excess is deposited in a similar area a few feet to the leeward.

J. CECIL ALTER (1937)







JOURNAL OF ATMOSPHERIC AND OCEANIC TECHNOLOGY VOLUME 15

Table 1. Summary (total and percentage of the DFIR) of daily observed precipitation for the NWS 8° standard gauge (with an Alter shield or unshielded) at Valdai, Reynolds Creek, and Danville WMO Intercomparison stations.

| Type of precipitation | Number of events (Day) | T_{max} (°C) | T_{min} (°C) | W (at 3 m) m s ⁻¹ | DFIR | NWS 8° measured | |
|---|------------------------|----------------|----------------|------------------------------|---------------------|--------------------|-------------------|
| | | | | | | Alter | Unshielded |
| (a) Valdai WMO site, October 1991 to March 1993 | | | | | | | |
| Snow | 154 | -4.1 | — | 3.8 | 357.4 mm 100.0% | 248.8 mm 69.6% | 156.5 mm 43.5% |
| Mixed | 73 | 0.7 | — | 4.5 | 463.9 mm 100.0% | 361.4 mm 77.9% | 303.4 mm 65.4% |
| Rain | 108 | 10.0 | — | 3.6 | 434.5 mm 100.0% | 400.3 mm 92.2% | 386.0 mm 88.8% |
| All | 335 | 2.2 | — | 4.0 | 1255.8 mm 100.0% | 1011.0 mm 80.5% | 845.9 mm 67.4% |
| (b) Reynolds Creek WMO site, November 1987 to March 1993 | | | | | | | |
| Snow | 59 | 2.6 | -6.7 | 2.5 | 87.3 mm 100.0% | — | 75.3 mm 86.3% |
| Mixed | 27 | 7.3 | -2.8 | 3.8 | 100.7 mm 100.0% | — | 86.6 mm 86.0% |
| Rain | 36 | 9.1 | -0.3 | 2.8 | 183.6 mm 100.0% | — | 179.2 mm 97.6% |
| All | 113 | 6.3 | -3.3 | 3.0 | 371.6 mm 100.0% | — | 332.1 mm 89.4% |
| (c) Danville WMO site, December 1986 to April 1992 | | | | | | | |
| Snow | 158 | -2.2 | -11.6 | 1.5 | 1051.3 mm 100.0% | 1018.4 mm 96.9% | — |
| Mixed | 21 | 2.1 | -8.6 | 1.0 | 650.8 mm 100.0% | 624.8 mm 96.0% | — |
| Rain | 22 | 6.4 | -1.6 | 1.1 | 291.1 mm 100.0% | 279.5 mm 96.0% | — |
| All | 201 | -2.6 | -3.0 | 1.2 | 1993.2 mm 100.0% | 1922.7 mm 96.5% | — |

YANG, GOODISON, METCALFE, GOLUBEV, BATES, PANGBURN, & HANSON (1996)

Yang et al., 1996

A regression of the daily gauge catch ratio (R , %) for the shielded and unshielded NWS 8" standard gauge as a function of the daily wind speed (W_s , m/s) at gauge height gave the best-fit regression equations for the different types of precipitation.

- Snow

$$R_{\text{Alter shield}} = \exp(4.606 - 0.036 \times W_s^{1.29}),$$

$$(n = 108, r^2 = 0.72).$$

$$R_{\text{Unshielded}} = \exp(4.606 - 0.157 \times W_s^{1.28}),$$

$$(n = 55, r^2 = 0.77).$$
- Mixed precipitation

$$R_{\text{Alter shield}} = 101.04 - 5.62 \times W_s,$$

$$(n = 75, r^2 = 0.59).$$

$$R_{\text{Unshielded}} = 100.77 - 8.34 \times W_s,$$

$$(n = 59, r^2 = 0.37).$$
- Rain

$$R_{\text{Alter shield}} = \exp(4.606 - 0.041 \times W_s^{0.69}),$$

$$(n = 64, r^2 = 0.18).$$

$$R_{\text{Unshielded}} = \exp(4.605 - 0.062 \times W_s^{0.58}),$$

$$(n = 64, r^2 = 0.27).$$

G. Johnson, G. Schaefer, R. McClure, & J. Johnson (1984?)
(USDA/NRCS and US Army Cold Regions Research & Engineering Laboratory)

Barrow Artificial Wind Shielding Comparison
October 1 - June 1
(cm of water)

| Year | Wyoming Shield | Nipher Shield | Alter Shield | No Shield | No Shield | comments |
|---------|----------------|---------------|--------------|-----------|-----------|--------------------------------------|
| 1989-90 | 6.73 | 4.70 | 3.33 | 2.06 | 1.35 | 69% 50% 31% 20% % of Wyoming Shield |
| 1990-91 | 6.83 | 6.17 | 2.84 | 1.60 | - | 90% 42% 23% % of Wyoming Shield |
| 1991-92 | | 4.40 | 2.56 | 1.02 | 0.79 | 58% 23% 18% % of Nipher Shield |
| 1992-93 | 10.64 | 11.28 | 4.44 | 1.60 | 2.31 | 106% 42% 15% 22% % of Wyoming Shield |
| 1993-94 | | 7.62 | 3.81 | - | 2.39 | 50% - 31% % of Nipher Shield |

http://acsvs.npolar.no/reports/archive/solidprecip/2_Abstracts/JohnsonG.pdf

Costs

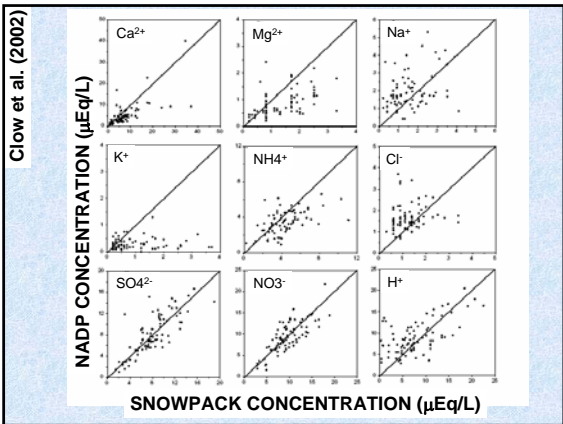
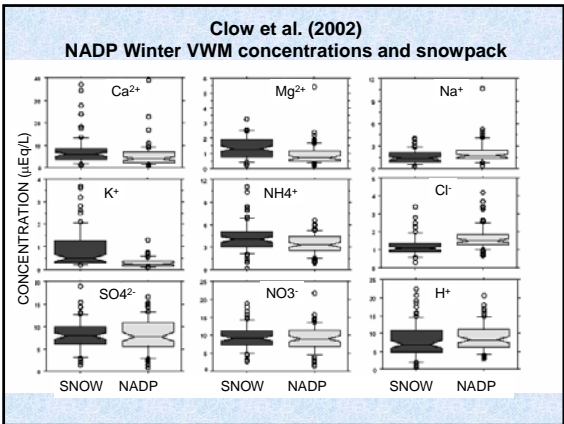
| Type | Vendor | Price |
|-------------|---------------------|---------|
| Alter | NovaLynx | \$475 |
| | Rickly Hydrological | \$425 |
| | ETI | \$525 |
| Tretyakov | Viasala | ? |
| | OTT | \$1,000 |
| NCAR Nipher | ETI | \$550?? |
| DFIR | Home Depot | \$5,000 |
| Wyoming | Home Depot | \$1,000 |

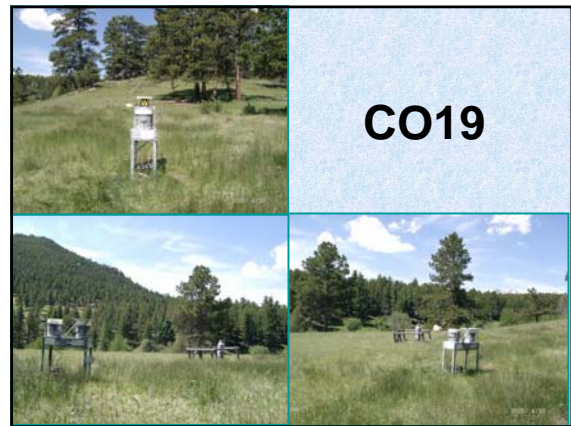
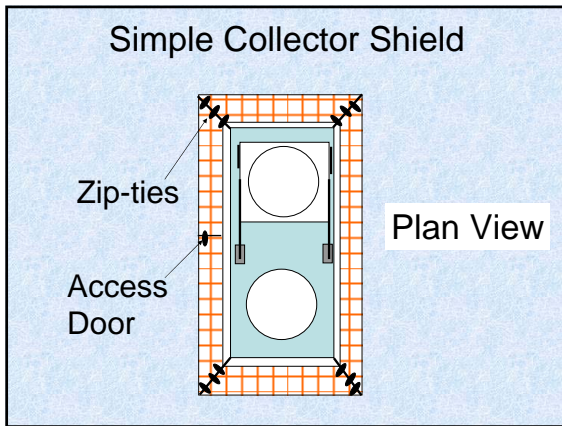
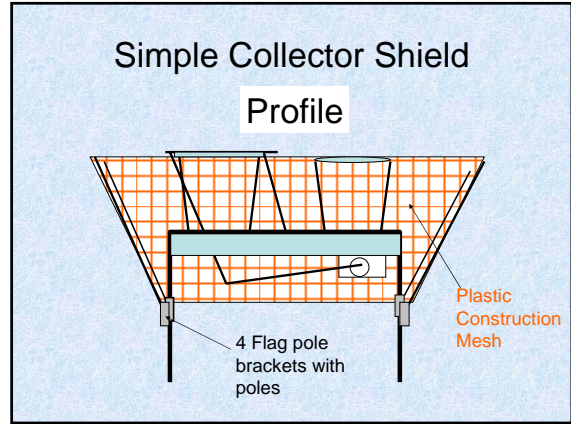
Windshields will only make catch efficiency worse!

Possible solution: Windshields for collectors

Issues:

- Splash / Contamination
- Step-function trends
- Acts as a sail to tip collector
- Are we unnecessarily obsessed with catch efficiency?





- ### Wetherbee's Motions
1. Begin an initiative to get all snow-affected precipitation gages fitted with either an Alter or Modified Nipher windshields as soon as possible.
 2. Mandate that all new sites above 1,000 meters altitude or in snow-affected climates must install a windshield on the precipitation gage. No traditional Nipher shields!
 3. Conduct co-located collection efficiency testing of prototype collector windshields at Arvada Site and/or CO19 (Rocky Mnt. Nat. Park).