Section 3 Cartridge receiving, processing:

3

General summary: This section supplies information on dismantling cartridges, converting hand-written log sheets to electronic files, and converting flow volumes and raw PM to mean 9-day air concentrations

Step 1: Receiving cartridge

Figure 1: Foreground: a disassembled SPARTAN cartridge

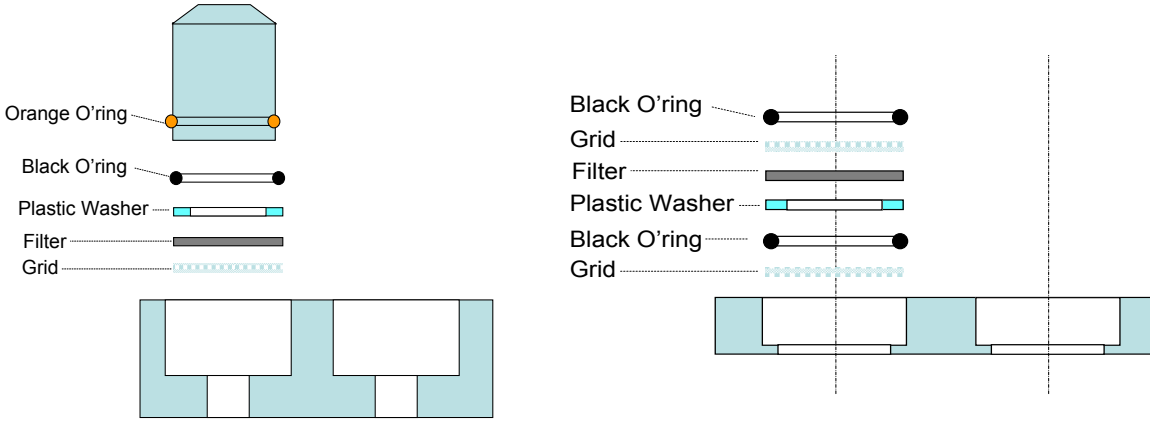
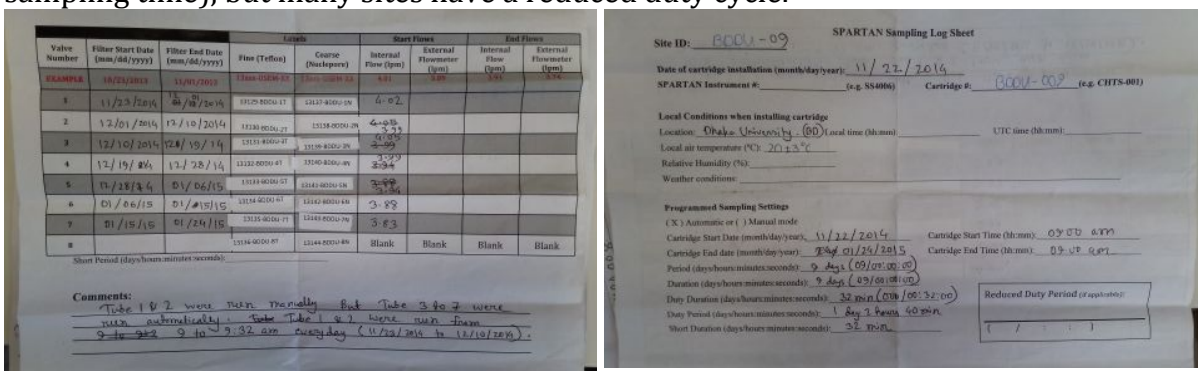


Figure 2: Cartridge assembly scheme. Left is TOP half (teflon), right is BOTTOM half (nuclepore). NB: we no longer use black o-rings. All o-rings are organge (softer than black, which makes a better seal)

Cartridges are received by way of courier (UPS, FedEx, DHL, or others). It has been our policy to ask sites to send us one cartridge at a time. Costs for shipping a single cartridge vary, but are approximately $50 CAD. When shipping OUT catridges or other supplies, always use UPS (very large discount applied to Dalhousie University)
We provide the following shipping address to all sites

[Name, e.g. Graydon Snider]
6310 Coburg Rd. room 218
Dalhousie University
Department of Physics and Atmospheric Science
Sir James Dunn bldg.
Halifax, NS
B3H 4R2
Phone: 902-494-1820

Inside along with cartridge itself should be a log sheet detailing when, for how long, and at what flow rate each filter sampled (a memory card sometimes included, depending on site, will have instrument-recorded data). By default each filter samples for 24 hours (actual sampling time), but many sites have a reduced duty cycle.



Valve Number	Filter Start Date (mm/dd/yyyy)	Filter End Date (mm/dd/yyyy)	Fine (Teflon)	Coarse (Nuclepore)	Start Flows: Internal Flow (lpm)	Start Flows: External Flowmeter (lpm)	End Flows: Internal Flow (lpm)	End Flows: External Flowmeter (lpm)
EXAMPLE	10/23/2013	11/01/2013						
1	11/23/2014	11/24/2014			4.02			
2	12/01/2014	12/10/2014						
3	12/10/2014	12/19/14						
4	12/19/2014	12/28/14						
5	12/28/14	01/06/15						
6	01/06/15	01/15/15			3.88			
7	01/15/15	01/24/15			3.83			
8					Blank	Blank	Blank	Blank

Short Period (days/hours:minutes:seconds):

Comments:
Tube 1 & 2 were run manually But Tube 3 to 7 were run automatically; Tube Tube 1 & 2 were run from 9 to 9:32 9 to 9:32 am everyday (11/23/2014 to 12/19/2014).

SPARTAN Sampling Log Sheet

Site ID: BDDU-09

Date of cartridge installation (month/day/year): 11/27/2014

SPARTAN Instrument #: _____ (e.g. SS4006) Cartridge #: BDDU-009 (e.g. CHTS-001)

Local Conditions when installing cartridge
Location: Dhaka University (BD) Local time (hh:mm): _____ UTC time (hh:mm): _____
Local air temperature (°C): 20±3°C
Relative Humidity (%): _____
Weather conditions: _____

Programmed Sampling Settings
(X) Automatic or ( ) Manual mode
Cartridge Start Date (month/day/year): 11/22/2014 Cartridge Start Time (hh:mm): 0900 am
Cartridge End date (month/day/year): Today 01/24/2015 Cartridge End Time (hh:mm): 09 00 am
Period (days/hours:minutes:seconds): 2 days (09/09:00:00)
Duration (days/hours:minutes:seconds): 2 days (09/08:08:00)
Duty Duration (days/hours:minutes:seconds): 32 min (00/00:32:00)
Duty Period (days/hours:minutes:seconds): 1 day 2 hours 40 min
Short Duration (days/hours:minutes:seconds): 32 min
Reduced Duty Period (if applicable): _____

Figure 3: Sample log sheet from University of Dhaka, Bangladesh (BDDU). Note there is some information missing.

As with the above example (figure 2), some information is left incomplete. Please ask site operator more details, if any are missing such as post-sampling flow rates, omitted dates, or programmed times not logged.

Memory card data also logs flow information, however many sites have shown this data to be corrupt. In future editions corruption problem will be fixed. However external flows are still need as a spot check to for inconsistencies (e.g. leaks in flow system).

Step 2: Unloading cartridge

Once received (at main physics office), the cartridge(s) are taken to Sexton campus to Mark Gibson's AFRG laboratory, room N310. There you will find a drawer labeled "IN FIELD", which contains filter petri dishes labeled [Site Code]-[Cartridge #], e.g. INKA-004. Individual

filters are then labeled 13161-INKA-1T. Normally all 16 filters (8 Teflon, 8 Nuclepore) are grouped in one custom-made petri dish holder. Individual

Figure 4: petri dish holder () containing one Teflon filter from Tsinghua University, China (CHTS). This filter is 1 of 16 of the CHTS_011 cartridge filters (13161 to 13176).

Disassemble and unload the cartridge in the HEPA hood (with blower turned OFF!). First place a fresh large Kimwipe under HEPA space before disassembling (this provides a clean working surface).

Tools needed:

- Hex key (opening cartridge)
- Two pairs of clean tweezers
- Custom-made plug remover (see figure 1)
- Methanol (for wiping tweezers, cleaning parts)
- Milli-Q water (for cleaning parts)

Remove all 8 screws with hex key. Separate cartridge halves by flipping over the two 2x2 top halves containing the Teflon filters. Wipe tweezers and proceed to place filters in the appropriately labeled dishes. Grab only the edge of filters. Anticipate there may be static, especially for nuclepore. Teflon filters (opaque white) go in dishes labeled 1T, 2T,…8T. Nuclepore filters (translucent, very delicate) go in dishes labeled 1N, 2N,…8N. NB: The 8^{th} slot is the blank and filter surface should look very clean.

Once all filters have been transferred to dishes, place filled petri dishes back into 16-slot filter holder. For added security, place two elastic bands lengthwise around the holder, and the ensemble into a medium-sized Glad or Ziploc plastic bag.

Step 3: Post-weighing filters

Packaged filters are brought to HERC (located in Dalhousie's LSRI building). Filters are unloaded from 16-slot holder and left to equilibrate for 24 hours. Please refer to **section 1** for explanation of pre and post-weighing procedures (identical to pre-weighing).

Once filters have been post weighed, they are measured for Equivalent Black Carbon (E-BC) via reflectance at HERC. Please refer to **section 6** for an explanation of E-BC measurements.

After BC measurements are performed at HERC, the filters are repackaged into same 16-slot filter holder and returned to Sexton (AFRG facility) for chemical analysis.

Please refer to **section 7 and 8** for ion chromatography (IC; cation & anion) and ICP nitric acid digestion.

Step 4: Transforming post-weigh and flow data into mass concentrations

In cartridge digital log Excel files compiled by Crystal Weagle you will find an outline like the following:

ARCB-001									
		Duty minutes	111	scaling factor 1					
				correction factor 0					
PM2.5									
Sampling Date Range	Filter ID	PM mass [ug]	PM Error	Average Flow [lpm]	Volume [m3]	PM2.5 conc. [ug/m3]	PM2.5 corrected	Error	
10/02/2014 - 10/11/2014	13001-ARCB-1T	35.83	1.45	4.11	4.108	**8.72**	**8.72**	0.84	
10/11/2014 - 10/20/2014	13002-ARCB-2T	31.70	4.89	3.91	3.907	**8.115**	**8.11**	1.25	
10/20/2014 - 10/29/2014	13003-ARCB-3T	33.50	6.89	3.84	3.839	**8.73**	**8.73**	1.79	
10/29/2014 - 11/07/2014	13004-ARCB-4T	27.40	1.90	4.10	4.093	**6.70**	**6.70**	0.46	
11/07/2014 - 11/16/2014	13005-ARCB-5T	50.50	5.09	3.84	3.839	**13.16**	**13.16**	1.33	
11/16/2014 - 11/25/2014	13006-ARCB-6T	34.47	3.90	3.89	3.89	**8.86**	**8.86**	1.00	
11/25/2014 - 12/04/2012	13007-ARCB-7T	48.60	6.05	3.92	3.918	**12.40**	**12.40**	1.54	
Blank	13008-ARCB-8T	7.20	1.51		0.000				
					Average: 9.08		9.53	1.17	
PMcoarse									
Sampling Date Range	Filter ID	PM mass [ug]	PM Error	Average Flow [lpm]	Volume [m3]	PMcoarse conc. [ug/m3]		Error	
10/02/2014 - 10/11/2014	13009-ARCB-1N	27.07	2.55	4.11	4.108	**6.59**		0.62	
10/11/2014 - 10/20/2014	13010-ARCB-2N	67.67	7.78	3.91	3.907	**17.32**		1.99	
10/20/2014 - 10/29/2014	13011-ARCB-3N	56.70	7.92	3.84	3.839	**14.77**		2.06	
10/29/2014 - 11/07/2014	13012-ARCB-4N	40.33	6.53	4.10	4.093	**9.86**		1.60	
11/07/2014 - 11/16/2014	13013-ARCB-5N	65.87	3.41	3.84	3.839	**17.16**		0.89	
11/16/2014 - 11/25/2014	13014-ARCB-6N	44.33	11.75	3.89	3.891	**11.39**		3.02	
11/25/2014 - 12/04/2012	13015-ARCB-7N	86.93	1.91	3.92	3.918	**22.19**		0.49	
Blank	13016-ARCB-8N	4.77	12.17	0.00	0.000				
					Average: 13.14			1.52	

Figure 5: Raw mass data (micrograms) combined with flow rates (lpm) and sampling time (daily duty time x 9 days). Total flow volume (translated from litres to m^3) is total sampling time x flow rate. PM2.5 and PMc concentrations are then Raw mass / Total flow Volume, reported as µg/m^3. NB: we reject reported masses for nuclepore filters with > 160 µg deposited material and/or flow rates that have decreased by > 12% (approx. 3.5 lpm from an initial 4.0). Both instances indicate likely clogging of filter has occurred.

Digital log sheets should follow the above template for standardization and simplicity sake.

- The Filter ID is again the format 13nnn-XXXX-1T, etc. ,
- PM mass (ug) is the raw post-weighed mass from HERC weighing
- PM error is 1 standard deviation from two combined triplicate HERC weighing, e.g.

$$\Delta PM_{tot} = \sqrt{\left(\Delta PM_{pre}\right)^2 + \left(\Delta PM_{post}\right)^2}$$

- Average flow is usually the mean of the pre and post-measured external flow (exceptions include when internal flows are available).
- Volume is flow rate x time / 1000 (convert from l to m^3)
- PM2.5 conc is PM mass / Volume

- PM2.5 corrected is based on SPARTAN-measured masses collocated with Harvard impactor filters. If data exists, we create a RMA plot of PM mass vs HI mass. This correction is subject to detailed analysis depending whether HI collocation has taken place, and whether values are properly correlated. By default scaling factor SF =1, correction factor CF =1. Equation is $PM_{corr} = SF \cdot PM_{meas} + CF$

It will take some time to figure out and collect site operator data, however once in the above format it will become much easier to digest.

$PM_{2.5}$ mass concentration and time ranges shown in figure 6 is collected with other data from that site in a .csv file (see Sections 4-8).

location = BuenosAires_ARCB

tube	start_year	start_month	start_day	start_hour	stop_year	stop_month	stop_day	stop_hour	PM_2.5_abs	Vol_m3	PM_2.5	scaling_factc	correction_f:	PM2.5_corr
13001-ARCB-1T	2014	10	2	9	2014	10	11	8	35.8333333	4.10779286	8.72325713	1	0	8.72325713
13002-ARCB-2T	2014	10	11	9	2014	10	20	8	31.7	3.90656439	8.11454692	1	0	8.11454692
13003-ARCB-3T	2014	10	20	9	2014	10	29	8	33.5	3.83850316	8.72736028	1	0	8.72736028
13004-ARCB-4T	2014	10	29	9	2014	11	7	8	27.4	4.09251834	6.6951441	1	0	6.6951441
13005-ARCB-5T	2014	11	7	9	2014	11	16	8	50.5	3.83858394	13.1558931	1	0	13.1558931
13006-ARCB-6T	2014	11	16	9	2014	11	25	8	34.4666667	3.89078319	8.85854209	1	0	8.85854209
13007-ARCB-7T	2014	11	25	9	2014	12	4	8	48.6	3.91845525	12.4028468	1	0	12.4028468

Figure 6: data entered in a Matlab-readable format

Other data will be added to columns right of PM25_Corr. Note that nuclepore data is not collected and stored in this upload sheet. As of now we are not sharing the nuclepore chemical and physical analysis on the Sparta-network.org website.

Further columns in upload sheet require composition information collected from IC and ICP analysis (**steps 7 and 8**).