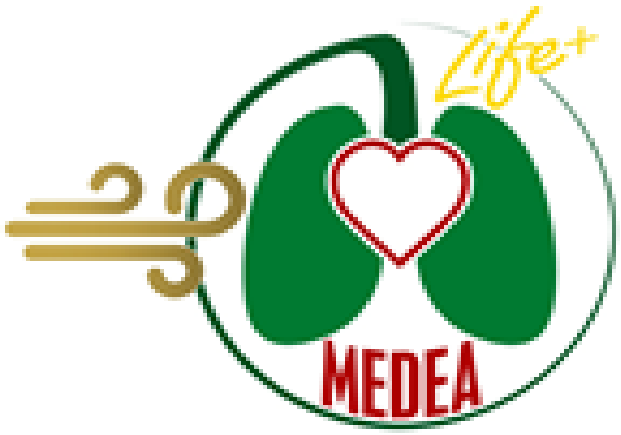

Sub-Action C.1

Deliverable C1.4. Protocols for collection of outdoor and indoor exposure data in vulnerable patient groups and preliminary pollution data from the pilot studies

Responsible beneficiary: UCY

Date: 31/08/2018

DRAFT-5JULY2018-MEDEA CASCADE ONLY SOP

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1. HOME/SCHOOL CASCADE SAMPLING SCHEME

DUST OR NON-DUST	INDOOR OR OUTDOOR	SAMPLE DURATION	TALENTO CONTROL TIMERS	24-HR TIMER PARTIAL HOURS	PM2.5 COLOR CODE	PM10 COLOR CODE
NON-DUST	INDOOR	7 DAY	USED	NOT USED	GREEN	RED
NON-DUST	OUTDOOR	7 DAY	USED	NOT USED	GREEN	RED
DUST	INDOOR	DURATIONOF DUST STORM + 1 DAY	NOT USED	USED	GREEN	RED
DUST	OUTDOOR	DURATIONOF DUST STORM + 1 DAY	NOT USED	USED	GREEN	RED

2. LAB

a. the lab should be located relatively close to the sites (homes/schools)
b. there must be a supply of deionized/distilled water
c. space for cleaning, assembly and disassembly of samplers
d. it needs to be clean (relatively dust-free) and have good lighting (for visibility)
e. table tops are wiped clean with paper towels, moistened with deionized water
f. sampler surfaces are wiped clean with Kimwipes moistened with deionized water
g. this lab needs a refrigerator to store collected sample filters

3. OUTDOOR SAMPLING SITE ISSUES

a. the site needs to be located relatively far from point sources, such as factories, incinerators, power plants, heavily trafficked roads, etc
b. access to the site should be restricted to minimize the potential for vandalism
c. the samplers need to be located away from any vertical surface (wall or adjacent taller building) at a distance of about one and one-half times the height of the surface
d. no big ventilation/exhaust ducts/fans within 10 meters of the site
e. must have one 15 amp rain-proof electrical circuit outlet
f. must have a flat area that allows for walking and equipment placement

4. OVERVIEW OF CASCADE SAMPLERS

a. These are 5LPM impactors, with cutpoints of both 2.5 and 10 µm, using polyurethane foam (PUF) as the impaction substrate, with two identical impaction stages in series for each cutpoint. $PM_{2.5}$ stages are marked with GREEN; PM_{10} stages are marked with RED. The 2.5 µm substrates are 3/8" diameter. The 10 µm substrates are 3/4" diameter. All cascade impactors are processed (filters loaded and unloaded, PUF substrates replaced) in the lab. The sequence of stages is: 1) inlet (only for indoor cascades); 2) "higher impaction stage"; 3) "lower impaction stage", and: 4) filter holder.

b. The same configurations of samplers are used for Routine, Blank, and Collocated samplers.

c. The Teflon filters for all samplers must be weighed at HSPH before and after sampling to measure net mass. After final mass measurement, the filters are analyzed for carbon by transmissometer, and elements by X-Ray Fluorescence (XRF).

d. 37mm Teflon filters for both PM_{10} and $PM_{2.5}$ will use the same format for filter IDs: "MEDEA-nnn-MS", where MEDEA is the study acronym, nnn ranges between 001 and 999, and MS is the code for gravimetric mass. Note that we anticipate using more than 999 filters.

5. OVERVIEW OF TASKS

a. School/Home Indoor Cascade Samples

1. Non-dust week

- In the lab prepare pump boxes, including initial sampler flows (with samplers attached to top of pump box), Talento sample-timers (programmed to start several samplers all on the same day), and then initial elapsed times
- Enter information on HOME/SCHOOL CASCADE LAB DATA LOG
- On a day prior to start day for a set of locations, transport pumps and impactors to home/classroom (impactors in plastic bags, not attached to pump boxes)
- Set-up in home/classroom, choose appropriate place for pump box (e.g., living room for homes, on top of a table)
- Connect impactors to pump box
- Plug in pump box. The Talento will start sampling on the same day for all (non-dust week) locations
- After one week of sampling, Talento will turn all pumps off at the same time
- Following the end time of sampling, return to each home/classroom, unplug pump box (does not have to be all locations on the same day)
- Measure final elapsed times, then final flows
- Enter information on the FIELD DATA LOG

2. Dust week

- For the second sampling week (dust week), take down the cascades with the non-dust sample

- Set up the fresh samplers (first test and record flows, then record start elapsed time)
- Enter information on FIELD DATA LOG
- Deactivate the Talento timer (push the button that makes the power stay on all the time), and set the frequency of sampling using the 24hr timers (pins in=off, pins out=on)
- Inform participants and/or field operators when to plug in pump box to start sampling
- One day after the end of the dust storm, inform participants and/or field operators to unplug the pump box
- At a convenient time after pump box has been unplugged, go to home/classroom and bring back pump box to lab (disconnect cascades for transport). Then do measurements in the lab (final elapsed times, final flows)
- Enter information on the LAB DATA LOG

b. School/Home Outdoor Cascade Impactors

1. Non-dust week

- In the lab prepare pump boxes, including initial sampler flows (with samplers attached inside the pump box), Talento sample-timers (programmed to start several samplers all on the same day), and then initial elapsed times
- Enter information on HOME/SCHOOL CASCADE LAB DATA LOG
- Transport pumps and impactors to home/classroom (impactors inside pump boxes, U-shaped inlets disconnected from pump boxes)
- Set-up outside home/classroom, choose appropriate place for outdoor sampler (e.g., same height from ground as with the indoor sampler, 3m distance from a vertical surface such as wall)
- Connect U-shaped inlets to pump box
- Plug in pump box. The Talento will start sampling on the same day for all (non-dust week) locations
- After one week of sampling, Talento will turn all pumps off at the same time
- Following the end time of sampling, return to each home/classroom, unplug pump box (does not have to be all locations on the same day)
- Measure final elapsed times, then final flows
- Enter information on the FIELD DATA LOG

2. Dust week

- For the second sampling week (dust week), take down the cascades with the non-dust sample
- Connect the fresh samplers (first test and record flows, then record start elapsed time)
- Enter information on FIELD DATA LOG
- Deactivate the Talento timer (push the button that makes the power stay on all the time), and set the frequency of sampling using the 24hr timers (pins in=off, pins out=on)

- Inform participants and/or field operators when to plug in pump box to start sampling
- One day after the end of the dust storm, inform participants and/or field operators to unplug the pump box
- At a convenient time after pump box has been unplugged, go to home/classroom and bring back pump box to lab. Then do measurements in the lab (final elapsed times, final flows)
- Enter information on the LAB DATA LOG

c. Sample Categories: Routine, Colo, and Blank

- *Routine* samples are for all scheduled home and school site measurements
- *Colos* are side-by-side measurements with identical samplers for quality control
  - The number of Colos should be 5% of the number of Routine samples
  - Colos for Indoor Cascade Impactors are (probably) not done in homes or schools with Routine measurements, but may be done in homes of staff members
  - Colos for Outdoor Cascade Impactors are (probably) done outside staff members houses or at the lab premises
- *Blanks* are samplers are prepared for quality control
  - They are assembled and dis-assembled in the lab (no sample collected)
  - The number of Blanks should be 5% of the number of Routine samples
  - One option is to have "Field Blanks" that are taken to the field, placed on racks like Routine samples, but with no connection to pumps, and left for the same duration as Routine samples
  - The other option is to have "Lab Blanks", that are kept in the lab, and have filters loaded and unloaded the same as Routine samples
  - HSPH recommends using only Field or Lab blanks, not both.

1. Sample START TIME
   1) has to be **selected** (at HSPH we use 09:00hr)
   2) must be the same for the whole study for the non-dust sample week
   3) If there are ambient particle measurements done by a government agency, it might be good to use the same start time (**consult with Petros, regardless**)
   4) The **selected** START TIME (of day) is used for all types of samples during the non-dust week
      a) Home/School Indoor Cascade
      b) Home/School Outdoor Cascade

6. HOME/SCHOOL CASCADE FIELD DATA LOG

a. Each LOG is used for a single set of one-week long samples
b. Enter the START DATE and START TIME for the pair of PM_{10} and $PM_{2.5}$ samplers.

c. Each pre-weighed filter is provided in a plastic Petri dish with two identical sample ID labels.
d. When a filter is loaded into the cascade impactor, both labels are placed on the impactor.
e. When the impactor is set up for sampling one label is left on the impactor and the other is placed on the DATA LOG.
f. Each sample pump (two per pump box) must be labeled with a PUMP # (this number is assigned at the start of the study and must stay the same for the whole study for each house or classroom).
g. As the impactors are attached to pump boxes, record PUMP #s on the DATA LOG.
h. The flow measurements for start will be made in the lab or at the site, and for end will be made at the Site.
i. Elapsed time measurements will be entered for start and end.
j. Enter any notes at the bottom of the logsheet.

7. PREPARATION OF CASCADE SAMPLERS

SECTIONS:

a. Cleaning
b. Greasing O-rings
c. Filter Holder (see pictures)
d. PUF Substrate Holders (see pictures)
e. Higher Impactor stage (PM_{10} or $PM_{2.5}$) (see pictures)
f. Lower Impactor stage (PM_{10} or $PM_{2.5}$) (see pictures)
g. Complete Assembly (see pictures)

a. Cleaning
   1) Clean all new parts with detergent/water
   2) New cascade components need to have components wiped clean with Kimwipes moistened with deionized water
   3) all parts must be dry before using
   4) During assembly, the inner surfaces of the sampler components must be wiped with moist (ethanol or deionized water) Kimwipes

b. Greasing O-rings
   1) O-rings for all the cascade samplers were initially greased before shipment, but they whenever the pieces fit too tightly together, they need to have fresh grease applied
   2) Black Buna rubber O-rings are used to seal the connections between the sections of the cascade samplers
   3) Use only Dow-Corning high vacuum silicon grease

4) To assemble and disassemble samplers without excess force, and to prevent damage to O-rings, it is necessary to lubricate the O-rings with a thin layer of silicone grease

5) To apply the proper amount of grease, use the following method:
   - Wash hands first
   - Dow Corning high vacuum grease is supplied by HSPH in small glass bottles
   - Use the small plastic wire-tie to take out a very small amount of grease
   - Put the grease on a finger tip
   - Use finger to apply a small amount of grease to the entire ring
   - Wipe excess grease off finger with Kimwipe
   - Then, use (relatively) clean finger to wipe off (gently) more of the grease on the ring.
   - When finished, to avoid getting grease on other surfaces, wash off hands with soap and water.

5) *<u>It is especially important to prevent getting grease on the Teflon filters</u>*

6) There is a small O-ring (black Viton rubber, size 027) used in the cascade filter pack – **<u>DO NOT PUT GREASE ON THIS O-RING</u>**

7) Whenever pieces using greased O-rings become difficult to attach and take apart, new grease must be applied

c. <u>Filter Holder Assembly</u>

1) Items needed to assemble the filter holder
   - Support piece for assembly of filter holder bottom (see pictures)
   - Filter holder sections (see pictures)
     - The *indoor cascade filter holder* bottom section has the flow outlet barbed fitting at a right angle to the overall cascade sampler
     - The *indoor holder* has a threaded rod on the bottom (with wingnut, used to attach to the top of the indoor pump box)
     - The *outdoor cascade filter holder* bottom section has the flow outlet in the middle, facing down (to attach to pump tubing inside the outdoor pump box)
     - The filter holder top section (with greased thick O-ring) is the *same for both indoor and outdoor cascades*
   - Viton O-ring
   - Stainless steel screen
   - New drain disc
   - Pre-weighed Teflon filter in plastic Petri dish with two lab labels
   - Four screws – phillips head, size 6-32, length 3/8”

2) The cascade samplers were assembled initially at HSPH, with O-rings and stainless steel screens installed (no drain discs or Teflon filters)—the screens may already adhere to the O-rings – if so it is best not to take them out (just clean screen, then install drain disc and filter – as described below)

3) Place a clean small Kimwipe on a clean tray

4) Place the support piece on the Kimwipe with the "wings" facing down
5) Wipe the filter holder bottom section clean with an ethanol-moistened Kimwipe
6) Place the filter holder bottom section on the support piece (see picture)
7) Make sure that the black Viton O-ring is all the way down inside the bottom piece
8) Place a clean stainless steel screen on top of the O-ring
9) Make sure the stainless steel screen is down completely on the O-ring.
10) Wipe the screen with an ethanol-moistened Kimwipe
11) Clean a forceps with an ethanol-moistened Kimwipe
12) Place the forceps on a clean Kimwipe when not in use
13) Use the clean forceps to take a new drain disc out of its plastic bag and place it on top of the screen.
14) Be extra careful to not contaminate drain discs in the plastic bag
15) Be careful to only use a single drain disc
16) Open a labeled plastic Petri dish with a pre-weighed Teflon filter
17) Use the forceps to place the Teflon filter on top of the drain disc with the shiny side of the outer ring facing up. The forceps must only contact the rigid outer ring. Otherwise they may make a hole in the thin, fragile membrane. If by accident a hole is made, the filter must not be used for a sample. It should be saved and used as a blank for gravimetric analysis.
18) Wipe the filter holder top section with an ethanol-moistened Kimwipe, **with special care to clean the surface that will touch the filter**
19) Carefully place the filter holder top section on top of the bottom section
20) Make sure that the filter and drain disc stay in the middle of the bottom section
21) Line up the screw holes for both pieces
22) Hold the top and bottom sections together and turn the filter
holder to have the bottom facing up, and place onto a clean Kimwipe, continuing to hold the parts together
23) Attach the four screws:
    - Turn each screw a little at a time
    - Make sure that there is even tightness for all
24) Keep the assembled filter holder on the clean Kimwipe (with the bottom facing up) until ready to attach to the rest of the cascade impactor
25) Both filter ID labels will be transferred from the Petri dish to the assembled cascade sampler
    - For the indoor cascade attach labels to the inlet stage
    - For to outdoor cascade attach labels to the higher impactor stage
    - One label will stay on the assembled cascade impactor until it returns to the lab for dis-assembly
    - The other label will be transferred to the Field Data Log Sheet
26) Make sure that the Petri dish is closed (store in clean plastic bag until filter is put back in when cascade sampler is dis-assembled)

d. PUF Substrate Holders

1) (see pictures)
2) The same procedure is done for both $PM_{2.5}$ and PM_{10} PUF
3) If not already done, remove the used PUF substrate from the substrate holder
4) Wipe the substrate holder clean with an ethanol-moistened Kimwipe
5) New PUF substrates are kept inside plastic bags inside dark location (to prevent pink color fading to orange after extensive exposure to light)
6) Use clean forceps to put a new PUF substrate into the substrate holder
7) Use the back side of the forceps to make sure the substrate is uniformly placed and completely down inside the cylindrical cavity of the holder
8) Keep the substrate holder in a clean place until ready to install in impactor stage

e. Higher Impactor Stage (PM_{10} or $PM_{2.5}$)

1) *For indoor cascades only*:
   - Wipe pieces with moistened Kimwipes
   - Attach the inlet section to the higher impactor stage nozzle
   - Gently push the indoor inlet onto the higher impactor stage nozzle (PM_{10} or $PM_{2.5}$)
   - Push the two pieces all the way together
   - Place this assembly on a clean Kimwipe, with the inlet pointing down
2) *For both indoor and outdoor cascades*
   - Install the substrate holder (with PUF) inside higher stage nozzle
   - For indoor cascades the inlet was attached (above) to the higher stage nozzle, and placed on a Kimwipe with the inlet pointing down.
   - Insert the clean substrate holder (with new PUF) inside the nozzle, with the PUF facing toward the nozzle jet.

f. Lower Impactor Stage (PM_{10} or $PM_{2.5}$)

1) Attach the lower stage nozzle to the higher stage nozzle
2) The lower stage nozzle must be the same size (PM_{10} or $PM_{2.5}$) as the higher stage nozzle.
3) The higher stage substrate holder with new PUF has already been inserted inside the nozzle (step just above – assembly is pointed down to keep the substrate holder inside the nozzle)
4) Gently attach the lower stage nozzle into the higher stage nozzle

5) Insert the clean substrate holder (with new PUF) inside the lower stage nozzle, with the PUF facing the nozzle jet
6) Keep this assembly on a clean Kimwipe, with the inlet pointing down, with the substrate holder (bottom side) facing up
7) This *partial assembly* is now ready to attach to the previously assembled filter holder

g. Complete Assembly

1) The partial assembly has been kept on a Kimwipe
2) Complete assembly includes:
   - Indoor has inlet, higher stage, lower stage, filter holder
   - Outdoor has only higher stage, lower stage, filter holder
3) The lower stage is facing up, with the PUF substrate inside
4) Attach the filter holder to the lower stage
   - Gently place the filter holder onto the lower nozzle
   - Push the pieces all the way together
5) Attach assembled Cascade impactor to holder plate bracket
   - *Outdoor Cascade*: (see pictures)
     - Outdoor cascade uses two holder plates
     - The bottom plate has four "wings" with a large hole in the middle, and is attached to the bottom of the filter holder – two wings have small holes and the other two have open "slots"
     - The top plate has two wings, also with a large hole and is attached to the top of the higher nozzle
     - Each wing of the top plate has a small hole used to attach it to the bottom plate with screws and wingnuts
     - The wings with slots will connect to the higher stage of the impactor to the inlet section that is mounted inside the outdoor cascade pump box (with wingnuts posts and screws)
     - The outdoor partial assembly was prepared (see above)
     - Place the top plate (with two wings) onto the top of the assembly (the plate has to be pushed gently over the black O-ring)
     - Hold the bottom plate (four wings) onto the bottom of the filter holder
     - Rotate the plates to align the small holes in the top and bottom plates
     - Attach two screws through these holes using wingnuts
     - The tops of the screws are at the top plate, the wingnuts are at the bottom plate
     - Tighten the wingnuts only enough to hold the pieces together, but not too tight
     - Note that the outdoor cascade will be mounted inside the outdoor pump box to an adapter tube section with two wings to connect using screws and wingnuts to the slots on the 4-wing plate (see picture)

- *Indoor Cascade:* (see pictures)
  - Indoor cascade uses only one holder plate (see picture)
  - This plate has a small hole in the middle and two "wings"
  - Each wing has a hole (one side is tapered, the other is flat)
  - The hole in the middle is to allow placement on the threaded screw on the bottom of the filter holder
  - The partially indoor outdoor cascade assembly was prepared (see above)
  - Remove the wingnut from the threaded screw
  - Slide the plate onto the threaded screw with the indented sides of the two holes facing away from the bottom of the filter holder
  - Replace the wingnut (not too tightly)
  - Connect each wing of the inlet piece to the bottom plate
    - Use two "binding posts" (cylindrical tubes with screw threads inside, and phillips screw head at the top)
    - The indented sides of the small holes in the wing must face away from the bottom of the filter holder allow the flat head of the binding post screws to be flush with the plate)
  - Rotate the filter holder bottom so that the barbed hose fitting is at about a right angle to the plane of the binding posts
  - Tighten the wing nut slightly more

8. SAMPLING EQUIPMENT

a. Indoor Cascade Sampling

1) Indoor 2-pump boxes used for PM_{10} & $PM_{2.5}$
2) Pump boxes & cascades are transported back and forth from lab to homes and schools

b. Outdoor Cascade Sampling

1) Outdoor 2-pump boxes used for simultaneous collection of outdoor PM_{10} & $PM_{2.5}$ with indoor PM_{10} & $PM_{2.5}$
2) Cascade samplers are installed inside outdoor pump boxes
3) Outdoor pump boxes are mounted on tripods (see pictures)

9. SAMPLING: CASCADE IMPACTORS

a. *Summary*:

1) This section is for both indoor and outdoor home and school sampling
2) Assume that for each season only a single one-week set of samples is collected in each home/school
3) INITIAL FLOW and FINAL FLOW are measured in the lab with the samplers attached to the pump box (both indoor and outdoor systems)
4) The indoor pump box and indoor samplers (in plastic bags) are transported to the home/school

5) The outdoor pump box with outdoor samplers attached inside is transported to the home/school, with the tripod support
6) Each pump is turned on for one week
7) For indoor systems, the samplers are disconnected and returned with pump box to the lab
8) For outdoor systems, the pump boxes (with samplers inside) and tripods are returned to the lab
9) Use the HOME/SCHOOL CASCADE FIELD DATA LOG to record all information
10) Use one DATA LOG for only a single one week's set of samples (both indoor and outdoor)

b. Pump Boxes:

1) Indoor Pump Boxes

- For each indoor pump box, a unique PUMP # is assigned for each pump
- One label with the PUMP # is placed next to the pump inside the box
- Another label with the same # is placed on the outside of the box next to the barbed fittings for tubing (to attach to cascade sampler)
- The two barbed fittings should also have color code labels :
  - RED for PM_{10}
  - GREEN for $PM_{2.5}$
- The indoor pump box is transported to the home/school, along with the cascade samplers in plastic bags
- In the home/classroom, attach the cascade samplers to the top of the pump box with wingnuts, then connect the pump tubing to the barbed fittings on the samplers

2) Outdoor Pump Boxes

- Attach outdoor sampler inside pump box (in the lab):
  - The top of the sampler is gently attached to the adapter tube inside the pump box
  - The adapter tube has two wings with holes
  - The two screws that hang down from the adapter tube are attached with wingnuts to the slots on wings on the bottom plate
  - The barbed fitting at the bottom of the outdoor cascade is attached to the pump tubing inside the pump box
- The outdoor pump box is transported with the sampler(s) inside and with the U-shaped inlet tubes disconnected
- Attach the outdoor pump box to the tripod (see pictures)
- Attach the inlet tubes to the ports on the top of the pump box

c. Sampling:

1) The indoor 2-pump box is placed on top of a table in the living/family room or classroom

2) The outdoor pump box is attached to the support tripod outside the home/school
3) The U-shaped inlet tubes are attached to the outdoor pump box
4) The outdoor cascades should already be attached inside the outdoor box. If not, then they must be attached and connected to pump tubing inside the box
5) Plug in pump boxes to electricity
6) Record START DATE and START TIME on the DATA LOG
7) The Talento Smart C15 timer will be set to automatically start and stop the 7-day sampling during the non-dust week.
8) For dust days, we will sample during the dust storm plus one more day, unless the episode lasts one week. Since we won't be able to know exactly how many days the dust episode will last, the Talento timer will be deactivated during the dust sampling and the sampling will be manually start and stop by the participant or the field operator. The two 24-hr timers that are inside pump boxes can control the frequency of the sampling: <u>each white prongs corresponds to 15 minute and must be pushed out to keep power on whenever the pump box is connected to electricity</u>
9) At the end of sampling unplug pump boxes
10) Record the END DATE and END TIME on the DATA LOG
11) Record END ELAPSED TIMES before measuring END FLOWS
12) Measure END FLOWS
    - These flows are measured with the samplers attached to the corresponding pumps that were used at the site
    - The indoor cascades must be attached to the pump boxes for flow measurements
    - The outdoor cascades are not removed from pump boxes until after measuring END FLOWS
13) After the second week sample, return sampling equipment and samplers to lab for processing

d. *Flow Measurement* (in the lab or at site before and after sampling, <u>same flowmeter must be used during the sampling period</u>):

1) <u>Indoor Pump Box Flows</u>

- Attach protective filters with tubing to barbed fittings
- Plug in pump box to electricity
- After 15min warm-up unplug pump box
- Remove protective filters
- Attach cascade samplers to the top of the pump box using wingnuts
- Attach pump tubing between the outlet nozzles on the bottom of the samplers and the barbed fittings on the pump box
- Remove big red cap with screen from the cascade inlet
- Attach flowmeter adapter to cascade inlet
- Connect flowmeter adapter to flowmeter with plastic tubing

- Plug box into electricity
- Measure flows (see section 10)
- INITIAL FLOW must be in the range of 5.00-5.10LPM
- If flow is not in this range, adjust valve to get in range
- FINAL FLOW must be measured and recorded <u>without adjustment</u>
- Record the flows on the HOME/SCHOOL CASCADE FIELD DATA LOG
- Unplug from electricity
- Disconnect flowmeter adapter from cascade inlet
- Replace big red cap with screen on inlet
- Disconnect cascade from pump box
- START ELAPSED TIME is measured after INITIAL FLOW, when pump is turned off
- FINAL ELAPSED TIME is measured before plugging pump to warm up for FINAL FLOW.
- All measurements are recorded on the DATA LOG

2) <u>Outdoor Pump Box Flows</u>

- Most steps the same as for indoor pump boxes
- The U-shaped inlet tube(s) must be attached to the pump box (only hand-tight (or slightly tighter with a wrench) because they have to come off and back on.
- Before pump warm up, disconnect small red cap with screen from inlet tube, attach protective filter (see pictures)
- After 15 minute warm-up, turn pump off,
- Disconnect protective filter from inlet
- Attach the flow adapter (with rubber tubing and plastic adapter) specifically designed to attach to inlet tube
- Use plastic tubing to connect the flowmeter to the flow adapter
- Other steps are the same as for indoor box flows
- After measuring flow, reattach the small red cap with screen to inlet tube
- Disconnect inlet tubes prior to transport of pump box to home

10. CASCADE IMPACTOR FLOW MEASUREMENTS:

1) Flow is measured using a calibrated rotameter:
   - An Excel spreadsheet is provided with each rotameter that includes the calibration curve (flow vs rotameter reading, with slope and intercept)
   - The glass “black” ball must be used for 5LPM cascade impactors. **Do not use** the stainless steel “silver” ball – it is used only for measuring 10LPM for Harvard Impactors.

- The black ball reading for a flow of 5LPM is written on a label on the rotameter: TARGET READING FOR 5LPM.
- Rotameter readings must use the **center of the ball**
- Note that when the rotameter is attached to measure flow, it causes a decrease of about 1.5% in flow due to a small resistance of the air flow through the rotameter, for a flow of 5LPM.
- It is necessary to avoid sudden changes in flow through the samplers because the sample filter can be distorted or broken if there is a large pulse of air
- A pulse occurs when a flow is blocked and then unblocked quickly (i.e. during attachment or disconnection of sampler or flowmeter)
- Check the black rubber O-ring on the quick-connect fitting on the rotameter. If it seems to be "dry", apply a thin layer of silicone grease (see section 6 above – Preparation of Cascade Impactors -- for how to do this). If the O-ring is not smooth, replace it with a new O-ring (then apply grease).
- The flow adapter for the outdoor cascade impactor has a rubber tubing part to attach to the U-shaped inlet tubes. It is necessary to remove the small red cap with screen from the inlet tube before attaching the flow adapter. The plastic connection tubing has a quick-connect fitting to attach to the rotameter.
- The flow adapter for the indoor cascade impactor is a rubber stopper with tube that attaches to the inlet. It is necessary to remove the large red cap with screen from the inlet before attaching the flow adapter.
- Rotameter, flow adapters, and connection tubing are all kept in a small plastic case.

2) Measure the INITIAL FLOW (and adjust to target flow if necessary):
   - The pump must be warmed up prior to flow measurement (with the sampler disconnected and a protective filter attached)
   - Turn the pump off before attaching the rotameter.
   - Connect the rotameter to the inlet using the flow adapter and connection tubing.
   - Check to see if the rotameter reading (black ball) is the TARGET READING FOR 5LPM.
   - Adjust flow, if needed to read within +/- one division of the TARGET.
   - Record measured reading on the DATA LOG
   - Turn off the pump and remove flow adapter and rotameter (leave sampler in place)
   - Re-attach the small red cap/screen (U-shaped inlet on outdoor pump box) or large red cap/screen (inlet to indoor sampler)
3) Turn the pump on to start the one week sample
4) Measure the FINAL FLOW:
   - This procedure is almost the same as for INITIAL FLOW
   - The difference is that the FINAL rotameter reading must be measured and recorded. Do not adjust it to TARGET READING at this time.

11. STORAGE/SHIPMENT OF TEFLON FILTER SAMPLES

a. Remove filter from the sampler
b. Put filter inside clean (re-used Petri dishes – wipe clean with ethanol moistened Kimwipe)
c. *Remove* the filter ID label from the body of the cascade and put it on the Petri dish
d. Tape Petri dishes closed with paper label tape
e. Teflon filters are shipped back to HSPH at the end of each sampling season (January-May) in re-sealable plastic bags

12. AIR CLEANERS

a. Air cleaners will be set up at 25 asthmatic houses and classrooms, and 26 AF patients houses in Cyprus, and Crete; and in 26 AF patients houses in Israel
b. After randomization, air cleaners will be placed in the living room/family room (of participating patients with AF and children with asthma) and also in the classroom (in the case of children with asthma)
c. The Air Filter/purifiers: Storm AP-1516D 400S model, CowayCo., Ltd
d. The filter is designed for rooms up to 533 sq. ft. (49.5 m^2) and therefore one air cleaner per classroom, and living room will be used
e. Air cleaner will be placed as close to the middle of the wall as is allowed, keeping some distance from air samplers
f. The air cleaners should be in the same position throughout the study period
g. Air cleaners will be running continuously during the dust season of each year
h. HEPA filters will be changed once a year
i. The outer screen will be cleaned once a month or more frequent depending on the situation (more frequent dust storms).
j. Please refer to attached manual for more details on operation and cleaning process.

13. TABLE OF MISC ITEMS

Key	#	**ITEMS FOR CASCADE SAMPLERS ONLY**
1.	21	Indoor **cascade 2-pump box** for PM2.5 & PM10 (routine + spare)
2.	21	Outdoor **cascade 2-pump box** for PM2.5 & PM10 (routine + spare)
3.	42	Indoor **cascade impactor** for PM2.5, with big red plastic cap with stainless steel screen (routine + spare)
4.	42	I**ndoor cascade impactor** for PM10 (routine + spare)
5.	42	O**utdoor cascade impactor** for PM2.5 (routine + spare)
6.	42	O**utdoor cascade impactor** for PM10 (routine + spare)
7.	6	Flow adapters for indoor cascade impactors –IN ROTAMETER CASES (routine + spare)
8.	6	Flow adapters for outdoor cascade Impactors—IN ROTAMETER CASES (routine + spare)
9.	20	Spare O-rings for rotameter quick-disconnect fitting– Size 011—black Buna rubber
10.	25	Extra 1-3/4" EC28 caps with holes
11.	12	Plastic cap with stainless steel screen for outdoor cascade inlet—EC12 red cap
12.	12	Extra EC12 caps with screens
13.	20	Extra EC12 caps (no screens)
14.	10	Spare O-rings for cascade outer connections—size 127—black 70 Buna rubber
15.	5	Spare O-rings for cascade filter holder—size 027-black Viton rubber
16.	20	Plastic caps for outdoor cascade inlet: size WW16x yellow
17.	60	Plastic caps for pump indoor pump box ports: size EC-4 red
18.	9	Protective filters for indoor pump box tubing (for pump warm-up)
19.	9	Protective filters for outdoor pump box U-shaped tube inlet (for warm-up)
20.	100	Resealable plastic bags to transport cascade samplers between lab and sampling site: 8"x7"
21.	3	Support piece to hold cascade base (when installing Teflon filter)
22.	400	3/8" diameter PUF substrates for PM2.5 cascades
23.	300	3/4" diameter PUF substrates for PM10 cascades
24.	300	Drain discs

25.	10	Extra cascade stainless steel screens
26.	25	Extra screws for cascade filter holder: stainless steel size 6-32, 7/16” length
27.	4	Extra binding posts with flat head screws for indoor cascades, size 8-32
28.	4	Extra round head screws, size 8-32, 3” length, with wingnuts, to hold outdoor cascade together
29.	4	Extra screws round head screws , size 8-32, 3.5” length, with wingnuts, to attach outdoor cascades inside pump box
30.	25ft	Extra amber latex tubing for indoor cascade pump boxes
31.	60	Extra caps for cascade barbed fittings, size EZ-215-12
1.	3	Connector tubing for rotameter
2.	3	Small bottles of silicone grease to lubricate O-rings
3.	300	Pre-weighed 37mm Teflon filters for PM10 and PM2.5 (inside Petri dishes with ID labels)
4.	6	Stainless steel forceps
5.	8	Small Kimwipes
6.	3	Large Kimwipes
7.	2	Plastic washbottle, 250ml
8.	2	Plastic washbottle, 125ml
9.	1	Box of paper label tape, different colors: ½” wide
10.	1	Box of paper label tape, different colors: ¾” wide
11.		

14. CASCADE IMPACTOR SCHEDULING

CASCADE IMPACTOR SCHEDULING (HOUSES AND SCHOOLS ARE DIFFERENT EVERY YEAR!!)								
INDOOR/OUTDOOR-1-week long								
Cyprus								
Year	Sampling week	Season	Asthmatic kids*		AF patients*	PM samplers	# 2-Pump boxes	Samples
			Houses	Classrooms	Houses			
2018	Pilot study (September-December)	dust	A	B		2.5 & 10	4	4
		clean	A	B		2.5 & 10	4	4
		dust			A	2.5 & 10	2	2
		clean			A	2.5 & 10	2	2
2019 & 2020	January-March	dust	A1+B2+C3	D1+E2+F3	G4+H5+I6	2.5 & 10	18	18
		clean	A1+B2+C3	D1+E2+F3	G4+H5+I6	2.5 & 10	18	18
		dust	A7+B8+C9	D4+E5+F6	G10+H11+I12	2.5 & 10	18	18
		clean	A7+B8+C9	D4+E5+F6	G10+H11+I12	2.5 & 10	18	18
	March-May	dust	A1+B2+C3	D1+E2+F3	G4+H5+I6	2.5 & 10	18	18
		clean	A1+B2+C3	D1+E2+F3	G4+H5+I6	2.5 & 10	18	18
		dust	A7+B8+C9	D4+E5+F6	G10+H11+I12	2.5 & 10	18	18
		clean	A7+B8+C9	D4+E5+F6	G10+H11+I12	2.5 & 10	18	18
Total:			*13*	*13*	*13*	*36*	*18*	*156*
Crete								
Year	Season	Sampling week	Asthmatic kids*		AF patients*	PM samplers	2-Pump boxes	Samples
			Houses	Schools	Houses			
2018	Pilot study (September-December)	dust	A	B		2.5 & 10	4	4
		clean	A	B		2.5 & 10	4	4
		dust			A	2.5 & 10	2	2
		clean			A	2.5 & 10	2	2
2019 & 2020	January-March	dust	A1+B2+C3	D1+E2+F3	G4+H5+I6	2.5 & 10	18	18
		clean	A1+B2+C3	D1+E2+F3	G4+H5+I6	2.5 & 10	18	18
		dust	A7+B8+C9	D4+E5+F6	G10+H11+I12	2.5 & 10	18	18
		clean	A7+B8+C9	D4+E5+F6	G10+H11+I12	2.5 & 10	18	18
	March-May	dust	A1+B2+C3	D1+E2+F3	G4+H5+I6	2.5 & 10	18	18
		clean	A1+B2+C3	D1+E2+F3	G4+H5+I6	2.5 & 10	18	18
		dust	A7+B8+C9	D4+E5+F6	G10+H11+I12	2.5 & 10	18	18
		clean	A7+B8+C9	D4+E5+F6	G10+H11+I12	2.5 & 10	18	18
Total:			*13*	*13*	*13*	*36*	*18*	*156*
Israel								
Year	Season	Sampling week	Asthmatic kids*		AF patients*	PM samplers	2-Pump boxes	Samples
			Houses	Schools	Houses			
2018	Pilot study (September-December)	dust	NA		A	2.5 & 10	2	2
		clean			A	2.5 & 10	2	2
		dust	NA		A1+B2+C3	2.5 & 10	6	6

2019 & 2020	January-March	clean		A1+B2+C3	2.5 & 10	6	6
		dust		A4+B5+C6	2.5 & 10	6	6
		clean		A4+B5+C6	2.5 & 10	6	6
	January-March	dust		A1+B2+C3	2.5 & 10	6	6
		clean		A1+B2+C3	2.5 & 10	6	6
		dust		A4+B5+C6	2.5 & 10	6	6
		clean		A4+B5+C6	2.5 & 10	6	6
Total:				*13*	*36*	*6*	*52*

* XY: X denotes the sample pair and Y the number of house or classroom

15. CASCADE IMPACTOR SAMPLING EQUIPMENT

CASCADE IMPACTOR SAMPLING EQUIPMENT	
Cyprus	
9	indoor 2-pump box routine
9	outdoor 2-pump box routine
9	indoor cascade $PM_{2.5}$ routine
9	indoor cascade PM_{10} routine
9	outdoor cascade $PM_{2.5}$ routine
9	outdoor cascade PM_{10} routine
9	single tripod routine
Crete, Greece	
9	indoor 2-pump box routine
9	outdoor 2-pump box routine
9	indoor cascade $PM_{2.5}$ routine
9	indoor cascade PM_{10} routine
9	outdoor cascade $PM_{2.5}$ routine
9	outdoor cascade PM_{10} routine
9	single tripod routine
Israel	
3	indoor 2-pump box routine
3	outdoor 2-pump box routine
3	indoor cascade $PM_{2.5}$ routine
3	indoor cascade PM_{10} routine
3	outdoor cascade $PM_{2.5}$ routine
3	outdoor cascade PM_{10} routine
3	single tripod routine
Total:	21 indoor and 21 outdoor pump boxes, 21 tripods, 42 $PM_{2.5}$ samplers, and 42 PM_{10} samplers

16. FIELD DATA LOGS

(draft) **HOME CASCADE FIELD DATA LOG**			
DUST/NON-DUST WEEK:			
OPERATOR:			REGION:
ROTAMETER ID:			HOME ID:
START DATE:			END DATE:
START TIME:			END TIME:
INDOOR	**PM2.5 GREEN**		**PM 10 RED**
FILTER LABEL			
PUMP #			
START ELAPSED TIME			
END ELAPSED TIME			
ROTAMETER ID			
INITIAL FLOW READING			
FINAL FLOW READING			
OUTDOOR	**PM2.5 GREEN**		**PM10 RED**
FILTER LABEL			
PUMP #			
START ELAPSED TIME			
END ELAPSED TIME			
ROTAMETER ID			
INITIAL FLOW READING			
FINAL FLOW READING			

NOTES:

(draft) **SCHOOL CASCADE FIELD DATA LOG**

DUST/NON-DUST WEEK:			
OPERATOR:			REGION:
ROTAMETER ID:			HOME ID:
START DATE:			END DATE:
START TIME:			END TIME:

INDOOR	**PM2.5 GREEN**		**PM10 RED**
FILTER LABEL			
PUMP #			
START ELAPSED TIME			
END ELAPSED TIME			
ROTAMETER ID			
INITIAL FLOW READING			
FINAL FLOW READING			

OUTDOOR	**PM2.5 GREEN**		**PM10 RED**
FILTER LABEL			
PUMP #			
START ELAPSED TIME			
END ELAPSED TIME			
ROTAMETER ID			
INITIAL FLOW READING			
FINAL FLOW READING			

NOTES: