TI 101D Filter Cassette Construction.

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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the process for constructing and assembling filter cassettes for use in the IMPROVE aerosol sampling network. The aerosol collection filter cassettes are purchased from Nuclepore Corporation, then modified slightly to accept the hardware used in the IMPROVE aerosol sampling network. All cassettes used in the IMPROVE aerosol sampling network are basically identical and interchangeable. The differences involve removable or replaceable parts such as masks, drain disks, and o-rings.

Each of the filter substrates used for aerosol sampling in the IMPROVE network, stretched teflon mesh, nylon, quartz, and quartz impregnated with glycerol and potassium carbonate, require specific cassette configurations. Table 1 lists the modules in which each substrate is used, and the appropriate cassette configuration.

Table 1 Summary of IMPROVE Filter Cassette Configurations

Module	*Filter*	*standard cassette*	*multiple holder adapter*	*o-rings*	*drain disk*	*mask*	*color coding Wednesday samples*	*color coding Saturday samples*
A	Teflon	yes	no	ethylene propylene	yes	2.2 cm^2	red, black	red, white
B	nylon	yes	no	ethylene propylene	no	none	yellow, black	yellow, white
C	quartz	yes	no	viton	yes	none	green, black	green, white
C/C	quartz/ quartz	yes	yes	viton/ viton	yes/ yes	none/ none	green, black	green, white
D	Teflon	yes	no	ethylene propylene	yes	none	blue, black	blue, white
D/S	Teflon/ impreg. quartz	yes	yes	ethylene propylene / ethylene propylene	yes/ yes	none/ none	blue, black	blue, white

2.0 RESPONSIBILITIES

2.1 Project Manager

The project manager shall:

- Determine cassette requirements for new sites for the next year.
- Calculate cassette requirements for special studies for the next year.
- Summarize expected cassette usage for the next year.
- Approve construction of cassettes under the supervision of the field specialist.

2.2 Field Specialist

The field specialist shall:

- Determine the number and type of parts necessary to construct the cassettes.
- Write purchase orders for parts and equipment to construct cassettes.
- Oversee construction of cassettes by the research technicians.

2.3 Research Technician

The research technician shall:

- Modify cassette parts to accept IMPROVE aerosol sampler hardware.
- Clean and sort cassette parts.
- Assemble and label new cassettes.

3.0 REQUIRED EQUIPMENT AND MATERIALS

3.1 Aerosol Filter Holder Modification

- 25mm Holders for Membrane Filters, Nuclepore Corporation.
- Shop lathe with rotating chuck, moveable tool arm, and low speed rotation setting.
- calipers
- Cutting bit for use on the shop lathe
- ¼" drill bit for use on the shop lathe.
- Clean containers for storing filter holder parts.

3.2 Aerosol Filter Holder Cleaning

- Modified parts of the 25mm Holders for Membrane Filters
- laboratory glassware cleaner
- Distilled de-ionized water
- Ultrasound bath
- Absorbent paper lab towels

3.3 IMPROVE Cassette Base Assembly

- Modified 25mm Holders for Membrane Filters bases
- A length of 'Tygothane' polyurethane tubing, ¼" ID, ½" OD, long enough to provide a 2" segment of tube for each cassette.
- Hot plate
- Small water basin to heat water on the hot plate
- Hose clipper
- Crazy Glue
- ¼" lengths of red, yellow, green, blue, black, and white shrink tubing. The tubing should shrink to roughly 7/16" when heated.
- ¼" All plastic Quick Disconnect coupling body fitting, #apc170-04, Bay Pneumatic Co.
- Hobby type heat gun

3.4 IMPROVE Filter Cassette Assembly

- All parts of the 25mm filter holder for membrane filter
- 25mm silicone gaskets, #490216
- 0.879" x 0.040" ethylene propylene o-ring
- 0.879" x 0.040" viton o-ring
- 22mm PE drain disk, #230500, Costar Corporation
- 2.2 cm^2 inert paper mask
- 1 7/16" non-threaded red cap, #EC-23, Caplug Division, Mark IV Industries Corporation

4.0 METHODS

The procedures for filter cassette construction are described in the following subsections:

4.1 Machining of New Cassettes
4.2 Cleaning of Cassettes
4.3 Assembly and Labeling of the Cassette Bases
4.4 IMPROVE Filter Cassette Assembly

4.1 Machining of New Cassettes

25mm Holders for Membrane Filters, purchased from Nuclepore Corporation, must be machined to provide the appropriate mounting and connection surfaces. When new, the aerosol holders have raised printing on their mounting surface and come with male Luer connectors. There are two purposes for machining the aerosol holders. First, to remove the printing, leaving a flat surface for mounting. Second, to enlarge the air flow channel through the connector. The procedures for machining new aerosol holders for use as filter cassettes are as follows:

1. Open the packages containing the filter holders and sort the parts into clean storage bins.
2. Firmly screw the filter holder base and the assembly ring together, leaving out all other parts, and place them in a clean storage bin. See Figure 1 for diagrams of these parts.
3. Take the storage bin with the partly assembled holders to the shop.
4. Set up a lathe to spin clockwise at slow speed with a cutter bit. Hold the partly assembled filter holders in the rotating chuck.
5. Insert the base end of the filter holder into the chuck and tighten the chuck to hold the partly assembled filter holder firmly.
6. Start the rotation, verifying the center of the filter holder is the center of rotation.
7. Using the cutting bit, remove 0.10" of the entire top surface of the assembly ring to eliminate the raised printing.
8. Stop the rotation, remove the filter holder, and verify the cut removed all printing and left a clean, smooth surface.
9. Damaged or incompletely processed filter holders should be reprocessed or thrown out.
9. Store the newly machined parts in a separate bin, and repeat steps 5 through 9 until all the filter holders have been processed.
10. Remove the cutter bit from the lathe and replace it with a ¼" drill.
11. Set the lathe to spin clockwise at slow speed with the ¼" drill bit on the movable arm positioned to pass through the center of rotation of the lathe.
12. Insert the base end of the filter holder into the rotating chuck and tighten the chuck to hold the partly assembled filter holder firmly.
13. Start the rotation, verifying the filter holder is centered on the center of rotation.
14. Slowly move the ¼" drill bit into the rotating filter holder, cutting out the center of the luer fitting and leaving a ¼" high, 5/16" outer diameter, ¼" inner diameter connector.

15. Move the drill bit out of the filter holder, stop the rotation, remove the filter holder, and verify that the drill left a centered, clean hole in the luer fitting.
16. Throw out or reprocess any incomplete or damaged filter holders.
16. Remove the filter holder and store the newly machined parts in a separate bin.
17. Repeat steps 12 through 16 until all the filter holders have been processed.

4.2 Cleaning of New Cassettes

Once machined in the shop, the base and assembly ring of the 25mm Holders for Membrane Filters must be cleaned to remove artifact from their surfaces. The cleaning process is as follows:

1. Unscrew the assembly ring from the filter holder base.
2. Remove, using a cleaning tool, any material from the machining process that is still attached to the filter holder.
3. Store the assembly ring and filter holder base in separate containers.
4. Place the assembly rings in an ultrasound bath with enough warm water to cover them.
5. Dissolve a small amount of laboratory glass ware cleaner in warm water and add it to the ultrasound bath.
6. Turn on the ultrasound bath and allow to run, occasionally moving the parts around, for 30 minutes.
7. Drain the soapy water from the ultrasound bath and rinse the parts thoroughly with distilled di-ionized water.
8. Allow the water to drain, then refill the ultrasound bath with reagent quality methyl alcohol.
9. Turn on the ultrasound bath and allow to run, occasionally moving the parts around, for 20 minutes.
10. Drain the methyl alcohol from the parts.
11. Spread the parts out on absorbent lab towels in a clean drying area.
12. Allow all parts to air dry thoroughly, then sort into a clean storage bin.
13. Repeat steps 4 through 12 for the filter holder base.

4.3 Assembly and Labeling of the Cassette Bases

Once modified and cleaned, the 25mm Holders for Membrane Filters Bases can be modified into cassette bases. The assembly process is as follows:

1. Clear a work surface in a clean area.
2. Plug in the hot plate and put the small container of distilled di-ionized water on the heater.
3. When the water is hot (boiling), put the end of the polyurethane tubing into the water. This will soften the tubing, making it easier to work with.
4. When the tubing is heated (about 30 seconds), get a filter holder Base and put a small amount of krazy glue around the outside of the drilled out Luer fitting.

5. Take the tubing out of the water, dry the end with a towel, and press it over the drilled out Luer fitting on the filter holder base. The entire fitting should be inside the tubing, and the end of the tubing should be flush with the surface of the base.
6. Carefully use the tubing clippers to cut the section of tubing connected to the filter holder base to a 2" length. The cut should be clean and perpendicular to the body of the tube.
7. Put the base with tubing attached in a clean storage box and repeat steps 3 through 6 until all the bases have been used.
8. Set up the heat gun in a well ventilated area and bring the box of bases with tubing attached.
9. Find the ¼" lengths of red, yellow, green, blue, black, and white ¾" diameter shrink tubing.
10. Determine the types of cassettes that will be made, recalling that each cassette is labeled with a color code to prevent its being used inappropriately. Generally, the same number of Wednesday and Saturday (black and white color codes respectively) are constructed.

Module and filter type	*Wednesday sampling*	*Saturday sampling*
A module teflon filters	red/black	red/white
B module nylon filters	yellow/black	yellow/white
C module quartz filters	green/black	green/white
D module teflon filters	blue/black	blue/white
D/S module teflon/impregnated quartz filters	blue/black	blue/white

11. Slip the ¼" lengths of colored ¾" diameter shrink tubing over the polyurethane tubing connected to the filter holder bases. The color indicating the module should be closest to the base, with the black or white shrink tubing closest to the end of the polyurethane tubing.
12. Rotate the base with the shrink tubing in the hot air stream from the heat gun until the shrink tubing has shrunk firmly onto the polyurethane tubing. Allow the base to cool, then place in a clean storage container.
13. Repeat steps 11 and 12 until all the filter holder bases have been labeled.
14. Return the storage container of now color coded filter holder bases with tubing attached to the work area with the hot plate and boiling water.
15. Open the package of ¼" All plastic Quick Disconnect coupling body fittings.
16. Holding the base, insert the tubing end of the part into the container of boiling water and hold it there for 30 seconds.
17. When the end of the tubing is softened, remove it from the boiling water and force it over the barbed hose connector end of the ¼" All plastic Quick Disconnect coupling body fittings. The hose must completely enclose the barb; the hose end being against the coupling body fitting.

18. Put the cassette base (the color coded filter holder base with tubing and body connectors will hereafter be called the cassette base) on a clean lab surface to cool and dry.

4.4 IMPROVE Filter Cassette Assembly

There are six basic filter cassette configurations used in the IMPROVE network. The basic configurations for each aerosol sampling module are listed below in Table 2.

Table 2 Basic Cassette Configuration for the IMPROVE Aerosol Sampling Network

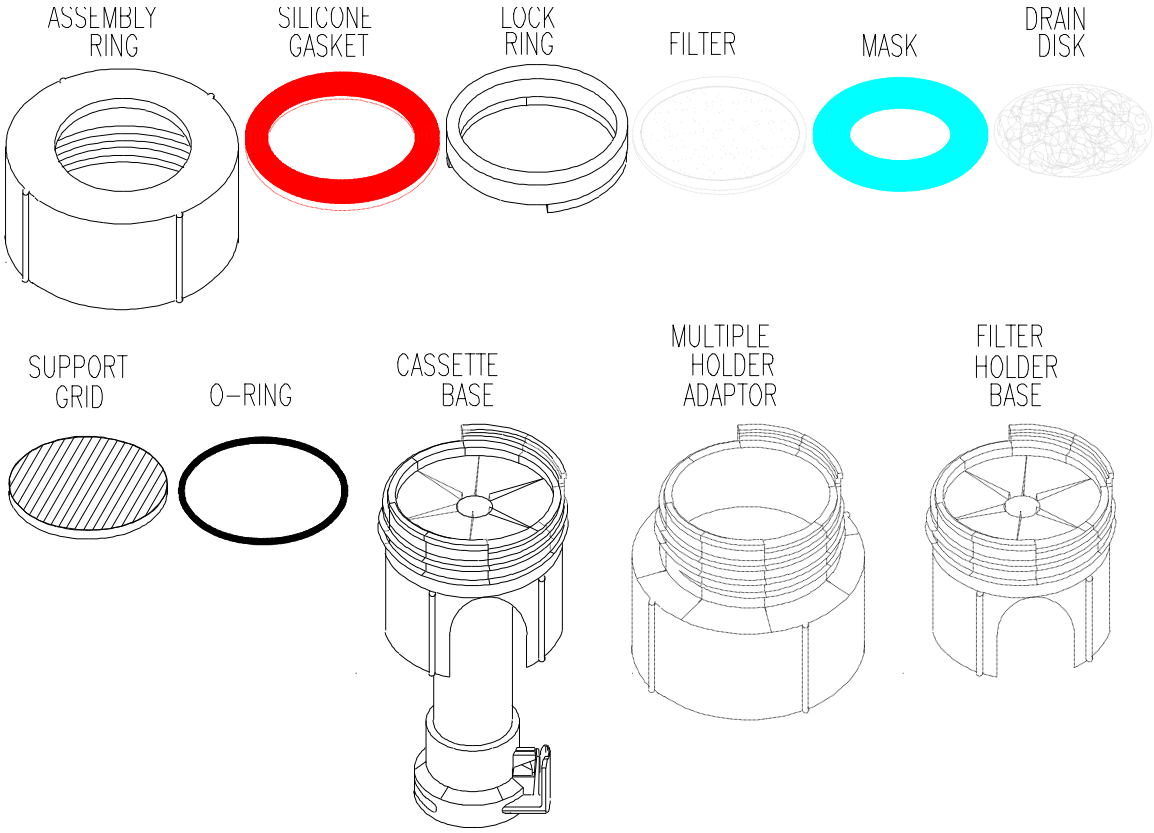
cassette type	color code (wed.)	color code (sat.)	# of stages	stage 1 (top) filter type	stage 2 (bottom) filter type	mask size	drain disk?	stage 1 (top) o-ring type	stage 2 (bottom) o-ring type
A	red/ black	red/ white	1	teflon		2.2 cm^2	yes	ethylene propylene	
B	yellow/ black	yellow/ white	1	nylon		no mask	no	ethylene propylene	
C	green/ black	green/ white	1	quartz		no mask	yes	viton	
C/C	green/ black	green/ white	2	quartz	quartz	no mask	yes stages 1 & 2	viton	viton
D	blue/ black	blue/ white	1	teflon		no mask	yes	ethylene propylene	
D/S	blue/ black	blue/ white	2	teflon	impregnated quartz	no mask	yes stages 1 & 2	ethylene propylene	ethylene propylene

The basic aerosol sampling cassette is created from combinations of the parts listed in Figure 1. The filter holder base is listed as well, though it is not used in the network until it has been modified into a cassette base.

When purchased, the cassette come disassembled in plastic bags. Each bag contains an assembly ring, an orange silicone gasket, a support grid, an ethylene propylene o-ring, and a filter holder base. The procedures for modifying the filter holder base into a cassette base are listed in sections 4.1 through 4.3. Once all the parts are available, and the filter holder bases have been upgraded to cassette bases, cassette construction can begin.

4.4.1 A Module Filter Cassette Construction
4.4.2 B Module Filter Cassette Construction
4.4.3 C Module Filter Cassette Construction
4.4.4 C/C Module Filter Cassette Construction
4.4.5 D Module Filter Construction
4.4.6 D/S Module Filter Construction

Figure 1 Filter Cassette Parts



4.4.1 A Module Filter Cassette Construction

1. Collect all the parts required for construction in a clean area. Parts needed include:
   - assembly ring
   - orange silicone gasket, or replacement o-ring
   - lock ring
   - mask
   - drain disk
   - ethylene propylene o-ring
   - support grid
   - cassette base labeled with red/black or red/white color coding
   - blunt tip forceps
   - red cap
2. Put the o-ring around the support grid and seat the support grid in the cassette base.
3. Using blunt tipped forceps, center the drain disk over the support grid.
4. Using forceps, place the mask over the drain disk, being careful not to move the drain disk onto the o-ring.
5. Seat the lock ring on the cassette base.

6. Place the orange silicone gasket in the assembly ring, and thread the assembly ring onto the cassette base.
7. Place a red cap over the open end of the assembly ring to prevent contamination.

4.4.2 B Module Filter Cassette Construction

1. Collect all the parts required for construction in a clean area. Parts needed include:
   - assembly ring
   - orange silicone gasket, or replacement o-ring
   - lock ring
   - ethylene propylene o-ring
   - support grid
   - cassette base labeled with yellow/black or yellow/white color coding
   - blunt tip forceps
   - red cap
2. Put the o-ring around the support grid and seat the support grid in the cassette base.
3. Seat the lock ring on the cassette base.
4. Place the orange silicone gasket in the assembly ring, and thread the assembly ring onto the cassette base.
5. Place a red cap over the open end of the assembly ring to prevent contamination.

4.4.3 C Module Filter Cassette Construction

1. Collect all the parts required for construction in a clean area. Parts needed include:
   - assembly ring
   - orange silicone gasket, or replacement o-ring
   - lock ring
   - drain disk
   - viton o-ring
   - support grid
   - cassette base labeled with green/black or green/white color coding
   - blunt tip forceps
   - red cap
2. Put the o-ring around the support grid and seat the support grid in the cassette base.
3. Using blunt tipped forceps, center the drain disk over the support grid.
5. Seat the lock ring on the cassette base.
6. Place the orange silicone gasket in the assembly ring, and thread the assembly ring onto the cassette base.

7. Place a red cap over the open end of the assembly ring to prevent contamination.

4.4.4 C/C Module Filter Cassette Construction

1. Collect all the parts required for construction in a clean area. Parts needed include:
   - 2 assembly rings
   - 2 orange silicone gaskets, or replacement o-rings
   - 2 lock rings
   - 2 drain disks
   - 2 viton o-rings
   - 2 support grids
   - multiple holder adapter
   - cassette bases labeled with green/black or green/white color coding
   - blunt tip forceps
   - red cap
2. Put an o-ring around the support grid and seat the support grid in the cassette base.
3. Using blunt tipped forceps, center the drain disk over the support grid.
4. Seat the lock ring on the cassette base.
5. Place the orange silicone gasket in the multiple holder adapter, and thread the multiple holder adapter onto the cassette base.
6. Put an o-ring around the support grid and seat the support grid in the multiple holder adapter.
7. Using blunt tipped forceps, center the drain disk over the support grid.
8. Seat the lock ring on the multiple holder adapter.
9. Place the orange silicone gasket in the assembly ring, and thread the assembly ring onto the multiple holder adapter.
10. Place a red cap over the open end of the assembly ring to prevent contamination.

4.4.5 D Module Filter Cassette Construction

1. Collect all the parts required for construction in a clean area. Parts needed include:
   - assembly ring
   - orange silicone gasket, or replacement o-ring
   - lock ring
   - drain disk
   - ethylene propylene o-ring
   - support grid
   - cassette base labeled with blue/black or blue/white color coding
   - blunt tip forceps
   - red cap

2. Put the o-ring around the support grid and seat the support grid in the cassette base.
3. Using blunt tipped forceps, center the drain disk over the support grid.
5. Seat the lock ring on the cassette base.
6. Place the orange silicone gasket in the assembly ring, and thread the assembly ring onto the cassette base.
7. Place a red cap over the open end of the assembly ring to prevent contamination.

4.4.6 D/S Module Filter Cassette Construction

1. Collect all the parts required for construction in a clean area. Parts needed include:
   - 2 assembly rings
   - 2 orange silicone gaskets, or replacement o-rings
   - 2 lock rings
   - 2 drain disks
   - 2 ethylene propylene o-rings
   - 2 support grids
   - multiple holder adapter
   - cassette bases labeled with blue/black or blue/white color coding
   - blunt tip forceps
   - red cap
2. Put an o-ring around the support grid and seat the support grid in the cassette base.
3. Using blunt tipped forceps, center the drain disk over the support grid.
4. Seat the lock ring on the cassette base.
5. Place the orange silicone gasket in the multiple holder adapter, and thread the multiple holder adapter onto the cassette base.
6. Put an o-ring around the support grid and seat the support grid in the multiple holder adapter.
7. Using blunt tipped forceps, center the drain disk over the support grid.
8. Seat the lock ring on the multiple holder adapter.
9. Place the orange silicone gasket in the assembly ring, and thread the assembly ring onto the multiple holder adapter.
10. Place a red cap over the open end of the assembly ring to prevent contamination.