

National Human Exposure Assessment Survey (NHEXAS)

Region 5 Study

Quality Systems and Implementation Plan for Human Exposure Assessment

Research Triangle Institute
Research Triangle Park, NC 27079
Cooperative Agreement CR 821902

Standard Operating Procedure

NHX/SOP-300-006

Title: The ACS Inorganic Class 100/10,000 Clean Lab Facility

Source: Research Triangle Institute

U.S. Environmental Protection Agency
Office of Research and Development
Human Exposure & Atmospheric Sciences Division
Human Exposure Research Branch

Notice: The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development (ORD), partially funded and collaborated in the research described here. This protocol is part of the Quality Systems Implementation Plan (QSIP) that was reviewed by the EPA and approved for use in this demonstration/scoping study. Mention of trade names or commercial products does not constitute endorsement or recommendation by EPA for use.

TITLE: STANDARD OPERATING PROCEDURE FOR THE ACS INORGANIC CLASS
100/10,000 CLEAN LAB FACILITY

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STATUS: IN PROGRESS: ☐
DRAFT: ☐
FINAL VERSION: ☒

REVISIONS:

No.	Date	No.	Date
0	†	6	
1		7	
2		8	
3		9	
4		10	
5		11	

† Effective date of this version is the date of the last approval signature;
revision 0 is the original version.

ACS INORGANIC CLASS 100/10,000 CLEAN LAB FACILITY

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1.0 INTRODUCTION

The ACS Inorganic Class 100/10,000 Clean Lab Facility is a controlled access laboratory designed for minimizing particulate contaminants for the purposes of ultra-trace metal analysis. The facility is restricted to Inorganics Research personnel and escorted visitors trained in the protocols necessary to maintain Class 100 conditions. Appropriate garments must be worn and protocols followed for admittance into the Class 100 Clean Lab area. This document outlines the proper procedures and equipment for use and maintenance of the ACS Inorganic Class 100/10,000 Clean Lab Facility.

2.0 LABORATORY DESCRIPTION

The ACS Inorganic Class 100/10,000 Clean Lab Facility is a suite of rooms within Dreyfus 193. Figure 1 shows the layout of each room; a description of each is provided in the following sections.

2.1 Office Area

The 193 Office is accessed from the Dreyfus hallway and has no entrance restrictions. There is a door from the Office into the Inorganic Class 100/10,000 Clean Lab Anteroom; this door remains locked from the Office side, but is unlocked from the laboratory side. This arrangement permits emergency egress from the Inorganic Class 100/10,000 Clean Lab and anteroom, but prohibits routine entrance from the office. The key to this door is kept in the Office.

2.2 Service Room

The Service Room is a small, general access room that contains supplies, gas cylinders, water deionizer, air purification system, refrigerator, and freezer. It is accessible from the Dreyfus hallway and has no entrance restrictions. The door from the Service Room into the Instrument Lab is a restricted passage. Only authorized personnel may enter the Instrument Lab. Both the Office and Service Room are supplied with air filtered through standard 95% efficiency filters, but not HEPA filters.

2.3 Instrument Lab

The Instrument Lab is a Class 10,000 area, with a partially HEPA-filtered air supply (HEPA-filters are located in areas of sample handling). Minimal particulate control measures are used ("tacky-mat" flooring at the entrance). The lab contains instruments for trace and ultra-trace metal analysis (GFAA, ICP, HGAF, etc.). The Instrument Lab is a restricted area accessible only to authorized personnel. It is entered via the 193 Service Room and may be exited to the Service Room, Anteroom, or through an emergency exit door to the outside of the building.

2.4 Anteroom

The Anteroom is the transition zone from the Instrument Lab to the Class 100 Clean Lab and is a restricted area, limited to trained personnel only. The Anteroom is supplied with HEPA-filtered air and provided with "tacky mat" flooring to reduce particulates carried into the Class 100 area. The Anteroom is used to put on Clean Lab garments before entering the Class 100 area (clean-lab coats, lab shoes or shoe covers, head covers) and to store Clean Lab cleaning supplies (lab cart, mop, bucket, clean wipes).

The Anteroom is the sole access to the Class 100 Clean Lab. The Anteroom has a door which opens to the Office area, which is to be used as an emergency exit only.

2.5 Class 100 Clean Lab

The Class 100 Clean Lab is an inorganic analysis laboratory designed to enable contaminant-free preparation of samples for metal analysis at the parts-per-trillion level. The two most unique features of the room are the ultra-clean air supply and the metal-free construction.

Ultra-clean air is supplied through HEPA filters located in a ceiling grid; over 90% of the ceiling is covered with 99.9975% efficient HEPA filters. As depicted in Figure 2, Class 100 air is forced downward in a laminar flow and bathes work benches with particle-free air. Air is returned to a recirculation unit at two heights along a plenum wall: the primary air return is a baseboard return extending from the floor up to a height of 18 inches; the secondary return is at hand level extending from the benchtop surface to a height of six inches above the benchtop. This air is recirculated through the ceiling HEPA filters to achieve continuous removal of particles.

Metal-free construction materials were used to the extent possible to build the Class 100 Clean Lab. This was done to prevent acid corrosion and resulting metal contamination. The walls, floors, benches, fume hoods, acid bath cabinet, drawers, and sinks are made of polypropylene, and all plumbing materials are either polypropylene or PVC. All other service lines (electrical, gas, etc.) are encased in PVC tubing.

The Class 100 Clean Lab contains several features in addition to the clean air supply that facilitate ultra-trace level analysis. The lab is equipped with three areas of one-pass, air exhaust: (1) an 8-foot wide Class 100 fume hood with vented base cabinet; (2) a 4-foot wide fume hood with vented base cabinet; and (3) a 6-foot wide vented acid bath cabinet. The fume hoods are used for acid digestion, evaporation, or extraction of samples and prevent exposure of personnel or equipment to acid vapors. Diagrams showing the design and air flow patterns in the 8-foot hood are presented in Figure 3. A microwave digestion system is located in the 4-foot hood, and two remote control ceramic hot plates are located in the 8-foot hood. The acid bath cabinet houses multiple tubs for acid leaching of glassware and plasticware. The interior of the cabinet is flushed horizontally with Class 100 air and vented to the outside of the building in order to minimize exposure of personnel to acid vapors even when the baths are open.

The Class 100 Clean Lab is the most restricted area of the Inorganic Class 100/10,000 Clean Lab facility, requiring appropriate apparel for entry (cleanroom shoes or shoe covers, cleanroom lab coats, etc.). Access to the Class 100 Clean Lab is through the anteroom via the Instrument Lab. The Class 100 Clean Lab also has an emergency door escape route leading to the outside of the building.

3.0 LABORATORY APPAREL

3.1 Office Area

The Dreyfus 193 Office area is non-restricted, non-laboratory area with no dress restrictions.

3.2 Service Room

The Dreyfus 193 Service Room is a non-restricted area with no dress restrictions.

3.3 Instrument Lab

The Inorganic Class 100/10,000 Clean Lab Instrument Lab is designated as a Class 10,000 environment; lab apparel requirements are set up to maintain this environment and for the safety of laboratory workers; requirements are described in the following sections.

3.3.1 Clean Garments

Cleanroom shoes or shoe covers are required for entrance to the Instrument Lab. Lab coats and powder-free gloves are available. A "tacky-mat" at the entrance door will reduce footborne contamination. The lab personnel should always be conscious of minimizing contamination when entering the Instrument Lab, and when passing from the Instrument Lab into the Class 100 Clean Lab.

3.3.2 Safety Garments

Working in the Instrument Lab will entail exposure to a variety of chemicals including dilute acids, sample digests, and standard metal solutions. The required protective measures are safety glasses and closed-toe shoes. Lab coats and acid-resistant gloves are recommended when handling samples, standards, reagents and wastes.

Visitors to the Instrument Lab will be required to wear appropriate shoes and safety glasses.

3.4 Class 100 Clean Lab

The Class 100 Clean Lab is designated as a Class 100 facility; the procedures and lab apparel required are designed to maintain the Class 100 conditions and for the safety of the lab personnel.

3.4.1 Clean Garments

There are strict requirements for garments to minimize particulates and contaminants carried into the Clean lab. Entry to the Class 100 Clean Lab is through the Anteroom, where clean room garments will be kept for laboratory personnel. Extra cleanroom garments will be available for visitors on the Service Room storage shelves.

- All personnel will remove or cover street shoes (laboratory workers will have shoes designated for clean room use only, visitors will use disposable shoe covers).
- All personnel will wear low-particulate, Class 100 lab jackets in the Class 100 Clean Lab.
- All personnel will wear disposable head covers.
- Class 100 powder-free gloves are available for working in the Class 100 Clean Lab. Gloves worn in the Instrument Lab should be rinsed or discarded before entry into the Class 100 Clean Lab.

3.4.2 Safety Garments

Safety garments are required in the Class 100 Clean Lab to protect the lab workers from exposure to concentrated acids and oxidizers used in sample digestion and from exposure to sample materials which may be partly or totally uncharacterized. Safety glasses, lab coat and appropriate shoes are minimally required. Gloves are recommended for handling toxic chemicals, acids or unknowns.

Additionally, lab personnel may use a face shield, lab apron, dust mask or respirator or other safety equipment for certain tasks. Routine safety equipment must meet Class 100 standards of cleanliness before being brought into the Class 100 Clean Lab, either purchased pre-packaged for Class 100 use from a clean room supplier, or cleaned and packaged in the Class 100 hood in the Instrument Lab. However, personnel safety is always the primary consideration and in some cases it may be necessary to use non-Clean Lab equipment or supplies.

4.0 MATERIALS HANDLING AND EXCHANGE

The working areas of Dreyfus 193 are laid out so that personnel pass from the "dirty" areas (i.e., the hallway, the office, the Service Room) to increasingly cleaner areas (the Instrument Room, the Anteroom, the Clean Room). Appropriate measures are taken to reduce contamination in each progressively cleaner area (see Sections 3.3-3.4.)

To minimize contamination in the cleaner areas, each area will be provided with its own supplies according to the tasks performed there. To this end, procedures are in place regarding supplies, cleaning procedures, sample storage and waste disposal for the Inorganic Class 100/10,000 Clean Lab Facility.

4.1 Office Materials Handling Protocols

No reagents or samples will be permitted in the Office area. Any documents, notes, notebooks or raw data brought into the Office area from the Instrument Lab or Class 100 Clean Lab will be as contamination free as possible.

4.2 Service Room Materials Handling Protocols

The Service Room acts as a storage area for the Instrument Lab and the Class 100 Clean Lab. Materials must pass from the Service Room to the Instrument Lab, then through the Anteroom into the Class 100 Clean Lab, with appropriate decontamination procedures in the Instrument Lab and Anteroom.

4.3 Instrument Lab Materials Handling Protocols

The Instrument Lab is designed for instrumental analysis and will have minimal reagent handling procedures. Reagents and samples will be brought into the Instrument Lab only for analysis purposes (samples, calibration standards, matrix modifiers, acids, blanks, etc.) or for cleaning procedures before transfer to the Class 100 Clean Lab.

4.3.1 Acid exposure in the Instrument Lab will be limited. No concentrated acids will be stored in the Instrument Lab.

4.3.2 Acid solutions used for ICP or AA flushing solutions will generally be <25% concentration and <1.0 L volume. Instrument reservoirs for acid solutions will be closed or covered with parafilm or similar sealant to minimize acid vapors in the Instrument Lab.

4.4 Class 100 Clean Lab Materials Handling Protocols

4.4.1 High Level Materials Handling Protocols

Specific lab bench space and lab supplies will be designated for High Level Operations (> 1 ppm metals concentration) within the Class 100 Clean Lab. High Level Operations are defined as the handling and dilution of concentrated metal standard solutions and for preparing reagents for sample preparation or analytical applications.

- 4.4.2 New supplies and equipment for High Level Operations will be initially washed and/or rinsed with deionized water and dried in a Class 100 environment.
- 4.4.3 High Level Operations labware will be washed and acid leached according to NHX/SOP-300-007, "Standard Operating Procedure for Cleaning Labware in the ACS Inorganic Class 100/10,000 Clean Lab Facility" then stored in cabinets designated for High Level Operations equipment. Washing basins, baskets and acid leaching baths will be designated for High Level Operations.
- 4.4.4 In general, High Level Operations equipment and supplies will not be used for other applications. Exceptions may be made on the judgement of the Laboratory Manager or Inorganic Lab Facility Supervisor.
- 4.4.5 The High Level Operations bench space will be cleaned and equipment and chemicals put away after all operations.

4.5 Low Level Operations Materials Handling Protocols

The Class 100 Clean Lab is supplied with designated labware (glassware, teflon and plasticware, pipettors and tips, volumetric pipets and bulbs) for exclusive use in Low Level Operations.

- 4.5.1 Supplies will be initially cleaned and decontaminated with stringent measures (see NHX/SOP-300-007, "SOP for Cleaning Labware in the ACS Inorganic Class 100/10,000 Clean Lab Facility") before being brought into the Class 100 Clean Lab.
- 4.5.2 Low Level Operation labware will be rinsed in the Class 100 Clean Lab or, if necessary, washed in the Instrument Lab, then acid leached in acid baths designated for Low Level Operations.
- 4.5.3 Under no circumstances will Low Level Operations equipment or supplies be removed from the Class 100 Clean Lab Facility or used in High Level operations.
- 4.5.4 Exposure of Low Level Operations labware to metal concentrations >1 ppm will be strictly avoided. Metal solutions or reagents brought into the Low Level Operations working areas will be of the lowest working concentrations possible.

- 4.5.5 New or replacement supplies (including reagents, acids, and samples) brought into the Class 100 Clean Lab will be in Class 100 packaging, or cleaned by laboratory personnel in the Class 100 hood in the Instrument Lab (see NHX/SOP-300-007, "SOP for Cleaning Labware for the Class 100/10,000 Clean Lab Facility") before being transferred into the Class 100 Clean Lab. Supplies packed in Class 100 packaging will be brought into the Anteroom, where external packaging can be discarded, then brought into the Class 100 Clean Lab, where internal packaging can be opened and discarded.

4.6 Waste Disposal

4.6.1 Office Area

Trash from the Office area will be recycled or disposed of by Housekeeping personnel according to RTI guidelines.

4.6.2 Service Room

Non-chemical trash from the Service Room will be disposed of by Housekeeping personnel according to RTI guidelines.

4.6.3 Instrument Lab

Non-contaminated trash from the Instrument Lab will be disposed of by Housekeeping personnel according to RTI guidelines. The trash can will be placed in the Service Room or the hallway for pickup.

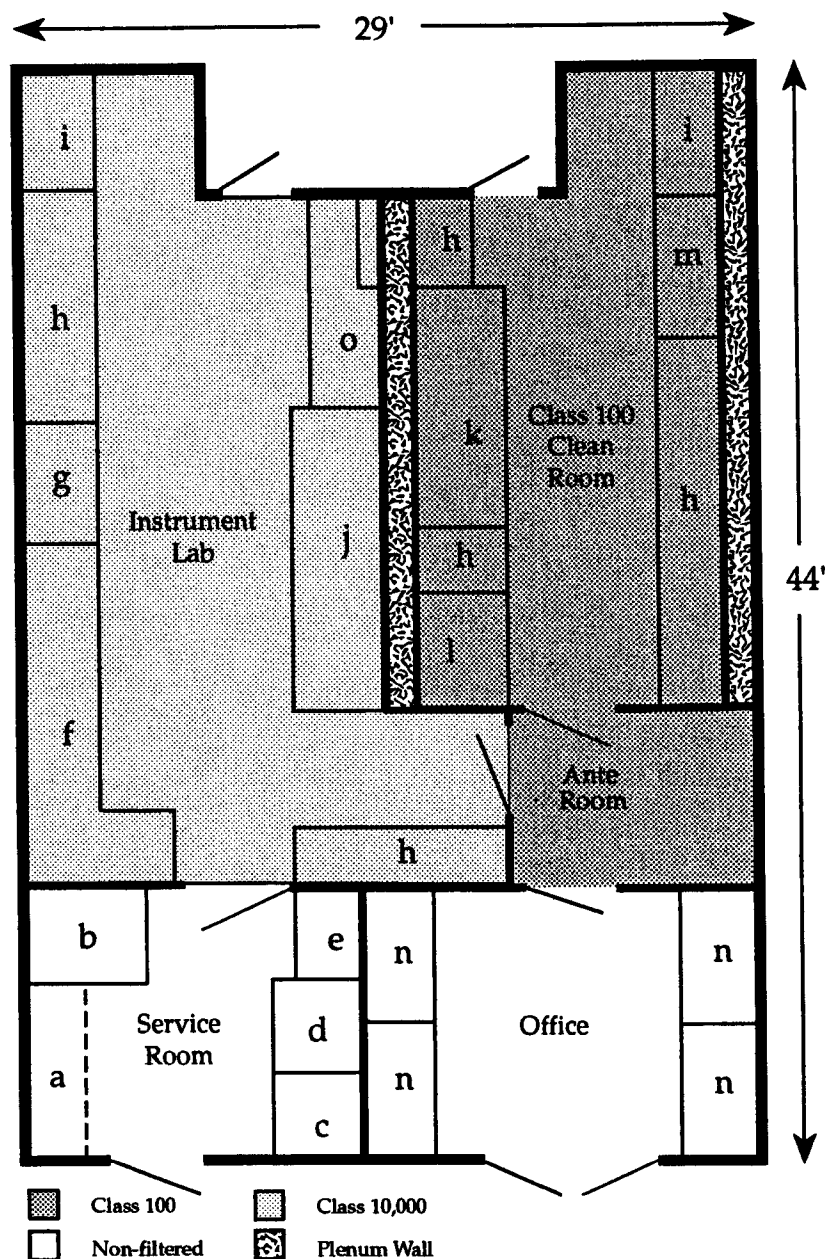
Chemical wastes from the Instrument Lab will be collected in plastic or glass containers. When possible, wastes will be neutralized and flushed down the drain. Otherwise, wastes will be labelled as to metals and matrix, and approximate concentrations (if >5 ppm) and collected by RTI Safety personnel. If necessary, chemical wastes will be transferred to Lab 169 for characterization, then collected by RTI Safety personnel. Lab personnel will be responsible for disposal of waste generated by their projects.

4.6.4 Class 100 Clean Lab

RTI Maintenance and Safety personnel will not need access to the Class 100 Clean Lab or Anteroom. Laboratory personnel will be responsible for all cleaning and waste collection in these restricted areas.

Non-contaminated trash from the Class 100 Clean Lab (and Anteroom) will be collected by the lab worker from lined, plastic trash cans in the Class 100 Clean Lab. The trash bag will be collected daily and disposed of with trash from other lab areas.

Chemical wastes from the Class 100 Clean Lab will be collected in plastic containers and transferred to the Instrument Lab for treatment and disposal. Chemical wastes will not be generated or stored in the Anteroom.



- | | | |
|------------------------|-----------------|--------------------------------|
| a. Gas Cylinders | f. PE 5100 ZL | k. 8' HEPA Hood |
| b. D. I. Water | g. 4' HEPA Hood | l. Non-HEPA 4' Exhausting Hood |
| c. Freezer | h. Bench | m. 6' Acid Baths |
| d. Refrigerator | i. Sink | n. Desk |
| e. Clean Room Supplies | j. ICP | o. PSA HGAF |

Figure 1. ACS inorganics class 100/10,000 clean lab facility.

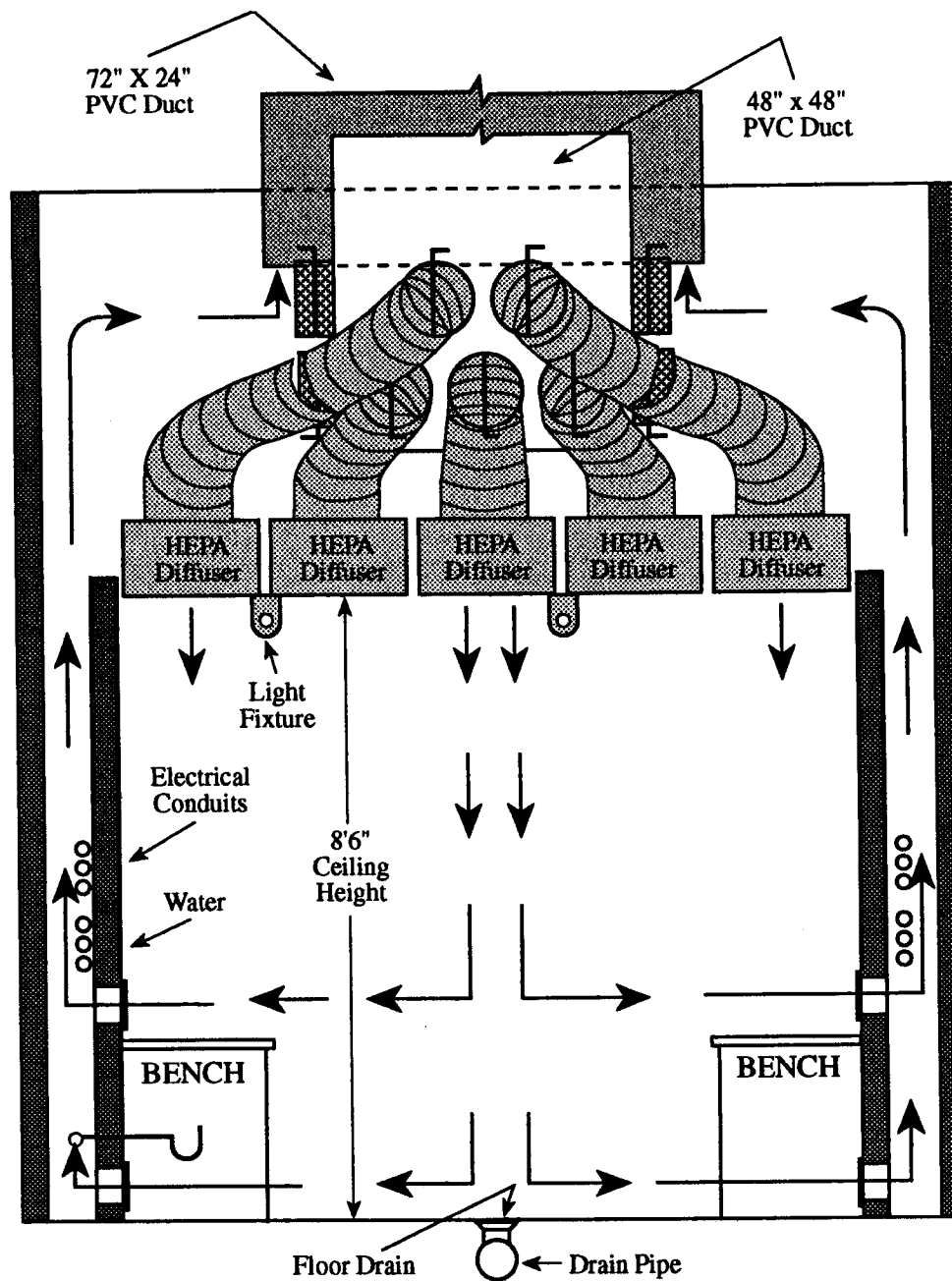


Figure 2. Cross-section view and air flows in the class 100 lab.

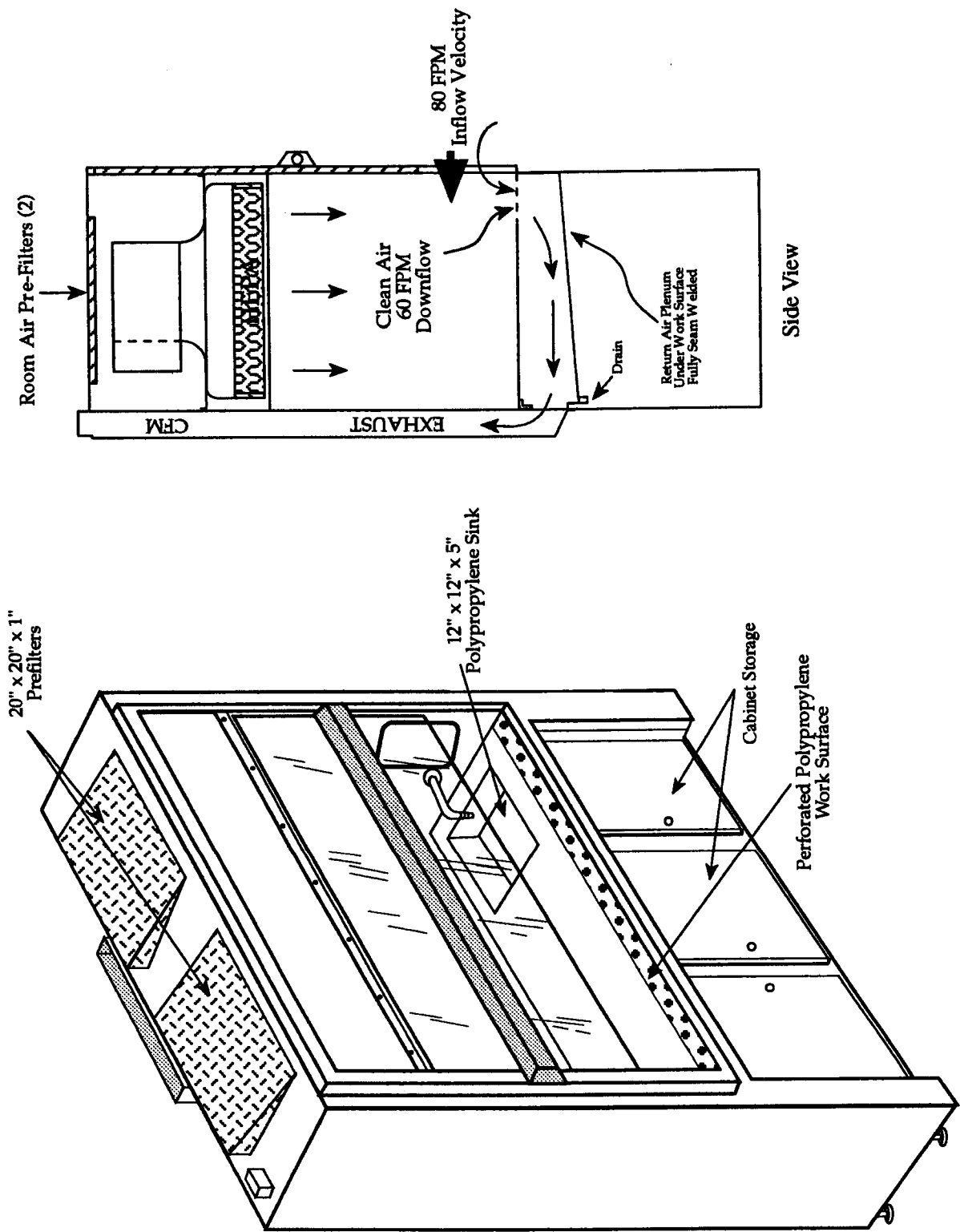


Figure 3. Laminar air flow-exhausted work station.