Designation: E1234 – 12

Standard Practice for Handling, Transporting, and Installing Nonvolatile Residue (NVR) Sample Plates Used in Environmentally Controlled Areas for Spacecraft[1]

This standard is issued under the fixed designation E1234; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the handling, transporting, and installing of sample plates used for the gravimetric determination of nonvolatile residue (NVR) within and between facilities.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1235 Test Method for Gravimetric Determination of Nonvolatile Residue (NVR) in Environmentally Controlled Areas for Spacecraft

2.2 *ISO Standards:*

14644-1, Cleanrooms and Associated Controlled Environments—Part 1: Classification of Air Cleanliness[3]

14644-2, Cleanrooms and Associated Controlled Environments—Part 2: Specifications for Testing and Monitoring to Prove Continued Compliance with ISO 14644-1[3]

2.3 *U.S. Federal Standard:*

FED-STD-209E Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones[4]

2.4 *Institute of Environmental Sciences and Technology:*

IEST-RP-CC001.3, HEPA and ULPA Filters[3]

IEST-RP-CC007.1, Testing ULPA Filters[3]

IEST-RP-CC034.1, HEPA and ULPA Filter Leak Tests[3]

IEST-STD-CC1246, Product Cleanliness Levels and Contamination Control Program[3]

2.5 *American National Standards Institute:*

ANSI/ASME B46.1-2009, Surface Texture (Surface Roughness, Waviness, and Lay)[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *ISO Class N (airborne particulate cleanliness class), n*—level of airborne particulate concentrations as defined in ISO 14644-1 and 14644-2, where 10^N is the maximum allowable concentrations (particles per cubic metre).

3.1.1.1 *Discussion*—The considered particle sizes (lower threshold values) applicable for classification with ISO 14644-1 are limited to the range from 0.1 through 5 µm. Particles larger than 5 µm (macroparticles) may be expressed in accordance with Annex E of ISO 14644-1.

3.1.2 *FS209, n*—the level of cleanliness specified by the maximum allowable number of particles per cubic foot of air as defined in FED-STD-209E.

3.1.2.1 *Discussion*—This is provided for information and to facilitate the transition to the use of the ISO classification standard (ISO 14644-1).

3.1.3 *clean area, n*—a general term that includes cleanrooms, controlled areas, good housekeeping areas, and other areas that have contamination control by physical design and specified operating procedures.

3.1.4 *clean zone, n*—a defined space in which the contamination is controlled to meet specified cleanliness levels.

3.1.5 *contaminant, n*—unwanted molecular and particulate matter that could affect or degrade the performance of the components upon which they reside.

3.1.6 *contamination, n*—a process of contaminating.

[1] This practice is under the jurisdiction of ASTM Committee E21 on Space Simulation and Applications of Space Technology and is the responsibility of Subcommittee E21.05 on Contamination.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Institute of Environmental Sciences and Technology, 940 E. Northwest Highway, Mount Prospect, IL 60056.

[4] Available from Institute of Environmental Sciences and Technology, 940 E. Northwest Highway, Mount Prospect, IL 60056, and U.S. government sources.

[5] Available from American Society of Mechanical Engineers, United Engineering Center, 345 E. 47th St., New York, NY 10017.

3.1.7 *controlled area, n*—an environmentally controlled area, operated as a cleanroom, but without the final stage of HEPA (or better) filters used in cleanrooms.

3.1.7.1 *Discussion*—Only rough filters (50 to 60 % efficiency) and medium efficiency filters (80 to 85 % efficiency) are required for a controlled area. The maximum allowable airborne particle concentrations are ISO Class 8.5 (FS209 Class 283 000) area for particles ≥0.5 µm and ISO Class 8 (FS209 Class 100 000) for particles ≥5.0 µm.

3.1.8 *environmentally controlled areas, n*—cleanrooms, controlled areas, good housekeeping areas, and other enclosures that are designed to protect products from contamination.

3.1.8.1 *Discussion*—Cleanliness is achieved by controlling air purity, temperature, humidity, materials, garments, and personnel activities.

3.1.9 *facility (clean facility), n*—the total real property required to accomplish the cleanroom functions.

3.1.10 *good housekeeping area, n*—an environmentally controlled area without quantitative cleanliness requirements but maintained in a visibly clean condition.

3.1.10.1 *Discussion*—Office, laboratory, and storage areas with air conditioning and janitorial service are typical of good housekeeping areas.

3.1.11 *HEPA (high efficiency particulate air) filter, n*—a filter for air with a removal efficiency in excess of 99.97 % for 0.3-µm sized particles.

3.1.11.1 *Discussion*—For this application, HEPA filters shall meet the requirements of IEST-RP-CC001.3, IEST-RP-CC007.1, IEST-RP-CC034.1, and 6.8 of this practice.

3.1.12 *molecular contaminant—nonparticulate contaminant, n*—nonparticulate matter.

3.1.12.1 *Discussion*—The molecular contaminant may be in a gaseous, liquid, or solid state. It may be uniformly or nonuniformly distributed or be in the form of droplets. Molecular contaminants account for most of the NVR.

3.1.13 *NVR (nonvolatile residue), n*—quantity of residual soluble, suspended, and particulate matter remaining after the controlled evaporation of a volatile liquid at a specified temperature.

3.1.13.1 *Discussion*—The liquid is usually filtered through a membrane filter, of a specified size, before evaporation. The process used to determine the NVR may affect the quantitative measurement. Process factors include filter size, solvent, and the evaporation temperature and atmosphere. For this reason, the process must be defined.

3.1.14 *particle (particulate contaminant), n*—a piece of matter in a solid or liquid (droplet) state with observable length, width, and thickness. The size of a particle is usually defined by its greatest dimension and is specified in micrometres.

3.1.15 *separative device, n*—equipment utilizing constructional and dynamic means to create assured levels of separation between the inside and outside of a defined volume. Some industry-specific examples of separative devices are clean air hoods, containment enclosures, gloveboxes, isolators and mini-environments.

4. Summary of Practice

4.1 Covered, stainless steel, NVR plates are transported in a sealed carrier within an outer nylon bag to the facility that is to be monitored for NVR deposition.

4.2 The outer bag is removed from the plate carrier within the entrance air lock of the cleanroom, controlled area, or other environmentally controlled area in accordance with the operational procedures for that facility and associated clean areas.

4.3 The clean NVR plate carrier is taken into the clean area.

4.4 Locations for attaching the plates within the clean area are in accordance with the facility contamination control plan, operating procedures, and other official documentation.

4.5 Each NVR plate is removed from the carrier, the cover is removed, and the plate is mounted in a vertical position within the clean area.

4.6 The cover is returned to the plate carrier for storage until required when the plates are collected after the required exposure time.

4.7 One of the NVR plates is removed from the carrier, the cover is removed, the cover is replaced, and the plate is returned to the carrier. This NVR plate is handled in the same manner as the exposed plates. This plate is designated as the blank or control sample.

4.8 After exposure, the NVR plates are removed from their locations in the clean area and are replaced with clean NVR plates in accordance with the facility and clean area contamination control plan, operating procedures, and other official documents.

4.9 The exposed plates are covered and placed into the original NVR plate carrier, returned to the analysis laboratory, and processed in accordance with Test Method E1235.

5. Apparatus and Materials

5.1 *NVR Plate,* Type 316 corrosion-resistant steel with an area of approximately 0.1 m^2 (1 ft^2). The plate shown in Fig. 1 has been found to be satisfactory. The surface texture of the sampling surface shall be 0.80 µm (32 µin.) or better per ANSI/ASME B46.1. The plate shall be electropolished and engraved with an identification number.

5.2 *NVR Plate Cover,* Type 316 corrosion-resistant steel. The cover shown in Fig. 2 has been found to be satisfactory. The surface texture shall be 0.80 µm (32 µin.) or better per ANSI/ASME B46.1.

5.3 *Noncontaminating Nylon (Polyamide) Bag* to enclose each covered NVR plate.[6]

5.3.1 Bags shall meet the safety and outgassing requirements for the spacecraft and spacecraft processing facility and shall not contain or generate molecular or particulate matter that could contaminate the NVR plate or NVR plate carrier.

[6] Heat-sealable Capran 980 from Allied Chemical has been found to be satisfactory.

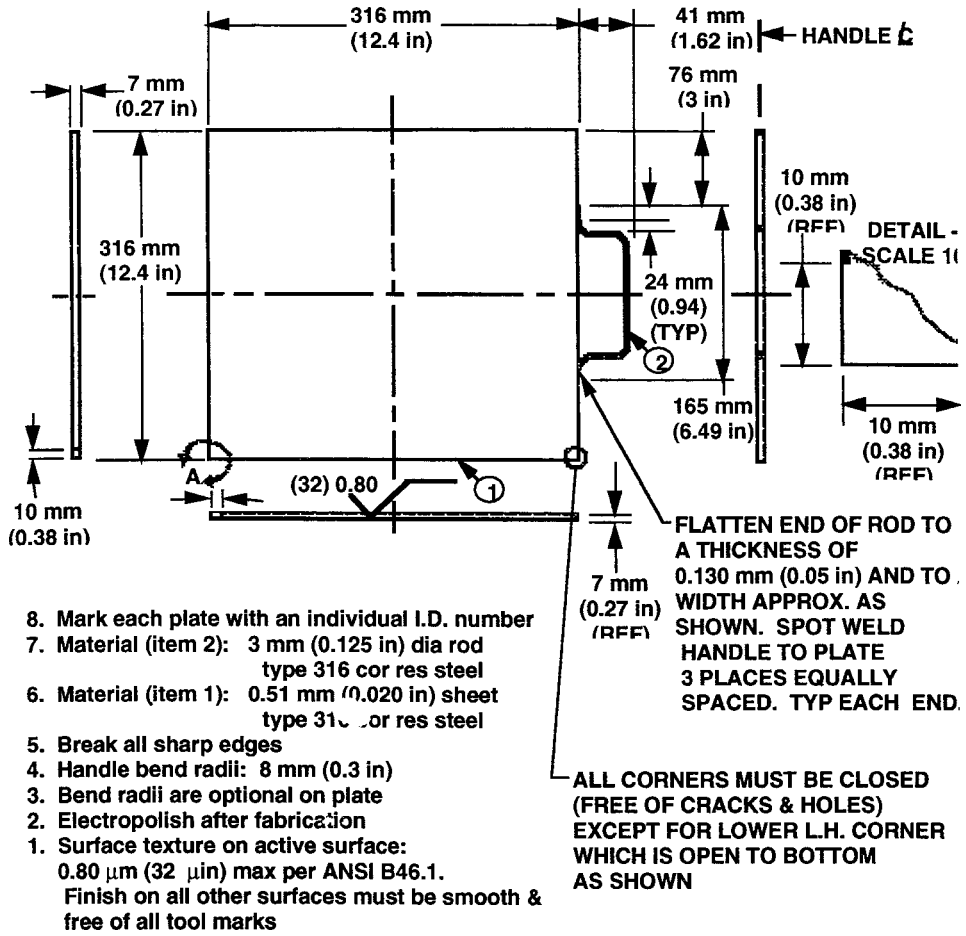

FIG. 1 NVR Collector Plate

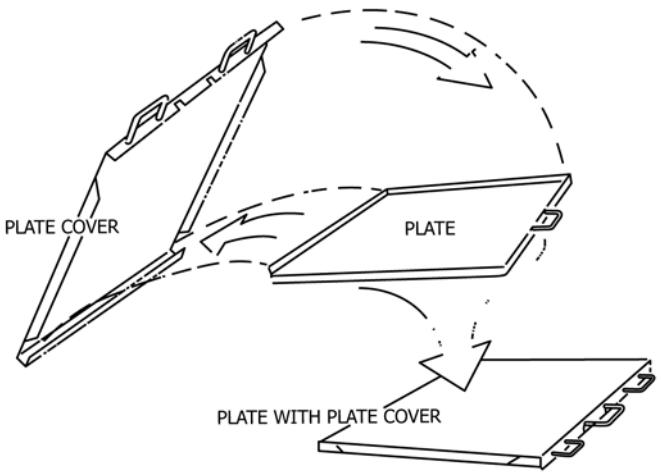

FIG. 2 NVR Plate Cover

5.4 *NVR Plate Carrier*—The sealable, aluminum carrier shown in Fig. 3 has been found to be satisfactory. The carrier shall be constructed so as to prevent cross contamination between plates.

5.5 *Noncontaminating Nylon (Polyamide) Bag*[5], to protect the NVR plate carrier in 5.4. The polyamide film material shall meet the safety and outgassing requirements for the spacecraft and spacecraft processing facility. (See Note 2.)

5.6 *HEPA filtered,* ISO Class 5 (FS209 Class 100), or better environment, as defined in ISO 14644-1, unidirectional air flow, clean work station.

5.7 *Gloves,* solvent compatible and resistant.[7] (**Warning**—Gloves shall be used to protect the hands from accidental spills of the NVR solvent and minimize contamination of exposed samples. Gloves shall be selected to meet local safety and contamination control requirements.)

5.8 *Oil-Free Aluminum Foil,*[8]to cover the NVR plate if the cover in 6.2 is not used.

5.9 *HEPA Filters*—All HEPA filters shall be constructed of low outgassing, corrosion-resistant, and fire-resistant materials such as Grade 1 in IES-RP-CC001.3. Filters with stainless steel or aluminum frames should be considered. The filters shall not be tested with DOP (dioctylphthalate) or other liquid aerosols. Ambient air and solid aerosol test methods are acceptable

[7] Pioneer green nitrile gloves, Catalog No. A10-1, have been found to be satisfactory.

[8] Fed Spec. Food Service Grade aluminum foil, oil free, Federal Stock No. 8135-00-724-0551 has been found to be satisfactory.

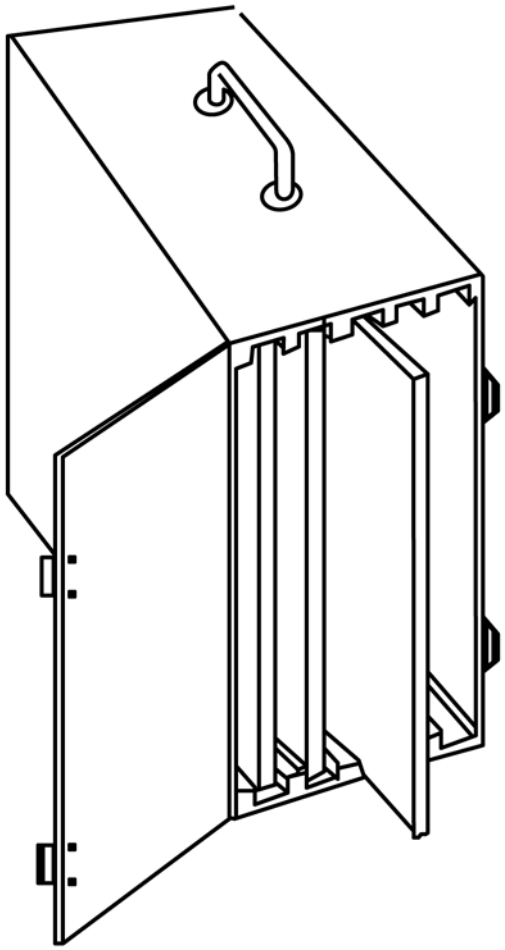

FIG. 3 NVR Plate Carrier

alternatives to the DOP test. Applicable test methods from IEST-RP-CC007.1 and IEST-RP-CC034.1 shall be considered.

6. Procedure

6.1 Clean and prepare the NVR sample plates and plate covers in accordance with Cleaning of Equipment (8.2) of Test Method E1235.

6.2 Verify that the carrier is visually clean. If cleaning is required, clean to Level 100A per IEST-STD-CC1246.

6.3 Perform all packaging operations in a unidirectional air flow in clean work station ISO Class 5 (FS209 Class 100) environment as defined in ISO 14644-1 or an equivalent cleanroom or clean zone.

6.4 Verify that the NVR plate cover (5.2) is on the NVR plate or that the oil-free aluminum foil (5.8) is installed.

6.5 Verify that a certification decal or tag (See Fig. 4) is included with each NVR plate.

NOTE 1—Care should be taken not to touch the sampling surfaces of the NVR plate. Gloves should be worn to prevent skin flakes and oil from contaminating the plates.

6.6 Verify that the serial numbers of the NVR plates, plate covers, and carrier are on the traveler paper (see Fig. 5).

CERTIFIED FOR SAMPLING	
Inspector:	Date:
LAB W.O. No.:	Date Sampled
Measurement: NVR	Quantity: (1) mg/
Item: (2)	Serial No.:

NOTE 1—(1) The quantity of NVR can be "mg/L," "mg/0.1 m^2," and so forth. (2) The item can be "NVR plate," "plate carrier," "NVR solvent," and so forth.

FIG. 4 Typical Certification Tag

6.7 Verify that the covered NVR plate is enclosed in a noncontaminating nylon bag (5.3) and installed in the NVR plate carrier. Place the lid on the carrier and fasten securely.

6.8 Affix the proper quality decal or tag (see Fig. 4) to the container in accordance with local requirements.

6.9 Seal the NVR plate carrier in the noncontaminating bag.

6.10 Attach the traveler sheets (Fig. 5) to the outer bag.

6.11 Transport the NVR plate carrier in a closed vehicle to the clean facility.

NOTE 2—The objective is to protect the carrier from contamination during transport. The noncontaminating nylon (polyamide) bag shall be used when the carrier is to be removed from a controlled environment for transport.

NOTE 3—NVR plates inside secured plate carriers are to be transported within a moderately controlled area, for example, inside the cab of the truck, as to limit exposure to contamination and excessive changes in temperature. Plates returning to the laboratory for analysis are particularly critical because of possible volatility of the NVR.

6.12 If the NVR plate carrier is not to be used immediately, store it within an outer nylon (polyamide) bag in an ISO Class 8.5 (FS209 Class 300 000) or better clean area, a controlled area, or a good housekeeping area. Reclean the plates in accordance with Test Method E1235, Cleaning of Equipment (8.2), after six months for acceptability or as determined by local conditions.

NOTE 4—An acceptable storage time for the NVR plates before requiring recertification should be determined because local conditions can affect the process.

6.13 Remove the outer bag in the entrance air lock of the cleanroom, controlled area, or other environmentally controlled area in accordance with the procedures of the clean areas for handling clean tools and instruments.

6.14 Clean the outside of the NVR plate carrier, if required, in accordance with clean area procedures.

6.15 Personnel shall wear the cleanroom garments prescribed for the clean area.

6.16 Carry the NVR plate carrier into the clean area.

6.17 Determine the mounting locations for the NVR plates. The locations are usually dictated by the contamination control plan and operating procedures for the clean area.

6.18 Open the NVR plate carrier and remove the NVR plates one at a time.

6.19 Put on gloves before handling the NVR plates.

1. _____ _____ _____
Sample No. Plate S/N Carrier S/N

2. INSTALLATION

by _____ Requester _____
Print Name Print Name

_____ _____
Signature Signature

_____ _____ _____ _____
Location Day Mo. Yr. Time

Comments

_____

_____

_____

3. RETRIEVAL

by _____ Requester _____
Print Name Print Name

_____ _____
Signature Signature

_____ _____ _____
Location Day Mo. Yr. Time

Comments

_____

_____

_____

4. DELIVERY TO ANALYTICAL LABORATORY

by _____ Requester _____
Print Name Print Name

_____ _____
Signature Signature

_____ _____
Day Mo. Yr. Time

Comments

_____

_____

_____

One copy to agency responsible for installation, retrieval, and transport, one copy to analytical laboratory, and one copy to requester with the laboratory report.

FIG. 5 NVR Sample Plate Traveler

6.20 Remove the plate from the plastic bag.

6.21 Remove the cover and store the cover in the carrier for use after the required exposure.

6.22 If aluminum foil was used to cover the plates instead of hard covers, carefully remove the foil from each plate without touching the sampling surfaces. Carefully store each foil for use after the required exposure. Discard the aluminum foil if it is contaminated or damaged and replace with a clean foil.

6.23 Mount the plates mechanically in the predetermined location in a vertical position.

NOTE 5—The vertical position is specified so as to minimize the deposition of large particles that can contain molecular matter that could cause an erroneous NVR upon contact with the NVR solvent.

6.24 Record the serial numbers, locations, and sample numbers for each sample plate. Transfer the information to the traveler sheet or work sheet and requester log book.

6.25 The requester shall maintain a logbook of all plate installations.

6.26 Remove at least one sample plate, remove the cover, replace the cover, and return the plate immediately to the NVR plate carrier for use as a blank or control sample.

6.27 Securely fasten the lid of the NVR plate carrier.

6.28 Store the closed NVR plate carrier within the clean area during the exposure period.

6.29 The exposure is usually for no less than one week and could be four weeks (one month) or longer. The exposure is determined by the contamination control plan and procedures for the clean area and special procedures for the operation.

6.30 Open the NVR plate carrier immediately before removing the exposed NVR plates from their mounts. Handle the container lid with care so as not to contaminate the interior surface.

6.31 Remove the exposed NVR plates from their mounts, one at a time, cover, bag, and return to the original NVR plate carrier.

6.32 Securely fasten the lid of the plate carrier.

6.33 Record the exposure times and any other appropriate comments on the traveler sheet.

6.34 Seal the NVR plate carrier in the approved, noncontaminating bag in accordance with clean area hardware removal procedures.

6.35 If required, install the clean NVR plates to replace the exposed plates by following the preceding procedures.

6.36 Transport the enclosed NVR plate carrier directly to the analytical laboratory in a closed vehicle. Do not exceed the maximum time for transport which is 60 min.

6.37 The receiver at the analytical laboratory shall sign, date, and record the time. One copy of the traveler shall be retained by the organization responsible for the retrieval and delivery of the sample plate.

6.38 Process the NVR plates as quickly as possible in accordance with the requester's requirements.

6.39 If required, store the bagged NVR plate carrier in an ISO Class 8.5 (FS209 Class 283 000), or better, a controlled area, or a good housekeeping area.

6.40 Remove the outer bag or container immediately before placing it in a clean workstation.

6.41 Analysis shall be in accordance with Test Method E1235.

6.42 Return one copy of the traveler to the requester along with the laboratory report (see Figs. 8–10 in Test Method E1235).

7. Keywords

7.1 cleanroom; NVR; nonvolatile residue; witness surface