
Class 100,000 Cleanroom
Operations Training Course Outline
for Calorimeter & Tracker
(more details being developed)

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Topics

- What is Contamination
- Contamination Effects
- Sources Of Contamination
- Cleanroom Entry Procedure
- Cleaning Technique
- Cleanroom Rules
- Common Mistakes
- Prevention

What is Contamination?

- Particles as small as 1 micron
 - The unaided eye can see particles as small as 50 microns on a good background
 - The thickness of a human hair is 100 microns
 - Time to fall 1 meter in still air for a 10 micron particle is 33 seconds, for a 1 micron particle is 48 minutes
- Molecular films
 - Uncured epoxy resins or hardener, oils, deposited vapors
 - Most thin films of contaminant are invisible to the unaided eye
- Outgassing / Offgassing
 - Low molecular weight compounds such as plasticizers, etc.

Federal Standard 209

- Airborne particulate cleanliness for cleanrooms and clean work areas
- “ This document is not a design specification for clean rooms or clean air devices, nor does it apply to supplies or equipment which may be used in clean rooms”
- “Rather it provides a means for specifying and measuring particulate air cleanliness levels.”
- “Because air cleanliness levels are affected by the people, activity, and equipment within the space as well as the room design, cleanliness classes normally apply only to operational facilities.”

Classification

Particle Diameter (um)

Class	0.1	0.3	0.5	5.0
1	35	3	1	
10	350	30	10	
100		300	100	
1,000			1,000	7
10,000			10,000	70
100,000			100,000	700

Contamination Effects

- Particles
 - Degrade Tracker and Instrument performance
 - Change thermal properties of materials
 - Obscure SSD thus reducing efficiency
- Molecular films
 - Reduce instrument throughput
 - Change thermal properties
- Outgassing
 - Create buildup of molecular film on cold surfaces on orbit

Sources of Contamination

Primary Sources

- Exposed Skin/Hair
- Non-cleanroom Paper
- Garments
- Vinyl, PVC, Rubber, Ink
- Operations: drilling, cutting, filing
- Environment
- Equipment
- People
- Chemicals
- De-Ionized Water
- Process

Secondary Sources

- Gloves
- Tools
- Work Surfaces
- Floor

Personnel as a Source

- A person motionless, sitting or standing, will generate 100,000 particles > 0.3 micron in diameter per minute.
- A person with arms, head, and body in motion will generate 1,000,000 particles > 0.3 micron in diameter per minute.
- A person walking at 2 mph generates 5,000,000 particles > 0.3 micron per minute.
- Fingerprints can not be completely removed by an alcohol wipe, and on many materials they etch the surface causing permanent changes to the surface properties.
- Human Contamination
 - Normal talking (saliva) – 2 to 3 Ft.
 - Coughing (saliva/lung tissue) – 4 to 6 Ft.
 - Sneezing – 10 to 15 Ft. (200 MPH)

Cleanroom Rules & Regulations

The recommended regulations necessary for the successful operation based upon the best class of air cleanliness attainable for the type of facility and equipment, are as follows.

- NO eating, smoking, or chewing gum or tobacco.
- Garments specified as applicable to a given facility must be worn when entering the area.
- Only approved clean room paper shall be allowed in the area.
- Cleanroom approved ball point pens shall be the only writing implement used.
- NO cosmetics of any type shall be worn by anyone entering the area. This includes: rouge, lipstick, eye shadow, eyebrow pencil, mascara, eye liner, false eye lashes, fingernail polish, hair spray, and the heavy use of aerosols, aftershaves lotions, and perfumes.
- The use of paper or fabric towels should be forbidden. Wash rooms should have electrically powered air blowers.

Cleanroom Rules & Regulations (cont'd)

- Gloves or fingercots, should not be allowed to touch any item or surface that is not known to have been thoroughly cleaned. Specifically, they should not touch any part of the anatomy covered or uncovered.
- Approved lint-free gloves, finger cots (powder-free) pliers, or tweezers should be used to handle material or parts if feasible. Fingerprints are a form of contamination and should be avoided.
- Solvent contact with the bare skin should be avoided, as most solvents will remove natural skins oils, and lead to excess skin flaking.
- Skin lotions or lanolin-based soaps are a good means of skin tightening and should help prohibit epidermal scale.
- All personal items such as keys, cigarettes, watches, matches, lighters, etc., should not be carried into the clean room.
- Valuable items such as wallets may be permitted in the cleanroom provided that they are NEVER removed from street clothing and are concealed by the clean room garment.

Cleanroom Rules & Regulations (cont'd)

- All parts of material, containers, racks, jugs, fixtures, and tools, should be cleaned to the same level of cleanliness specified for the product being processed.
- No tool should be allowed to rest on the surface of the bench or table, but should be placed on a clean room wiper or a re-cleaned surface to guard against contamination which has settled on the work surface being transferred to the tool.
- All material, containers or equipment introduced into the sterile room must be subjected to stringent sterilization procedures prior to entering the clean area.
- **NO ONE** who is physically ill, especially with a stomach or respiratory disorder, may enter the sterile rooms or clean rooms.

Prohibited Personal Actions

- Scratching Head
- Combing Hair (in gowning room area)
- Removing Cleanroom garments prior to gowning area
- Horseplay, fast motions
- Using external medications i.e., lens solution.
- Wearing a torn or soiled cleanroom garment.
- Removing items from under the cleanroom garment.
- Bringing non-approved items into the clean area.
- Not cleaning items before bringing them into the clean area.
- Blowing off work areas.
- Improper changing of gloves.
- Wearing clean room garments OUTSIDE the cleanroom area.
- Storing cleanroom garments in personal article locker.

The 10 Rules of a Good Cleanroom Management

- Enforce Discipline.
- Train and certify all levels of personnel.
- Write & update process procedures.
- Establish quality assurance.
- Write a cleanroom standard.
- Come up with a good attitude in the cleanroom.
- Make the cleanroom a safe environment.
- Maintain stock of supplies.
- Someone to supervise all housekeeping activities.
- Someone to cross-train people and maintain records.

Cleanroom Materials

Garment Construction

Generic/Brand Name

- Polytetrafluoroethylene/Gore-Tex
- Non-woven/Tyvek

Configuration

- Membrane bonded to polyester fabric
- Non-woven fabric

Glove Construction

Generic/Brand Name

- Polytetrafluoroethylene/Gore-Tex
- Latex/rubber
- Nitrile/rubber

Configuration

- Membrane bonded to polyester fabric
- Film (elastomer)
- Film (elastomer)

Surface Cleaning Techniques

- Dry Cleaning Methods
 - Jet blowing
 - Vacuuming
 - Mechanical Brushing
 - Plasma sputtering

- Wet Cleaning Methods
 - Liquid jets
 - Washing
 - Solvent washing
 - Combined techniques

Maintenance Questions

(to be answered for cleanroom maintenance)

- Where are your housekeeping supplies stored?
- Do you have DI water available for cleaning? Where?
- What type of mop are you using?
- What type of surfactant?
- How often are you cleaning?
- What determines the frequency?
- Who is responsible for determining the efficiency of cleaning procedures?
- How often is the gowning area cleaned?
- How is trash removed from the cleanroom?

Maintenance Questions (cont'd)

- What type and where are the trash receptacles located?
- What type of garments are the cleaning personnel wearing?
- Are the cleaning personnel wearing gloves?
- How often and who cleans the work surfaces?
- Do you have an in-house vacuum?
- Do you have a portable vacuum?
- Who changes the light bulbs and how are they changed?
- What is the particle burden limit of the surfaces in your cleanroom?

Cleanroom Personnel Entry Procedure

- Wash hands after eating or smoking
- Remove items you will need from pockets
- Pick up garments: Smock, booties, cap, face mask. Dress from top down
- Do not let booties touch “dirty” side of floor
- Put on ESD wrist strap then gloves

Cleanroom Equipment Entry Procedure

- Hand carried items
 - Items already clean and double bagged may be taken directly into cleanroom. Remove first bag in ante room, second bag in cleanroom.
 - Items not already clean should be cleaned in the ante room until no particles are visible from 2 feet away. Vacuuming followed by wiping with isopropyl alcohol will usually be sufficient.
- Large equipment
 - Bring in through equipment access door. Coordinate cleaning with engineer in charge of contamination.

Cleaning Technique

- Bolts, nuts, fasteners
 - Place in ultrasonic bath for 10 minutes (do a lot at one time)
- Lager Items
 - Vacuum holes and crevices.
 - Tape over chipping paint, etc.
 - Wipe unidirectionally, changing wipe every 2-3 strokes. Continue until the wipe looks clean after wiping.

Common Mistakes

- Touching face or hair with gloves
- Keeping face mask below the nose
- Using tools that have fallen on the floor without recleaning them
- Not changing gloves when a questionable surface has been touched
- Picking up gloves by the fingers instead of the wrist when gowning up
- Bringing tools into the cleanroom without cleaning them (usually carried in a pocket, such as a pen)

Prevention

- Keep cleanroom wipes and alcohol in a squeeze bottle handy for recleaning tools and work surfaces
- Be aware of the contamination sources and change your gloves as often as necessary
- If you have to wipe your forehead while wearing gloves, use a cleanroom wipe (dry), not your sleeve
- Follow cleanroom rules
- Use only approved materials for flight hardware, including lubricants and fasteners