

# Cleanroom Recommended Gowning Protocol

## *Dirty Link in the Ultra-Clean Chain?*

Semiconductor manufacturers invest hundreds—even thousands—of dollars per square foot of cleanroom space to meet the stringent particle standards required for profitable yield rates. Shouldn't the same standards be required of the people who enter and potentially contaminate this ultra-clean environment?

Proper cleanroom garments, including hoods, face masks, booties and gloves, help to contain particles that people emit. Yet improper gowning procedures can negate your investment in cleanliness and threaten yields of sensitive semiconductor devices. Once a garment is contaminated—violated by contact with a dirty surface—it spreads particles everywhere it goes.

Sure, you can train personnel on proper garmenting procedures, but how do you guarantee compliance? A violated garment doesn't set off alarms, and few facilities can afford quality control monitors to supervise every person through every washing and dressing stage. Yet if strict controls are not observed, dirty gloves and coveralls almost certainly will come in contact with clean operations.

## A Gowning Area that Supports Clean Protocol

The simplest and most economical approach to this dilemma is a correctly designed gowning area, complete with well designed change room products, that keeps personnel on a clean track.

This design starts with a room that meets the same cleanliness specifications you require of your cleanroom itself. It includes a laminar flow of HEPA-filtered air, typically emitted through ceiling filter/fan units. This continuous wash of clean air immediately removes personnel-emitted contaminants, as well as particles present even in cleanroom-laundered garments (see Figure 1). Failure to maintain the desired particle standard in the change area will lead to clean garments becoming violated.

Activity	No. of particles ( $\geq 0.3\mu\text{m}$ )
Person emits during garmenting process	3,000,000/min.
Cleanest skin (hands)	10,000,000/ft <sup>2</sup>
Employee street clothes	10,000,000 to 30,000,000/ft <sup>2</sup>
Floor and bench surfaces	> 10,000,000/ft <sup>2</sup>
Garments supplied by cleanroom laundry	1,000,000/ft <sup>2</sup>

**Figure 1: Gowning Area Particle Generators**

**Source: Encyclopedia of Clean Rooms, Bio-Cleanrooms and Aseptic Areas, Dr. Philip Austin, P.E., 2000**

The [Change Room illustration](#) depicts an effective floor plan that places the proper gowning stations in appropriate locations. Although many variations on this layout are possible, they should support these key garmenting guidelines:

**Don't Touch!** Most cleanliness violations occur when a garment is touched by dirty hands, or when it touches a dirty floor. Hands and gloves should therefore be washed and dried frequently. Select washers and dryers with no-touch IR sensors to minimize the chance of violating gloves. Maintain ultraclean, unviolated surfaces where garments can be donned without contamination.

**Dress from the Head Down!** That way, released particles won't fall on clean garments or booties.

**Understand Garment Design!** In most instances, gloves and booties are worn over coverall sleeves and cuffs, and hoods are tucked inside collars. Make sure that personnel are trained on how to seal these gaps between clothing, and include a mirror to allow final self-inspection. Hang a photo of a correctly garbed person next to the mirror as a "how-to" guide.

**Minimize Motion!** As Figure 2 indicates, people wearing cleanroom garments emit thousands of particles per minute even when sitting still! People in street clothes, walking from one change room location to another, release millions of particles. Change room plans should therefore minimize motion, especially during the final stages of dressing, by efficiently organizing the flow of personnel from one station to another.

**Minimize Maintenance!** Do you have dedicated, trained personnel to peel off adhesive shoe mats, wipe down gowning benches, keep "clean zones" regularly scrubbed, empty waste receptacles, restock garb dispensers, and perform other upkeep with the absolute regularity that your protocol requires? If not, look for ways to minimize reliance on humans—through automation, careful product positioning, choice of materials, and so forth. Initial cost may be higher, but reduced maintenance and greater compliance provide a rich return on your investment!

**Train and Reinforce!** A good change room design supports proper protocol, but it doesn't teach it. Make sure that personnel complete a formal training program, and stress protocol by hanging reminder posters at every gowning station that reinforce proper procedures.

<b>Particles &gt;= 0.3µm emitted per minute in garment indicated</b>					
<b>Personnel Activity</b>	<b>Snap Smock</b>	<b>Standard Coverall</b>	<b>2-Piece Coverall</b>	<b>Tyvek® Coverall</b>	<b>Membrane Coverall</b>
No Movement	100,000	10,000	4,000	1,000	10
Light Movement	500,000	50,000	20,000	5,000	50
Heavy Movement	1,000,000	100,000	40,000	10,000	100
Change Position	2,500,000	250,000	100,000	25,000	250
Slow Walk	5,000,000	500,000	200,000	50,000	500
Fast Walk	10,000,000	1,000,000	400,000	100,000	1,000

**Figure 2: Austin Contamination Index**  
 Source: *Encyclopedia of Clean Rooms, Bio-Cleanrooms and Aseptic Areas*, Dr. Philip Austin, PE, 2000  
 Note: Light/heavy movement refer to partial body movements (motioning with arm, tapping toes, etc.).  
 Change of position refers to whole body motion (standing up, sitting down, etc.).

**Cleanroom and Change Room References by Dr. Philip R. Austin, PE**

Contact Dr. Austin for information on his  
 Contamination Control Seminars: (734) 427-8450.



**Encyclopedia of Clean Rooms, Bio-Cleanrooms and Aseptic Areas**, 3rd Edition Acorn Industries, 2000, 1,000 pp.

Covers every aspect of contamination control, including Class 100,000 through Class 1 cleanrooms; bio-cleanrooms; sterile rooms; major governmental standards; air, fluid, and gas filtration; vertical and horizontal laminar flow facilities; and personnel and equipment.

<b>Cat. #</b>	
<b>5012-01</b>	<b>\$ 403</b>

**Also by Dr. Austin:**

	<b>Cat. #</b>	
<i>Design and Operation of Bio-Cleanrooms for Medical Devices</i> Acorn Industries, 1994, 440 pp.	<b>5013-37</b>	<b>\$ 230</b>

<i>Design and Operation of Pharmaceutical Bio-Cleanrooms and Aseptic Areas</i> Acorn Industries, 1994, 440 pp.	<b>5013-38</b>	<b>\$ 230</b>
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