

# Optimizing Cleanroom Performance Through Use of Undergarments

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The cleanroom or controlled environment was developed to help the aerospace industry control the quality problems and equipment failure caused by dust and particulate contamination. The potential impact of microorganism and microscopic dust lead a wide range of industries to adopt cleanroom technology. Cleanrooms can now be found in food processing plants, pharmacies, pharmaceutical/biotech companies, medical device manufacturers and across the microelectronics industry. The use of contamination control technology has improved the safety and reliability of the products and devices produced by these companies.

This demand for cleaner environments to control smaller and smaller particles has challenged the latest generation of cleanroom garments. The focus of the contamination control industry today is to provide the most efficient removal of contamination from the room. This includes identifying the sources of contamination and taking steps to keep it out of the critical space. If the contamination load due to external (to the cleanroom) sources is reduced the existing cleanroom infrastructure may be able to achieve a higher level of performance without a change of the hardware.

The most important source of contamination in the cleanroom is the microbial and particulate material generated by the operators in the room. Humans shed thousands of particles every minute which consist of everything from hair and skin flakes to bacteria that reside on the skin. In addition to this contamination the clothing that is worn under the garment can have a large impact on the quality of the cleanroom environment. Employee owned clothing used while mowing the lawn, grooming a horse or any of a myriad of activities, can produce undesirable contamination for the cleanroom. Garments that are made of natural fibers such as cotton or wool are very efficient at trapping environmental contaminants and transporting them into the cleanroom. These contaminants are then released from the fabric during normal cleanroom activities. In addition, these natural fiber garments are contamination sources due the decomposition of the fabric and fibers as the garments are worn and used. Once these contaminants are in the room it is only a matter of time before they begin to enter the controlled area.

The IEST Particle Containment Test (Body Box) is used to compare the performance of cleanroom garment systems under controlled conditions. If the test is performed correctly it can also be used to test the impact of undergarments in the cleanroom environment. In this case the overlaying barrier garment system must be held constant in order to be sure of the particle load from these garments. This report combines the results of several body box comparisons to illustrate the impact that wearing a cleanroom processed undergarment has in the particles shed while working in the cleanroom.

Figure 1 compares the rate of particle generation by an individual in the body box while wearing normal street clothes, an industrially processed 65% polyester/35% cotton work uniform (e.g. Whites). In this case the subject is wearing identical nonwoven disposable coveralls & hoods. The test clearly indicates the impact that undergarments can have on the overall performance of the cleanroom even if a barrier garment is present. Careful consideration of the sources of employee born contamination can pay large dividends in the operation of the cleanroom.

**Figure 1**

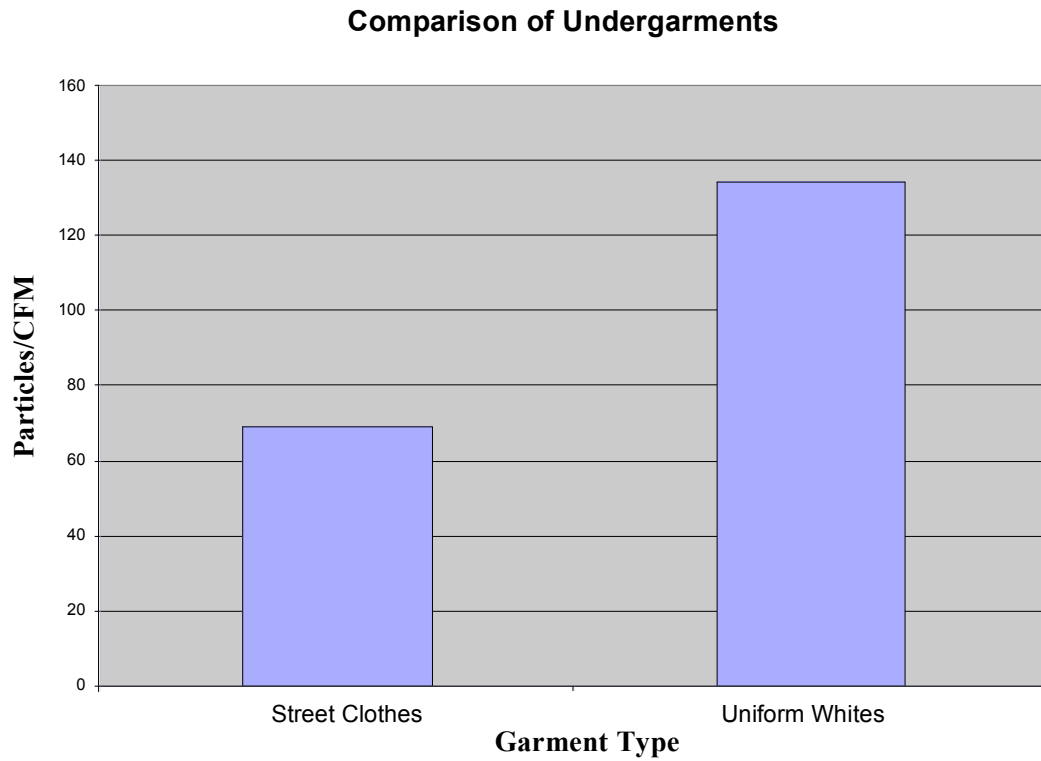
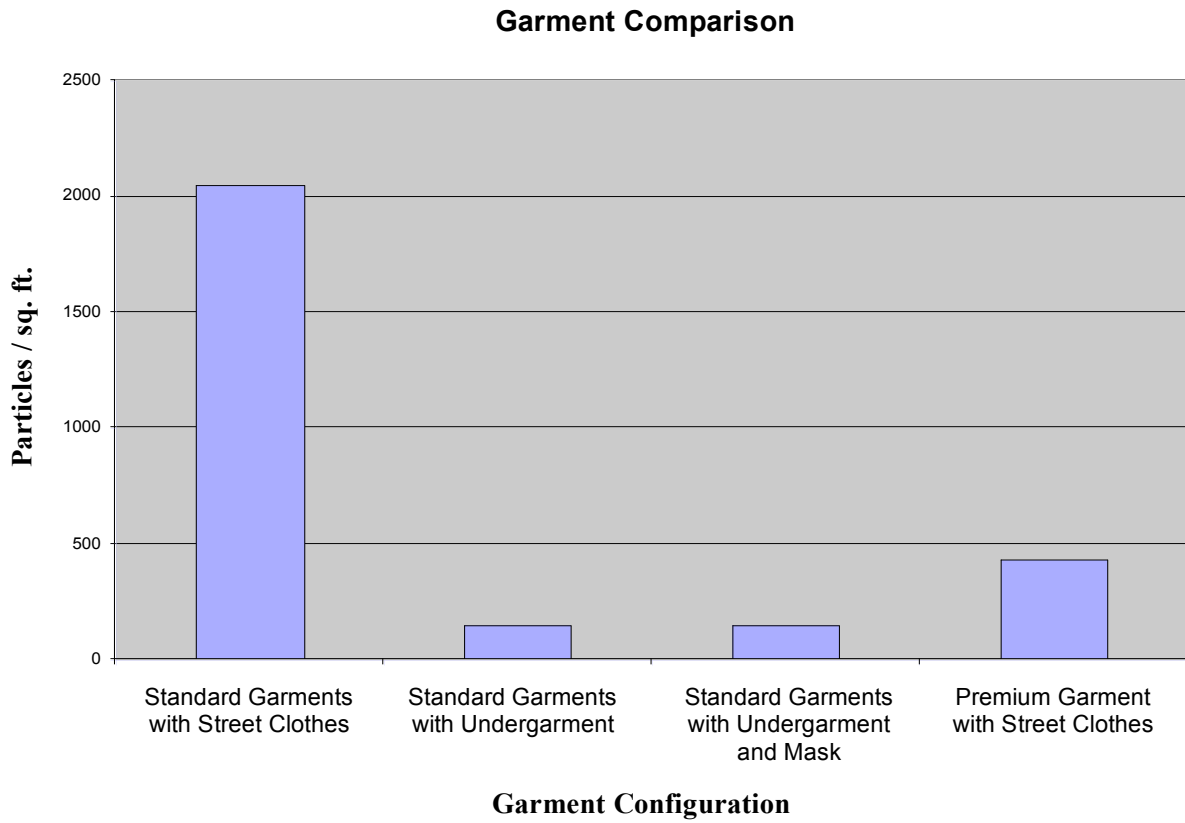


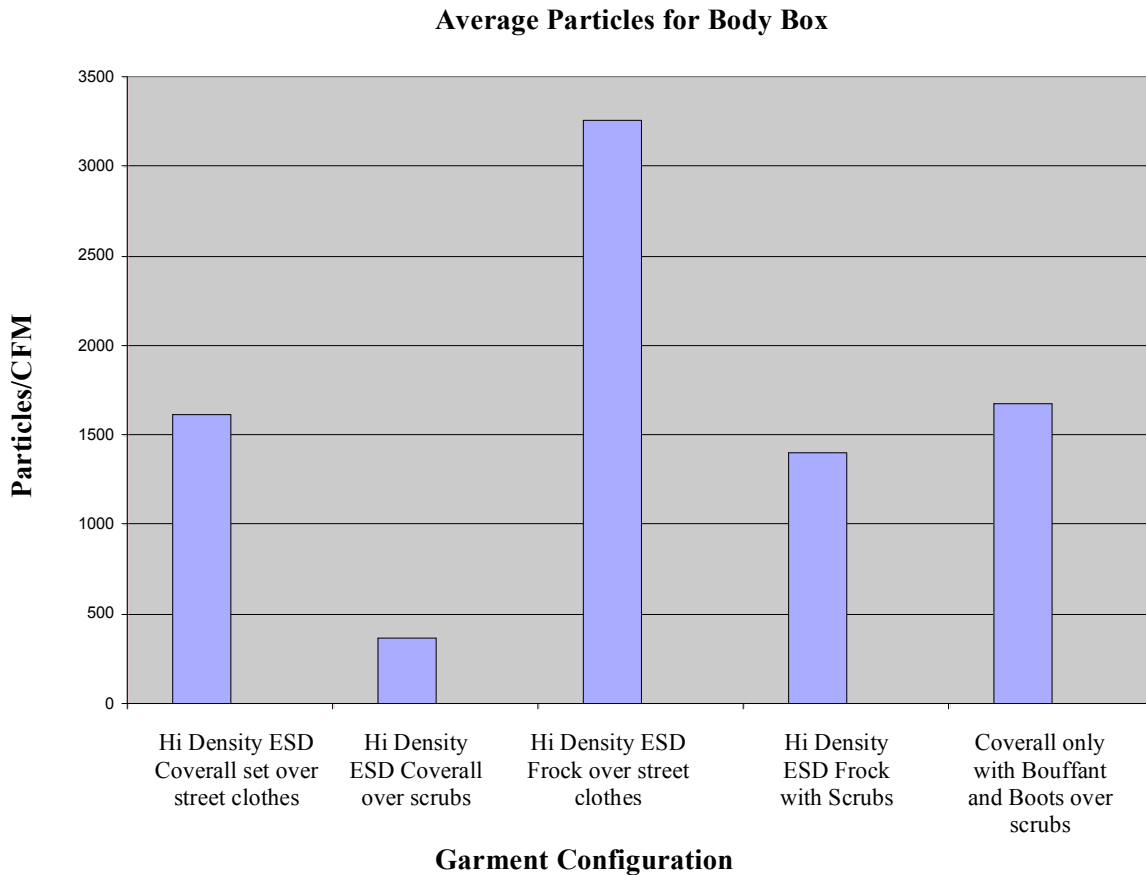
Figure 2 shows testing performed for a microelectronics company who wanted to upgrade the performance of the cleanroom and they were considering the purchase of some very expensive high end garments. This study showed them that they could stay in their current standard barrier garments with cleanroom processed undergarments and achieve very good results. The cleanroom was able to meet a lower cleanliness class without using an expensive premium garments. The overall impact was they save a good deal of money while achieving their desired result.

**Figure 2**



The story is the same in the medical device study that is illustrated in Figure 3. This study compares the impact of the use of cleanroom processed undergarments with several different types of cleanroom gowns. The final analysis of the information shows that in this application the use of a cleanroom frock with undergarments provides the same level of protection as a complete coverall hood and boots over street clothes.

**Figure 3**



The advanced products and medical treatments that we depend on today require the strictest contamination control during manufacture. A failure of the cleanroom or cleanroom garment system can have very serious consequences for the end user. The trend in the contamination control industry is to extend control strategies beyond the critical area to prevent contamination before it becomes a problem. The implementation of a cleanroom undergarment/scrub program is one of the most effective methods for lowering the overall particulate load in the cleanroom. This in turn will improve the performance and predictability of the processing environment and reduce the incidence of quality problems due to contamination. This allows the cleanroom operator to focus on making product and not on whether the garment system is adequate.

## References

Institute of Environmental Sciences and Technology RP-CC-3.3: Garment Considerations for Cleanrooms and Other Controlled Environments.

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