S45: Design and Construction Considerations For Cleanroom Facilities For Nanotechnology Research

Tim Loughran, Managing Partner
Richard Dean PE, Project Director
AdvanceTEC, LLC

CleanRooms Contamination Control Technology Conference and Exhibition March 22, 2005
Agenda

- Introduction
- Traditional Cleanroom Design Considerations
- Specific Design Considerations
- Questions
AdvanceTEC is a cleanroom contractor specializing in the microelectronics and semiconductor markets. We have extensive staff experience in designing, constructing, and installing process systems and tools for wafer fabs and related technologies.
Traditional Design Concerns

Concerns that are prevalent designing any cleanroom facility:

- The 3 Most Important Steps to successfully execute a cleanroom design are:

  1. Assembling an Equipment Data Base
  2. Creating a Utility Summary (Matrix)
  3. Developing an Equipment/Tool Layout
Traditional Design Concerns

What does the utility list and layout provide in terms of answers that will help us properly design the cleanroom:

- Exhaust Requirements
- Heat Loads
- Process Cooling Loads
- DI Water Requirements
- Spec Gas Requirements
- Process Gas Requirements
- Utility Space Requirements
- Material and Personnel Egress Requirements
Traditional Design Concerns

From the values summarized by the utility list we can size the utility equipment that dictates utility requirements:

- Make Up Air Requirements
- Humidifier Requirements
- Boiler Requirements
- Chiller Requirements
- Electrical Loads
- Process Utility Loads
Specific Nanotechnology Concerns

What is Nanotechnology:

• Technology developed at the atomic or molecular level
• Ability to control or manipulate at that level
• Creating or using structures that have novel properties due to their size
Specific Nanotechnology Concerns

Nanotechnology Applications:

- **Creation of new materials with superior strength, conductivity, or resistance**
- **Microscopic machines or probes that can be injected into the body for diagnosis or repair**
- **Creation of bio-chips that detect contamination or dangerous substances in the body or air**
Specific Nanotechnology Concerns

Size of Nanometer:

• 1 Nanometer = One-Billionth of a meter
• DNA is in the 2.5 Nanometer range
• Smaller than a living cell requiring microscopes that present unique design challenges
Specific Nanotechnology Concerns

Some Items are of greater concern to Nanotechnology cleanroom design:

- Noise
- Electromagnetic Interference
- Vibration
- Airflow
- Cleanliness Classification
Specific Nanotechnology Concerns

Noise Concerns

- Noise and Vibration Interrelate
- SEM Equipment - prevalent in Nano Rooms - requires background noise as low as NC-45.
- Moving air and minimizing noise are diametrically opposed forces.
- Specific Air Delivery treatment should be considered.
Specific Nanotechnology Concerns

Air Delivery Treatment Methods:

- Sound Attenuation
- Some Sound attenuating treatments are directly contradicting to cleanroom design.
- Co-Planer & Fan Wall Technology helps address noise with the added benefit of reducing EMI concerns in cleanroom air delivery systems.
Specific Nanotechnology Concerns

Electromagnetic Interference (EMI) Sources:

- Geomagnetic- Earth, Steel, Building Elevators
- Construction- Electrical and MEP Equipment
- Equipment- CRT’s, ballasts, internal process equipment
- Stray RF Sources- Marine, mobile, broadcast, cell, microwave
Specific Nanotechnology Concerns

EMI Solutions:

- Passive Shielding
- Active Field Cancellation
- Address issues in the design process.
- Place generating sources as far from the process as possible.
Specific Nanotechnology Concerns

Vibration Concerns & Sources:

- **Nano objects** require stable environments with active vibration control.
- **Thresholds** are 4 times more sensitive than normal laboratory design concerns.
- **External foot traffic** can cause vibration that is of concern.
Specific Nanotechnology Concerns

Vibration Abatement Techniques:

- Isolated slabs.
- Strategic location of the most sensitive laboratories.
- Decoupling of fan decks and HVAC equipment from laboratories.
- Active control utilizing air cushioned slabs.
- Point of use isolation.
Specific Nanotechnology Concerns

Airflow Concerns:

- Moving air to achieve cleanliness and reducing sound and vibration are diametrically opposed forces.
- We tend to have to reduce velocity to achieve our sound and vibration concerns.
- We then need to consider design features that will allow us to achieve the cleanliness goals with reduced airflow.
Specific Nanotechnology Concerns

Cleanliness Classifications Required for Nanotechnology Research:

- Economics dictate cleanliness class more than any other single factor.
- Yields are not of utmost concern in the research arena.
- The actual cleanliness requirements for commercialized nanotechnology devices are unrealized. Gas phase filtration will be of utmost concern.
- We are dealing with particles no more than 4 atoms in dimension.
- 90 nm is the current leading edge line width.
Specific Nanotechnology Concerns

What are the design concerns of a NanoBio Cleanroom?
Specific Nanotechnology Concerns

Integrating Semiconductor, Chemistry, and Bio design features into one facility:

- Dedicated Gowning Facilities
- Particulate levels vs. Bio burden
- Positive vs. Negative Pressurization Schemes
- Architectural Features
- Safety/Isolation
How do we insure all the concerns we have are addressed?

- Utilize specialized consultants
- Incorporate case studies from previous facilities
- Create design teams that can achieve all the facility goals.
- Capitalize on the community's willingness to share experiences
- Incorporate construction team in the design review
SUMMARY

Questions/Comments

• What are your concerns?
• What are your experiences?