

The formulae $\frac{\partial U_i}{\partial x_j} + \frac{\partial}{\partial x_j}(\rho U_i) = -\frac{\partial P}{\partial x_j} + \frac{\partial}{\partial x_j}(\mu \frac{\partial U_i}{\partial x_j}) + g_i(\rho - \rho_s)$ for building $\frac{\partial}{\partial x_j}(\rho \bar{U}_i) = -\frac{\partial P}{\partial x_j} + \frac{\partial}{\partial x_j}(\mu \frac{\partial \bar{U}_i}{\partial x_j} - \rho \bar{u}_i \bar{u}_j) + g_i(\rho - \rho_s)$ state of the art $\frac{\partial}{\partial x_j}(\rho \bar{U}_i \bar{U}_j) = \frac{\partial}{\partial x_j}(\lambda \frac{\partial T}{\partial x_j} - \rho \bar{u}_i \bar{u}_j)$ biomedical research facilities.

Understanding Nanotechnology & Nano Facilities

Nanotechnology is the science, engineering, and technology of functional systems that can be observed, conducted, and controlled at the molecular scale. The nanotechnology field is responsible for continued groundbreaking advancements in medicine; its impact on human health extends from prevention to diagnosis and treatment of diseases. Uses include nanoparticles for chemotherapy via nanocarriers, which focus on targeting cancerous cells and thereby reduce harm to healthy cells.

Advancements in nanotechnology have been accompanied by advancements in nano facility architecture. This is typically demonstrated in new construction, such as MIT's MIT. Nano building, which departs from standard nano facility design by incorporating above ground structures, expansive glass facades, natural light, and views into work areas. Regardless of other design choices, all nano facilities should adhere to a base set of requirements that accommodate the health, safety, and functional requirements associated with nano research.

Pre-Design

Prior to design, a risk assessment should be performed to ensure the success of the project and determine the degree of stringency required. Identifying the objectives, budget, and equipment requirements will aid in understanding the limitations of the facility and its ability to accommodate existing nano lab research and future technology.

General Design Criteria

General design criteria for nanotechnology lab space require the use of environmental control systems and the minimization of ground-borne vibrations from HVAC equipment, construction, and elevators. Additional facility design considerations include structural isolation from the main building, restricted access, air handling, regulated temperature, humidity control, and reduced particle concentration via air filtration. Site planning considerations include locating nano facilities far from high-voltage transformers, electrical power lines, roads, railway traffic, and parking lots to minimize ground-borne vibrations.

Specific Design Criteria

Specific design criteria for nano labs include non-recirculating ventilation systems with 100% exhaust air and ventilation rates of

6-12 air changes per hour. Lab pressurization should be negative to the hallway. Safety showers, eyewash stations, and other means of emergency irrigation must be accessible within the area where the work is to be performed. Offices and general-purpose workstations should not be located inside laboratories that handle nanomaterials. Additional specific design criteria for nano facilities include the following:

Storage. The primary storage location for a chemical is determined by the hazards of the material. Chemical incompatibility and chemical instability must be determined to ensure proper storage procedures.

Hazard Controls. While the health risks from exposure to nano particles are not known, standard laboratory practices regarding the use of hazardous chemicals and gases must be followed. Safety, work practice, and equipment controls must be adhered to when handling nano particles.

Chemical Fume Hood. Activities that are likely to release nano particles should not be performed in open work areas; a fume hood may therefore be required.

Furnace Exhaust. Exhaust from all furnaces used to produce nano particles must be trapped and ducted out of the room.

Vacuum Protection. Mechanical vacuum pumps must be protected using cold traps. The pump exhaust must be vented into an approved exhaust duct or chemical fume hood.

Conclusion

This article outlines several general planning fundamentals and specific design guidelines for nano lab facilities. Continued research is necessary to fully understand the benefits of nanotechnology and its role in healthcare.

Further Reading

NIH 2019 DRM Appendix O.2 Specialty Labs – Electron Microscopes and Nanotechnology

Nanotechnology- Big Things from a Tiny World