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Management

REVIEW ON PLANNING PREMISES AND DESIGN CONSIDERATION OF A NANO MEDICINE CENTRE

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ABSTRACT Nano medicine is a highly multidisciplinary field cutting across many disciplines, including colloidal science, chemistry, applied physics, materials science, and even mechanical and electrical engineering. Both the technical criteria and human criteria that culminate in the design of nanotech laboratories and facilities can present astounding complexities to the architects and engineers involved in creating the design. Even the best planning effort cannot predict perfectly how spaces will be used, or anticipate technological advancements that may dramatically affect space requirements. Over time, spaces will be assigned to different researchers and programs, so architects and engineers should do what they can to build flexibility into any design. The fundamental object of sustainable design is a bigger compatibility between the artificial and the natural environments without compromising the functional requirements of the buildings and their respective costs and a challenge for the future.

KEYWORDS :

INTRODUCTION

Nanotechnology is a field of applied science and technology involving control of matter on a scale smaller than 1 micrometre, normally between 1-100 nanometres, as well as the fabrication of devices on this same length scale. It is a highly multidisciplinary field cutting across many disciplines, including colloidal science, chemistry, applied physics, materials science and even mechanical and electrical engineering. Two main approaches are used in nanotechnology : one is a "bottom – up" approach where materials and devices are built from molecular components which assemble themselves chemically using principles of molecular recognition; (The other being a "Top-down" approach) where nano- objects are constructed from larger entities without atomic – level control. The impetus for nanotechnology has stemmed from a renewed interest in colloidal science, coupled with a new generation of analytical tools such as the atomic force microscope (AFM) , and the scanning tunnelling microscope (STM). Combined with refined processes such as electron beam lithography and molecular beam epitaxy, these instruments allow the deliberate manipulation of nanostructures, and in turn lead to the observation of novel phenomena.

There are very few Nano technology and Nano medicine centers in India. In an effort to achieve the aim and objectives of the study, the methodology adopted for this study was an extensive review of literature on the subject matter.

Nano Medicine Research centre: Planning and Designing Considerations

Nano scale research is a vast and complicated field of study that can engage a wide range of discipline from both basic and applied science. Inherent in the nature of emerging areas of research, of programme and of a specific location are requirement that make each project unique : there is no standard design solution in reality , many types of nano scale research require specialize laboratories designed to meet an array of special criteria. Sustainable Design Principles in construction sector. The design methods of sustainable construction identify, support and recommend evolution of practices and technologies that deal with all the aspects sustainability of the sector. The fundamental object of sustainable design is a bigger compatibility between the artificial and natural environment without compromising the functional requirement of the buildings and their respective costs. The methods are to be developed to comprehensively account for all parameters of environmental, functional, economic and social impacts. Building constructions effects each of the four topics of sustainable development viz., cological, economic, social and cultural development. Environmentally, sustainable construction ensures more economical use of finite raw materials and reduces, and above all, prevents the accumulation of pollutants and waste. The designers from architects to structural, mechanical and electrical engineers have to be educated and equipped to meet the challenges. Performance based building is an approach to building-related processes, products and services with a focus on the required outcomes. Environmental life-cycle analysis (LCA) The Life-Cycle-Analysis (LCA) is internationally recognized as a usable approach to evaluate the environmental impacts of products or processes.

Specific parameters for Nanotechnology Research Centre

It requires a different breed of laboratories and clean rooms. As nano scale research evolves and so must the architecture and building technologies. Nano medicine research facilities are divided into four parts:

- A clean area, which can be either a major or minor portion of the structure;
- The animal laboratory
- The utility systems necessary to support the clean area;
- The rest of the building –everything from conventional labs and offices to conference spaces and public amenities.

The infrastructure is both the least visible and the most underestimated of the three components, contributing significantly to the cost and planning effort. Nanotechnology clean room cost range widely depending on infrastructure and utility support concepts selected and clean room costs should be evaluated with respect to the entire facility budget. Large part to the facilities are built to meet the stringent requirements presented by nanometer scale research programmes.

Establishing technical requirements for a project:

Establishing technical requirements is the important first-step to designing a building that will not become prematurely obsolete. Nano scale research is a vast and complicated field of study that can engage a wide range of disciplines from both basic and applied science .Inherent in the nature of emerging areas of research, of program, and of specific location are requirements that make each project unique: there is no standard design solution. In reality, many types of nano scale research require specialized laboratories designed to meet an array of special criteria. The complex mix of technical requirements for nano scale research are aimed at creating an interior environment that is extremely controlled, to a degree far exceeding other research facilities, both for the science itself and for proper operation of equipment. Conducting atomic level measurements and characterization, as well as nanofabrication and other function typically found in nano scale research often require critical environments that demand tighter control of the fluctuation of environmental characteristics with in the laboratory . These technical considerations might involve controlling temperature and humidity levels, isolating vibration and acoustic noise, reducing the quantity and size of airborne particulates, and shielding from electrical, electromagnetic, and radio frequency interferences. Electron microscopes are most sensitive to many of the above "noise" sources. Additionally, temperature fluctuation along the length of a laser beam could cause distortion and therefore lose focus and accuracy in measurements.

Temperature and humidity control

Temperature can be closely controlled and maintained by designing systems that circulate the volume of air inside the room with a high number of air changes per hour. In typical laboratories, temperature fluctuations are controlled to ± 1 degree Celsius. Closer temperature control is sometimes needed and the tolerance can range from 0.5 degree Celsius down to a range of ± 0.01 degree Celsius in highly critical spaces.

Vibration isolation

It is equally important to test the potential site at the outset to gauge ambient vibration levels, both during the day and at night. Once the threshold is set and the site's vibration level is identified, then building design options can be considered.

Airborne contamination

At the nanometer scale, some spaces may require the control of airborne particulates (dust particles) , other may require the control of molecular contamination (biological matter) . Dust particles have a negative impact on the devices.

Electrical, electro magnetic, and radio frequency interference

Everything from a small fluctuation in the electrical power supply to electromagnetic interference (EMI) or radio frequency interference (RFI) can degrade research. At the outset of design, it is important to understand the specific requirements of the anticipated research in order to determine if EMI or RFI could be problematic.

Special consideration

Nano scale research facilities also must evaluate and make provisions for human criteria the present and future scientist who conducts research with in the facility and also the public interface between the facility and the communities at large are factors that need consideration. Various laboratories which are designed as separate modules, should be connected through a series of bridges and connectors to shared spaces that allow for communication, collaboration and collective activity. These spaces should be secure, yet the protocols less stringent than working within the main lab. Ample opportunities for collaboration among scientist strategically placed interaction areas should be provided even if the facility have highly sensitive laboratories and clean rooms .these areas are essential in fostering the impromptu communication inherent in any interdisciplinary research context. Designer should be aware of the importance of a building's iconic image, toward the future needs and include spaces that will be easily adoptable for future growth and development.

Designing for the unknown (the future)

A nanotechnology facility needs to be designed with the future in mind. The building should allow to grow the research programme. In addition to flexibly designed laboratories and clean rooms, open shelled spaces should be created that can be completed and adapted when more funding is available and future research parameters are ascertained.

Large facility

The best in class layout for a 300-mm substrate nanotech research facility is a ballroom configuration, with the researchers working in open clean room. A full floor below them, often called a subfab, contains the support equipment, such as pumps, cihllers, cryo compressors, etc., and the facility systems. The mechanical HVAC units are typically located on the interstitial level or the penthouse above the clean room. Sizes for a 300-mm nanotech facility range from as small as 15,000 sf to as large as 35,000 sf.

Medium facility

A medium –sized clean room facility is designed in the same fashion as a large facility with a configuration difference which may be a bay/chase or even a hybrid, which is a combination of ballroom and bay/chase concept. In the hybrid configuration, the clean room is organized to accommodate equipment that is extremely sensitive to environmental concerns, such as electromagnetic interference , vibration, and acoustics (EVA), typically located far away from the elevators, electrical switch gears, and other components in the clean room that generate EVA.

Small facility

Clean rooms built for 150-mm substrates are commonly laid out like a series of wide-toothed combs. The "dirty" sides of the room- the support chases – are the teeth of the comb, and the clean areas are the spaces between the teeth. There are several variations on this theme: Labs with a center clean aisle ; a clean aisle on one exterior wall and a chase aisle on the other ; and chase and clean spaces that are either symmetrical or irregularly sized and spaced. The clean spaces are located where they fit in the process. The smaller clean room facility is heavily populated with utility –hungry tools that require higher use of power consumption as opposed to a disproportionate number of metrology and support tools in the larger facility , which require less energy.

Design Parameters

These facilities should fundamentally be designed for the care and maintenance of the experimental animals. The architecture and building systems should be specifically aimed at maintaining light environmental control over the facility to avoid the introduction of contaminants or pathogens, and prevent the possibility of infectious outbreaks, and avoid the transmissions of odors. The design should promote maintainability, cleanliness, Organize circulation to permit controlled flows of people, animals, material, supplies, and waste without failure down time or disruption .

Components of a vivarium

Procedure Rooms – Proximate to AHRs and frequently interchangeable with them; they are a primary setting for research activity within the unit. The method of alloying researcher axes under controlled condition is a critical issue.

Barrier Elements – Air locks, lockers, pass-through autoclaves provide the primary barrier and access control that separate the controlled animal care environment from external influences.

Cage wash- They are the hubs for all cleaning sanitizing, and husbandry activities. These areas are dominated by equipment – generated heat and moisture. The major equipment items include pass through rack washers, tunnel washes, pass through auto claves bedding dispenses and dump stations, and bottle washing and filling stations.

Cage storage- It is a necessary function, but a space consumer, which should not be over looked.

General storage- A necessary space and function for feed, bedding, and equipment has to be incorporated into the operational flow and space allocation.

Quarantine – Isolated AHRs for suspect and incoming animals that could be a source of infection.

Dedicated receiving Dock-A dock specific to animal functions is generally required. An elevator dedicated to animal usage should be located near the dock.

Necropsy/Perfusion-Critical support function used for post mortem procedures on sacrificed animals. It is a "dirty" function that should not proximate to "clean" areas.

Containment facilities- These are the facilities for working with potentially infectious biological agents. They operate under negative pressure to prevent the escape of air to the general environment. Wastes and effluents are separately contained and decontaminated. Sophisticated control and monitoring systems and equipment are employed to achieve closely controlled and regulated air pressurizations and flows.

Barrie Facilities- Facilities for working with immuno compromised species. These operate under positive pressure to keep contaminants out. As in contaminants facilities, control and monitoring systems and equipment are utilized in barrier facilities to maintain the required pressures and flows.

Veterinary care- Lab and care functions e.g. surgery clinical chemistry and histology.

Veterinary office space - Some provision for in unit office spaces for veterinary care staff.

Staff support areas-Break area cafeterias, work stations, lockers and rest rooms facilities. All are intended to support veterinary and research staff during their in unit tours of duty.

Mechanical /Electrical equipment spaces-Mechanical equipment rooms, electrical and telecom closets , room for terminal trim devices such as dampers, coils, humidifiers and control , distribution shafts, and mechanical pent houses. A desirable goal is to locate the spaces and devices in a manner that allow the separation of maintenance functions from animal care functions.

Corridors : Tie everything together .These should be wide enough to accommodate animal rack ,cart and material traffic flow, not just egress requirements. Corridors should have a clear width of 7`-0" to 8`-0". Corridors should have impervious finishes so that they are easy to clean and maintain. Protective components such as bumper and corner guards are frequently employed to protect walls and doors from heavy, abusive traffic.

Lab planning concepts in a nanotechnology research centre

The laboratories module is the key unit in any lab facility. When designed correctly, lab module will fully coordinate all the architectural and engineering systems. A well designed modular plan should provide the following benefits.

Flexibilities – The lab modular, should encourage change with in the building. Research is changing all the time, and building must allow for reasonable change. It means the ability to expend easily , to readily accommodate reconfigurations and other changes and to permit a variety of uses.

Two-directional lab module-Design a lab module that works in both direction allows the case work to be organised in either direction.

Three-directional lab module- A three lab module planning concept combines the basic lab module or a two directional lab module with any lab corridor arrangement for each floor of a building.

All vertical risers must be - Fully coordinated (Vertical risers include fire, stairs, elevators, rest rooms, and shafts for utilities.)Las design with overhead connects and disconnects allow for flexibility and fast hook of equipment. The mechanical electrical and plumbing systems must be coordinated in the ceiling to work with the multiple corridor arrangements.

Expansion- The use of lab planning modules allows the building to adept easily to needed expansions or constructions without sacrificing facility functionality. The relationship of the labs officers and corridors is critical for the impact on the image and operation of the buildings. Natural light may not be desirable for special instruments and equipment such has nuclear magnetic resonance (NMR) apparatus electron microscopes and lasers and vivarium facilities.

Open lab vs, closed lab- An open lab concept encourages multiple teams to focus on separate research projects. The architectural and engineering systems are designed to affordably accommodate multiple floor plans that can easily be changed according to the research teams needs. Closed labs are still needed for specific kinds of research or for certain equipment nuclear magnetic resonance (NMR) equipment electron microscopes tissues culture labs, darkrooms and glass washing are examples of equipment and activates that must be housed in separate dedicated spaces. The glass walls may be used which allow people to be see each other, while also having their indl spaces.

Flexible engineering system- Flexible engineering services supply and exhaust air, water, electricity, voice/data, vacuum systems- are extremely important must labs they must have easy connects /disconnect at the walls and ceiling to allow for fast affordable hookups of equipment .

Separation of hot zone - This is the space way equipments emit hot air (ovens) are fume hoods etc and large amount of toxic air is exhausted. This area does not need to be aie conditioned and it reduces considerable load from HVAC system. A proper exhaust lay out supported by forced draft fresh air ventilation is sufficient.

Equipment zones- Equipment zones are a must in the initial design equipment zones are usually fitted out when the research team moves into the lab that is when the team knows exactly what will be needed to do the work.

Using the full volume of the lab space- Many labs today are equipment intensive and require as much bench space as possible using the full volume of the lab space to stack equipment and supplies can be very helpful and cost effective for over head service carriers and overhead service carriers is hung from underside of the structural floor system.

Workplace tasks that can increase the risk of exposure to nanoparticles;

- Working with nanomaterials in liquid media without adequate protection (e.g., gloves)
- Working with nanomaterials in liquid during pouring or mixing operations , or where a high degree of agitation is involved.
- Generating nanoparticles in non enclosed systems.
- Handing (e.g., weighing, blending ,sprying) powders of nanomaterials .
- Maintenance on equipment and processes used to produce or fabricate nanomaterials and the cleaning-up of spills and waste material containing nanomaterials .
- Cleaning of dust collection systems used to capture nanoparticles .
- Machining, sanding , drilling , or other mechanical disruptions of materials containing nanoparticles.

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