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The formulae $\frac{\partial \rho U_i}{\partial t}+\frac{\partial}{\partial x_j}(\rho U_i U_j)=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial U_i}{\partial x_j}\right)+g_i(\rho-\rho_0)$ *for building* $\frac{\partial}{\partial x_j}(\rho \overline{U}_i \overline{U}_j)=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial \overline{U}_i}{\partial x_j}-\rho\overline{u_i' u_j'}\right)+g_i(\rho-\rho_0)$ *state of the art* $\frac{\partial}{\partial x_i}(\rho \overline{U}_i \overline{H})=\frac{\partial}{\partial x_i}\left(\lambda\frac{\partial \overline{T}}{\partial x_i}-\rho\overline{u_i' h'}\right)$ *biomedical research facilities.*

Interstitial Spaces in Laboratory Buildings

Laboratories require extensive HVAC, plumbing, electrical and other utilities to support their environmental requirements for temperature, humidity, ventilation, pressurization, filtration, and exhaust. Systems and equipment may include air handling equipment, coils, ductwork, motorized dampers, air volume terminal units, reheat coils, HEPA filters and their housings, piping, isolation valves, test ports, BAS sensors and controls, water, waste disposal, and lab gases, electrical, IT infrastructure, and fire protection, as well as miscellaneous specialty equipment.

Key to the successful operation of lab facilities is regular inspection and maintenance of the numerous systems and components which require adequate and safe access, good illumination, orderly physical arrangement, access to controls, and clearly visible labeling, as well as the ability to isolate individual labs to enable modifications while surrounding labs remain in operation.

Also important is avoiding lab downtime and disruption to researchers by minimizing maintenance inside and in the above-ceiling space of occupied labs. Segregation of labs and researchers from maintenance activities can be beneficial to both by avoiding the use of ladders and tools around and above expensive equipment, as well as prevent or minimize physical and health risks to maintenance personnel. This segregation is especially important for sensitive, hazardous, or highly regulated program areas.

One of the best ways to provide adequate segregation for maintenance is by incorporating interstitial space in the facility design. An interstitial space with a waterproofed, walkable floor above a laboratory can provide a dedicated space for utility system components which is both isolated from the lab and enables easier, more efficient maintenance access, thus greatly reducing maintenance interference with research operations.

Advantages of Interstitial Spaces

- **Equipment access, visibility, and lifecycle cost**: Equipment in an interstitial space is generally much more accessible than equipment in a ceiling cavity. This facilitates maintenance, which will increase reliability and efficiency and can contribute to reduced operating costs.
- **Segregation of maintenance functions:** Equipment can be accessed without personnel entering or disrupting the operations of the laboratory served.
- **Reduced need for accessible ceilings:** A facility supported by an interstitial space has less need for ceiling access and can more readily accommodate a monolithic ceiling. This is especially beneficial in clean rooms and frequently decontaminated facilities.
- **Optimal location of equipment:** An interstitial space allows equipment to be near the area it serves, reducing duct and conduit runs.

Disadvantages of Interstitial Spaces

- **Increased building first costs:** Interstitial spaces add floor levels, elevator stops, an exterior wall area, and other components that increase first costs.
- **Increased building height:** Interstitial spaces increase building height, which may be an issue with zoning restrictions, interrupted viewsheds, and shading of lower structures nearby.
- **Increased systems and equipment first cost:** Localized, smaller pieces of equipment may be used in lieu of fewer pieces of centralized equipment to maximize the utility of an interstitial space.

Interstitial Space Design Recommendations

To maximize effectiveness, an interstitial space should be planned and constructed as follows:

- Interstitial spaces must be designed to support both current and planned equipment and the live load of maintenance personnel and activities.
- Interstitial floors must be concrete or another durable substrate (corrugated metal or similar uneven surface decking is not acceptable) that is appropriate for a slip-resistant, waterproof floor finish.
- Walking zones must be provided with clear head height and unobstructed floors to eliminate trip hazards.
- Interstitial floors should be provided with water leak detection systems with sensors that are strategically placed, including above critical or high value labs, as appropriate.
- Floor drains (4”) should be provided at a rate of no less than one per approximately every 2,000 sq. feet and located to be reachable from any drain valve by a 50’ hose.

Conclusion

As the complexity of research lab support systems grows to serve more sophisticated research programs, interstitial spaces are an increasingly appealing alternative to the traditional practice of using the limited above-ceiling space for most utilities. A well-designed interstitial space facilitates maintenance and segregates maintenance and research functions, both of which are highly desirable and add value to laboratory building operations.

‘Design Requirements Manual (DRM) News to Use’ is a monthly ORF publication featuring salient technical information that should be applied to the design of NIH biomedical research laboratories and animal facilities. NIH Project Officers, A/Es and other consultants to the NIH, who develop intramural, extramural and American Recovery and Reinvestment Act (ARRA) projects will benefit from ‘News to Use’. **Please address questions or comments to:** megan.teague@nih.gov