The National Institutes of Health | Division of Technical Resources | Office of Research Facilities

Design Requirements Manual **News to Use**

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

Ceiling Heights in Laboratories

DRM section 4.4.3.4 includes a required minimum ceiling height of 9'-0"and an optimal ceiling height of 9'-6" in laboratories. Although laboratories by their nature are individually planned and must respond to the requirements of the research to be conducted, good practice and long experience has proven that these ceiling heights are necessary to provide the flexibility required by evolving research programs.

Laboratories are regularly updated to reflect changes in staffing, equipment and research protocols. A new lab or major renovation should be designed to accommodate the planned use for which programming and planning is conducted, but also to accommodate future equipment and functions that can reasonably be anticipated for the space. Although ultimate flexibility and universal adaptability is an unrealistic expectation, a laboratory design is not successful if it cannot accommodate a reasonable range of upgrades and changes.

Many DRM requirements and good practices are intended to provide the design with features to accommodate future programs, equipment and protocols, even if not required by the specific program that will occupy the space at the time it is being designed and constructed. This forethought is necessary so inevitable future program changes can be accommodated without major renovations. These include:

- A flammable storage cabinet is required in every lab to allow for chemical use. (4.5.3.2)
- 42" door widths are required to allow for the installation of large equipment. (4.2.2.2)
- Lab air exchange rates are not reduced during off-hours to allow for extended operations.
- Offices floor loading is required to be 100 PSF to allow for conversion to lab. (5.2.1)
- DRM 6.2.1 calls for a 20% increase in sizing for air handling and exhaust systems. This is not a safety factor, but a future factor for expansion in research technology and changes in space usage which happens often at NIH.

This same rationale supports the requirement that ceiling heights be adequate to allow lab users wide latitude when purchasing and/or reusing equipment. Equipment should be selected based on function, value and other program considerations and not be limited by the ceiling height of the lab.

Biological safety cabinets (BSCs) are one example of a common equipment type whose selection and function may be limited by ceiling height. Two widely-used recirculating BSC units by leading manufactures are 60.9" and 61.8" tall, resulting in units that are over 8'-0" tall when installed on standard 3'-0" bases. Most BSC manufactures require a minimum of 8" clearance above the BSC for air flow, and NIH Division of Occupational Health and Safety (DOHS) required a minimum of 1'-2" above BSCs for access to filters for inspection and maintenance. Both of these units function without limitation at 9'-6" ceiling height, but have operational or installation limitations in a space with a 9'-0" ceiling height. Limitations increase further as ceiling heights decrease.

Lower ceiling heights will force restrictions on the lab user regarding the equipment selection, installation or operation. For a BSC a researcher may be limited on which unit can be purchased or the unit may have to be installed on a lower or telescoping base. Additionally, existing units may not be able to be reused.

Additional reasons for the 9'-0" ceiling height include:

- 9'-0" allows for more efficient direct/indirect pendant lighting.
- 9'-0" allows for more diffuse distribution of air, resulting in lower air velocities and more efficient distribution.
- Aesthetics and spaciousness.
- Transmittance of daylight deeper into the lab.

Conclusion

When programming a new space, whether for new construction or a major renovation, designers must consider flexibility for both the current user as well as future occupants. This includes providing adequate ceiling height, as required by DRM section 4.4.3.4. This is challenging and no space can be fully adaptable to future changes but designers must reasonably anticipate the ever changing needs of research. It is the designers' responsibility to ensure laboratory programs are not unduly limited by facility restrictions including ceiling heights.

'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/E's 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:** shawm@nih.gov

Further details on this month's topic are available on the DRM website DRM Section 4.4.3 Laboratory Finishes
https://www.orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/Pages/DesignRequirementsManual2016