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

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

Manifold Exhaust Requirements and ANSI/ASSP Z9.5-2022

Laboratory ventilation is critical to provide an environment that protects personnel from overexposure to harmful airborne contaminants generated within a lab. Many considerations (safety, flexibility, energy, redundancies, etc.) need to be evaluated in the selection, design, and operation of lab exhaust systems. Standard ANSI/ASSP Z9.5-2022 "Laboratory Ventilation" provides minimum requirements and best practices for laboratory ventilation systems. The standard also addresses enhanced energy efficiency goals, especially where there is potential to impact work, health, and safety. ANSI/ASSP Z9.5-2022 does not apply to all systems and laboratories (e.g., high containment facilities, radioisotope or explosive labs, and biosafety cabinets). This News to Use briefly compares the fume hood exhaust duct manifolding requirements and recommendations of ANSI Z9.5 to those of the Design Requirements Manual (DRM).

Manifolding Guidance and Considerations

The DRM and ANSI Z9.5-2022 permit manifolding of exhaust systems inclusive of general lab and fume hood exhaust where criteria are met. Both require each branch of manifolded chemical fume hood duct connected to an exhaust system to be equipped with flow-regulating devices. The DRM specifically requires pressure-independent exhaust flow control on each fume hood and the general lab exhaust serving each lab (7.3.3.3.B).

Manifolded exhaust systems can offer multiple advantages over individual/dedicated exhaust systems, including:

- Increased dilution of contaminant concentrations
- Lower first and operating and maintenance costs
- Decreased cost to provide redundancy and emergency power
- Fewer exhaust discharge stacks to place on a roof
- A discharge plume with enough mass to reach a plume height sufficient to avoid reentry of contaminants into the building and increase atmospheric dispersion
- Reduced required shaft space for ductwork

Manifolding can also provide for future flexibility to add or relocate fume hoods over the life of the facility, as appropriate per risk assessment. Such flexibility does require that future capacity allowance be provided for in the exhaust risers and exhaust fans capacity. The DRM does require allowance for future capacity in new laboratory exhaust air systems (6.2.1), which in part provides for allowances for future fume hoods in the labs.

The DRM and ANSI Z9.5-2022 require all exhaust air streams in a manifolded system to be compatible. ANSI Z9.5 considers exhaust streams compatible if the concentrations of flammable or explosive vapors are maintained below their Lower Explosion Limit (LEL) and the streams cannot form explosive compounds. Per the DRM, The Division of Occupational Health and Safety (DOHS) confirms air stream compatibility (6.1.22).

Separate and dedicated exhaust systems are required for several applications at NIH, like ducted biosafety cabinets, radioisotope hoods, wet exhaust, perchloric acid fume hoods and other applications as determined by risk assessment or by DOHS. While ANSI Z9.5-2022 does make certain exceptions for the manifolding of radioisotope hoods where HEPA and/or carbon bed filtration are provided between the hood(s) and the manifold, the standard further cites increased system static pressure requirements associated with filtration and the potential need for booster fans as reasons to discourage placing radioisotope hoods onto manifolded systems.

Manifolded devices, where used, can enhance energy recovery. While dedicated exhaust systems require additional and smaller heat recovery devices as well as more space and control points and higher maintenance costs, larger systems are more easily centralized and can economically provide laboratory heat recovery with fewer heat recovery devices.

Conclusion

Designers can successfully implement manifolded laboratory exhaust systems with proper hazard assessment accounting for exhaust compatibility, quantity and types of hoods, and best practices. Before designing manifolded or dedicated systems, planners should review the DRM and ANSI Z9.5-2022 and consult the Division of Technical Resources (DTR) and DOHS—and, in the case of dedicated radioisotope hoods, the Division of Radiation Safety (DRS).

Additional Information

1. ANSI/ASSP Z9.5-2022: *Laboratory Ventilation*
2. NIH DRM (Rev 1.5) 3-5-2020

'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:** mario.orellana@nih.gov