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News to Use
Design Requirements Manual

The formulae $\frac{\partial \rho U_i}{\partial t} + \frac{\partial}{\partial x_j}(\rho U_j U_i) = -\frac{\partial P}{\partial x_i} + \frac{\partial}{\partial x_j}\left(\mu \frac{\partial U_i}{\partial x_j}\right) + g_i(\rho - \rho_0)$ for building $\frac{\partial}{\partial x_j}(\rho \overline{U_i U_j}) = -\frac{\partial \overline{P}}{\partial x_i} + \frac{\partial}{\partial x_j}\left(\mu \frac{\partial \overline{U_i}}{\partial x_j} - \rho \overline{u_i u_j}\right) + g_i(\rho - \rho_0)$ state of the art $\frac{\partial}{\partial x_i}(\rho U_i H) = \frac{\partial}{\partial x_i}\left(\lambda \frac{\partial T}{\partial x_i} - \rho \overline{u_i h}\right)$ biomedical research facilities.

'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@mail.nih.gov

BSL-3 and ABSL-3 HVAC System Requirements - Part I

HVAC systems play a critical role in control of hazards in a bio-containment facility. Biosafety Laboratories (BSL)-3 and Animal Biosafety Laboratories (ABSL)-3 animal facilities shall comply with all requirements for BSL-2 laboratories and ABSL-2 animal facilities as described in the DRM Chapter 6 Mechanical Systems Design. This article includes additional requirements to be included in level-3 bio-containment laboratories and bio-containment animal facilities. Design of BSL-3 and ABSL-3 laboratories shall be reviewed and approved by NIH Division of Technical Resources (DTR) and NIH Division of Occupational Health and Safety (DOHS). This article is based on DRM Section 6.6 Biosafety Level-3 and Animal Biosafety Level-3 Bio-containment. Part 1 covers the contents up to DRM 6.6.9 Air Filtration. Part 2 will cover the remaining subjects in DRM Section 6.6.

Supply Air Systems in BSL-3/ ABSL-3 Laboratories

(1) Dedicated Supply Air Systems: To provide protection against cross-contamination to spaces outside of containment, BSL-3 and ABSL-3 laboratory spaces shall be provided with dedicated supply air systems, which do not serve any other laboratory spaces outside the containment laboratory. BSL-3 and ABSL-3 supply air systems may not be combined to a common system. Refer to DRM Chapter 7 Building Automation Systems for detailed control requirements and pressure control requirements.

(2) Independent Supply Air Terminal: In as much as possible, each room shall be served by an independent supply air terminal. This is to maintain pressure differential and isolate rooms during decontamination.

Ventilation Rates in BSL-3 Laboratories

BSL-3 laboratories shall be provided with a minimum of 6 air changes per hour (ACH). Ventilation rates in animal facilities are typically 10 to 15 outdoor ACH. This minimum air flow shall be maintained at all times, including unoccupied periods. Ventilation systems shall be designed to remove all heat dissipated by all equipment within the lab space and provide all exhaust air requirements from fume hoods, BSCs, sterilizers, etc. These ventilation rates have been established to not only provide for the safe and effective removal of potential airborne contaminants from the laboratory air space, but also for odor control and removal of animal dander.

Relative Room Pressurization

Airflow in bio-containment facilities BSL-3 and ABSL-3 shall be designed to move from "clean" areas toward the bio-containment space. The system shall be designed to maintain a negative pressure differential of 12.5 Pa (0.05 in. w.g.) between each pressure zone. Where multiple containment zones exist within the suite, sequentially more negative pressure must be established so that more contaminated rooms are placed at greater negative pressure to less contaminated rooms. Monitoring and control devices shall be provided to ensure that the pressure differential is maintained. Visual readout devices and alarm devices shall be provided at the entry to the containment space, in anterooms, and at entry to the individual rooms within the containment suite.

Anterooms

Anterooms shall be located between the BSL-3 and ABSL-3 and the clean corridor outside the bio-containment space. An anteroom provides a dedicated entry and exit for the laboratory, a gowning area, storage of supplies, etc. These anterooms are typically negative to the clean corridor and positive to the BSL-3 and ABSL-3 spaces keeping the contents in the bio-containment room from leaving that room. That is, the BSL-3 and ABSL-3 room is negative to the anteroom. The use of anterooms needs to be reviewed with DTR and DOHS.

Exhaust Air Systems

(1) Dedicated Exhaust Air Systems: BSL-3 spaces shall be provided with dedicated exhaust air systems. BSL-3 and ABSL-3 may not be combined to a common system or any other system serving spaces outside the bio-containment space. This dedicated exhaust air system shall include pressure-independent constant-volume air terminal units, roof-mounted exhaust fans (number of fans to provide N + 1 redundancy), variable frequency drives (VFD) for filter loading and/or for multiple room applications, exhaust stacks, etc.

(2) Exhaust Ductwork Materials: All exhaust ductwork shall be welded stainless steel and gastight to allow for decontamination.

(3) Independent Exhaust Air Terminal: In as much as possible, each room shall be served by an independent exhaust air terminal.

Air Filtration

(1) Supply Air: Supply air serving BSL-3 laboratories and ABSL-3 animal facilities is not required to be high efficiency particulate air (HEPA) filtered, unless specifically required per the program. If HEPA filtration is requested on supply air, it shall be reviewed by DTR and DOHS.

(2) Exhaust Air HEPA Filtration: Exhaust air HEPA filtration is recommended and each particular system/application shall be reviewed with the user, DTR, and DOHS. If HEPA filtration is not required, the exhaust air system shall be designed with provisions for adding HEPA filtration in the future.

(3) HEPA Filter Location: HEPA filters shall be located as close as possible to the containment barrier penetration. HEPA filters shall be rated for 99.99% efficiency at 0.3 microns. These filters shall include provisions for bag-in/bag-out filter replacement. HEPA filters shall be located with consideration to replacement and testing procedures. HEPA filters shall be zoned so that shut downs can be coordinated. Provide redundant filter banks to allow replacement of filters during operation.

(4) HEPA Filter Housings/Dampers: The HEPA filter housings shall be welded stainless steel construction. Each HEPA filter shall be capable of in situ decontamination and full face scanning. Bubble-tight dampers with end switches shall be used for HEPA filter isolation. Bubble-tight dampers shall be of the positive seal type with zero leakage and rated for the pressure classification of the system.

(5) HEPA filters and Specialized Equipment: Certain equipment such as a continuous flow centrifuge that gives out aerosolized air shall be protected with HEPA filters before discharging the air into the room.