Division of Technical Resources
Office of Research Facilities
The National Institutes of Health
Vol. 01, No. 23
February 2012

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 $\frac{\partial}{\partial x_j}(\rho\overline{U_i}\overline{U_j})=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial \overline{U_i}}{\partial x_j}-\rho\overline{u_i'u_j'}\right)+g_i(\rho-\rho_0)$ state of the art $\frac{\partial}{\partial x_i}(\rho U_i H)=\frac{\partial}{\partial x_i}\left(\lambda\frac{\partial T}{\partial x_i}-\rho\overline{u_i'h'}\right)$ 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: ms252u@nih.gov

Compressed Gas Systems

Compressed gas systems are a typical component of biomedical research laboratories. Specific requirements for compressed air, natural gas, specialty lab gases, and vacuum shall be verified during the programming phase of a laboratory project. Compressed gas systems may consist of a cylinder or bulk supply system, each with a separate reserve supply. Specific reserve capacities are based on estimated average consumption and vary based on cylinder-based systems versus bulk systems. Sources of local resupply are also factored into the reserve duration and capacity requirements. Point-of-use gas cylinder systems are sized in accordance with program requirements through consultation with the use group. Compressed air may be produced with compressors or cylinders. Cylinders may be only be utilized for very limited applications where provision of central compressed air would be impractical and when the condition is approved by the NIH Project Officer. Bulk supply systems shall include a telemetry system that is compatible with the various vendor suppliers utilized by NIH.

Laboratory and vivarium gas supply and distribution systems shall be completely independent of gas systems serving clinical patients. Gas system components for medical or vivarium, or laboratory use shall, at a minimum be factory cleaned and packaged as for oxygen service. Prior to operation, all gas systems shall be verified free of cross connections, pressure tested to at least 150% design operating pressure using inert gas of cleanliness and purity not less than the design process fluid, and verified of required cleanliness and purity throughout the entire system.

Primary services to each floor of a building wing shall be connected to respective supply risers, independent of other floors or building wings. Risers shall be located either inside the building wing served, or in a common area to multiple building wings. In general, unless noted otherwise, maximum velocity in distribution systems shall not exceed 20 m/s (4000 fpm), and pressure drop shall not exceed 10% for systems operating above 380 kPa (55 psi), and shall not exceed 20 kPa (3 psi) for systems operating below 380 kPa (55 psi).

An adequate number of valves shall be provided so as to facilitate maintenance; and to isolate systems for renovations and unexpected emergencies without affecting operation of adjacent spaces. Valves shall be provided at the base of each riser, at each riser connection, at branch piping to each laboratory equipment group, and at equipment requiring maintenance. Each distribution loop or double-fed main and risers shall be provided with sectionalizing valves such that a branch or portion of the piping serving an individual lab and individual floors may be shutdown without disrupting the service to the entire floor, other floors or building areas. Where valves are located above ceilings, thorough coordination of piping services shall be required to ensure proper access for valve operation.

Pressurized gases shall not be piped into a biosafety cabinet. The use of compressed gases (such as lab air) has been shown to disturb intended airflow patterns within biosafety cabinets. Fuel gas has also proven hazardous, and is generally not required or desired in bio-safety cabinets following modern research techniques.

NIH requires most pressurized gases (with the exception of fuel gas, vacuum, and general instrument air) to be provided utilizing special materials and brazing methods to maintain system cleanliness, at least equivalent to that required for oxygen service. The A/E shall specify the performance qualifications to maintain system cleanliness. Brazing criteria of general lab gases shall meet Section IX, ASME Boiler and Pressure Vessel Code or ANSI/AWS B2.2 Standard for Brazing Procedure & Performance Qualifications, both as modified by NFPA-99 or the Copper Development Association for medical gas application. Where high purity gases are required, additional specification criteria shall be provided to ensure product standards, joint quality and cleanliness consistent with the required application.

Stubouts for lab gas turrets shall be secured to structure to provide rigidity and the A/E should provide a stainless steel plate for wall-mounted turrets to protect walls from damage.

Where sufficient demand exists, central bulk gas systems (including cryogenic tanks and vaporizers) shall be provided in lieu of numerous compressed gas cylinders. Typically, this applies to gases such as carbon dioxide and nitrogen, but may vary for each project. Bulk systems shall be located in a secured area and in full compliance with NFPA standards. The specific location of bulk tanks shall be subject to NIH approval. For cases where a set contract is in place, the NIH Project Officer can advise as to the gas purveyor is to be utilized for provision and service of the bulk cryogenic tank farm, as well as how systems are to be specified for purchase or (less common) rental. Duplex vaporizers, refrigeration units, etc. should generally be provided as necessary to ensure continuous service. Stand-off warning signage shall be provided for bulk tanks with regards to safety valve/rupture disc discharge. Cryogenic piping systems shall be vacuum jacketed.

Research at the NIH has requirements for many different specialty gases, including helium, argon, hydrogen, oxygen, nitrogen, carbon dioxide, carbogen, and numerous gas mixtures of various purity. Planning shall allow for the proper storage of full and empty gas cylinders, including separate storage areas for flammable and oxidizing gases. All compressed cylinders must be secured with cylinder restraints to the building structure, toggle bolts and similar designs are not acceptable. Cylinder restraints shall be provided in storage areas, local distribution closets, and at points of use in the laboratories. Gas systems shall be designed in accordance with NFPA standards and fire codes, including provision of special gas storage cabinets, flame arrestors, and ventilation. The arrangement of specialty gas systems shall be coordinated with NIH ORF, DOHS, and DFM. Ultra-high purity gases are typically located near to the point of use, and special system materials and procedures will be required to maintain system cleanliness and gas purity.

Specific differential requirements that distinguish between medical compressed gas systems and non-medical compressed gas systems (both gas production and distribution differences) will be covered in detail in next month's edition of *News to Use*.

Further details on this month's topic are available on the DRM website
http://orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/DesignRequirementsManualPDF.htm
DRM Chapter 2, Section 3; DRM Chapter 8, Section 8