Division of Technical Resources
Office of Research Facilities
The National Institutes of Health Vol. 01, No. 42
September 2013
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 $\frac{\partial}{\partial x_j}(\rho\overline{U_i U_j})=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial U_i}{\partial x_j}-\rho\overline{u_i' u_j'}\right)+g_i(\rho-\rho_0)$ 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'.
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Piping Insulation Systems

While piping insulation may seem routine, inadequate consideration can have significant impact on research facilities. Section 6-4 of the Design Requirements Manual provides basic requirements for these systems to be used along with the substantial detailed technical guidance that is readily available throughout the facilities design and construction industry.

Appropriately applied piping insulation systems serve a variety of critical functions including thermal control vital to energy savings and efficient operation, protections of building surfaces from condensation, mold and water damage; acoustical dampening, personnel protection associated with isolation from hot and cold surfaces, and in some cases can even be used to address unique considerations such as UV damage protection and as a means of achieving cleanable surfaces where piping materials are otherwise unsuitable.

Piping insulation systems are composed of the primary insulating material, external protective jacketing, and a variety of components as required to maintain the appropriate system continuity and durability (such as insulation jacketing, coverings for the various fittings and valves, fasteners, joint and end sealing systems, and insulation support inserts). All these components help protect the insulation from crushing and maintain its useful function.

Laboratory research facilities often have a myriad of specialty piping systems of various materials which can directly influence the insulation system selected. One of the most critical considerations is confirming compatibility of the insulation inclusive of its various components and installation methods with the actual material of the piping system or application itself. Inadequate consideration can lead to failure of piping systems. For example, many insulation formulations may contain chlorides (which can cause corrosive pitting and failure of stainless steels). Some jacketing materials may contain plasticizers or other incompatible components which can induce stress cracking or otherwise be detrimental to certain plastic piping systems. Some insulation systems (such as unjacketed calcium silicate and perlite materials) are unsuitable for research areas sensitive to dust. Special cleanliness characteristics and materials are required for food processing and clean room areas to protect from potential contamination and maintain suitable cleanliness.

Where insulation systems are utilized for control of condensation, care must be applied to ensure complete and thorough insulation results inclusive of sealing of joints and terminal ends. Hangers and supports are applied on the outside of insulation to prevent breach of the vapor barrier along with use of appropriate insulation inserts. Poorly applied insulation systems can sometimes be prone to a wicking effect and once insulation systems start to get wet (whether due to condensation, leakage, or an inadequately completed system repair) damage to large amounts of piping insulation beyond the initial insulation breach can occur resulting in trapped liquid under the insulation, an undesirable condition which compromises insulation effectiveness and could eventually result in piping failure.

The DRM also maintains specific requirements for application of insulation materials. As examples, the NIH requires storm drainage systems to be fully insulated as well as portions of drainage systems which carry cold waste to an appropriate point of dilution. Insulation which can contribute dust concerns is limited with regards to acceptable locations. In the case of rainwater drains, both vertical and horizontal storm lines are insulated. The cost of insulating the small amount of vertical piping associated with rainwater leaders is not offset by the potential damage that occurs to research facilities and their piping networks due to condensation of these systems, especially during periods of renovation to a lab or floor where environmental control may be reduced in part of a facility from normal operating conditions. Storm overflow systems (which do not normally carry water) do not require insulation on vertical sections. Condensation protection associated with inadequate design and insulation application should not be taken lightly. Drippage around drain bodies (whether roof drains or even floor drains receiving cold condensate) can be significant, contribute to mold, and could even incite a loss of research, especially where a lab is directly beneath the defective condition. Poor planning of piping installations (and especially condensate receiving drains serving mechanical equipment) can result in inadequate capability to properly insulate these drains as cast in floor slabs, resulting in on-going condensation problems. The DRM plumbing chapters provide further requirements to ensure drain bodies may be effectively insulated, and it is important requirements are properly coordinated.

A variety of valves and serviceable components are installed in laboratory piping systems and in many cases continuous insulation is required to maintain system effectiveness and energy efficiency. The use of removable insulation covers is required for large valves and specialties to facilitate routine maintenance access without damage to the insulation system. In all cases insulation systems must be selected appropriate to the piping system application, intended purpose, and installation environment; whether exposed to UV light, high humidity, or in a location of potential mechanical damage or impact. In the cases of external moisture, insulation jacketing systems must be provided with an approved, fully sealed jacket. Piping systems applied in areas where the insulation could be compressed (such as walkable areas) must be sufficiently strong to withstand compressive forces. Piping in exposed materials handling areas must be fitted with suitable stainless steel or aluminum jacketing to a distance of at least 8-feet above the floor. Piping insulation in mechanical rooms less than 8-feet above the floor and where otherwise required is provided with heavy PVC or suitable metal (aluminum or stainless steel) protective jacketing. Compatible insulation inserts are required at interface with pipe hangers and supports. Insulation systems must be appropriately durable and protected from normal wear and tear which includes provision of appropriate fitting covers. While direct bury of insulated systems are avoided at the NIH, the use of approved prefabricated leak-tight systems would be necessary where such installations cannot be avoided.

Piping insulation systems must be selected with appropriate fire hazard ratings which shall not exceed 25 for flame spread and 50 for smoke developed as per ASTM E84 or NFPA 255. All components used in conjunction with insulation systems must be appropriately resistant to mold and insects. Exposed insulation should be avoided in sterile spaces, as well as animal holding rooms and BSL-3 areas in as much as possible. Where not otherwise avoidable, such insulation must be readily cleanable and not harbor insects, moisture, or vermin. Thoughtful location of piping and equipment, along with proper rough-in placement can often minimize the need for such insulation. Where required, fully sealed, hard-jacket systems including pre-insulated piping components (typically with a hard plastic or stainless surface) are available, and requirements associated with these spaces are discussed in other chapters of the DRM.

Insulation is often required to provide freeze protection; however the design engineer must carefully consider whether insulation in itself is adequate for the proposed application, and also whether piping is acceptably located in the first place. Other sections of the DRM limit piping installations within exterior walls, recognizing insulation is not a substitute for a reliable heat source or other precautions for freeze protection. Regardless of the purpose of the piping insulation system, a thorough and professional application of the insulation system is critical to its success, and must be adequately specified to be in accordance with industry standards and all manufacturers' recommendations and reviewed during facility construction. Contractor requests for any deviations / substitutions should not be permitted without prior approval from DTR.

Further details on this month's topic are available on the DRM website
http://orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/Pages/DesignRequirementsManualPDF.aspx
DRM Chapter 6, Section 6-4 Thermal Insulation Systems