Division of Technical Resources
Office of Research Facilities
The National Institutes of Health
Vol. 01, No. 21
December 2011

# News to Use

Design Requirements Manual

The formulae $\frac{\partial \rho U_i}{\partial t}+\frac{\partial}{\partial x_j}(\rho U_i U_j)=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial U_i}{\partial x_j}\right)+g_i(\rho-\rho_0)$ 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 $\frac{\partial}{\partial x_j}(\rho U_j H)=\frac{\partial}{\partial x_j}\left(\lambda\frac{\partial T}{\partial x_j}-\rho\overline{u_j' h'}\right)$ 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

## High Purity Water Systems

The quality of high purity water from a central building distribution system shall be established as a joint decision among the researchers and design team. Water quality requirements must reference an appropriate industry standard (such as ASTM or NCCLS) or be very specific as to the necessary parameters so that the system can be appropriately engineered and maintained. In making these decisions, the team must consider not only water quality requirements and the need of individual researchers to have confidence and a clear definition of the delivered water quality, but also the immediate and long term economies toward achieving and maintaining that end product and meeting the need for flexibility. The use of process terminology such as "RO" and "DI" is never adequate in itself to define required water quality.

Numerous types and combinations of water systems are installed for laboratory use, and specific applications may require use of distillation, deionization, and Reverse Osmosis (RO) technologies to achieve specific water quality requirements. A central fully circulating RO system to supply general use purified water with application of local polishing equipment at specific point-of-use areas is most commonly provided at NIH facilities. Typically, these systems are arranged to provide a medium grade (ASTM and NCCLS Reagent Grade Type III or Type II) water quality with enhanced parameters to limit bacterial colonization. Type III grade water as specified in ASTM Standard D 1193 shall be provided for heat exchangers used for steam humidification, electrically powered sterilizers, and similar applications.

Common Requirements are as follows:

1. A site-specific water supply analysis shall be prepared during the design stage to determine required water treatment.
2. Water for pharmaceutical or animal drinking water purposes shall be from completely independent, dedicated purification systems sourced directly from potable water, and not combined with other water systems.
3. The A/E shall clearly define sizing parameters of the systems including total daily consumption, peak system flow, distribution flow to each floor or zone, and maximum flow per outlet. Each floor or zone distribution main shall be field adjusted so that all research functions are satisfied.
4. Primary equipment downstream of the storage tank shall be arranged in parallel to allow for continuous supply of purified water to research spaces.
5. 254 nm UV light and submicron filters shall be provided for all systems. Additional UV light (such as 185 nm) should be provided only as needed for Total Organic Carbon (TOC) reduction, based on a more stringent required water quality parameter.
6. The distribution system shall be designed to maintain the temperature of the water under 29°C (85°F).
7. System fluid must be shielded from light with opaque materials; pH, nitrogen, phosphate and CO2 levels controlled and sanitation methods followed to preclude growth of algae.
8. Drainage systems receiving waste water from high purity water systems and production equipment shall be corrosion resistant.
9. Distribution systems shall be continuous circulating type with features to minimize bacterial colonization. A minimum velocity corresponding with turbulence Reynolds Number (Re) of not less than 10,000 is required throughout the system under all conditions, including at peak design demand. Higher scouring velocities may be required in some applications.
10. The system shall be designed to provide a minimum residual pressure of 140 kPa (20 psi) at outlets (after polishers) and maximum pressure shall not exceed 550 kPa (80 psi). Pressure requirements at polisher inlets shall be verified and can often be as much as 240 kPa (35 psi).
11. Surge pressure ratings of the system components must be considered in determining required system zoning.
12. Pressure reducing valves shall not be used in the distribution system as a substitute for multiple distribution zone pumps/ tanks, with the exception that pressure control devices shall be provided at the end of supply or end of return as required to maintain adequate pressure under varying demand conditions. The use of pressure reducing valves in these fully circulating systems can cause numerous pressure control problems and fouling issues.
13. Plastic piping may require continuous or more frequent supports based on manufacturer's recommendation.

The piping system distribution on each floor shall be independent of other floors to the connection with the main supply and return riser. Where serpentine distribution systems are utilized from one laboratory into another, they shall be arranged such that the supply and return system serves only a single floor and only a single laboratory wing prior to connecting to the main supply and return risers. For large facilities, the system shall be further segregated to facilitate shutdown of services by corridor or groups of laboratories to minimize potential disruption during future modifications. Direct return arrangements consisting of a parallel supply and return main with a branch takeoff from both the supply and return main to serve each laboratory shall be considered to allow for individual shut-down, reduced branch pipe sizing, and maximize future flexibility. Where recirculating faucets are required, direct return arrangements shall be utilized to provide a connection point for return water flow. Each connection to the return main shall be provided with a balancing valve or engineered flow restrictor and appropriate flow meter.

Equipment and piping materials must be carefully selected for compatibility with the degree of water purity required. The DRM provides guidance as to acceptable materials. It is especially important that system installers are properly certified in pipe joining technologies and that all fusion equipment is calibrated, quality control strictly maintained, and systems properly tested.

Further details on this month's topic are available on the DRM website
http://orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/DesignRequirementsManualPDF.htm
DRM Chap. 8, Sections 8-4.