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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 $\frac{\partial}{\partial x_j}(\rho\overline{U_i}\overline{U_j})=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial U_i}{\partial x_j}-\rho\overline{u_i'u_j'}\right)+g_i(\rho-\rho_0)$ 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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Animal Drinking Water - Part 1

The type and selection of Animal Drinking Water (ADW) system (whether central bottle or packet fill, piped distribution, or pre-packaged water) is a significant program decision that must be made through consultation with the program veterinarian, principal investigator, and other representatives of the Animal Research Facility (ARF) use group. Bottle or packet fill systems may be advantageous for limited program areas (such as barrier facilities, high containment, and areas where risk of flooding of cages may be of high concern), however such arrangements can be labor intensive, provide a non-continuous supply and may not be ideal for many programs. While the use of automation can greatly reduce labor, piped distribution of ADW to each rack is typically preferred for large facilities (as well as for applications with non-human primates and large animals) and can be advantageous by reducing risks of injury to personnel and on-going labor costs associated with filling, husbandry, washing, and disposal. Regardless of method of delivery, water quality is always a critical consideration.

The minimum standard for makeup supply to ADW systems is potable water in conformance with the Safe Drinking Water Act (SDWA), 40 CFR Part 141, www.gpo.gov; AAALAC Guide www.aaalac.org. However even water that is deemed potable for human consumption will typically require additional treatment to render the water consistently suitable for various animal models in the biomedical research program, and to minimize risk of unacceptable contaminants and support stability of water quality.

Minimization of research variables is a key consideration in designing ADW systems and directly influences the types of systems utilized, including the need for water treatment. Tolerances of the research model to variability in the drinking water supply can be a significant concern, especially where such variables could pose a risk of achieving validatable/ reproducible results or result in loss of extensive, long-term research. Even where water supplies to systems start out as potable, it must be recognized that the characteristics of incoming water supplies can be subject to a range of variations. For example, municipal supplies are often subject to routine seasonal source water changes, unforeseen backflow or contamination (such as from a broken water main), normal changes in treatment processes (such as residual disinfectants, i.e. chlorine vs. chloramines, flocculants and other changes of treatment approach.); as well as introduction of contaminants upstream (fluxes, plasticizers, or even ionic or organic contaminants). In many cases even water supplies that are potable and in conformance with the SDWA (and therefore have maximum contaminant levels safe for human consumption) may have contaminant levels inappropriate for research applications, or may lose potability during distribution.

The use of potable water with an appropriate treatment train (typically activated carbon) followed by Reverse Osmosis (RO) is required for a majority of applications (along with appropriate provisions for water turn-over and microbial control). Such arrangements provide stability of source water with substantial reduction of ionic, organic, and microbial contaminants, as well as control of particles and colloids that can proliferate contamination. Make up of ADW from laboratory water or house purified water is not acceptable (even with downstream treatment) and could pose unacceptable risks. Both lab water systems and house purified water systems (i.e. RO/DI etc.) are subject to potential backflow (whether microbiological or chemical in nature) and in cases of house purified water systems, are also subject to routine maintenance shutdowns, increased risk of microbial contamination, fungi, algae, and even cyanobacteria. Such systems require routine sanitizations, and the sanitization process itself could pose risk to the ADW. Consequently and to ensure appropriate control for the critical research under the animal research facility program, the DRM mandates water systems serving ADW source to be completely independent of other systems, fed directly from potable water.

In the pretreatment train, activated carbon systems must be conservatively sized (series arrangements are recommended) for chlorine and chloramines, and should be routinely replaced. Quality RO membranes (typically thin film such as polyamide) are most often recommended. Provision of adequate water storage volume can be critical during an emergency or malfunction, and the reliability of upstream water supply, program and maintenance SOP's, and even location of the facility can influence storage tank sizing. Tanks should typically provide 48 hours of peak demand, and the use of duplex tanks (each sized for 24 hours) is recommended. Systems should be designed to minimize plausible risks of failure, and redundant distribution pumps are required. Treatment systems supplying the tanks should be able to do so in not more than 3 hours, and caution must be applied to consider the impact of large tanks on microbial control. Tanks should include a hydrophobic vent filter to reduce potential contamination.

Treatment and distribution systems must be on stand-by power and appropriately monitored to preclude unplanned disruptions and immediately alert of equipment or distribution failures. An appropriate disaster mitigation SOP should be in place to address system malfunctions or catastrophic loss of facility water supply. The use of automatic monitoring reporting to the appropriate staffed ARF monitoring system is typically required. Examples of parameters that should be monitored include make up water supply flow/pressure, RO system operation (typically reject percentage) and failures, ADW storage tank level, distribution system flow meter (for circulating systems) or pressure monitor (for flushing systems), proportioner chemical Oxidation Reduction Potential (ORP)/pH/dissolved ozone etc. (as applicable), distribution system water temperature, and pressure/flow monitoring of individual PRV/flush stations.

Next month's article will discuss ADW distribution, system microbial control, rack flood prevention, and related general requirements.

Further details on this month's topic are available on the DRM website
http://orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/DesignRequirementsManualPDF.htm
DRM Chapter 8, Section 5