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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* $\frac{\partial}{\partial x_j}(\rho U_j U_i)=-\frac{\partial P}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\frac{\partial U_i}{\partial x_j}-\rho\overline{u_i u_j}\right)+g_i(\rho-\rho_0)$ *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'.
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Animal Drinking Water - Part 2

Maintenance of water quality and minimization of potential cross-contamination are significant considerations in the design of Animal Drinking Water (ADW) and are factors in the selection and arrangement of the treatment/ production/ distribution as well as systems operation and maintenance. Once water has passed through the carbon beds and subsequent RO, residual disinfectants from municipal potable water will have been removed leaving the system especially prone to microbial proliferation due to temperature, low flow, and the general nature of ADW distribution arrangements. Water is often acidified with USP grade sulfuric or hydrochloric acid or chlorinated as a means of microbial control, with acceptable chemical residuals determined through consultation with the program as appropriate to the research models prior to selecting system materials. The potential of disinfection by-products (DBP's) should be considered as may be influenced by the characteristics of the on-site water supply and selected microbial control method. Each ADW system should include an appropriate chemical proportioner with automatic injection to facilitate normal water treatment and routine sanitization, except where alternative routine microbial control protocols are utilized (such as active monitoring through SOP's to initiate frequent chemical sanitant, or periodic in-place or portable ozonation or heat methods which may be desirable for some applications where distribution of chemically treated water is undesirable). Where chemical proportioners are utilized, they must include fail-safe arrangements to monitor and preclude over-dosage. The use of 254nm UV and post-UV submicron filtration is recommended to reduce microorganisms and organic matter entering the distribution system post-production, though while critical for recirculating systems; UV does not provide residual protection.

A water quality monitoring plan which includes routine monitoring of microbial contaminants should be followed and will typically include monitoring of endotoxin (to provide a rapid indicator of system microbial condition -typically LAL or gel-blot), total heterotrophic plate count and/or periodic epifluorescence microscopy, or a number of other methods with samples taken at sufficient locations to provide appropriate representation of water quality. Acceptable levels of contaminants (whether chemical or microbiological) will be determined by the program but in no case should exceed levels acceptable for potable drinking water. Routine sanitizations are typically accomplished through injection of chemical sanitant (products such as hydrogen peroxide/ peracetic acid preparations, hyper- chlorination, or use of intermittent ozonation or heat); all of which require disconnect of racks during the process. Individual manifolds should be sanitized through a manifold flush station. It is important to maintain routine changes of the carbon cartridges serving the production train as such beds can be a haven to microorganisms.

In selecting wetted materials, consideration of chemical leaching, sanitization method compatibility, joint method, susceptibility to light infiltration (which can promote growth of algae), and durability must be evaluated. Even where systems are acidified or chlorinated, systems must be arranged and selected of materials to facilitate effective periodic sanitizations. The use of 316L clean joint stainless steel is recommended for most systems, but often unsuitable for hyperchlorination. Varying plastics, (including PVDF, PVC's, and pigmented IR fusion copolymer polypropylene) may also be acceptable, each with advantages and disadvantages dependent upon application. While PVC's may offer advantages of easy repair, unless low extractable PVC material is utilized, the potential elevated levels of leach out associated with common PVC/CPVC compounds and the solvent cement process throughout the initial months or year after start-up should be considered by the program along with particular attention to the selection and sufficient curing (at least 24 hours) of solvent cements to reduce such contamination. At a minimum, all components within the waterway (including elastomers) should be non-contaminating, system sanitant resistant, FDA compliant for food contact, including NSF-61. Natural rubber is avoided. Piping distribution must stand off from vivarium walls to promote cleanability, be adequately durable, located out of reach of animals (especially NHP's) and be protected from other potential damage (such as during rack movement).

Distribution pressures must be controlled as appropriate to the individual species and should be locally adjustable. The arrangement of system zoning and cross contamination control provisions between program areas, as well as flexibility to accommodate varying species and research models with their unique water quality and pressure requirements for each room or zone, shall be evaluated with the program prior to design. System zoning shall allow for independent isolation of the system to manageable sections without affecting zones on other floors, building wings, or other program areas. Distribution systems must be arranged to ensure either continuous circulating flow of the supply and returns piping mains with supplemental flushing of individual rack manifolds or rooms branch lines, or to provide for complete automated flushing of the entire system including individual rack manifolds. After the supply drop to individual rack manifolds, the manifold should flush to a room or individual manifold flush connection such that there is no distribution of water past drinking water nozzles from one rack manifold to the supply of the next manifold or room. Common systems shall not serve across higher biosafety levels, and appropriate means of cross-contamination control shall be considered by the program dependent upon application or risk (for example barrier facilities). Multiple zones shall be provided with dedicated PRV stations for each room to permit program flexibility, except that a single PRV station may serve multiple rooms housing the same species within the same suite where pre-approved. Systems shall be arranged to limit dead legs and accomplish complete flushing and turn-over of the system water contents at least daily, with an indirect discharge to an appropriate interceptor through an air-gap (typically a sink within the holding room), flush main to a remote receptor, or trough drain serving the space). Flushing flow rate must be at least 3 to 6 FPS to achieve adequate scouring efficiency.

Rack flooding can cause significant loss of research, whether due to animal drowning or thermal effects. Consideration during planning can minimize these risks and should be discussed during facility design. Cages may be fitted with screened drain openings and piped gutter systems, specific nozzle types may be selected to reduce flood risk, and automatic systems may be omitted in certain areas for areas deemed of special concern.

Precautions must be taken during construction to prevent contamination or establishment of biofilms prior to occupancy and ADW systems shall be commissioned, flushed, sanitized, and water quality comprehensively tested by qualified labs to ensure proper operation prior to use.

It is especially important that designs be reviewed and approved prior to issuance for construction, including where systems are documented for design-build or vendor construction.

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