

The formulae $\frac{\partial \rho U_i}{\partial x} + \frac{\partial}{\partial x_j} (\rho U_j U_i) - \frac{\partial \tau_{ij}}{\partial x_j} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial U_i}{\partial x_j} \right) + g_i (\rho - \rho_s)$ for building $\frac{\partial}{\partial x_j} (\rho U_j H) - \frac{\partial \tau_{ij}}{\partial x_j} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial U_i}{\partial x_j} - \rho \overline{u_i' u_j'} \right) + g_i (\rho - \rho_s)$ state of the art $\frac{\partial}{\partial x_j} (\rho U_j H) - \frac{\partial \tau_{ij}}{\partial x_j} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial U_i}{\partial x_j} - \rho \overline{u_i' u_j'} \right)$ biomedical research facilities.

Equipment Schedule: DRM Appendix G

During the programming and subsequent phases of any laboratory project it is essential to properly document the equipment that will be used in the lab in an Equipment Schedule. Equipment has a major impact on the design of any lab, and will affect all aspects of the design, including but limited to:

Space: Adequate space must be provided for equipment, including space for operation and ancillary components. Space must also be adequate for installation, removal and maintenance.

Layout: Equipment must be located in an arrangement that is safe, and which promotes an efficient sequence of operations. The most hazardous or sensitive equipment is generally located farthest from the entrance.

Utilities: The quantity and locations of power (normal, uninterrupted, emergency), piped services and other utilities must be adequate to support the planned equipment, and to provide a degree of flexibility for additions and upgrades.

Air Supply and Distribution: HVAC systems must be designed to dissipate equipment heat load and to provide exhausts, laminar flow and other specialized equipment requirements.

Cost: Equipment is a major cost of any project, even if the equipment is existing. Existing equipment must be moved and may have to be installed by the contractor, calibrated and certified.

Process

The programming process must include equipment planning. A first step is a survey and inventory of the equipment currently used which will be moved or duplicated in the new space. Information collected includes make and model number, size and clearances, utility requirements and all other parameters required for equipment installation and operation. A next step is the selection of new equipment. Discussions with users must include all anticipated equipment as well as potential future equipment acquisitions or upgrades. It must be acknowledged that equipment and processes evolve, so selection of equipment may involve assumptions. It is good practice to develop a preliminary equipment list early in the programming process which is updated and revised as more information becomes available. Knowing that additional changes are inevitable, the construction documents should not be designed overly proscriptively to specific equipment, but should include factors that allow a degree of flexibility to allow for equipment substitutions and additions. Small, plug-in, benchtop equipment is usually not an important factor and may not have to be included in equipment planning if adequate bench space and electrical outlets are provided.

Key Parameters

In order to design the laboratory to accommodate equipment key parameters must be obtained and documented. The level of detail will vary by the complexity of the equipment, and should be determined by the project. Typical parameters for each piece of equipment include:

- **Make and Model:** The specific make and model should be provided for existing equipment and for new equipment, if known. For equipment with many similar manufacturers and models (refrigerators, for example) a 'basis of design' model should be selected for planning purposes.
- **Quantity:** Some equipment may be needed in quantity due to capacity, usage or the need for redundancy.
- **Dimensions:** Required equipment dimensions (width, depth, height) in metric or imperial, following project requirements (See Appendix E, A-E Submission Requirements). Dimensions should include clearance for air circulation, opening of covers and doors and all other space required for installation, operation and maintenance.
- **New or Existing:** determination of whether equipment exists or will be purchased for the project.
- **Responsibility for Furnishing and Installing:** Documentation of whether the equipment is contractor furnished (CF) or government finished (GF), and contractor installed (CI) or government installed (GI). Generally equipment which is hard-connected is contractor installed, and equipment which is built-in is contractor furnished.
- **Power Requirements:** Electrical connection requirements, including volts, phase, wattage, receptacle type and emergency.
- **Heat Output:** Heat generated by the equipment, in both standing and running conditions.
- **Special Requirements:** Include any special or unusual parameters which could impact the placement, connections, installation or operation of the equipment. These vary widely and can include weight, vibration production or sensitivity, hazards, connections to building mechanical or utility systems, special environmental conditions, the need for ancillary or support equipment, and required adjacency to other equipment or laboratory component.

DRM Appendix G

Appendix G is a sample Equipment Schedule. The Schedule contains a level of information appropriate for many lab projects. Depending on the complexity of the project the A/E may simplify or expand the Schedule as appropriate, adding columns to included parameters important for the specifics of the project and its equipment. The Schedule is provided as an example, but it does not have to be used; the A/E may use a different format or layout that they prefer if it contains the requisite information.

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Further details on this month's topic are available on the DRM website

<https://www.orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/Pages/DesignRequirementsManual2016>

DRM Appendix G