Division of Technical Resources
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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'.
Please address questions or comments to: ms252u@nih.gov

Facility Design Criteria for Electron Microscopes – Part II

March News to Use provided general design criteria and specific criteria for Electron Microscopes. This News to Use will provide specific criteria for temperature and humidity control, airflow across the column, control of air pressure changes, vibration considerations and acoustic noise.

Temperature and Humidity Control and Airflow across the Column

- Keep temperature changes to less than 0.1 degree Celsius per hour.
- Keep airflow across the column to less than 20 feet per minute. The airflow across the column may vary depending on the type and sensitivity of the equipment. Perform a risk assessment and set the airflow rate based on the results.
- A rough estimate of the heat output of a microscope (power supply and electronics rack) is 5kW. Confirm the thermal load from the vendor before the design.
  - Separate (and cool independently of the column and microscope) cooling for power supply and electronics racks.
  - Construct a shelter surrounding three sides of the column to prevent drafts blowing across the column.
  - Wrap column in bubble wrap or neoprene to dampen thermal fluctuations.
  - Radiant cooling system to control temperature is recommended and is an inexpensive retrofit used in conjunction with a forced air A/C system to control humidity.
  - To retrofit a forced air cooling system:
    - Add a reheat coil with feedback from the thermo-coupler near the column to reduce temperature fluctuations.
    - Place the inlets away from the column to avoid unacceptable currents.
    - Diffuse the air flow by installing a perforated ceiling tile with hundreds of small holes across the tile (but with none directly above the column) and arrange tiles to produce laminar flow.
    - A less expensive solution is to add a duct sock that is tightly sealed to the air inlet.
    - Minimize the cycling of cooling.
    - Minimize air supply to the instrument room to avoid sudden fluctuations in temperature.
    - Use the most accurate temperature probes.

Note that modern electron microscopes except monitors are usually continuously powered to maintain the stability and alignments. Monitors are routinely powered off (or set to energy saving mode) unless they have been replaced with the cooler flat-screen models.

Control of Air Pressure Changes

Pressure changes can cause blurring or deflection depending on the instrument. Air pressure changes of 1 Pa can result in stage deflection of about 0.1nm. Barometric pressure changes due to weather or opening an outside door in the building can affect the microscope room pressure.

To maintain pressure stability, recommend air pressure changes to less than a few Pascal per minute.

Vibration Considerations

Vibrations in a floor supporting the microscope may be caused by traffic on roads, rails or nearby machinery or movement of the building itself.

- The vibration criterion (VC) will be based on VC-D with the maximum vibration of 6 micrometers/sec, RMS. as measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz.
- In order to reduce vibration to a minimum, support sensitive equipment on an isolated high mass platform designed to have a resonant frequency far below any internal resonance characteristics of the equipment itself.
- Surrounding background vibrational noise, or the "natural frequency" of a facility, should lie well above the resonance frequency of the high mass platform.
- Recommend the installation of the microscope on an isolated high-mass concrete slab on bedrock or appropriate engineered fill, with a gap between the concrete slab and the surrounding structure. The gap may be filled with a closed cell neoprene rubber gasket which does not transmit vibrations.
- The walls should be isolated from roof and the floor slab.

Acoustic Noise

In order to reduce the entrance of noise and to dampen noise in the room recommend the following:

- Achieve Noise Criteria NC-35 rating;
- Remove noisy microscope equipment (such as pumps, power racks, and compressors) to a different room or to a dedicated room;
- Another option for noise reduction is to install acoustically "dead" walls, which may be achieved through curtains or cloth covered fiberglass sound absorbent tiles with a sound absorbent factor of 1.15.

Room Layout and Architectural Features

High resolution instrument room layout will vary depending on the type and sensitivity of equipment specified and site constraints.
The electron microscope suite should include at a minimum:

- Separate room for heat, vibration or noise generating equipment associated with the electron microscope.
- Vibration isolation slab on grade for electron microscope.
- Appropriate shielding. Electromagnetic (EM) interference cancellation may require EM cancelling systems or shielding depending on the requirements of the microscope and building conditions.
- Dual pane windows for better sound isolation.
- Physical separation from busy corridors and other sound and vibration generating areas.

Other systems to consider include: Cooling Water (supply and return); House Vacuum; Dry N2 gas; Fire Alarms; Fire Sprinklers; Emergency Light; Oxygen Sensor; Telephone; Internet; and Instrument (ground) Shielding.

Further details on this month's topic are available on the DRM website
http://orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/Pages/DesignRequirementsManualPDF.aspx
DRM Appendix J