Division of Technical Resources | The National Institutes of Health | Vol. 01, No. 76
Office of Research Facilities | July 2016

News to Use — Design Requirements Manual

The formulae for building state of the art 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: shawm@mail.nih.gov

Electrical System Neutral and Ground

One of the least understood and, often, misunderstood aspect of the electrical system is electrical system grounding. One of the reason confusion arises is due to use of interchangeable terms of Neutral and Ground. A Neutral represents a reference point within an electrical distribution system. Neutral conductors connected to the reference point should, normally, be noncurrent carrying conductors, sized to handle momentary faults (short circuits) occurring in electrical equipment. A Ground, on the hand, represents an electrical path, normally designed to carry fault current when an insulation breakdown occurs within electrical equipment. This means that Neutral can be grounded, but Ground is not neutral. In a 3 phase low voltage distribution system, the preferred installation consists of five wires i.e. 3 phase conductors, a neutral conductor and a separate ground conductor.

Introduction of non-linear loads, such as computers, electronic lighting, TVs, VCRs and other switch-mode power conversion equipment, created 3rd harmonics overloading of the neutral conductor, prompting the need for proper grounding of the equipment as well as proper sizing of the neutral conductor.

As the characteristics of electrical equipment changes from linear to non-linear, the nature of grounding expands from the task of insuring the safety of personnel to insuring that one type of electrical equipment does not interfere with other types of electrical equipment. Lowering electrical system impedance is critical for proper functioning of electrical equipment. To lower system impedance, the NIH Design Requirements Manual (DRM) requires that when a large percentage (50% or more) of the load is non-linear, provide the following:

(1) Branch circuit panelboards with 200% neutrals.
(2) Full-size individual neutrals for each branch circuits.
(3) Oversized neutrals for shared circuit homeruns for modular furniture.

Nonlinear equipment causes rapid changes in voltage and current while transferring energy from the distribution system to the equipment load, creating a phenomena similar to a small radio transmitter. As a result, we need to address Radio Frequency Interference types of electrical noise to other equipment. Usually other equipment, in metallic enclosures is not affected by these small radio-type signals; however, some equipment circuitry may be affected.

The typical solution is to add RFI filters in the incoming power lines to the offending equipment. Proper functioning of these RFI filters requires proper grounding. The normal grounding practice is to connect the RFI filters to same ground point used by the equipment causing the condition when a high frequency, low impedance path to ground exists. Otherwise, it may be necessary to install a separate conductor back to the Neutral reference point in the electrical system.

Unfortunately, too many variables exist within any grounding system. Proper sizing of conductors, use of RFI filters, and installation of low impedance grounding path are critical to suppress electrical noise. The general practice should include discussions with equipment suppliers to determine if and what types of electrical interference affect their products.

Further details on this month's topic are available on the DRM website
http://orf.od.nih.gov/PoliciesAndGuidelines/BiomedicalandAnimalResearchFacilitiesDesignPoliciesandGuidelines/Pages/DesignRequirementsManualPDF.aspx
DRM Chapters 10 and 6 Sections 10-6 and 6-2.