# DESIGN GUIDELINE 230060
# MECHANICAL SOUND AND VIBRATION CONTROL

## General

Sound and vibration shall be carefully evaluated on all projects, for both interior and exterior impacts.

## Related Sections

**U-M Design Guideline Sections:**
230010 – HVAC Design

**U-M Master Specification Sections:**
220548 – Vibration Control
230593 – Testing, Adjusting and Balancing

## Sound Design Requirements

### Interior Sound Impacts

Typical space noise criteria levels are listed in Design Guideline 230010. For NC/RC levels not listed in that section, levels shall not exceed those listed in Chapter 46 of the ASHRAE HVAC Applications Handbook (most current addition).

NC/RC levels are a general design criteria only. Spaces where sound is of a special concern, such as large lecture halls, theaters, etc., shall be evaluated using more rigorous criteria based on recognized guidelines. Criteria should be reflected in Design Intent Document and/or in Construction Documents.

For new buildings or major renovations, a study by an acoustical consultant should normally be performed. This study should determine expected sound levels for major space types and, where expected levels exceed established criteria, provide project specific alternative solutions. All significant sound impacts shall be evaluated, not just from mechanical and electrical equipment sources; for example, the impact of a large number of people walking on a hard surface that is located over a more sound sensitive space. For renovation projects, the study should include sample testing of existing areas.

For sound control, low cost solutions are the preference in lieu of more conservative solutions, in particular for spaces without special sound concerns. For instance, the use of acoustical flex duct (not to exceed 5') is preferred over equipping all VAV/CAV boxes with sound attenuators. Noise generating equipment should be located outside of more sensitive areas, i.e. over corridors, when possible, etc.

Duct sound liner shall not be used unless protected by a solid or perforated metal liner. Sound liner protected by perforated metal shall in addition be wrapped with an approved flexible liner. Unprotected duct liner may only be used for short transfer duct applications.

Schedules shall indicate the maximum NC levels (sound power) for terminal boxes, diffusers, lab air valves, and similar equipment. Fan and sound attenuator schedules shall indicate the sound power and attenuation levels required in each octave band. Sone levels may be listed for small fans in lieu of octave band levels.

For new buildings or very large renovations, sample sound readings (NC and dBA) for typical spaces should be taken on a post construction basis, to verify if NC levels were achieved. This testing can typically be done by the Test and Balance contractor. More extensive post construction evaluation tests should normally be performed for areas with very special sound concerns, eg. theaters, auditoriums. Further, if these special spaces were renovated, pre-construction sound readings should be taken for comparison to post construction sound levels.

Floating floors should be considered for major mechanical rooms located over sound sensitive areas.

### Exterior Sound Impacts

All new construction shall be assessed for exterior sound impacts on surrounding neighborhoods. The normal UM policy is that buildings are not to contribute a perceptible increase to the ambient noise environment. In terms of human perception, a 3 dB change (or less) would typically be considered imperceptible. However the specific characteristics of exterior sound sources shall also be considered, i.e. frequency and reverberant effects, time of day cycling, etc. In no event shall City of Ann Arbor noise guidelines be exceeded. For new buildings or improvements to existing buildings involving the addition of significant sound generating mechanical or electrical equipment to the building exterior, a study by an acoustical consultant should normally be performed. Such studies shall assess sound impacts and, where required to meet the above criteria, provide alternative project specific solutions. Such a study would typically require pre-construction field measurements of existing ambient noise levels to set baselines.

## Vibration Design Requirements

Vibration impact and control shall be evaluated for specialized fixed equipment, such as MRIs, as well as building mechanical and electrical equipment.

### Vibration Criteria

The maximum allowable vibration levels in the horizontal, vertical, and axial planes for building equipment shall be specified as follows:

| | |
|---|---|
| Pumps | 0.13 in/s RMS |
| Centrifugal Compressors | 0.13 in/s RMS |

| | |
|---|---|
| Fans (all types) | 0.09 in/s RMS |
| Chillers | mfg. recommendation. |

Specify that all equipment over ½ HP be field vibration tested. Specify that equipment found to exceed the allowable vibration levels be repaired and retested until within allowable limits, at no cost to the owner.

**Vibration Isolation**

The minimum vibration isolation required for mechanical and electrical equipment shall conform to the Selection Guide for Vibration Isolation, ASHRAE HVAC Applications Handbook (most current addition).

For spaces with special vibration concerns, eg. clean rooms, theaters, certain medical or research equipment rooms, etc., an acoustical/vibration consultant should be utilized to assess impacts and recommend solutions. During project programming, ambient vibration levels should be recorded if vibration sensitive equipment is planned for buildings adjacent to significant vibration sources, i.e. heavily traveled roads. The results of these tests may dictate that special isolation be provided to accommodate sensitive equipment.

Unless specifically waived by the U-M design coordinator, large pumps and fans installed above grade shall be specified with inertia bases.

Avoid the blanket specification of expensive spring type vibration hangers for piping and duct. Typically when flexible connectors are employed at duct/pipe connections to equipment and the equipment base is properly isolated, spring hangers are only recommended for the first two hangers.