NOISE AND VIBRATION CONSIDERATIONS FOR DATA CENTERS AND IT FACILITIES

BY ETHAN BRUSH

Information technology is a crucial aspect of virtually all business and organizational operations around the world. The number and size of data centers to support these operations have been rapidly increasing in recent years. Firms must design and construct spaces that provide suitable environments for the data center equipment.

When in proximity to other human activities, the design of data centers must also consider the environmental effects produced in surrounding areas. For instance, large amounts of heating, ventilation, cooling (HVAC) and power are needed to keep the massive amounts of electronics operating together smoothly. The noise and vibration produced by the supporting mechanical and electrical systems should be considered in the design and maintenance of the facility. Failure to do so could result in not meeting project noise requirements or in receiving complaints from building occupants.

So, what steps can be taken to mitigate unwanted noise and vibration from data centers?

Nature of data centers

Data centers are facilities that house computer hardware that manages operational information for companies and their clients. They perform what is commonly referred to as mission-critical functions because if they become unavailable, even for a brief period, operations may be impaired or stopped completely. Recently, a major airline was forced to cancel flights throughout the world due to an outage at one of its data centers.

Data centers often exist as standalone facilities whose sole purpose is to provide a company's information infrastructure from one large central location. They also exist as smaller installations co-located within a multitude of facilities to provide the same functions on a smaller scale. These smaller data centers may support any number of institutions such as hospitals, universities or smaller companies.

In recent years, the size of computer hardware components has decreased, allowing for a higher density of equipment in a space to keep up with the demand for more data storage. Consequently, this often increases the energy required for powering and cooling the equipment. Whether in a standalone building or part of multiple facilities, it's important to address noise and vibration considerations when planning for and operating data centers.

Noise and vibration sources and options for mitigation

NOISE AND VIBRATION PRODUCED BY DATA CENTERS

Many components of building heating, ventilation and cooling systems should be considered as likely noise and/or vibration sources. The air needed to cool computer equipment will need to pass through inlet and outlet vents, and through associated ductwork, creating noise concerns at high-flow velocities. Large fans with rotating motors will be needed in air-handling units, as well as compressors and chiller towers to provide air conditioning. Standby generators are often employed as well to mitigate the risk of the loss of power.

NOT EVERY FACILITY IS THE SAME

The level of concern for noise and vibration is not the same for every facility. For example, a university science or hospital building may house powerful microscopes and other equipment that are very susceptible to relatively low levels of noise and vibration. In this case, significant mitigations in the design of data center support equipment would be required.

A less extreme and more common example is data centers in office buildings, where noise and vibration concerns could disrupt office activities. Noise from associated HVAC equipment can make it difficult to communicate, especially in conference rooms, and continuous perceptible floor vibrations can be quite bothersome to employees at their desks.

For standalone data center facilities, there may be no sensitive noise or vibration receptors inside the building except for the hardware and infrastructure equipment, which generally have higher tolerances than most human uses. Here the largest concern is about avoiding outdoor noise from equipment that may exceed local regulations or be bothersome to neighbors. In fact, community noise should be a concern for any data center facility with rooftop or outdoor HVAC components.

MITIGATION METHODS

Facility managers have an important role in managing equipment maintenance and upgrades for data centers, which is why it is important to consider various methods to lower noise and vibration for sensitive receptors in the building or the surrounding area.

Specifiers can treat noise and vibration at the source by choosing and designing for quieter equipment. Slower fans speeds and higher-quality balance requirements are examples of how to lessen noise and vibration emissions at their source. FMs can also address these challenges via the path that noise or vibration travels to a sensitive receptor. They can apply this several ways, such as by adding resilient mounts and fasteners to everything from large reciprocating engine generators to the smaller pumps, fans, pipes and ductwork.

This can also mean housing generators and other loud equipment inside acoustic enclosures or behind sound barriers. Silencers affect the path of noise through airflow chambers, reducing the amount of sound at the inlet or outlet orifice. Most facility managers are probably generally aware of the products and designs for these mitigation methods as they are used in virtually all other HVAC systems that serve general building use. The important takeaway is that noise and vibration concerns should be addressed as early in a data center project as possible. Many of the methods for mitigation might require shutting down the data center temporarily if installed retroactively, which can be costly and difficult to manage.

Project examples

DATA CENTER IN AN URBAN ENVIRONMENT

In the financial industry, the proximity of a data center to stock trading activities is of utmost importance. The enormous amount of data that is transferred daily means that even though it is moving at the speed of light, proximity to the financial markets ensures the information reaches its destination as quickly as possible. A data center performing this function thousands of miles away would not have this benefit. Therefore, many data centers are installed and planned in urban settings.

A project in New York City planned for the use of its own combined heat and power generation at its facility in support of high-density data center operations. The benefit of generating electricity onsite can be a financial decision as well as a way to mitigate the risks associated with relying solely on commercial grid power.

In this case, the power plant was to employ two combustion turbine generators on an upper floor of a multi-story building and three large diesel generators in the sub-basement. Associated radiators and air cooling towers on the rooftop of the building were also part of the design, as well as air inlet and exhaust louvers at various locations of the building façade. The project was required to meet New York City noise limits at the nearest residential and mixed-use properties, which were very close to the existing building.

The project team developed a sound model to address each source of noise to the community. The analysis of air inlet and exhaust systems identified the need for significant mitigation and several sets of silencers were included in the ventilation design. The two combustion turbine generators on the upper floors were required to be housed inside acoustical enclosures. Analysis of the rooftop cooling towers estimated that their noise contributions would be negligible and that the radiators could be made compliant by using reduced-noise fans.

There were potential sensitive receptors of vibration in addition to noise within the building and adjacent properties, so a robust vibration isolation plan was also specified throughout the project. The generators, cooling towers, fan motors and even chilled water pipes were attached to the building and foundation through resilient mounts and fasteners.

STANDALONE DATA CENTER NOISE MITIGATION

A provider of high-volume internet-based transactions planned a major addition to an existing data center in a remote location. At the time of the construction of the original facility, it was not near any sensitive receptors (residences, hotels, schools, etc.). However, an adjacent property was expected to be developed in the future and new city noise regulations were to be imposed on the expanded facility. The risks of not addressing a noise regulation could result in fines or the requirement to install costly retroactive mitigations.

First, the team developed a sound criterion for the facility using baseline ambient measurements and the anticipated new local noise regulations. Predictive modeling of sound levels based on manufacturer's information aided in the selection of appropriate equipment and mitigation treatments to adhere to the project goals. The team conducted a post-construction sound survey as part of the commissioning of the newly upgraded facility. The sound levels observed at nearby community property lines demonstrated the project's compliance with the established criterion.

STANDBY GENERATOR FOR A DATA CENTER IN A CORPORATE BUILDING

A global investment company sought to reduce the risk of downtime to its servers by installing a backup diesel electric generator on the building rooftop. Executive suites and conference rooms were located on the top floor of the building, and the company was concerned about the noise and vibration that the new generator would produce. The company could tolerate a certain amount of noise or vibration in the event of lost power, but as most facility managers know, large generators are operated frequently as part of routine maintenance.

The team conducted a study to investigate the potential for noise and vibration transfer into the office and conference room areas. First, they brought a large speaker up on the rooftop near where the generator would be located. The speaker produced large amplitudes of sound at all frequencies and the team measured the resulting noise levels in the office area. The team combined these data with the generator manufacturer's sound data to estimate the expected amount of airborne noise intrusion. Second, they used a large-force hammer to impart vibrations atop the capped steel columns where the generator was to be mounted and measured the resulting floor vibrations in the offices below. The team used data collected near similar generators to predict the level of vibration that could be expected in the occupied areas of the building below.

This study confirmed that both noise and vibration would be an issue for occupants of the building, and the team chose proper mitigations for the generator. They placed a large enclosure around the generator that featured silencers for the air inlets and outlets, and the entire enclosure structure was placed on isolated spring mounts to reduce the transfer of vibration into the building. **FMJ**

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