

The Smithsonian National Zoo – Arabian Leopard Enclosure

PRELIMINARY ACOUSTIC NARRATIVE

January 22, 2026



SMITHGROUP

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January 22, 2026

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1700 New York Avenue, NW, Suite 100
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Re: The Smithsonian National Zoo – Arabian Leopard Enclosure
Preliminary Acoustic Narrative

Dear Ms. Jardis:

Metropolitan Acoustics has completed a preliminary analysis intended to inform pricing exercises for the Arabian Leopard Enclosure at the Smithsonian National Zoo in Washington DC. This report addresses preliminary recommendations for a temporary acoustic barrier during construction, mechanical and electrical noise and vibration control, and vibration monitoring during construction.

The information in this report is intended to be used as a guide for architectural and engineering disciplines so appropriate acoustical performance can be achieved. These recommendations are based on our meeting with the design team on January 13, 2026, and project documentation received January 21, 2026.

For the readers' convenience, [blue text](#) indicates an external link to a product. Please let us know if you have any questions regarding this information.

Best regards,

metropolitan acoustics, llc



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TERMINOLOGY

Sound Level

Sound pressure levels (SPL) are commonly expressed on a logarithmic scale in decibels (dB). The human ear is most sensitive to mid-frequency sound, such as speech, and less sensitive to high- and low-frequency sound at typical listening levels. To account for this, sound pressure can be expressed in units of A-weighted decibels (dBA).

Background sound levels in unoccupied rooms from mechanical and exterior sources are typically specified in terms of Noise Criteria (NC) ratings. The NC is a single-number rating derived from octave band sound pressure levels from 63 to 8000 Hz.

For both dBA and NC ratings, a higher number corresponds to louder sound levels. For reference, a 3 dB difference in ratings represents a just-noticeable difference, a change of 5-6 dB is clearly noticeable, and a sound level that is 10 dB higher is perceived to be twice as loud.

Vibration

Root-mean-square (RMS) acceleration is typically measured as a multiple of the acceleration due to Earth's gravity (g). One g is approximately equal to 386 in/s^2 or 9.81 m/s^2 and is one of the most common units for vibration measurements using accelerometers in buildings. RMS amplitude is used to describe the "smoothed" vibration amplitude of acceleration and velocity.

Sound Transmission Class (STC)

A comparison of the effectiveness of wall and floor/ceiling assemblies in attenuating airborne sound is typically presented in the form of sound transmission class (STC) ratings. STC is a single-number rating of the effectiveness of an assembly at isolating airborne sound and is derived from transmission loss (TL) values between 125 to 4000 Hz. A higher number corresponds to a higher degree of acoustical isolation.

Noise Reduction Coefficient (NRC)

A common way to present the sound absorption properties of a material is the noise reduction coefficient (NRC), where 0 is completely reflective and 1 is completely absorptive. It is the arithmetic mean of the absorption of a material in the octave band center frequencies from 250 to 2000 Hz. For example, NRC 0.70 means that the material will absorb approximately 70% of the sound between 250 and 2000 Hz that is incident upon its surface.

TEMPORARY ACOUSTIC CONSTRUCTION BARRIER

CONFIGURATION

The preliminary location of the temporary acoustic construction barrier is noted below in Figure 1, with the barrier shown in red to the south side of the site. This is adjacent to the Panda House and the zoo's main concern is sound from demolition and construction to the pandas. The length as shown is approximately 160'.

The barrier should be approximately 15' high, which breaks the line of sight from the construction zone to the Panda area.



Figure 1: Location of temporary construction barrier in red

MATERIALS

The barrier should have a minimum face weight of 4 PSF. Since this will be temporary for the demolition of the buildings on site as well as the installation of footings and other loud activities, we recommend using a temporary barrier carrying minimum ratings of STC 25 and NRC 0.70. The absorptive side of the barrier should face the construction site. Examples of suitable materials are as follows:

- [Environmental Noise Control Sound Walls](#)
- [softdB Temporary Noise Barriers](#)
- [Noise Monitoring Services Temporary Sound Walls](#)

PRELIMINARY MECHANICAL & ELECTRICAL NOISE AND VIBRATION CONTROL

The information and recommendations presented below are provided as design guidelines for mechanical system noise and vibration control for this project. Upon receipt of design documents that indicate equipment locations, unit selections, duct sizes, airflow volumes, and terminal units and devices, acoustical calculations will be performed to predict the background sound level in select spaces. The calculations will consider the acoustical performance data for each piece of equipment and use the design documents to model the airborne path to each room taking appropriate deductions for ductwork, elbows, or junctions, as well as other adjustments, such as room dimensions, demising assemblies, and room absorption. The background sound level in each space will then be compared to acoustical design goals.

DESIGN GOALS

Table 1 provides the recommended background sound level design goals for each type of space, adapted from the ASHRAE Applications Handbook guidelines.

<i>Space</i>	<i>Design Goal</i>
Public facing spaces	NC 35
Animal holding spaces	NC 35
Back of house spaces	NC 45

EQUIPMENT RECOMMENDATIONS

Indoor Air Handling Units

The typical contributors to sound levels from indoor air handling units are duct-borne, duct breakout, casing-radiated, and structure-borne noise. We recommend the following for indoor air handling equipment AHU-1, located in the mechanical room:

- Locate indoor air handling units within dedicated mechanical rooms whenever possible, and not within occupied spaces.
 - Mechanical rooms should be separated from occupied spaces by buffer spaces, e.g. closets or unoccupied rooms, if possible; otherwise, special considerations with regard to the sound isolation properties of the demising assemblies may be required.
 - Provide a massive and stiff structure to allow for proper functioning of vibration isolators.
 - All ductwork within mechanical rooms should be 20 ga. or heavier to prevent noise in the mechanical space from breaking into the ductwork.
 - All ductwork within the mechanical room or within 25' of mechanical equipment, whichever is greater, should be decoupled from the structure using combination metal spring and neoprene hangers with a minimum static deflection of 1" for RPM <500 and 1/2" for RPM ≥500, such as [Mason 30N](#).
 - Incorporate duct silencers, 1" to 2" internal duct lining, or both on supply and return air duct paths prior to exiting the mechanical space.
 - Duct silencers should be manufactured by [Price Industries](#), [Vibro-Acoustics](#), [IAC Acoustics](#), or similar.
- Incorporate vibration isolation pad for floor-mounted indoor air handling units as follows:
 - Indoor air handlers can be directly mounted to slab-on-grade housekeeping pads.
 - Internal spring isolators should be used to reduce vibration from the fans.

- Fabric connections should be used to connect ductwork to the discharge and inlet of these units. The fabric connections should be at least three inches wide and provide separation between the ducts without being taut.
- Flexible connectors should be specified at electrical conduit connections to all motorized/vibrating equipment.
 - Provide each flexible conduit connection with enough slack to form an 8" deep U-shaped bend.
- Incorporate all recommendations presented in the [Duct and Duct Accessory Recommendations](#) section of this document.
- Incorporate all recommendations presented in the [Piping and Pipe Accessory Recommendations](#) section of this document.

Exhaust Fans

Exhaust fans EF-1 and EF-2 are intended to be roof-mounted above the mechanical room. EF-1 is intended to exhaust air from animal spaces and run continuously while EF-2 will operate under a schedule/occupancy load and will exhaust air from non-animal spaces. Refrigerant exhaust fan REF-1 will operate only in case of an emergency; it will also be located on top of the mechanical room.

- Locate exhaust fans above non-critical spaces such as corridors, equipment rooms, and stairwells. Avoid placing fans above noise-sensitive spaces.
- Reduce duct-borne noise using duct silencers, 1" to 2" internal duct lining, or both as necessary on exhaust air duct paths prior to exiting the mechanical space or rooftop.
 - Duct silencers should be manufactured by [Price Industries](#), [Vibro-Acoustics](#), [IAC Acoustics](#) or similar.
- Depending on size and location, isolate upblast and downblast exhaust fans from the roof curb using combination metal spring and neoprene rail or neoprene isolators.
 - Combination metal spring and neoprene rail isolators should be such as [Mason RSL](#), with a minimum static deflection of 1".
 - Neoprene isolators should be sized to provide a minimum 0.2" static deflection; an example of a suitable isolator is one layer of [Mason Super WSW](#).
 - The gap between the roof curb and the fan cover should be sealed with closed cell neoprene foam or similar material to form an airtight seal.
- Isolate floor/roof mounted fans (non-curb mounted) using restrained combination metal spring and neoprene mounts, such as [Mason SLR](#), sized to provide a static deflection of 1" to 3" depending on the rotational speed of the fans, the location of the equipment, and the supporting structure.
- Fabric connections should be used to connect ductwork to the discharge and inlet of these units. The fabric connections should be at least three inches wide and provide separation between the ducts without being taut.
- Flexible connectors should be specified at electrical conduit connections to all motorized/vibrating equipment.
 - Provide each flexible conduit connection with enough slack to form an 8" deep U-shaped bend.
- Incorporate all recommendations presented in the [Duct and Duct Accessory Recommendations](#) section of this document.

Condensing Units

Three condensing units will be located outside on grade. The exact location is yet to be determined.

- Flexible connectors should be specified at electrical conduit connections to all motorized/vibrating equipment.
 - Provide each flexible conduit connection with enough slack to form an 8" deep U-shaped bend.
- Incorporate all recommendations presented in the [Piping and Pipe Accessory Recommendations](#) section of this document.

Emergency Generator

This project will have one (1) 150 KW emergency generator, a Generac SG150, located on slab-on-grade in a separate area in the building with screened walls. We recommend the following:

- For airborne sound control, we recommend the generator be enclosed in a Level 1 sound attenuated enclosure. According to the manufacturer, this enclosure reduces sound levels to 70-80 dBA at 7 meters. We recommend this approach as opposed to using the standard weather enclosure.
- For vibration control, we recommend the following:
 - Option 1: Install the generator set on restrained combination metal spring and neoprene mounts such as [Mason SLR](#) with minimum 2" deflection.
 - ♦ Confirm with the manufacturer and relevant engineering disciplines that the rail/dunnage/framing system has the structural integrity to provide the required deflection.
 - Option 2: Incorporate a 1" isolation/expansion joint around the perimeter of the generator room.
- Incorporate all recommendations presented in the [Duct and Duct Accessory Recommendations](#) section of this document.
- Incorporate all recommendations presented in the [Piping and Pipe Accessory Recommendations](#) section of this document.

DUCT AND DUCT ACCESSORY RECOMMENDATIONS

Airflow Velocities in Ductwork

Aerodynamic sound is related to excessive airflow velocities (fpm) and turbulent airflow through a duct element and at distribution devices. Turbulence generates noise and increases static pressure in the system, while flow-generated noise is proportional to the airflow velocity (i.e., the faster the speed, the more noise generated). Airflow velocities should be limited to reduce aerodynamically generated sound in ducts depending on the design goal for a space and the location of the ductwork. Table 2 and Table 3 provide airflow velocity guidelines, based on the Sound and Vibration Control chapter of the ASHRAE Applications Handbook.

Table 2. Maximum Recommended Duct Airflow Velocities to Achieve Specific Acoustical Design Criteria The Smithsonian National Zoo – Arabian Leopard Enclosure			
Main Duct Location	Design Goal	Maximum Airflow Velocity (fpm)	
		Rectangular Duct	Circular Duct
In shaft or above drywall ceiling	NC 45	3,500	5,000
	NC 35	2,500	3,500
Above suspended acoustic ceiling	NC 45	2,500	4,500
	NC 35	1,750	3,000
Duct located within occupied space	NC 45	2,000	3,900
	NC 35	1,450	2,600

Notes:

1. Airflow velocities marked with an asterisk have been interpolated from ASHRAE
2. Branch ducts should have airflow velocities of about 80% of values listed.
3. Velocities in final runouts to outlets should be 50% of values or less
4. Elbows and other fittings can increase airflow noise substantially depending on type. Thus, duct airflow velocities should be reduced accordingly.

Table 3. Maximum Recommended Air Velocities Through the Free-Area of Supply or Return Diffusers/Grilles/Registers to Achieve Specific Acoustical Design Criteria The Smithsonian National Zoo – Arabian Leopard Enclosure		
Design Goal	Maximum Free-Area Airflow Velocity (fpm)	
	Supply air outlet	Return air opening
NC 45	625	750
NC 35	500	600

Note:

Preceding table is intended for use when no sound data are available for selected grilles or diffusers, or no diffuser or grille is used. The number of diffusers or grilles increases sound levels depending on proximity to receiver. Allowable outlet or opening airflow velocities should be reduced accordingly in these cases.

Balancing Dampers

Noise is generated as airflow passes through balancing dampers, typically perceived as a whistle or hiss. To mitigate this noise, we recommend the following:

- Locate dampers at least five duct diameters upstream of each air terminal device.
- Incorporate 1" thick internal duct lining between the damper and air terminal device.
- Avoid locating dampers directly behind or integral to the diffuser.

Flexible Connections

- Fabric connections should be used to connect ductwork to the discharge and inlet of all fans and equipment with fans.
- The fabric connections should be at least three inches wide and provide separation between the ducts without being taut.
 - Where thrust restraints are required to prevent the flexible connection from being pulled taut, we recommend [Mason WBI](#) and [WBD](#).

Duct Transitions

- The included expansion angle for transition ducts should be no more than 15 degrees to help prevent duct rumble.

Acoustical Duct Liner

- Select acoustical duct liner composed of fiberglass or cotton fiber of 3-6 PCF density and a minimum rating of NRC 0.70; examples of suitable products include [Johns Manville Linacoustic RC](#) or [Spiracoustic Plus](#).

Duct Penetrations

- Oversize penetrations for ductwork by 1/2" so that the penetrating element does not come in contact with the wall, roof, or floor/ceiling assembly.
 - The resulting gap should be filled with backer rod and sealed with a resilient, non-hardening sealant.
 - Larger penetrations or gaps should be sealed with a dense material such as [Hilti CP 618](#) fire-stop putty.

Flexible Duct

- Incorporate 3' to 5' of non-metallic insulated flexible duct as final connections to supply air diffusers. We recommend the following flexible duct products or approved equivalent:
 - [Quietflex QAS](#)
 - [Flexmaster Type 6](#)
 - [Thermafex M-KE](#)

- To reduce noise generated by flexible ductwork, we recommend the following:
 - Remove excess material so that the duct is taut.
 - Route flexible duct as straight as possible.
 - Do not turn the flow using flex duct except for a final connection to a diffuser.
 - Support flex duct elbows using a product such as [Thermaflex FlexFlow Elbow](#) or a field-built equivalent to prevent kinks and bends.

Transfer Ducts

Transfer ducts can create flanking paths for sound through full-height partitions. To reduce sound transmission through transfer ducts, we recommend the following:

- Transfer ducts should have a total path length of at least 6’.
- Transfer ducts should be internally lined with 1” fiberglass duct liner.
- Construct transfer ducts of 20 ga. (min.) sheet metal configured in a “Z” or “U” shape as follows:
 - 1.5 equivalent duct diameters of straight duct
 - One 90° mitered elbow
 - 1.5 equivalent duct diameters of straight duct
 - One 90° mitered elbow
 - 1.5 equivalent duct diameters of straight duct
- An alternative to a field-built transfer duct is a manufactured product such as [Price Air Transfer Silencer model XTU or XTZ](#).

Duct Routing

- Avoid routing duct mains above noise-sensitive rooms.
 - Duct mains should run above corridors or non-noise sensitive spaces.
 - Branch ducts should enter each room through the corridor partition in lieu of passing over occupied spaces.

Air Terminal Devices

Selection of diffusers, grilles, or registers should account for the sound level generated. Noise generated at each device can contribute to the sound level in each space.

- Select devices with NC ratings at least 5 points lower than the design goal of the room. For example, diffusers installed in a space with a design goal of NC 35 would be selected for a maximum rating of NC 30.
- Do not install diffusers directly to the sides or bottom of exposed ductwork due to velocity noise coming through diffusers. Always use a minimum 3’ length of ductwork coming off of the main duct to slow down the air before the diffuser. Volume dampers should be located at the duct/branch connection.

PIPING AND PIPE ACCESSORY RECOMMENDATIONS

Flow Noise and Vibration

Turbulence, sharp pressure drops, and entrained air can cause flow noise and vibration to be reintroduced into the system. To reduce flow noise and vibration, we recommend the following:

- Size piping so that velocities are a maximum of 4 FPS for piping 2” and smaller and a maximum of 10 FPS for larger pipe sizes.
 - Flow velocities should be as low as possible, within the above limits, while maintaining the required pressure.

Pipe/Conduit Penetrations

- Oversize penetrations for piping by 1/2" so that the penetrating element does not come in contact with the wall, roof, or floor/ceiling assembly.
 - The resulting gap should then be filled with backer rod and sealed with a resilient, non-hardening sealant.
- Larger penetrations or gaps should be sealed with a dense material such as [Hilti CP 618](#) fire-stop putty.

Refrigerant Piping

- Avoid routing exposed refrigerant piping in noise sensitive spaces.
 - If unavoidable, wrap the piping with limp-lagging. The limp-lagging should include a quilted fiberglass decoupling layer and a mass-loaded vinyl outer layer (minimum 1 PSF), such as [Sound Seal B-10 LAG/QFA-3](#).
 - Alternatively, route the piping above a mineral fiber ACT or GWB ceiling.

Pipe Hangers and Supports

To reduce vibration and noise transmission from piping into the building structure, resilient pipe hangers and supports should be utilized.

- For suspended piping:
 - Isolate all piping within 50' (centerline length) of vibration-isolated equipment and pressure-regulating valve (PRV) stations using combination metal spring and neoprene hangers, such as [Mason 30N](#). The isolator-type and deflection for the piping is contingent on the equipment being isolated:
 - ♦ The first three isolators should provide the same deflection as the equipment isolators or 2", whichever is less.
 - ♦ Remaining isolators should provide 0.75" of deflection or the same deflection as the equipment isolators, whichever is less.
 - ♦ Isolate piping with a diameter greater than or equal to 2" adjacent to or below noise-sensitive areas with combination metal spring and neoprene hangers with minimum deflection of 1/2".
- For floor-supported piping – isolate all piping in equipment rooms and adjacent to isolated equipment.
 - Restrained combination metal spring and neoprene isolators should be used for piping in close proximity to the equipment, such as [Mason SLR](#).
 - Thrust-rods or thrust restraints, such as [Mason WBI/WBD](#), should be utilized where piping is subject to large thermal movement.
- At all remaining pipe support locations, provide vibration isolation as follows:
 - Wrap the pipe in a closed-cell foam, such as [ArmaFlex](#), with a minimum thickness of 1/2" at the support locations. Clamps should be sized for the dimension of the pipe plus the ArmaFlex to avoid excess compression of the ArmaFlex.
 - ♦ Prefabricated products include [HoldRite Silencer Products](#) and [LSP Acousto](#).
 - There should be no direct contact between the pipe and the clamp/hanger.
 - ♦ This includes support locations where the pipe is insulated with calcium silicate or similar hard insulators.
 - Select resilient clamps such as [Hydro-Craft Hydro-Strut](#) for strut channel attachments.
 - Avoid plastic clamps such as Hydra-Zorb and Cush-A-Clamp, as they are not acoustically resilient.

VIBRATION MONITORING DURING CONSTRUCTION

Metropolitan Acoustics will be monitoring vibration levels during construction. Our equipment contains long-term batteries that can last on a charge up to six months. The system operates on cellular connection and will push email and SMS notifications to approved staff or construction team members in real time when thresholds are exceeded. Additionally, daily or weekly reports will be issued summarizing the activity during that time period.

We will conduct a site visit to:

- Observe the conditions of the site.
- Identify installation locations for monitoring equipment at or beyond the boundaries of the construction site.
- Install vibration monitoring equipment at up to three (3) locations identified.

We will return to the site to change the batteries when they are nearing depletion, as well as at the conclusion of monitoring to retrieve the equipment. Monitoring will continue for up to twelve (12) months; additional months can be added if the construction is not completed.

The cost of the monitoring will be \$32,500 for 12 months with additional months at \$2,000/month.