APPENDIX 1: Acoustics Narrative

INTRODUCTION

We have conceived this building acoustically as two buildings - an architecturally distinguished but acoustically (almost) normal office building attached to a rehearsal room that is both architecturally and acoustically remarkable. This narrative describes our current acoustics recommendations. Some of these design approaches are likely to be adjusted as the building goes through Design Development.

This document describes addresses the three areas of acoustic concern:

- Internal acoustics of the rehearsal room and other sensitive rooms
- Isolation of exterior sound and sound among acoustically sensitive spaces
- Control of noise and vibration generated by building systems

Goals:

- The rehearsal room will be a flexible space with excellent Room Acoustics for rehearsals, while also accommodating recitals, lectures, and receptions at the highest quality level that budget allows. The various spaces in the office wing will have acoustics that are designed to support their functions well.
- Isolation targets aim at providing a high level of isolation between the rehearsal room and the office wing, and from the exterior to the rehearsal room. On occasion, low levels of outside noise may be slightly audible within the rehearsal room. Within the office wing we aim for reasonable speech privacy and minimal disturbance.
- Noise Control efforts will target a range of background noise levels, from virtually silent for the rehearsal room to comfortably normal for much of the office building. In all cases, we will pursue a balance of low, mid, and high frequency sound that is pleasant and free of tonal character.

Room Acoustics - General:

Spaces in the office wing will require modest attention to ensure that speech communication is easy and loudness buildup is not excessive. In an open plan office areas and the double height entry absorption will be needed to control the unwanted spread of sound. However, the main focus of room acoustics in this building is the rehearsal room.

The rehearsal room captures a large volume (40’ x 48’ x 33’+) to prevent sound building up to uncomfortably loud levels and to allow music to linger with a moderately long reverberation time. Room surfaces are shaped to sustain sound while avoiding flutter (high frequency trapped

between parallel surfaces) and preventing an excessive buildup of sound in the lower 7' of the room, where the musicians and listeners will be. Some additional texturing of the walls provides more random scattering of sound, to further soften harshness. A simple, modestly curved ceiling provides clean communication within an ensemble while preventing fluttery buildup between the floor and ceiling. Clerestory and narrow windows cut into some of the corners of the room provide additional levels of diffusion.

For louder uses and uses where speech clarity is important, we are providing adjustable acoustic absorption. This currently takes the form of hinged doors that open to expose absorption, movable banners, and loose upholstered chairs. In addition, there is some fixed absorption to provide basic control of loudness and reverberation, even when the room is empty. Balancing the high cost of movable absorption and the moderate cost of fixed absorption against the needs for loudness control and reverberation control is an ongoing process. Our current approach is to allow the room to range from quite reverberant (few people, movable absorption stored) to slightly reverberant (room full of people, movable absorption exposed). The limitations inherent to this approach are that the room will not be suitable for very loud musical forces (such as a percussion ensemble) and that anyone giving a lecture will have to take care to speak clearly or will need an audio system that does not throw sound randomly into the room.

Isolation - General:

Successful sound isolation begins with good space planning. In the current layout, offices are separated from the rehearsal room by distance and circulation zones. A structural isolation joint between the rehearsal room and the office wing could provide additional protection. Around the rehearsal room, heavy walls, double pane windows, and vestibules provide protection from outside noise, including the on-grade mechanical equipment. Within the office wing, acoustic batt in the gypsum board walls, acoustic sealant at the tops and bottoms of walls, and additional layers of gypsum board at critical adjacencies maintain speech privacy. Where piping or ductwork penetrates an acoustically significant wall or ceiling, the penetrations are carefully sealed with acoustic sealant.

Noise/Vibration Control - General:

So that musicians are able to focus on their activities, and because audio recording is anticipated, ambient noise levels must be very low in the rehearsal room. To maintain speech privacy in private offices and open plan offices, a basic level of background noise must be provided in the office wing – near silent HVAC would be a problem.

Recommended criteria for ambient (background) noise levels are listed in this section as Room Criteria (RC) curves. In addition to controlling overall background noise levels, the frequency balance of the noise must be in balance, not sounding "rumbly", "hissy", or "tonal." The "neutral"

(N) spectrum descriptor is therefore used to indicate these requirements. For background noise levels between RC-25 to RC-50, the criteria are expressed in terms of RC as published in the current ASHRAE Handbook. For background noise levels below RC-25, the criteria are expressed in terms of RC as based upon our experience, and resemble the Preferred Noise Criteria (PNC) curves published in older editions of the ASHRAE Handbooks.

To achieve the room criteria targets, airborne noise from machinery must be controlled close to the source. Air turbulence noise must be avoided in the air distribution system. Vibration generated by machinery or building service systems must not be allowed to transmit into the building's structure. Most of the mechanical equipment serving the OBF building is located on grade, with the rehearsal room shielding the office wing from the noise. Exhaust fans in the office wing will be vibration isolated.

ACOUSTICS BASIS-OF-DESIGN

Rehearsal Room

Room Acoustics:

- Walls – Two adjacent walls of split face block, parged or filled with latex filler and painted; consider limewash in lieu of paint. Assume up to 10% of the wall may have additional sound diffusing panels, made of routed wood or MDF or GFRG backfilled with plaster.
- Walls - Two adjacent walls of multi-layer gypsum board or plywood, braced off cmu, finished with plaster or tongue and groove wood flooring. These walls are gently curved with a complex convex curve – vertical at the center of the wall, and leaning back at each end of the wall, so that the bottom of the wall is a straight line and the top of the wall is a gentle convex curve.
- Floor – Hardwood tongue and groove flooring.
- Ceiling – Multi-layer gypsum board or plywood, suspended from the roof deck, finished with plaster or tongue and groove wood flooring. The ceiling is a simple convex curve with a tight radius over the stage end of the room and a gentler radius over the bulk of the room.
- Fixed Absorption – Limited areas of thin felt and fabric-wrapped glass fiber panels. Supply and return air grilles may also be counted within the square footage required for fixed absorption in this room. The total area of fixed absorption necessary is approximately 1,000 square feet.
- Movable Absorption – Tall hinged wood doors near corner windows that open into the cavity of the curved walls, allowing sound to bleed into the insulated interior of the wall. Motorized wool serge banners. Upholstered loose seating may also be counted within the

quantity of movable absorption within the room. The total area of moveable absorption is approximately 2,000 square feet.

Isolation:

- Structural isolation – Structural isolation joints at connection to office wing.
- Walls –Minimum 8" thick poured in place concrete or grout-filled CMU shell.
- Floor - Resiliently supported plywood subfloor on concrete slab with perimeter isolation joint.
- Ceiling – A Lightweight roof system requires that the shaped gypsum ceiling be continuous, and be sealed airtight at the surrounding walls.
- Windows/Skylights – Independent double window system. Laminated/insulated glass at all windows to the exterior; ¾" - 1" thick, laminated window on independent frame at interior, may be angled in plan or section; minimum 4" air space between interior and exterior window systems, but 12" airspace preferred – glass fiber behind perforated metal at perimeter of airspace.
- Doors - Vestibule with gasketed doors to Lobby. STC-55 door directly to exterior if vestibule cannot be provided.

Noise/Vibration Control:

- Air handler remotely located at least 50'-0" of duct length away from this space, including a pair of 7'-0" sound attenuators separated by 10'-0" of straight ductwork for each air handler supply outlet and return inlet.
- Dedicated, custom air handler with quiet-type and efficient plenum fans.
- Variable speed drives for supply and return fans.
- Internal duct lining, 2" thick when both duct dimensions greater than 24", 1" thick otherwise.
- Air velocities less than 900fpm in main ducts.
- Air velocities less than 600fpm in main ducts within space.
- Air velocities less than 300fpm in branch ducts.
- Balancing dampers located at least 5 lineal feet away from air inlet/outlet devices.
- Out-of-airstream type fire dampers when located within 20'-0" of duct length of air inlet/outlet devices.
- Supply diffusers and return grilles selected for NC-10 max.
- No plumbing piping, HVAC piping, or ducts serving other spaces passing through this space.
- LED lighting drivers remotely located away from space.
- Sinewave or IGBT dimmers for all incandescent lighting.
- Silent electronic ballasts for any fluorescent lighting.

- No transformers in or near space.
- Dedicated, fire alarm notification appliance circuit and amplifier for space.

Rehearsal Room Vestibule (Sound and Light Lock):

Room Acoustics:

- Walls – 2" thick fabric wrapped glass fiber panels on at least one wall.
- Ceiling – suspended lay-in sound absorptive ceiling.

Isolation:

- Walls – multi-layer gypsum board and concrete/CMU walls.
- Ceiling – Lay-in tile ceiling with carpet at the floor of the concrete slab above.
- Door to Rehearsal Room – 1 3/4" thick solid core wood or glass fiber filled hollow metal, minimal glazing, full perimeter gasketing, no latch or panic hardware.
- Doors to Lobby and Exterior – 1 3/4" thick solid core wood or glass fiber filled hollow metal, minimal glazing, full perimeter gasketing; quiet panic hardware.
- Windows – Consider laminated glass for higher isolation to the lobby, as well as the exterior.

Noise/Vibration Control:

- Ambient noise design goal of RC 25-29(N).
- Quiet-type VRF unit located in space.
- No plumbing piping, HVAC piping, or ducts serving other spaces passing through this space.

Board Room

Room Acoustics:

- Walls – 1" thick fabric wrapped glass fiber panels on at least one wall.
- Ceiling – suspended lay-in sound absorptive ceiling.

Isolation:

- Walls – Multilayer Gypsum board wall, to all surrounding spaces, with double stud construction required to elevator and restroom spaces.
- Ceiling – High CAC lay-in tile ceiling with carpet at the floor of the concrete slab above.
- Door to Exterior– Glass fiber filled hollow metal door, minimal glazing, full perimeter gasketing.

- Doors to Lobby– 1 3/4" thick solid core wood or glass fiber filled hollow metal, minimal glazing, full perimeter gasketing.

Noise/Vibration Control:

- Ambient noise design goal of RC 20-24(N).
- Dedicated VAV box located in hallway with at least 20'-0" of duct length to diffusers, including a 5'-0" sound attenuator
  OR
  Quiet-type VRF unit located in hallway with at least 20'-0" of duct length to diffusers, including a 5'-0" sound attenuator.
- 1" thick internal duct lining downstream of VAV box or VRF unit.
- Air velocities less than 700fpm downstream of VAV box or VRF unit.
- Air velocities less than 350fpm in branch ducts.
- Balancing dampers located at least 5 lineal feet away from air inlet/outlet devices.
- Supply diffusers and return grilles selected for NC-15 max.
- No plumbing piping, HVAC piping, or ducts serving other spaces passing through this space.

Artistic Director

Room Acoustics:

- Ceiling – suspended lay-in sound absorptive ceiling.

Isolation:

- Walls – Full height walls with multi-layer gypsum board or heavy exterior construction, providing a continuous acoustic barrier to the exterior and surrounding interior spaces.
- Ceiling – Lay-in tile ceiling with carpet at the floor of the concrete slab above.
- Doors – Full perimeter gasketing.
- Windows – Consider laminated glass for higher isolation to the lobby, as well as the exterior.

Noise/Vibration Control:

- Ambient noise design goal of RC 25-29(N).
- Dedicated VAV box located in Vestibule with at least 15'-0" of duct length to diffusers
  OR
  Quiet-type VRF unit located in Vestibule with at least 15'-0" of duct length to diffusers.
- 1" thick internal duct lining downstream of VAV box or VRF unit.

- Air velocities less than 800fpm downstream of VAV boxes.
- Air velocities less than 400fpm in branch ducts.
- Supply diffusers and return grilles selected for NC-20 max.
- No plumbing piping, HVAC piping, or ducts serving other spaces passing through this space.

Library

Room Acoustics:

- Floor – Carpet.
- Ceiling – Suspended lay-in sound absorptive ceiling.

Isolation:

- Walls – Multi-layer gypsum board walls.
- Floor – Carpet.
- Roof – Roof deck with concrete or cement board layers.
- Ceiling – Suspended lay-in ceiling.
- Doors - Gasketed solid-core door.

Noise/Vibration Control:

- Ambient noise design goal of RC 30-34(N).
- Dedicated VAV box located in hallway
  OR
  Quiet-type VRF units located in space.
- 1" thick internal duct lining downstream of VAV box.
- Air velocities less than 1000fpm downstream of VAV box or VRF unit.
- Air velocities less than 500fpm in branch ducts.
- Supply diffusers and return grilles selected for NC-25 max.

Lobby

Room Acoustics:

- Ceiling – Sound absorptive ceiling.

Isolation:

- Roof – Roof deck with concrete or cement board layers.

Noise/Vibration Control:

- Ambient noise design goal of RC 30-34(N).
- Dedicated VAV boxes located in Lobby
  OR
  Quiet-type VRF units located in Lobby.
- 1" thick internal duct lining downstream of VAV boxes or VRF units.
- Air velocities less than 1000fpm downstream of VAV boxes.
- Air velocities less than 500fpm in branch ducts.
- Supply diffusers and return grilles selected for NC-25 max.

Offices

Room Acoustics:

- Ceiling – suspended lay-in sound absorptive ceiling.

Isolation:

- Wall - Multi-layer gypsum board walls.
- Roof – Roof deck with concrete or cement board layers.
- Ceiling – Suspended lay-in ceiling.
- Window - Laminated/insulating glass at all windows to exterior.
- Doors – Gasketed solid-core doors.

Noise/Vibration Control:

- Ambient noise design goal of RC 30-34(N).
- Dedicated VAV box located in hallway
  OR
  Quiet-type VRF units located in space.
- 1" thick internal duct lining downstream of VAV boxes.
- Air velocities less than 100fpm downstream of VAV boxes.
- Air velocities less than 500fpm in branch ducts.
- Supply diffusers and return grilles selected for NC-25 max.

Open Office

Room Acoustics:

- Ceiling – suspended lay-in sound absorptive ceiling.

Isolation:

- Roof – Roof deck with concrete or cement board layers.

Noise/Vibration Control:

- Ambient noise design goal of RC 35-39(N).
- Dedicated VAV box located in hallway
  OR
  Quiet-type VRF units located in space.
- 1" thick internal duct lining downstream of VAV boxes.
- Air velocities less than 1200fpm downstream of VAV boxes.
- Air velocities less than 600fpm in branch ducts.
- Supply diffusers and return grilles selected for NC-30 max.

MEP Rooms

Room Acoustics:

- Ceiling – sound absorptive ceiling with an NRC of 0.75.

Isolation:

- Walls – Multi-layer gypsum board walls.
- Doors - Gasketed solid-core or hollow metal doors.

Noise/Vibration Control:

- Vibration isolation mounts/hangers at equipment.
- Resiliently-supported ducts and piping within 50 lineal feet of connected equipment.
- Flexible duct, pipe, and conduit connections at vibration-isolated equipment.

Rooftop/Outdoor Equipment

Noise/Vibration Control:

- Sound power level limits at air handlers, exhaust fans, and VRF units.
- Vibration isolation mounts at equipment.

- Resiliently-supported ducts and piping within 50 lineal feet of connected equipment.
- Flexible duct, pipe, and conduit connections at vibration-isolated equipment.
- Barriers or enclosures, as necessary, to reduce radiated noise to window at the first floor of the rehearsal room.

Elevator

Isolation:

- Walls – multi-layer gypsum board walls.

Noise/Vibration Control:

- Variable speed door controls and bumpers that prevent door slamming.
- Vibration isolation mounts/hangers at machine units.

Restrooms

Noise/Vibration Control:

- Water hammer arrestors.