THE NEW SURREY HOSPITAL

AND

BC CANCER CENTRE PROJECT

Schedule 1 – Statement of Requirements

Appendix 1D – Acoustic, Vibration, and Noise Control Measures

APPENDIX 1D – ACOUSTIC, VIBRATION, AND NOISE CONTROL MEASURES

1. Definitions

a. **"ASTC"** is the Apparent Sound Transmission Class. It is a single number rating used to assess the in-situ sound isolation performance of partitions for comparison against the laboratory tested STC rating. ASTC ratings differ from NIC ratings in that the NIC is a direct difference method, while the ASTC rating is a better test of the partition itself as it removes the influence of the room finishes, therefore allowing for testing prior to full fitout. The measurement methodology is defined in ASTM 336;

b. **"CAC"** is the Ceiling Attenuation Class. It is a single number rating that indicates the sound isolation performance of a ceiling. The number specifically relates to how well a ceiling system blocks sound from passing through a common plenum shared by two adjacent spaces separated by a wall built up to the ceiling;

c. **"dBA"** is a weighted overall sound pressure level that is weighted to more closely represent the human response to sound. The A-weighting primarily reduces the influence of low frequencies in reporting of overall sound levels;

d. **"FEM"** stands for finite element method and involves the use of a dynamic structural analysis modelling software package capable of modelling vibration input and response;

e. **"Leq"** is the equivalent continuous sound level. The Leq is the steady sound level that is equivalent in energy to the fluctuating noise over a specified period of time;

f. **"Lmax"** is the maximum sound level measured over a given period of time. For the purposes of this Appendix, the Lmax is defined as the Lmax measured with a 'slow' time weighting unless otherwise noted.

g. **"NC"** means: Noise Criteria. NC is a single number rating that is sensitive to the relative loudness within a given space at different frequencies;

h. **"NIC"** stands for Noise Isolation Class. NIC is the single-number rating of the noise reduction that is measured between adjacent spaces. It is related to the STC of the partition separating the adjacent spaces but does not require correction for partition area or the sound absorption capacity of the receiving room. NIC is then simpler to measure in the field than ASTC and is the most direct measure of sound insulation between rooms. The methodology for measuring NIC is defined in ASTM 336;

i. **"NRC"** means Noise Reduction Coefficient. NRC is a single number rating of the sound absorbing properties of a material – derived by arithmetically averaging the Sabine absorption coefficients at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz. An NRC of 0.00 indicates zero absorption, while an NRC of 1.00 indicates 100% absorption;

j. **"Occupied Spaces"** includes all spaces normally occupied by patients and staff and includes corridors, workrooms, lobbies, etc. Spaces such as storage rooms, mechanical/electrical rooms, etc. are not considered Occupied Spaces.

k. **"RT_{60}"** stands for reverberation time. RT_{60} is the time (in seconds) taken for the sound level in a room to decrease by 60 decibels following the abrupt termination of the source of sound. RT_{60} is the primary measure of 'acoustic liveness' of a space. A short RT_{60} (i.e. less than 0.9 seconds) favours speech intelligibility, while a long RT_{60} (i.e. greater than 1.5 seconds) favours music. For the purposes of this document the RT_{60} is the average of the 500 Hz, 1000 Hz, and 2000 Hz octave bands;

l. **"STC"** means (Laboratory) Sound Transmission Class. STC is a single number rating that is an indication of a partition's ability to block sound (primarily in the speech frequencies). The higher the STC rating, the higher is the sound transmission loss, for instance, loud speech can be understood fairly well through an STC 30 wall, but will not be intelligible through an STC 60 wall;

m. **"STC_C"** means the Composite Sound Transmission Class. The STC_C is the area-weighted logarithmic average expected when a partition is composed of multiple components with varying STC values, typically a door, window, and wall section.

2. General

a. The Design-Builder will design and construct the Facility in consultation with an Acoustic and Vibration Consultant.

b. The Acoustic and Vibration Consultant will provide reporting as provided in the Submission Requirements Section 2.5.4.18 of Schedule 1.

c. LEED

i. There are two potential LEED points available for acoustics.

ii. LEED v4.1 is preferred over LEED v4.0

iii. If LEED credits for acoustics are being sought, then the more stringent of the requirements listed in the SOR and this Appendix, or the LEED requirements will be followed.

iv. Any conflicting requirements between LEED and the SOR requirements will be addressed through RFIs and coordination with the Authority.

d. Where acoustic requirements conflict with other requirements within the SOR, these will be addressed through RFIs and coordination with the Authority.

e. If there is any conflict in requirements between this Appendix and the SOR or other referenced sources (e.g., LEED, other standards, or bylaws), the most stringent requirement will be adopted.

f. Where acoustic requirements are not specified, the Acoustic and Vibration Consultant will provide recommendations for design targets that align with the requirements for similar spaces in the SOR for approval by the Authority.

3. Noise Isolation Requirements

a. Provide wall and floor assemblies with STC/ratings in accordance with Table 1 below. Field performance of wall and floor assemblies will be within 5 points of the STC rating when measured according to ASTC testing standards.

b. Table 1 assumes that floor plans are developed to avoid acoustically conflicting occupancies both vertically and horizontally. For example, work utility spaces will not be placed directly adjacent to Noise Sensitive Spaces (as defined in Section 3.j). Where these types of adjacencies cannot be avoided, extra effort will be taken to eliminate the risk of intrusive noise transfer and the Design-Builder will:

i. Provide an Acoustic and Vibration Consultant’s report for review and approval by the Authority that demonstrates:

ii. Lmax (including that from impact and structure-borne noise) will remain below the Noise Criteria in Table 6; and

iii. Vibration in the sensitive space will not exceed the limits set in Section 11.

c. Demonstrate that the recommendations of the acoustic and vibration consultant’s report are implemented in the design;

d. Demonstrate compliance during commissioning by taking sound and vibration measurements in the Noise Sensitive Spaces while the equipment in the noise-producing space is in operation; and,

e. Investigate noise and vibration complaints when the Facility is in operation and correct any deficiencies at no cost to the Authority if the above criteria are not met.

f. Extend the STC rated assembly full-height from floor to the underside of structure above for all walls and partitions requiring an STC rating in Table 1. If such a wall or partition cannot extend full height (including modular partitions), provide an alternate system and provide an Acoustic and Vibration Consultant’s report verifying that the required level of

speech privacy and other requirements will be achieved with the proposed design.

g. The sound isolation ratings in Table 1 are considered the laboratory STC ratings except where noted. The field rating (ASTC or NIC) will be within 5 points of the ratings shown in Table 1 and are to be verified by post construction testing.

   i. will be addressed to maintain the required field performance sound isolation Details such as the ceiling plenum conditions, windows, doors, penetrations through the constructions, electrical box placement, recessed cabinets, etc. rating.

   ii. Table 1 will provide Normal speech privacy (except at corridor walls with standard, non-acoustically rated doors), assuming a background sound level of at least NC 30 (35 dBA).

h. Where a designated space is not fully enclosed (e.g., patient bays with a curtain as one partition, workstations, etc.), the partition requirements will be reduced to STC 45.

i. If adjacency combinations are not covered by Table 1, Design-Builder will propose STC ratings for any such new adjacency combinations for review and approval by the Authority, based on similar adjacency combinations, room type, functionality, intent, and purpose of the room.

Table 1 – Minimum STC Ratings of Demising Walls and Floor/Ceiling Assemblies

Room Categories[1]	Patient room[3]	Medical/Procedure rooms	Specialty Medical	Washrooms[2 3]	Lounge areas[3]	Circulation, reception, public areas[3]	Shared offices and workspaces[3]	Private offices[3]	Critical Acoustic	Work utility spaces[4]	Building services[4]
Patient room[3]	50	50	60	50[5]	50	50	50	50	60	55	60
Medical/Procedure rooms		50	60	55	50	50	50	50	60	55	60
Specialty Medical			60	60	60	60	60	60	65	60	65
Washrooms[2 3]				45	55	50	55	55	60	45	55
Lounge areas[3]					50	45	45	50	60	55	60
Circulation, reception, public areas[3]						n/a	45	50	60	50	60
Shared offices and workspaces[3]							45	50	60	55	60
Private offices[3]								50	60	55	60
Critical Acoustic									60	60	60
Work utility spaces[4]										45	60
Building services[4]											45

Notes:

1. Room Categories are defined in Table 2
2. Assumed where washroom partitions do not include doors (i.e., no direct access between spaces). Where partition includes piping, the partition will be minimum STC 55 with minimum double or staggered stud construction and piping mounted to washroom side of partition only. Where there is a door connecting the spaces, STC 45 is acceptable.
3. Assumed where partitions do not include doors (i.e., no direct access between spaces). Where there is a door connecting the spaces, STC 45 is acceptable.
4. STC levels are minimum requirements, note that noise levels in surrounding spaces will not exceed background sound levels in Table 6.
5. Sound isolation ratings are not applicable between patient rooms and connected ensuite washrooms where large openings are required to support tracks for patient movement.

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Table 2 – Definition of Room Categories

Room Categories	Description of Requirements	Rooms Represented
Patient Room	Privacy: moderate Sound requirement: quiet Sound generation: raised voice	Consult Room Exam Room Exam/Treatment Room Exam/Treatment Room - AIR Decision Room Decontamination Area/Room Look Good Feel Good Room On-Call Room Patient Room Patient Room AIR
Medical/Procedure rooms	Privacy: basic Sound requirement: moderate Sound generation: raised voice	Accessioning Anaesthesia Block Room Automated Cell Counter Automated Coagulation Area Automated High-Volume Analyzer Area Automatic Endoscope Reprocessor Blood Gas/Whole Blood Analysis Area Bone Marrow Work Area Central Processing – Accessioning Chemistry Lab/Work Area Workbench Urinalysis Area Wash-Up/Glassware Soaking Data Image Centre – Medical Imaging Frozen Section Room Microscopy Microscope Station Operating Room Operating Room – HDR Operating Room – Isolation Procedure Room Processing Room Research Area Clean Room Stress Testing Room Trauma Room
Specialty Medical	Privacy: high Sound requirement: quiet Sound generation: low	CT rooms (including SIM) MRI rooms (including SIM) PETCT/SPECT Control Rooms Echo Room Equipment Testing – Biomed Imaging Room Ultrasound Procedure Room (including TRUS) Screening Mammography Room Diagnostic Mammography Room Irradiator Room Orthovoltage/Superficial Reading Room Systemic Therapy Treatment Spaces (spaces where patients receiver chemotherapy)

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Room Categories	Description of Requirements	Rooms Represented
		Treatment Bunker Interior Secure Rooms[3]
Washrooms	Privacy: basic Sound requirement: moderate Sound generation: raised voice	Washrooms Change Rooms Shower Room Ensuite Locker Areas/Rooms
Lounge areas	Privacy: basic Sound requirement: quiet Sound generation: raised voice	Waiting Area Gathering Area Lounge Resource Centre - Patient/Family
Circulation, reception, public areas	Privacy: low Sound requirement: moderate Sound generation: raised voice	Patient Check-In Reception Circulation Exercise/Wellness Room Lobby Retail
Shared offices and workspaces	Privacy: basic Sound requirement: quiet Sound generation: normal voice	Business Work Area Care Team Station Control Desk Courier Reception & Packaging Dispensing Display IV Staging & Prep/Checking Room Medication Room Office – Shared Office – Foundation Open Assembly Area Security Room Pharmacy Oncology Pharmacy Transfusion Medicine Work Area Work Hub Workroom Workstation
Private offices	Privacy: moderate Sound requirement: quiet Sound generation: normal voice	Office – Private
Critical Acoustic	Privacy: high Sound requirement: very quiet Sound generation: amplified speech or similar	Multimedia Rooms[2] Computer Training Room Group Room Sacred Space Quiet Room Videoconference/Seminar Room - UBC Viewing Room Virtual Health Workstations Phone Room
Work utility spaces	Privacy: low Sound requirement: moderate Sound generation: moderate equipment noise, potential	ADC Replenishing Bike Room Storage Assembly

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Room Categories	Description of Requirements	Rooms Represented
	impact noise/activity	Supply Cleaning Cooling Room Detergent Dispensing Dishwashing Holding Housekeeping Mailroom Food services Packaging Shipping/Receiving Refrigeration (Cooler, Freezer) Back of House Scanning Room Computer Room Communications Rooms Electrical closets
Building services	Privacy: none Sound requirement: none Sound generation: high levels of equipment noise	Compactor Compressor Room Cyclotron Electronics Shop Equipment Room Loading/Receiving Machine Shop Mechanical shafts Mechanical rooms Electrical rooms Elevators Elevator machine rooms Garages Maintenance rooms FMO workshops Waste Bin Area Technical Area Bin Wash Station Blast Chilling/Blast Freezer/Rapid Thaw Cart Drying/Staging/Wash/Holding Laundry

Notes: 1. Spaces below to be defined according to the requirements of the area they serve. Where they connect multiple spaces, the more stringent criteria will be applied.

- Alcove
- Anteroom
- Anteroom – Secure
- Bay
- Buffer Zone
- Cubicle
- Entrance Vestibule
- Kiosk
- Station
- Vestibule

2. Refers to Multimedia room Types 1, 2, 3, 5A and 6 (with the exception of Patient Rooms) as defined in Schedule 1, Section 7.8.15.3.14.

3. Walls between Secure Rooms and other occupied spaces (except Secure Room and their Anterooms), will be double wall assemblies; the Secure Room side of which will be minimum 150mm (6”) cast-in-place concrete, filled concrete block, or similar construction, while the other side will be a free-standing steel-stud and gypsum board/plywood assembly. The cavity between the two will be fully insulated. There will be no doors or windows in such walls.

j. The following Room Categories (per Table 2) are considered 'Noise Sensitive' spaces:

   i. Patient Rooms;
   ii. Medical/Procedure Rooms;
   iii. Specialty Medical;
   iv. Lounge Areas;
   v. Shared Offices and Workspaces;
   vi. Private Offices; and
   vii. Critical Acoustic spaces.

k. Design-Builder will provide door assemblies or an approved alternative as reviewed by the Authority that meet the minimum STC requirements as listed in Table 3 and assign them as noted in Table 5. A door schedule will be provided to the Authority for review.

l. Doors that will not be fitted with automatic door bottoms or sound-rated sweep seals (Type D0), the door undercut will not exceed 12mm.

m. Sliding doors will have full perimeter gaskets to maintain contact with the door and frame with the intent of eliminating sound leakage pathways.

n. Use solid wood doors for corridor doors.

Table 3 – Door Types

Door Type	Description - Example Components	Minimum STC Rating of Door Assembly
D0 – Basic	Basic door with no seals, or sliding door	15
D1 – Standard	Solid core wood or insulated (fibrous) metal door with full perimeter seals and automatic door bottom	30
D2 – Acoustic Rated Door	Lab rated door with full perimeter seals and automatic door bottom	38
D3 – Acoustic Rated Door Assembly	Lab rated door and assembly (frame, hardware, and seals)	45
D4 – Specialty Acoustic Door Assembly	Lab rated door and assembly (frame, hardware, and seals)	55

Note: Where windows are included in doors, the overall performance of the door type will be met.

o. Design-Builder will provide interior glazing that meets the minimum requirements of Table 4 and assigned per Table 5. A window/glazing schedule will be provided to the Authority for approval.

Table 4 – Glazing Types (interior partitions only)

Glazing Type	Description	Minimum STC Rating of Window Assembly
G0 – Basic Glazing	Basic glass	15
G1 – Standard Glazing	Sealed glazing unit or monolithic glass sealed into a frame.	30
G2 – Acoustic Rated Glazing	Sealed glazing unit or monolithic glass, likely laminated.	35
G3 – Acoustic Rated Glazing Assembly	Double laminate sealed unit	42
G4 – Specialty Glazing Assembly	Custom construction and detailing with large airspace between thick laminated lights	50

Table 5 – Minimum Door/Window Requirements

Room Category[1]	Door Designation	Side Light Designation[2]	Viewing Window Designation
Patient room	D1	G1	G3
Medical/Procedure rooms	D1	G2	G3
Specialty Medical	D2	G3	G3
Washrooms	D0	G1	--
Lounge areas	D0	G0	G2
Circulation, reception, public areas	D0	G1	G2
Shared offices and workspaces	D0	G1	G3
Private offices	D0	G2	G3
Critical Acoustic	D3	G3	G4
Work utility spaces	D1[3]	G2	G3
Building services	D2[3]	Not recommended	Not recommended

Notes: 1. Room Categories are defined in Table 2

2 Designations are for door sidelights only to a maximum of door height by 460 mm wide.

3. Building services and similar utility room doors will be located in Back of House corridors or other non-noise sensitive areas separated and away from Occupied Spaces. If building services doors open to noise sensitive areas, then an appropriate door (and/or vestibule) will be provided to comply with background noise requirements in Table 6. Supporting documentation will be provided. Compliance testing will be required.

p. See Schedule 1, Section 7.8.15.4 for additional acoustic requirements for Multimedia Rooms

q. Operable partitions will meet the sound isolation requirements for the intended use of the

individual spaces when divided (e.g., when divided into separate conference rooms, the operable partition will adhere to the requirements for each smaller room). Further requirements are listed below:

i. Operable partitions will be provided to have a minimum STC design rating as specified in Table 1 and will achieve minimum in-situ performance that is the lower of either ASTC/NIC 45 or ten (10) points below the STC design rating;

ii. Top and bottom seals will be operable;

iii. End stops will be rigid;

iv. The bulkhead will be insulated and designed to support the partition to meet the sound isolation requirements;

v. There will be no pass-through doors in operable partitions;

vi. The operable wall will not close on carpet, a smooth and level surface will be provided for a proper seal; and

vii. Submittals for operable partitions will be provided for review and approval by the Authority.

4. Background Noise – Interior Spaces

a. Design-Builder will:

i. in undertaking the design of the Facility, evaluate the expected noise from all mechanical and other systems in the Facility, including Design-Builder supplied equipment; and

ii. design and construct the Facility so that noise from the mechanical and other systems does not exceed the noise levels specified in Table 6 below, within the room or space identified.

Table 6 – Noise Criteria – Maximum Noise Levels Within Various Spaces

Room Categories (as defined in Table 2) (unless noted otherwise)	NC	dBA/dBC
Patient Rooms (single patient) On-call rooms	35	40/60
Patient rooms (multiple occupant patient care areas), including: assessment/exam/treatment, consult/interview, etc.	40	45/65
Medical/Procedure rooms	40	50/70
Specialty Medical	25	30/55
Washrooms	45	50/70
Lounge areas	40	45/65
Care team stations (all)	40	45/65
Circulation, reception and public areas	45	50/70
Shared offices and workspaces	45	50/70
Private offices	35	40/60
Critical Acoustic	25	30/55
Work utility spaces	45	50/70

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5. Noise Control – Exterior

a. Exterior noise levels for normal operations, transient events, and emergency power generation systems operation will be assessed by an Acoustic and Vibration Consultant using industry standard sound source modelling and sound propagation techniques/software. The Acoustic and Vibration Consultant will provide a report for review and approval by the Authority that demonstrates compliance with this section by providing details for the required acoustic controls and by indicating expected noise levels at all critical locations.

b. Normal Operation (Without Emergency Power Generation)

i. Noise from normal operations that include all mechanical and electrical systems running simultaneously (including electrical substations/transformers) but excluding the emergency power generation system will not exceed:

a. the specified room interior noise levels (15-minute Leq) specified in Table 6;

b. 55 dBA in exterior spaces associated with the Facility, such as courtyards, gardens, patios or similar outdoor spaces, and particularly those noted in Schedule 1 Section 2.1.1.6 (plaza, wellness walkway and Secure Outdoor Spaces);

c. 60 dBA at the façade of the Facility; and

d. 45 dBA at neighbouring property lines.

ii. Infrequent, short duration transient events such as emergency vehicle noise will not exceed 50 dBA 15 min Leq and 65 dBA Lmax in Noise Sensitive Spaces.

c. Operation of Emergency Power Generation

i. Noise levels due to the operation of the emergency power generation system will not exceed:

a. the specified room interior noise levels (1-minute Leq) specified in Table 6 by more than 5 points;

b. 60 dBA in exterior spaces associated with the Facility, such as courtyards, gardens, patios or similar outdoor spaces, and particularly those noted in Schedule 1 Section 2.1.1.6;

c. 65 dBA at the façade of the Facility;

d. 55 dBA at neighbouring property lines except along the south property line where abutting a light industrial area in which case the noise level will comply with the City bylaw requirements; and

e. The outdoor sound level requirements for the emergency generator described in Section 5.c.i b and c do not apply within 6.1m (20ft) of the combustion exhaust and the vent air intake and exhaust.

ii. The sound level limits for the emergency power generation system will be accomplished by using high-grade combustion exhaust mufflers, cooling air intake and exhaust silencers, sound absorption in the generator room, high transmission loss partitions to enclosure the generator, vibration isolation systems, and other means as necessary.

6. Sound Masking

a. The following spaces will include sound masking systems designed to maximize speech privacy:

i. Patient Check-In and Reception;
ii. Corridors serving Patient Rooms;
iii. Intake Work Counter;

iv. Large open work areas with twenty (20) or more workstations;
v. Dispensing Areas and Counters in Pharmacies;
vi. Medication Rooms;
vii. Office – Shared with three (3) or more workstations;
viii. Work Hub – Technologists; and
ix. Workrooms except for those listed in Appendix 1K [Multimedia Room Matrix].

b. The sound masking system will include the following:

i. Sound masking controller will have the ability to create zones based on user requirements;

ii. Strategically located speaker assemblies installed above or flush to a conventional suspended acoustic tile ceiling;

iii. Speaker assemblies generating unique, diffuse and unobtrusive sound with spatial and temporal uniformity, and having a spectrum shape designed to mask speech and low-level unwanted noise;

iv. Levels will be set to 45 dba +/- 1 dba within each of the areas requiring sound masking and changes between spaces;

v. The system will be designed to minimize transitions between spaces to avoid attention to the sound masking system; and

vi. The system will be adjustable by Facility operators without direct local controls.

7. Pneumatic Tube (PT) System

a. Consider all aspects of potential noise from the pneumatic tube system. As a minimum:

i. PT system will be located, installed, and enclosed as required to not exceed an Lmax (slow) dBA/dBC level as specified in Table 6 for noise sensitive spaces and Lmax (slow) dBA/dBC +5dB above the level specified in Table 6 for non-noise sensitive spaces;

ii. intermittent noise as well as impact noise at the send/receive stations is allowable only within the room housing the send/receive stations. Provide controls that ensure noise in adjacent spaces does not exceed the LMax (slow) dBA/dBC levels as specified in Table 6 for noise sensitive spaces and Lmax (slow) dBA/dBC +5dB above the level specified in Table 6 for non-noise sensitive spaces;

iii. avoid placing send/receive stations in Noise Sensitive areas as specified in 2.f.;

iv. avoid placing diverter units and PT horizontal and vertical runs in or above Noise Sensitive areas as specified in 2.f.;

v. install PT runs over acoustic tile or gypsum wallboard ceilings in Occupied Spaces that are not considered acoustically sensitive areas; and

vi. consider isolated, mass-loaded acoustic wrap/lagging or internally insulated, 2-layer GWB enclosures for diverter units and horizontal and vertical tubes, where required for noise control.

8. Acoustical Finishes

a. Acoustical room finishes, defined as room finishes with an NRC of greater than 0.70, will be used in all Occupied Spaces except where prohibited by code requirements.

b. Acoustic tile ceilings with a minimum NRC rating of 0.70 and minimum CAC rating of 35 will be used throughout the Facility unless noted otherwise in the Agreement, or where equivalent alternate treatment is provided or where prohibited by cleanroom requirements.

c. The extent and placement of acoustical finishes will be assessed by Design-Builder's Acoustic and Vibration Consultant and summarized in a report for review by the Authority.

d. Sound absorbing materials will be incorporated into the design of rooms so that the Reverberation Time (RT_{60}) of the rooms do not exceed the values listed in Table 7.

e. See Schedule 1, Section 7.8.16.6 for additional acoustic requirements for Multimedia Rooms.

f. Sound absorbing and reflecting materials will be placed to enhance speech communication in all spaces where teaching or group discussion will occur.

g. Where achieving the RT_{60} in Table 7 appears to be challenging because of limited scope for use of conventional sound absorbing materials due to safety/security concerns, alternative approaches will be presented to the Authority for approval.

h. Dividable spaces (those with operable partitions) will meet the requirements of this section for all configurations of the dividable space.

Table 7 – Maximum Room Reverberation Times for Unoccupied Rooms

Room Categories (as defined in Table 2)	Reverberation Time (Seconds) (in 500, 1000, and 2000 Hz Octave Bands)
Patient rooms	0.7
Patient rooms (multiple occupant clinical spaces)	0.7
Medical/Procedure rooms	0.8
Specialty Medical	0.6
Lounge areas	0.8
Circulation, Reception and public Areas	1.0
Shared offices and workspaces	0.8
Private Offices	0.7
Critical Acoustic	0.6
Work utility spaces	ACT ceiling wherever possible
Building services	Acoustic treatment on ceilings of spaces where sound levels are >80 dBA
Atrium	1.5

i. Acoustic treatments will meet the following requirements:

   i. Friable materials are not permitted;

   ii. Acoustic panels that are framed are not permitted; and

   iii. Wall mounted acoustic materials will be mounted on walls with concealed stainless steel tamper resistant fasteners such that they will not be compromised or removed without use of special tools.

9. Operating Rooms with Imaging Equipment

a. Special care will be given in the design of any rooms containing Medical Imaging equipment, such as the CT Scanners. Attention will be paid to:

   i. Limiting floor vibration to meet the structural floor vibration requirements for the imaging equipment; and

   ii. room finishes will be applied to control noise build-up in the space.

b. For rooms containing Medical Imaging equipment, the extent of noise and vibration control detailing will be determined by Design-Builder's Acoustic and Vibration Consultant in

addition to meeting the requirements of Schedule 1.

10. Gym Floor Impact Noise Control

a. Gyms, fitness, wellness, and physical rehabilitation spaces will not be located directly above or beside the following Room Categories (see Table 2):

   i. Patient Rooms,

   ii. Lounge Areas,

   iii. Private Offices,

   iv. Critical Acoustic rooms, and

   v. any other spaces where background noise levels are NC 35 or less or sleep is expected.

b. When gyms, fitness, wellness, and physical rehabilitation spaces are directly above or adjacent to the following space types:

   i. Medical/Procedure Rooms; and

   ii. Shared Office and Workspaces.

c. The gyms, fitness, and physical rehabilitation spaces will require the following:

   i. The IIC rating of the floor finish and floor structure only (i.e., excluding ceilings and underside finishes) will meet a minimum rating of IIC 65;

   ii. Spaces directly below will have a minimum of an acoustic tile ceiling with a minimum CAC rating of 35; and

   iii. Impact noise levels (Lmax) in adjacent spaces will not exceed 35 dBA or 55 dBC.

11. Vibration (General)

a. Design the structural system to minimize the effects of vibration. Vibration is to be limited to acceptable levels for the use, occupancy, and equipment requirements of the spaces.

b. The Acoustic and Vibration Consultant will address and coordinate vibration controls and structural/foundation design with the Structural Engineer and Mechanical Engineer, as necessary to meet the requirements of this Section.

c. Vibration will be controlled to meet the limits specified in this Section and will include consideration of the following sources:

   i. External vibration from road, rail, and any other sources from the surrounding area and from known future sources on the site (e.g., generators, utility building, etc.). See Section 13 for additional detail on road/rail noise and vibration;

   ii. Internal vibration from sources such as mechanical, electrical, elevator, and medical equipment systems and all associated ducts, pipes, conduit, etc. See Section 14 for more detail on mechanical vibration control requirements; and

   iii. Internal vibration from normal expected activities such as footfalls, vehicle traffic (from parking levels), and operational activities or movements such as equipment carts or MDRD activities See Section 12 for additional detail on the modelling requirements.

d. Vibration levels in the Facility will not exceed the more stringent of the limits provided in Table 8 or specific equipment requirements for items such as the CT, MRI, or LINAC systems.

Table 8 - Vibration Limits

Common Classification	Room Categories (see Table 2), Occupancy, or Equipment Requirements	Maximum Vibration Velocity (μm/s)
Residential Day (ISO)	Circulation, Reception, Public Areas Lounge Areas Private Offices Shared Offices and Workspaces Waiting rooms and corridors Washrooms Work Utility Spaces (except where internal equipment or processes require lower vibration)(3)	200(1)
Residential Night (ISO)	Patient rooms and other sleep areas	140(1)
Operating Theatre (ISO)	Medical/ Procedure rooms(3) Critical Acoustic (including ceilings and walls that support video cameras in Multimedia Rooms) Operating Rooms and critical work areas(3) Bench microscopes up to 100x magnification	100(1) (threshold of human perception)
VC-A	Basic Laboratory Bench microscopes up to 400x magnification Optical and other precision balances(3) Optical comparators(3) CT Scanner(3)	50(1)
VC-B	Microsurgery(3) Bench microscopes at magnification greater than 400x(3) Optical equipment on isolation tables(3) LINAC System(3)	25(1)
VC-C	Magnetic resonance imagers (including simulators) and Magnetic resonance imager LINACs(3)	12(2)

(1) Value of constant velocity regions measured in one-third octave bands of frequency range 8 to 100 Hz. Based on ASHRAE, AISC and ISO Criteria. Vibration velocity at 4 Hz is to be limited to 2 times the allowable vibration at 8 Hz. Vibration level depends on walker weight and gait. Appropriate footfall conditions will be applied for the space type under consideration.

(2) Value of constant velocity region measured in one-third octave bands of frequency range 1 to 100 Hz.

(3) Evaluation of internal equipment is required to ensure that the requirements for any vibration sensitive equipment will be met, in which case the most stringent criteria will be applicable.

e. In-situ measurement verification of floor vibration characteristics is to be carried out where specified by the equipment manufacturer and as required in Schedule 1 Section 5.12.12.7(3).

f. A site assessment has been complete by SLR: “New Surrey Hospital Noise and Vibration Baseline” dated November 2020. This report will be reviewed for a clear understanding of the site limitations.

12. Footfall and Vehicle (parking garage) Vibration Modelling

a. A FEM structural model of the building will be constructed with sufficient detail to assess the input and response of the structural system to dynamic loading from various sources.

b. The FEM structural modelling will follow the analysis procedures outlined in CCIP-016 and SCI-P354 or an equivalent standard approved by the Authority.

c. The FEM structural model will be capable of modelling modes up to and including the greater of 15 Hz or the fundamental mode of the bay being analyzed.

d. All unique structural bays supporting Occupied Spaces will be modelled.

e. Footfall modelling will:

   i. Be done in all spaces requiring vibration levels at or below the Operating Theatre Criteria and a sample cross section of other spaces to demonstrate typical performance in typical or 'worst-case' bays and conditions;

   ii. Evaluate fast walking in corridors surrounding spaces of concern. Fast walking is defined as 102-132 steps/minute (1.7-2.2 Hz);

   iii. Evaluate slow walking in vibration sensitive spaces such as patient rooms, offices, ORs, MRIs, etc. Slow walking is defined as 75-108 steps/minute (1.25-1.8 Hz);

   iv. Footfall modelling will be done at increments of 0.1 Hz over the range of walking frequencies defined above in order to capture any structural resonances;

   v. Walking will be modelled with an 85 kg (~185 lb) walker with appropriate adjustments for gait (dynamic amplification factor); and

   vi. Adjustments for impulse input above 10 Hz will be considered as per CCIP-016 and SCI-P354.

f. Vehicle-Induced Vibration Modelling will:

   i. Evaluate the input from vehicle movement in the parking garage into the building structure and into Occupied Spaces;

   ii. The modelling will examine the input based on typical impacts from driving over structural joints and speed bumps (if applicable) with the vehicle response function and will assess results in Occupied spaces beside, below, and above the garage space, especially those spaces requiring Operating Theater Criteria vibration levels or lower;

   iii. The vehicle will be the largest vehicle expected to be used within the structure;

   iv. Appropriate vehicle speed will be considered;

   v. The structural model will be able to analyse appropriate frequencies/modes to capture the response from the modelled vehicle excitations.

13. Road and Rail Noise and Vibration

a. Ensure that vibration levels from rail yard operations and roadway traffic do not exceed vibration levels specified in Table 8 within the Facility.

   i. Vibration from rail yard operations and roadway traffic will be measured to understand vibration levels at the site and soil conditions for estimating site propagation (or based on SLR's report: "New Surrey Hospital Noise and Vibration Baseline" dated November 2020);

   ii. A vibration propagation model will be developed to estimate vibration at various sensitive locations on the property; and

   iii. The vibration propagation model and the FEM structural model of the building (developed in Section 12) will be used to predict vibration levels at the most sensitive spaces within the Facility to demonstrate compliance with Table 8.

b. The design of the façade will be such that the 24-hour Leq inside the Facility is 10 dB less than the dBA/dBC levels listed in Table 6 based on measurements and modelling of road and rail noise.

c. The design of the façade will be such that maximum road and rail traffic noise, with a focus on activities in the rail yard, (LMax, fast) inside the Facility does not exceed the

dBA/dBC levels listed in Table 6 by more than 7 dB based on measurements and modelling.

d. A façade noise intrusion report will be provided to the Authority for review and approval and will include the following:

   i. Measurement details, results, and findings for the Site;

   ii. Modelling methods, assumptions, and results for the Site and Facility;

   iii. Façade noise levels based on measurements and modelling, including variation with distance, direction, shielding, etc.;

   iv. Envelope construction requirements to meet the interior noise limits for all spaces from road and rail traffic noise, including OITC ratings and required areas of the various envelope components (wall, window, etc.), resultant indoor sound levels, and mitigative solutions required to meet the interior noise limits; and

   v. Indicate where glazing rated above OITC 33 is required and the indoor sound level expected with a maximum OITC 33 glazing.

14. Vibration Isolation

a. All rotating equipment will be vibration isolated. Mechanical or electrical equipment that is not properly isolated can transmit vibrations into the building structure, which can in turn radiate as noise throughout the Facility. The following requirements will be met;

   i. Isolators and other vibration control components will, as a minimum, meet the recommendations in ASHRAE, 2015 – Chapter 48 “Noise and Vibration Control”;

   ii. Where the recommendations in ASHRAE, 2015 – Chapter 48 “Noise and Vibration Control” and items within the Statement of Requirements conflict, the higher performance requirement will be met;

   iii. All isolated equipment and components will have seismic and or wind restraints as required by building codes and will be reviewed for compliance by a qualified structural engineer;

   iv. Seismic snubbers or other controls used to limit motion during a seismic or wind event will not interfere with or limit the isolation performance of vibration isolation systems during normal operation;

   v. Select isolators in accordance with equipment weight distribution to allow for an average deflection meeting or exceeding the specified deflection requirements after equipment start-up, and that no single isolator has a deflection less than 75% of the rated static deflection specified;

   vi. A minimum of 4 isolators are required for each piece of equipment;

   vii. Rotating equipment will not be permitted to operate below 600 RPM. This is the lowest rotating speed for which 98% vibration isolation efficiency can be achieved with springs of practical static deflection (4 inches); and

   viii. All hung equipment will utilize spring isolators designed for the weight and vibration characteristics of the equipment, and at the same time will be suitably seismically restrained.

b. Pipes, ducts, conduit and other components connecting to vibrating equipment will meet the following requirements:

   i. Install vibration isolation pump drops on all hydronic pumps, air handling unit drops on air handling units and flexible couplings where required on piping as per manufactures guidelines. Install flexible connectors on all ductwork, piping, and conduit connected to isolated or mechanically vibrating equipment. Where flexible connectors cannot be provided, vibration isolate all of the ductwork, piping, and conduit from the building structure;

ii. Electrical connections will incorporate a length of flexible conduits or cables, that are compliant with Schedule 1 requirements and that include at least one 90-degree bend with slack before connecting to structure. Fuel connections will incorporate a length of braided flexible fuel lines with sufficient slack for movement in all directions to minimize the transmission of vibration from vibrating equipment to other building components and will include at least one 90-degree bend with slack before connecting to structure;

iii. Where pipes, ducts, and conduits leave the mechanical room, penetrations will be sleeved and sealed air-tight with non-hardening mastic or caulk;

iv. Where isolated piping connected to noise generating equipment is routed from the mechanical room through plumbing chases or other openings, there will be no contact with the structure, framing, gypsum wallboard or any other elements which will radiate noise;

v. Pipes connected to chillers will have both flexible pipe couplings/connectors and resilient hangers;

vi. Resilient hangers will be installed on all mechanical room piping and ductwork connected to vibration isolated equipment. Hangers will be included for a distance of 100 pipe diameters or 15 m, whichever is greater. The three closest hangers to the vibration source will be suspended by means of an isolator having the same static deflection as that of the isolated equipment. The remaining isolators will be selected for the greater of 19 mm static deflection or one-half the static deflection of the isolated equipment;

vii. Rigid attachment or direct contact of pipes, ducts, drains or vacuum lines to the structure adjoining noise-sensitive spaces will be avoided; and

viii. Where vibrations are induced in piping or duct work due to air/water flow, the gap between the pipe and the structure will be filled non-hardening mastic caulking. Example Hilti Products are **Hilti CP 601S elastic firestop sealant, Hilti CP 606 firestop joint filler, Hilti Intumescent Firestop FS-One, Hilti CP 611A intumescent firestop mastic and the Hilti CP 657 firestop system.

c. Steam pressure reducing valve stations and their associated piping will be isolated from the structure.

d. Installation of vibration isolation systems will meet the following:

i. Do not attach isolators to equipment or to structure in a fashion which impairs their isolation capabilities or causes any change of position of equipment, piping or duct work resulting in stresses or misalignment;

ii. Rigid connections between equipment, building components, and structure will be avoided through coordination with other trades;

iii. Provide a minimum clearance of 50mm (2”) to other structures, piping, equipment, etc., for all equipment mounted on vibration isolators;

iv. Where hold-down bolts for isolators or attachments penetrate roofing membranes, co-ordinate with roofing contractor;

v. Pumps and piping will be independently supported and aligned prior to final connection such that no piping loads are imposed on the pump;

vi. Flexible duct connectors will be installed such that the duct cross-section is not reduced by the deflection of the flexible connector;

vii. Locate isolation hangers as near to the overhead support structure as possible;

viii. Where mechanical units capable of generating high noise levels are located on a light-weight roof structure, the units will be mounted on a platform above the roof deck to provide an air gap (buffer zone) and locate the unit away from the associated roof penetrations to allow acoustical treatment of ducts before they

enter the Facility; and

ix. Thrust restraints that incorporate the same deflection as isolators will be used for all fan heads, all suspended fans, and all base-mounted and suspended air-handling equipment operating at 2 in. or more total static pressure and restraint movement adjustments will be made under normal operational static pressures.

e. All large mechanical units (fans, AHUS, etc.) will be placed on minimum 100 mm thick housekeeping pads that extend a minimum of 300 mm beyond the footprint of the equipment. Housekeeping pads will be anchored to the building structure and sized to ensure required pull-out strength of mounting bolts is provided and spalling at the edges is avoided.

f. Elevator motors and hoist equipment will be isolated from their supporting structure using rubber pads having a static deflection under load of at least 2 mm. These will include a steel plate on the top of the pad to uniformly distribute the weight of the equipment to the entire area of the pad.

g. Elevator switchgear cabinets will be isolated from the machine room floor and/or wall using rubber pads or isolators having a static deflection under load of at least 2.5 mm. If rubber pads are used for a floor mounted cabinet, these will include a steel plate on the top of the pad to uniformly distribute the weight of the cabinet to the entire area of the pad.

h. Transformers will be vibration isolated using neoprene or steel springs having rated static deflections as shown in Table 9 below.

Table 9: Rated Static Deflection Required for Transformer Isolation

Power Range (KVA)	Slab On Grade (structurally discontinuous slab)	Slab On Grade (structurally continuous slab)	Elevated Slab
Under 45	3 mm	3 mm	3 mm
45-225	3 mm	3 mm	5 mm
225-750	5 mm	25 mm	25 mm
Over 750	25 mm	25 mm	25 mm

i. Electrical connections to vibration isolated equipment will be made with flexible conduit or other flexible means so as not to restrict the maximum anticipated movement of the equipment under the design seismic excitation.

j. Electrical connections will incorporate a length of flexible conduits or cables, that are compliant with Schedule 1 requirements and that include at least one 90-degree bend with slack before connecting to structure.

k. Noise and vibrations of electrical equipment / components (transformers, luminaries, cables etc.) will not exceed the permissible NC levels listed in Table 6.

l. All engine driven generators will have spring isolators providing a minimum static deflection of:

i. Slab on grade: 25 mm
ii. Suspended slab (up to 6 m span): 38 mm
iii. Suspended slab (6m-9m span): 64 mm

m. Generator sets will be mounted on spring isolators and inertia bases so as to control movement during start-up and loading changes and the transmission of vibration into the building structure so that the resulting vibration levels experienced throughout the Facility and the Hospital Campus do not exceed the limits specified in Section 11.

n. Fuel connections will incorporate a length of braided flexible fuel lines with sufficient slack for movement in all directions to minimize the transmission of vibration from vibrating equipment to other building components and will include at least one 90-degree bend with slack before connecting to structure.

15. Acoustic Testing and Verification

a. Refer to Schedule 1 Section 5.6.22 Acoustic and Vibration Performance Testing for testing and verification requirements for acoustical performance.