

## 4 Hydraulic Services – Noise and Vibration

Refer also to acoustic details – Appendix 1

### 1 Application of this specification

The requirements or standards constrained within this acoustic specification are in addition to any other non-acoustic requirements such as structural integrity, fire rating, material, compatibility etc.

Where the acoustic requirements or standards contained in this specification exceed those stated in another specification or drawing then the requirements of this specification shall override the other requirements. Where multiple performance requirements are stated the systems installed shall comply with all requirements.

Install all systems in accordance with the manufacturer's requirements and recommendations unless this specification required a higher standard.

### 2 Noise Criteria

#### *Internal Noise levels*

Noise from hydraulics plant inside the development shall not exceed the levels given below. Unless stated otherwise, the noise level criteria shall not be exceeded with the plant operating under normal operating conditions, and at start-up for intermittently operating plant items. Maximum noise levels in typical areas are listed in the table below:

Space/Activity Type	Noise Level dB(A)Leq
Wards	35
Consult Rooms, Meeting, Procedure, Private Office, Interview	40
Operating Theatre, Open plan office, Staff Room, Recovery	45
Lobby / Reception	45
Toilets / Store Rooms	50

**Table 14 – Recommended Design Internal Noise Level Criteria for different areas**

Noise within rooms shall be free of tones or other undesirable characteristics.

#### *Noise during a Fire Emergency*

Noise from all plant during a fire emergency shall comply with the requirements of the local Standard or requirements. As a guide, noise levels during a fire emergency should not exceed 80 dB(A) within fire isolated passageways or 65 dB(A) within occupied spaces. Noise levels inside the fire control room shall not exceed 65dB(A) during a fire emergency.

#### *External Noise Levels*

Intrusiveness criteria permit noise generation to be no more than 5dB(A) above existing background noise levels.

Location	Time of Day	Background noise Level – dB(A)L90	Intrusiveness Noise Objective dB(A)Leq(15min) (Background + 5dB)
	Day Time (7am - 6pm)	38	43
	Evening (6pm - 10pm)	38	43
	Night (10pm - 7am)	31	36

**Table 15 – Intrusiveness Assessment**

### INP - Amenity Assessment

The Amenity criteria set additional criteria based on the land use of the noise sensitive receivers. Amenity criteria are as follows:

Receiver Location	Land Type	Time of Day	Amenity Noise Objective dB(A) Leq(Period)
All Potentially Affected Residential Properties	Suburban	Day Time (7am – 6pm)	55
		Evening (6pm – 10pm)	45
		Night (10pm-7am)	40
Commercial		When in use	65

**Table 16 – Amenity Assessment**

### Outdoor Areas on the Development Site

Noise emissions to external areas on the site are to comply with the specified levels below:

- Public Spaces (areas where people may sit): <55dB(A)Leq
- Public Spaces (thoroughfares): <60dB(A)Leq

## 3 Plant Noise Levels

It should be ensured that systems are installed, adjusted and balanced so that excessive noise is not created, and the scheduled internal and external noise levels are complied with.

### Noise Generated by Hydraulic System

Noise from the hydraulics system should be minimised by:

- Limiting pipe velocities in water systems to not more than 1.5m/s.
- Laying out pipes to minimise the number of changes in direction and installing pipes so that the effective cross-sectional area of the pipe is maintained at pipe bends and junctions.
- Selecting valves and fittings that minimise the generation of noise.
- Installing pressure reducing stations as required to eliminate excessive pressure at the terminal valves.
- Controlling structure-borne noise (i.e. plant and pipe vibration transmitted into the building structure) with the use of plant isolation mounts, resilient sleeves, etc
- Routing piping to avoid noise sensitive locations such as meeting rooms.
- Provision of water hammer arrestors in reticulation piping to dishwashers and washing machines.
- Fixing piping and caulking stud penetrations to prevent pipe movement within studwork.
- Locate waste pipes floor penetrations so that they do not fall within or near sound rated walls.

- Do not run piping along the head of walls, or in front of the head of sound rated walls that prevents access to the wall for caulking.

## 4 Vibration Criteria

### General Areas

Vibration levels caused by activities on the site (including plant) should not exceed the levels specified in the EPA document “Assessing Vibration Guideline” at any place of different occupancy at and around the site. The Assessing Vibration guideline provides operational vibration criteria for maintaining human comfort within different space uses.

The Assessing Vibration Guideline recommends maximum weighted vibration levels for continuous vibration sources, such as mechanical services plant, and for impulsive vibration sources. The weighted curves outlined in the British Standard BS 6472:2008 “Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)” includes guidance for the assessment of human response to building vibration including continuous vibrations caused by mechanical plant and equipment.

Human response to vibration has been shown to be biased at particular frequencies which are related to the orientation of the person. This standard provides curves of equal annoyance for various orientations. These curves are applied as correction filters such that an overall weighted acceleration level is obtained. As the orientation of the resident is unknown or varying the weighting filter used is based on the combined base curve as given in ISO 2631 & Australian Standard 2670 “Evaluation of Human Exposure to Vibration and Shock in Buildings (1 to 80Hz)” which represents the worst case of the X, Y and Z axes. Filtered measurements are made in all three co-ordinate axes and the highest value axis used.

The standard assesses the annoyance of intermittent vibration (which are generally associated with vibrations induced by trains etc.) by using the Vibration Dose Value (VDV). Alternatively the VDV may be estimated by the eVDV which is derived by a simpler calculation using an empirical factor. The VDV or eVDV is calculated for the two periods of the day being the “Daytime” (7am-10pm) and “Night time” (10pm-7am).

The vibration limits recommended for maintaining human comfort in residences and offices are shown in the table below.

Location	Maximum z-axis weighted RMS vibration acceleration (m/s <sup>2</sup> )		Vibration Dose Value (m/s <sup>1.75</sup> )
	Continuous	Impulsive	Intermittent
Inpatient Unit/ ICU/ CCU	0.010	0.30	0.20
Office areas	0.020	0.64	0.40
Workshops	0.040	0.64	0.80

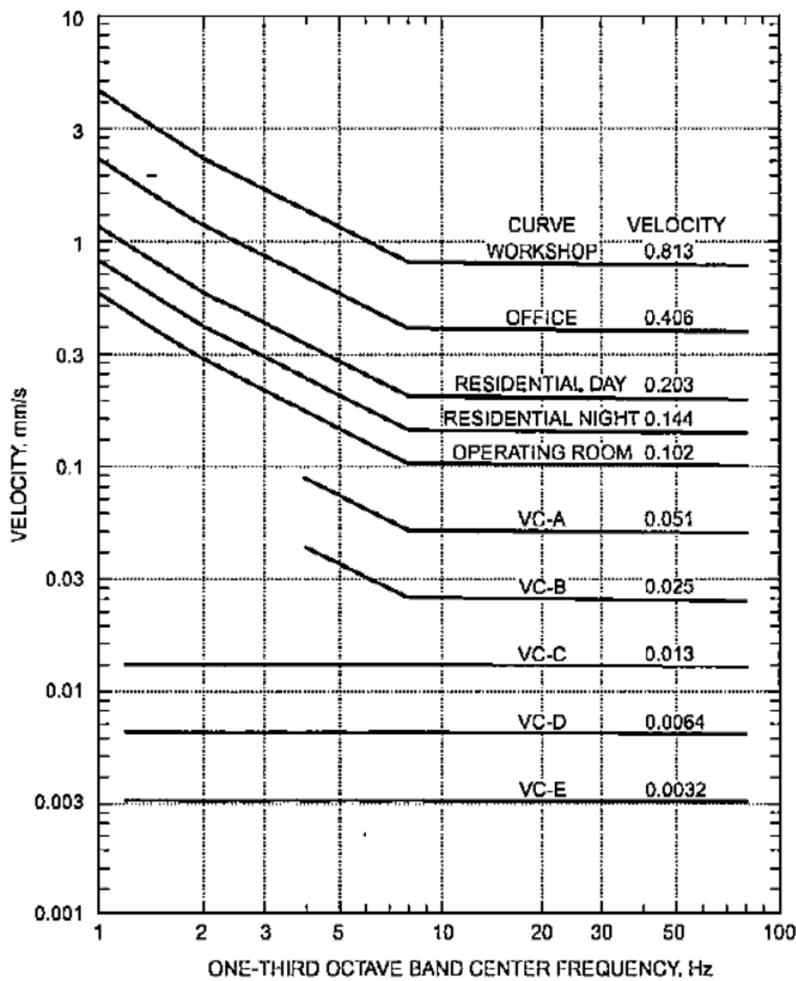
**Table 17 – Vibration Limits for different types of occupancy**

### Critical Areas

Recommended vibration criteria for critical areas of the hospital development are as follows.

- Theatres – R1 (“Operating Room”) curve.

Relevant curves are extracted below.



**Figure 10 – ASHRAE Equipment Vibration Criteria**

Note:

- When the vibration source is constant (as generated by plant), the rms (average) level is to be used.
- When the vibration source is intermittent (as generated by footfall during normal walking), the rms (max 1 second) level is to be used.

## 5 Ameliorative Treatments to Structure Borne Noise and Vibration

Minimise the transmission of vibration to the building structure to ensure the noise and vibration criteria are achieved by:

- Statically and dynamically balancing rotating plant and equipment. Out of balance shall not exceed 0.03mm kg/kg of rotating element after installation. Where specified, provide balancing test certificates.
- Providing isolation mounts or hangers for vibrating plant and equipment.
- Providing inertia blocks where required to limit the vibration amplitude.
- Isolating piping, electrical conduit, etc subject to vibration from the building structure.
- Providing flexible connections where piping is connected to vibrating plant and machinery.
- Where pipes is fixed to stud walls no part of the piping, fixtures and valves or noggings to support the pipes and valves shall contact or bridge between the stud wall and any other independently supports wall element.

## Anti-Vibration Mounts and Isolators

### Selection of Equipment Isolation Mounts

Select isolation mount type and minimum static deflection according to the following table (refer above for isolator types).

Plant	Isolator type	Minimum static deflection
Small Vertical and In-line Pumps < 1 kW motor	M3	10 mm
Pumps > 1 kW motor	M4	25 mm
Water tanks	M1/H1/HE1	2 mm
Boilers	M2	6 mm
Hot water units	M2	6 mm
Electric Fire Pumps	M3	10 mm
Diesel Fire Pumps	M4	25 mm

**Table 18 – Isolator Schedule**

#### Isolation Mounts

##### Type M1 - Waffle Pad Mounts

Waffle pad mounts shall be: minimum 17mm thick neoprene rubber (nitrile rubber where oil contamination is possible); cross ribbed with alternately raised ribs on both faces of the pad; loaded within the load range of the isolator with a minimum static deflection of 1.5mm.

##### Type M2 - Multiple Layer Waffle Pad Mounts

Multiple layer waffle pad mounts incorporating; specified number of layers of Type M1 Waffle Pad Mount; 1.5mm thick metal shim plate between the pad layers; minimum 1.5mm static deflection per layer.

##### Type M3 - Neoprene Mounts

Neoprene mounts should be selected to give the static deflections under load nominated for the item of plant and incorporate: separate steel top and base plates completely embedded in elastomer; elastomer colour coded for identification of load rating; non-skid mounting surfaces; bolt holes for bolting down plant.

##### Type M4 - Spring/Neoprene Mounts

Spring/neoprene mounts should be selected to give the static deflections under load nominated for the item of plant and: be laterally stable without any housing or other lateral support; be capable of an additional travel to solid of at least 50% of the rated static deflection; incorporate a levelling facility; a spring diameter not less than 0.8 of the loaded height; incorporate a 6mm thick neoprene base pad to isolate acoustical frequencies. Isolators exposed to weather should have zinc plated springs and housings coated with a flexible epoxy to prevent corrosion.

#### Isolation Hanger Types

##### Type HE1 - Neoprene Hanger Elements

Neoprene hanger elements should be selected to give the static deflections under load nominated for the item of plant and incorporate: separate steel top and base plates completely embedded in elastomer which should interlock in the event of fire or mechanical failure; elastomer colour coded for identification of load rating; hole for locating hanger and a lip to locate the element within in the mounting hole.

##### Type H1 - Neoprene Hangers

Neoprene hanger elements should be selected to give the static deflections under load nominated for the item of plant and incorporate: Type HE1 - Neoprene Hanger Element located within a galvanised steel cage with provision for threaded hanger rods to screw into the hanger element;

provide sufficient clearance around the threaded hanger rod to ensure it cannot touch the hanger cage.

### **Type H2 - Spring/Neoprene Hangers**

Spring/neoprene hangers should be selected to give the static deflections under load nominated for the item of plant and: be laterally stable without any housing or other lateral support; be housed in a galvanised steel cage; be capable of an additional travel to solid of at least 50% of the rated static deflection; incorporate a levelling facility; a spring diameter not less than 0.8 of the loaded height; incorporate a neoprene base pad to isolate acoustical frequencies. Isolators exposed to weather should have zinc plated springs and housings coated with a flexible epoxy to prevent corrosion, and self-draining cups.

### **Piping Isolation Mounts**

Piping within 15m of any pump shall be vibration isolated using type M4 or H2, 25mm static deflection isolators; type M3/H1, 10mm static deflection mounts elsewhere within 20m of the pumps or chillers.

Isolate any other small diameter piping runouts to fan coil units further than 20m of the pumps using a flexible 12mm thick foam sleeve between the pipe and the clamp (2 layers) fitted between the pipe and the clamp. The clamp should then be tightened just sufficiently to hold the pipe, but not over tightened.

### **Resilient Pipe Sleeves**

Where required, install resilient pipe sleeves between the pipe and pipe clamps to isolate pipe vibration from the clamps. Sleeves should be 12mm thick foam (2 layers) fitted between the pipe and the clamp. The clamp should then be tightened just sufficiently to hold the pipe, but not over-tightened.

### **Flexible Pipe Connections**

Flexible connections shall be fitted to all pump piping connections. These shall be twin sphere reinforced-rubber elements, be capable of withstanding internal pressure and other forces and be compatible with the fluid in the pipe.

### **Equipment Bases**

Pumps shall be installed on concrete plinth which itself is isolated from the structural slab on a layer of 10mm thick matting. The mass of the plinth shall be at least 1.5 times the mass of the equipment being supported including pipe fittings, etc. Bases shall minimise the height of the centre of gravity of the machine/base.

25mm static deflection spring isolator required between the plinth and the pump base.

### **Installation of Vibration Isolation Mounts**

The mounts shall be levelled once the equipment is fully loaded in its operating condition with a minimum clearance between the machine and the structure of 15mm, and adjusted to ensure that the isolators are loaded correctly. Ensure that the isolators are not bridged by mounting bolts or contact between any part of the machine or an unisolated part of the isolation mounts and the structure.

The number and spacing of the mountings shall be selected to minimise machine rocking. Static and dynamic forces during operation and start-up shall be considered when selecting the mounts.

During construction, pump isolation mounts shall be bridged with a timber block to prevent the possibility of overloading of the mounts during the installation of the piping.

Piping hangers and mounts shall be adjusted so that there is minimum strain on piping with the system operating in its normal condition.

Where there is a possibility of significant lateral loads occurring use hold down bolts, lateral restraints, or housed mounts to locate equipment.

## 6 Penetrations

### General

- Decrease the sound rating isolation rating of the wall, floor, etc.
- Allow the transmission of vibration from pipes and ducts to the wall, floor, etc.

### Pipe Penetrations

Seal pipes penetrating slabs or walls, as follows:

Project noise criterion in adjacent spaces	Seal type
Domestic water within 25m of Pump	Type PB seal
Elsewhere including waste pipes	Type PA or PB seal

**Table 19 – Pipe Penetration Seal Types**

Where the building element penetrated consists of one or more leaves then all leaves shall be acoustically sealed.

### Location of Penetrations in Acoustically Rated Walls

Where possible where pipes and cables running though ceiling voids enter or pass through an acoustically rated wall (or pass into a wall cavity forming part of an acoustically rated wall) the pipes/cable shall be as close as possible to the head of the wall.

Locate pipe and duct penetrations away from corners and other inaccessible locations that prevent access to seal the penetration.

## 7 Waste and Stormwater Pipes

The following schedule provides the recommended acoustic treatment to piping. Refer also to Part G - Appendix I for detailed drawings.

Service	Location*	Pipe Treatment
Waste Piping / Stormwater Piping (not siphonic)	Meeting Room, Office/Open Plan Office, Consult, Theatre, Interview, Lounge, Staff room, Waiting area	Pipes wrapped with Acoustic Supplies 5 kg/m2.
	Meeting Room, Office/Open Plan Office, Consult, Theatre, Interview, Lounge, Staff, with perforated/slotted ceiling below	Pipes wrapped with 2 layers of Acoustic Supplies 5 kg/m2.
	Lobbies/waiting areas with perforated or slotted ceiling below.	Pipes wrapped with Acoustic Supplies 5 kg/m2.

	Wards/In-patient units.	Pipes wrapped with Acoustic Supplies 5 kg/m2.
Siphonic Drainage	All Areas	Pipes wrapped with Acoustic Supplies 5 kg/m2. Wrap with 2 layers if located over perforated/ slotted ceiling.

**Table 20 – Acoustic Treatment to Waste and Stormwater Pipes Generally**

\*If the walls around the rooms nominated do not run full height – lagging should extend minimum one metre past the line of the wall below.

Pipes required to be externally lagged using 5 kg/m2 loaded vinyl shall have an outer aluminium foil backing. The loaded vinyl shall be separated from the pipe with a layer of minimum 25mm thick open cell foam. Overlap all joints by minimum of 50mm and tape airtight with aluminium tape. In addition all pipes which are required to be lagged which penetrate slab soffits, walls, risers or like shall have the pipe lagging flanged (minimum 50mm lap) to the meeting surface or sealed with a flexible sealant equal to Bostik 2637.

All waste pipes shall be kept a minimum of 20mm clear of any part of the structure including walls, ceilings, ceiling hangers, etc. Waste pipe penetrations shall be sealed as recommended above for pipe penetrations. Mortar or render should be kept clear of the penetrations so as to prevent any bridging between the pipe and the wall.

## 8 Electrical

### *Belt Driven Plant*

Belt driven intermittently operating plant having motors rated at greater than 2.5kW shall be fitted with motor starters that limit the build-up in motor speed at start-up. These are required to eliminate the possibility (especially in the future after belt wear has occurred) of belt squeal being audible in occupied spaces having a noise criterion of 45dB(A) or lower, on adjacent properties and on residential terraces/external spaces.

### *Electrical Wiring*

Individual electrical cables can be sealed with Selleys Proseries Fireblock sealant or equal. Bunches of cables shall be drawn through a 5mm thick, 600mm long PVC conduit packed with polyester fibre, fibreglass or rockwool insulation. Seal around the conduit by filling with a non-shrinking grout or flexible polyurethane sealant

### *Contactors/Starters/Controllers*

Noise from contactors, starters and controllers shall be inaudible inside rooms having a noise of 45dB(A) or lower, on adjacent properties and on residential terraces/external spaces. Provide enclosures around these items and/or vibration isolate the items from building elements where they may give rise to the transmission of structure-borne noise.