BULLETIN

BRANZ
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PREVENTING NOISE IN PLUMBING INSTALLATIONS

- The movement of fluids through pipework will always generate some noise.
- The subjective effects of that noise will determine the level of nuisance to users.

1.0 INTRODUCTION

1.0.1 The transport of fluids through a pipe system will always generate sound energy, due to vibrations caused by the mechanical forces involved. Much of this sound goes unnoticed, but when it impinges on the enjoyment of those working, sleeping or relaxing within a building it is referred to as noise.

1.0.2 The subjective effects on different users of the same level of noise can vary widely. There is no standard measure for the level of nuisance caused by noise. Sounds generated within pipework are unlikely to reach levels which could be a health hazard but they may still cause a substantial loss of enjoyment, particularly to people highly sensitive to them. Noise can also be embarrassing to building owners or users, especially when associated with sanitary plumbing.

1.0.3 Noises generated by poorly designed pipework within a completed building structure are often very difficult to eliminate or reduce. Noise travels much faster in water and will travel greater distances than airborne sound. Once generated, noise can also pass through or react with the building structure and be either amplified or reduced, altering the perceived level for the building user.

1.0.4 Noise produced within the plumbing system is carried by:

- vibrations directly through the air
- through the pipework itself to other areas of the building
- through the structure as structure-borne noise
- transfer to a building element, e.g. wall lining, which may amplify the noise.

1.0.5 Protection against noise generation should be a basic responsibility of both the designer and installer of the pipework.

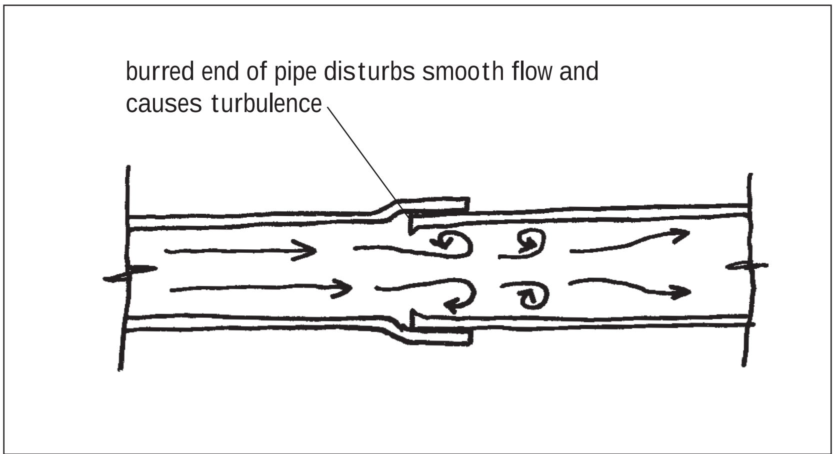

Figure 1. Turbulence in badly made joint.

1.0.6 The causes of noise in plumbing services are related but different for:

- high pressure/ high velocity systems
- low pressure systems
- outlets and fittings
- gravity discharge systems.

2.0 HIGH PRESSURE SYSTEMS

2.0.1 A high pressure water system is any water system operating at or more than a pressure of 300-400kPa.

2.1 Turbulence

2.1.1 Turbulence is the main cause of noise in high pressure systems and is caused by changes in direction, interruptions to flow patterns or variations in the speed of the transported liquid. These changes will occur in joints, bends, alterations in pipe size and other interruptions to the smooth flow of the liquid (Figures 1 and 2).

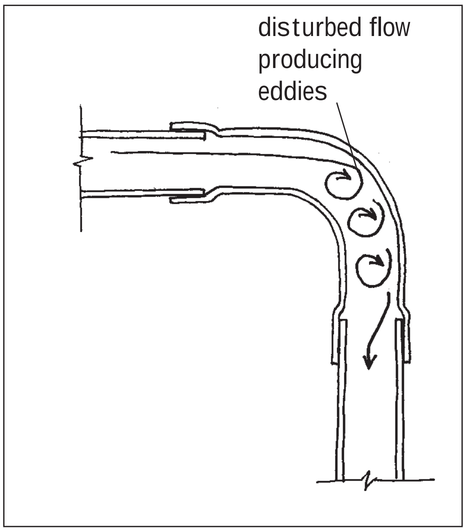

Figure 2. Turbulence in change of direction.

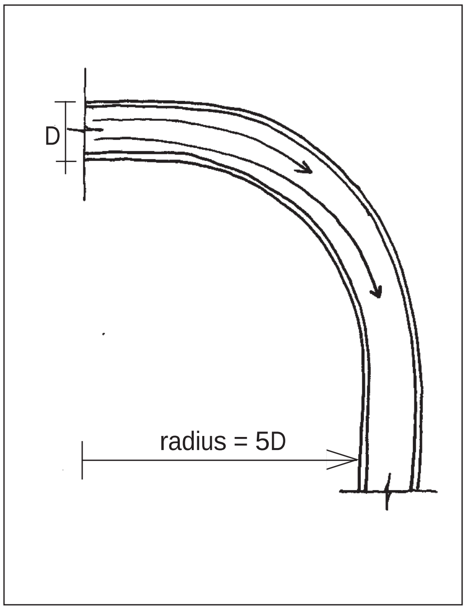

Figure 3. Smooth flow through large radius bend.

2.1.2 The higher the pressure or speed and the more sudden the change to the smooth flow of the liquid, the more noise will be produced.

2.1.3 Turbulence within the liquid can be evidenced externally by the vibration of pipework or the noise produced. The sound can vary markedly in both amplitude and frequency, from a high-pitched scream to a low frequency buzz. High frequency noise will generally be transmitted within the pipework and will be heard over some distance, possibly several rooms away, with lower frequency sounds often transmitted through the structure.

2.1.4 Turbulence-induced noise may be reduced by:
- forming bends in pipes with a radius at least five times the diameter of the pipe i.e. 50 mm minimum radius bend for a 10 mm diameter pipe (Figure 3)
- using tapered joints and avoiding ridges or hollows in pipe walls
- using smooth bore pipes and avoiding burred edges which would interrupt the flow (Figure 4).

2.2 Water Hammer

2.2.1 Water hammer occurs in high pressure systems when a large column of liquid is backed up behind a fitting. A sudden variation in flow rate causes large fluctuations in pressure because water does not compress and is unable to dampen the forces involved. These pressure fluctuations set up shock-waves through the pipework known as 'water hammer'. Water hammer can be very loud, especially where pipework is able to move and strike the structure. It is most common in copper piping, which is less flexible than plastic piping, but now occurs less frequently than when the use of galvanised steel pipe was widespread.

2.2.2 Fittings which can cause this shock are: plug taps, spring-closing valves (as in drinking fountains), quick-acting single lever or ceramic disc taps and washing machine and dishwasher solenoid valves.

2.2.3 Water hammer can also come from an external source, e.g. jumpers in the boundary toby, high-volume swimming pool float valves.

2.2.4 Water hammer can be eliminated by one or more of the following:
- reducing the pressure on the fitting inducing water hammer
- using a slower acting valve or tap
- fixing the pipework rigidly to the structure to prevent movement

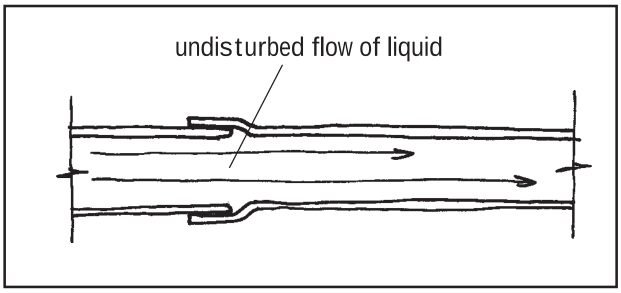

Figure 4. Smooth flow through well-made joint.

- providing a relief bend or flexible section to absorb the shock
- fitting a proprietary water hammer arrester as near as practicable to the offending fitting.

2.3 Fittings-Induced Noise

2.3.1 Fittings such as taps, stop cocks, float valves, tees and bends vary widely in flow characteristics, especially when taps or valves are only partially open. Modern fittings are quieter than older ones due to improved design, but all fittings are a potential source of noise (Figure 5).

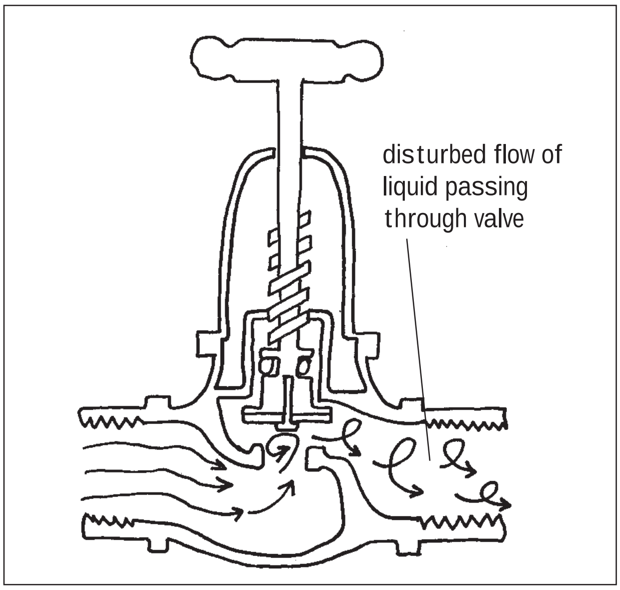

Figure 5. Disturbed flow of liquid passing through valve.

2.3.2 Tap washers at an advanced stage of wear can become loose on the spindle and rotate causing loud, high frequency vibrations which will 'sing' through the pipework and be felt at the tap.

2.3.3 Float valves which have lost their silencer pipes will sometimes cause waves in the surface of the water within a cistern. These waves will cause the ball valve to fluctuate between open and closed and set up pressure waves within the pipework supplying the valve. Should these oscillations harmonise with the natural frequency of the column of water supplying the fitting, quite large vibrations can be set up.

2.3.4 Fittings-induced noise can be reduced, or the effects minimised by:

- reducing water flow through a fitting by reducing the supply, e.g. turning down the isolating valve to the WC cistern
- reducing pressure to a fitting by installing a pressure limiting valve
- choosing fittings to match the expected pressures and flow rates
- siting cisterns, supply tanks and other containers away from noise-sensitive areas.

3.0 LOW PRESSURE SYSTEMS

3.1 Splashing

3.1.1 Splashing will occur when a piped liquid falls onto a hard surface or another volume of liquid. This occurs in low pressure systems feeding storage tanks, cisterns or other containers by means of a float-controlled valve where an air gap is required to prevent back-flow, as required by NZBC G12/AS1.

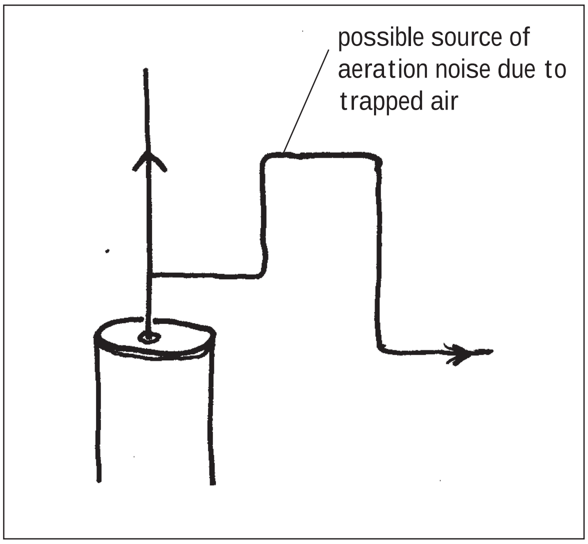

Figure 6. Avoid loops in pipework which may trap air.

3.1.2 Splashing sounds can also occur where a liquid drops vertically through a large diameter pipe and strikes an abrupt change in direction. This situation exists in gravity discharge pipes and stormwater systems when the liquid separates from the wall of the pipe and is able to free fall.

3.1.3 The level of sound produced by splashing is normally low but users may be highly aware of its occurrence if associated with sanitary plumbing. Large diameter (100 mm or larger) plastic pipes are prone to splashing noise due to their low mass.

3.1.4 Downpipe or other rainwater-associated noises are generally more noticeable at night when ambient or background noises are low.

3.1.5 Reduce splashing or impact noise by:
- using flexible pipe supports which will deaden the noise
- forming junctions in discharge pipes and stacks with a bend, not a tee intersection, to smooth the flow
- not allowing stormwater to free fall (bend or slope)
- isolating or sound insulating supply/ storage tanks or cisterns.

3.2 Thermal Movement

3.2.1 Noise can be produced in discharge pipework due to sudden expansion or contraction in the length of pipework, caused by changes in the temperature of the liquid being transported.

3.2.2 Noise produced from this source is normally the result of friction or impact on some other part of the structure or associated fitting as the pipe expands or contracts. PVC discharge pipes used for kitchen and bathroom waste pipes are a common source of this type of noise.

3.2.3 Reduce thermally induced noise by:
- providing for expansion where temperature changes are anticipated
- ensuring pipes subject to thermal movement do not rub or scrape on the structure or fittings but have space to move or a support collar which allows movement.

3.3 Aeration

3.3.1 Air bubbles in water cause a significant increase in water-flow noise. This normally occurs in discharge systems which are running close to capacity at changes in section or flow direction or in hot water systems which are poorly laid out.

3.3.2 Reduce aeration noise by:
- providing adequate venting by means of vent pipes
- avoiding disruptions in flow
- designing the system to sweep away entrained air, avoiding the accumulation of air pockets
- avoiding pipe loops in low pressure systems which can trap air (Figure 6).

4.0 OTHER CAUSES

4.1 Boiling

4.1.1 Boiling can occur in any system with an uncontrolled heat source such as a wet-back or boiler. Such systems are open vented and the convection flow of heated water is unrestricted.

4.1.2 Boiling temperatures in uncontrolled systems can be reduced by:

- sizing the wet-back element and water storage capacity to match its use
- controlling the heat output at the source.

4.2 Appliance-Induced Noise

4.2.1 Plumbing-related appliances such as dishwashers, washing machines, centralised vacuum systems, pumps etc are often the source of high levels of noise. This is due, not only to water or fluid-related noises, but also to the mechanically induced vibrations caused in their operation.

4.2.2 Appliance noise can be minimised by:

- siting away from noise-sensitive areas
- mounting appliances firmly to a slab or other 'heavy' structure
- providing flexible mountings to dampen out vibrations
- avoiding out-of-level mountings.

5.0 PREVENTING NOISE

5.0.1 To minimise noise and nuisance from plumbing installations generally:

- ensure that flow velocities do not exceed 3 m/s
- avoid loose or flexible hangers for all pressure systems
- fix pipework with adequate clearances to the building structure
- provide pipe supports as required by NZBC G12/AS1 (water supply pipes) and G13/AS1 (foul water)
- allow for thermal movement
- separate likely sources of noise from quiet areas
- avoid unnecessary joins and bends
- ensure cut ends of pipes are not burred but are left full-bore
- make changes in direction with swept bends
- avoid penetrations in noise control building elements between units — NZBC G6 1.01 (c)
- avoid rigid connections to noise control building elements — NZBC G6 1.01 (c)
- comply with NZBC G1 3.2 (e) to prevent nuisance to occupants in adjoining spaces.

6.0 CODES AND STANDARDS

Building Industry Authority, Wellington
New Zealand Building Code Handbook and Approved Documents, E2/AS1, G1 3.2 (e), G6 1.01 (c), G12/VM1 and AS1, and G13 AS1.

Standards New Zealand, Wellington
NZS 7643 Code of practice for the installation of unplasticised PVC pipe systems
NZS/AS 3500.0 Glossary of terms
NZS/AS 3500.2 Sanitary plumbing and drainage
NZS/AS 3500.2.2 Acceptable solutions

Australian Building Codes Board
Building Code of Australia for class 2 to class 9 buildings
Part F Health and amenity - F5 Sound transmission and insulation.

7.0 FURTHER READING

BRANZ Bulletins
299 Plastic piping – types and properties
300 Plastic piping – installation

8.0 CREDITS

BRANZ acknowledges the input by way of critical comment to this Bulletin from:

Derek G Staines, Wellington.
Eric Palmer, Wellington.
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John Sutherland, Auckland.

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