Pilkington Float Glass Plant Noise Control

Environmental Noise Control Case Study

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In this case study we have set out to illustrate some of the problems and noise control methods that are routinely used by practising acoustical engineers to reduce environmental noise emission from a large engineering works. The mathematics on the reflection, diffraction, transmission, absorption, diffusion and dispersion of sound are both complex and fascinating and form an integral part of every noise control project. In this case study we have preferred to look at the why's and the how's of noise control on a major project, rather than get caught up in the mathematical intricacies of sound propagation. The principles of noise control are much the same whatever the size of plant involved. However, a float glass plant worth over $80M is large enough and noisy enough to be a trifle daunting. Overcoming some of the problems required more than a little ingenuity.

On 14 May 1987 the Minister for Planning and Environment, Mr Bob Carr (now Premier of NSW) approved a development application by Pilkington ACI to establish a Float Glass Plant on a green field site at Ingleburn, NSW. One of the conditions of consent was:

"The Applicant shall install noise control equipment in accordance with the requirements of the State Pollution Control Commission and the development shall be operated so as not to exceed noise levels approved by the Commission." Pilkington chose to leave the resolution of this seemingly innocuous requirement to the acoustical engineers at Day Design Pty Ltd.

The new Float Glass Plant location is approximately 1 km from the nearest quiet residential area in Ingleburn (to the South of the plant) and 400 metres from the nearest residential premises at Denham Court (to the North of the plant near the M5 Motorway). Undeveloped industrial land was located on either side.

In July 1987 the State Pollution Control Commission set L10 noise contribution limits at nearby residences at 38 and 43 dB(A) respectively for night-time and day-time operation of the plant.

Solving any large problem is often best achieved by reducing it to a number of more easily digested bite-size problems. We considered the plant in the following seven smaller segments:

Services Plant Room
Fin Fan Coolers
Furnace Building
Bath Building Lehr Building
Cullet Transfer Building
Batch Plant

Late in 1987 we were handed a set of architectural plans and given the best wishes of the project managers, Howie Herring & Forsythe Pty Ltd and asked to prepare a Noise Impact Report, complete with recommendations for cost-effective control of noise from the plant.

The starting point in preparing a Noise Impact Report is to find out how much noise the proposed development is going to produce. We determined the sound power levels for all major items of plant either by measuring the sound levels at a similar Pilkington float glass plant in Melbourne, or by obtaining sound power data from fan and other equipment suppliers. Determination of sound power levels of machinery operating inside or adjacent to factories cannot be achieved using classical laboratory or free field techniques. Over the years we have developed our own techniques for fast and accurate determination of sound power levels inside semi-reverberant factory areas and near large reflective surfaces.

Predicting the level of noise intrusion at nearby residential premises involves mathematical modelling on computer. We used our own well-proven custom-written software to estimate noise emission from the seven items of plant, making due allowance for distance loss, building element sound transmission losses, barrier losses, land topography effects, silencer insertion loss, directivity losses, molecular absorption, temperature inversion effects, wind refraction, etc, assuming the "worst atmospheric condition".

The predicted typical maximum level of noise emission from the float glass plant (without noise control) was found to be to be in the order of 60 dB(A) at nearby residences. To limit the L_{A10} noise emission to 38 dB(A) required 22 dB(A) noise reduction.

1. Services Plant Room

Float glass manufacturing is a continuous operation. Molten glass is drawn out of the furnace continuously, conditioned and cooled in the Lehr, then cut into large panels for distribution, or broken and recycled. Once started, the plant must operate 24 hour per day, 365 days a year, and can only be closed down (at great cost) for major furnace refractory repairs, etc. To cope with the possibility of electrical power failure a number of large standby diesel alternators and diesel pumps are required. These are housed in a Services Plant Room. Noise control was achieved by means of masonry walls, metal deck roof, insulated plasterboard ceiling, silenced cooling-air intake and discharge ducts and tandem engine exhaust silencers. Plant room doors were of solid-core timber fitted with acoustic seals. Ventilation openings were fitted with duct silencers.

2. Fin Fan Coolers

The float glass manufacturing process requires the dissipation of large amounts of heat. This is achieved by large air cooled fan-coil units termed Fin Fan Coolers by their suppliers Jord Engineers Pty Ltd. The initial proposal by Jord Engineers was for the supply of a set of six 4 metre diameter Fin Fan Coolers (running at 220 rpm) with a potential contribution of 55 dB(A) at the nearest residential area. The cost of erecting an acoustic enclosure with air intake and discharge silencers to reduce the noise by almost 20 dB(A) was estimated to be almost $200,000. The suppliers were approached with the problem and it was found more economical for them to offer a set of four 6.7 metre diameter Fin Fan Coolers (running at 70 rpm) that did not require any further noise control. Measurements by Day Design after commissioning of the plant confirmed that the 20 dB(A) noise reduction was achieved by this simple and cost-effective expedient.

Many engineers are skilled in the use of fan laws to predict noise emission for various diameters and speeds. A better selection at the initial design stage is often the most cost-effective method of controlling fan noise. A constant and bitter complaint of acoustical engineers is that we are not consulted early enough to influence the equipment selection. Too often the design team has the afterthought: "perhaps we had better call in an acoustical consultant to check the noise levels". Sometimes the equipment is on order and the only recourse is an expensive enclosure complete with duct silencers. Fortunately, this was not the case with the Pilkington Float Glass Plant at Ingleburn, NSW.

There is a danger of fatigue-failure when using large diameter aluminium blade rotors. In this case we made sure that the natural resonant frequency of the blades did not coincide with the forcing frequency of the fan. There has been no problem with blade fatigue-failure.

3. Furnace and Bath Buildings

The heart of the float glass plant is the gas-fired glass furnace, where the raw stock materials are melted down to glass and then floated out over a bath of molten tin into the Lehr. The furnace employs a dual regenerative combustion system in which the primary and secondary combustion air is pre-heated by passing through a refractory lined regenerator. Most of the combustion noise is contained within the heavy refractory-lined walls of the furnace.

Dissipating the excess heat from the furnace is a major problem. The furnace building was designed with a large expanse of open louvres in the furnace-building walls to allow the entry of cooling air. These large ventilation openings in the walls made the containment of noise very difficult. A 14m x 36m vertical-discharge Robertson natural draft Roof Monitor vent was provided to allow the discharge of hot air. Noise emission from this vertical-discharge roof vent was a source of concern. It was large enough to emit a considerable volume of sound, but the directivity loss for such a large vent was uncharted territory in 1987. It was decided to provide acoustic lining of the Monitor at a later date if required. It was later found to be unnecessary, so a significant saving was achieved.

The vast quantity of air required for cooling of the furnace walls was supplied by a number of large axial flow fans. These were a significant source of noise at nearby receptor locations, many of them requiring approximately 25 dB(A) noise reduction. This was achieved by fitting air intake and discharge duct-silencers, and/or providing acoustically lined air intake plenums. All combustion and regenerator fans were fitted with air intake duct silencers.

One of the major noise sources noted while inspecting the Pilkington, Victoria, float glass plant was that caused by the natural-gas pressure-reducing assembly. About 20 metres of large diameter piping on the downstream side of the pressure reducing valve emitted high noise levels (90 dB(A) at 1 metre) inside the furnace building. We recommended the fitting of micropore reactive-silencers downstream of the pressure reducing valves at the Ingleburn plant. This provided approximately 20 dB(A) noise reduction and pipe lagging was not required.

4. Lehr Building

The dissipation of heat was not such a problem in the Lehr building as in the Furnace building. With the exception of a ridge vent along the centre of the roof, we were able to seal this building to provide an adequate sound barrier envelope. The glass making process requires large quantities of cool air from outside the building to be drawn into the building by axial flow fans and blown into the Lehr. Hot exhaust air from the Lehr is drawn off by a series of centrifugal fans and exhausted to atmosphere. Air intake and discharge ducts were fitted with silencers.

5. Glass Cutting, Warehouse and Batch Plant

The major noise source in these areas is that caused by cullet and waste glass being broken and dropping into a waste hopper where it is conveyed back to the furnace for recycling. This is a cold process, therefore heat dissipation is not a requirement in this building. The buildings are therefore sealed and provide adequate sound insulation. The cullet dump hopper has since been enclosed to reduce occupational noise exposure, thus further reducing environmental noise emission from the plant.

6. Compliance Check After Commissioning of Plant

Given the significant distances to nearby residential areas and the presence of a Motorway and other industrial noise sources in the area, it is not possible to quantify the level of noise emission from an industrial development simply by measuring with a sound level meter in front of the nearest house. It is necessary to approach close enough to the factory to measure the noise emission above the background noise level, and then calculate the contribution from the plant at the nearest residences. We have carried out a number of annual noise compliance checks since the time of commissioning in 1988.

The first check was in April 1989, when it was found that the level of noise from the Pilkington float glass plant was either equal to or 2 dB(A) less than the specified criterion at each residential location. The next check was in August 1990, when we found the plant to be from 1 to 3 dB(A) less than the specified noise criterion at critical nearby residences. On the third occasion, in January 1992, under different weather conditions, we found the plant noise to be from 6 to 7 dB(A) below the specified noise criterion at the nearby residential premises. These results show that the "worst atmospheric condition" assumptions made for this project were correct.