Noise Control of Coal Pulverizers
An Implementation of User Friendly Design

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Process Description
Five of Ontario Hydro's generating stations are fuelled by coal. In order to extract maximum energy from this fuel, while minimizing emissions, the coal must be pulverized before it enters the boiler combustion zone. At our largest fossil station each boiler is served by five pulverizers which grind coal to fine dust which is then transported to the boiler burners, entrained in high pressure air flow.

These vertically oriented coal mills have 14 ft. diameter cylindrical housings fabricated of heavy steel plate. The housing is supported on a cylindrical plate steel base such that the bottom plate of the housing is about 7 ft. above grade level.

The grinding elements of the pulverizers can be considered as giant ball bearings. Raw coal is crushed between ten 30 in. diameter balls and a stationary upper grinding ring, and a rotating lower grinding ring. The lower ring is driven by a 500 hp motor through a robust right angle gearbox located within the housing support base. A pressurized labyrinth seal at the drive shaft entry prevents blow out of coal dust and pressurized heated primary air from inside the housing.

Noise Sources
The brute force required to break down the bituminous coal results in high vibration levels throughout the pulverizer, and consequential emission of high level noise. The grinding noise is broad band in character and distributed over frequencies below about 1 kHz. The gearbox is also a source of lower frequency noise, but at a lower level than that of the process noise.

In addition to that from the grinding process, significant noise originates from the seal assemblies. This emission, comprising both broad band and tonal components, is generated by high pressure air leaking through the seal gap. Because there is inevitably some eccentricity in the seal fit, the tonal components are modulated at the 37 rpm mill drive speed. Depending on the seal eccentricity and air pressure, the tonal peaks may be found in any of the octave bands from 1 kHz to 16 kHz.

Noise Exposure
Mills must be kept under close surveillance to maintain their adjustment and detect potential failures such as oil leaks before they can cause a forced outage. One member of the crew operating each pair of generating units is responsible for inspection and adjustment of ten mills several times per shift. Operators are careful to wear hearing protection during their surveillance tours as noise levels in the vicinity of the mills can exceed 100 dBA. A typical surveillance visit could require the operator to spend up to 2 minutes inspecting the gearbox and motor. On some rounds, a more extended visit is required as the operator increases the load on the grinding elements by stroking a lever actuated hydraulic pump at a panel adjacent to the mill.

Project Scope
As part of a pilot project to demonstrate the practicability of retrofit of noise controls to power station equipment, a package of controls was developed and implemented on a single mill.

Because high level, lower frequency noise induced by the grinding process was beyond control by passive means, effort was concentrated on controlling the annoying seal air squeal.

The challenge in retrofit installations is to design cost effective controls which do not interfere with surveillance and maintenance, and which do not compromise the performance and durability of the equipment being controlled. Review of all recommendations by a project team comprising participants from design engineering, construction, operations, and maintenance, insured that optimal controls would be implemented.

Design Requirements
The following design requirements were agreed to by the project team:

- reduce noise emission by 8 dBA or more
- protect operators from high level sound even when under the mill housing
- not obstruct visual observation of gearbox
- not result in area under housing being designated a confined space
- minimize additional heat load under housing
- not restrict access to gearbox for housekeeping, inspection, maintenance or removal

Extensive noise surveys identified and quantified the contributing sources and propagation paths. Seal air leakage at the shaft entry into the housing was the dominant source under the mill housing and also propagated into the surrounding area through 3 large openings in the housing base. Because the operator is required to carefully inspect the gear box during each visit, it was necessary to control the noise as close as possible to the source, rather than simply contain it within the area under the housing.

Noise Control Design
The first stage of control is a cylindrical acoustic shroud (Photo 1.) and associated baffle plate surrounding the bottom seal area; replacing the existing coupling safety guard. This is 1.5 in. thick, fabricated in appropriately sized segments to facilitate installation and removal, and incorporating hatches to provide access for measuring and setting the coupling and seal.

Acoustic panels lining the support base interior ceiling and much of the walls absorb seal air and gearbox noise and also reduce the heat load under the housing which is of benefit both to the operators and to gearbox durability.

The 40 ft.^{2} opening at the front of the support base is closed with an acoustic panel (Photo 2.) incorporating double doors hung from heavy duty cam-rise hinges. Detents hold the doors open at 120° so that operator access to clean up leaked oil and absorbent is unrestricted. Vision panels in each door and internal illumination facilitate gearbox surveillance from outside.

Two openings, each of 9 ft.^{2}, at the back corners of the gearbox provide access to the hold-down bolts which require frequent retightening. One of these openings is closed off by a removable steel panel with a ventilation opening fitted with a simple acoustic trap.

Heated air and fumes are extracted from the housing base by a fan attached to the mill housing and joined to the other opening by an acoustically lined duct. Both side walls of the duct are hung from vertical hinges. Access to the hold-down bolts is accomplished by releasing a set of draw latches to fully open the duct (Photo 3.). Visual inspection of the gearbox and bolts is accommodated by a vision panel in the outside duct wall.

Replacement air is provided by an additional acoustically controlled opening located low on the housing support base.

Results

As expected, implementation of the controls is effective primarily in controlling noise above about 500 Hz. The spectra presented in Fig. 1 display the noise measured 1 m. from the front of the mill, with and without controls. At this location the overall noise reduction is about 13 dBA. At a location just inside the support base, the reduction is about 6 dBA.

Operator feedback regarding the trial installation has been positive and there has been no significant increase in gearbox temperature. Similar controls are now being fabricated for the 4 other mills on the Unit. Noise reductions on some of these may exceed that achieved on the trial unit because the seal air is a more significant contributor to their overall emission.

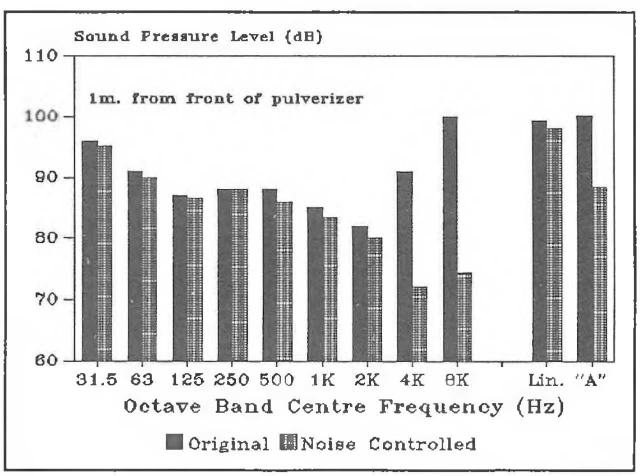

Fig. 1. Pulverizer Noise Reduction

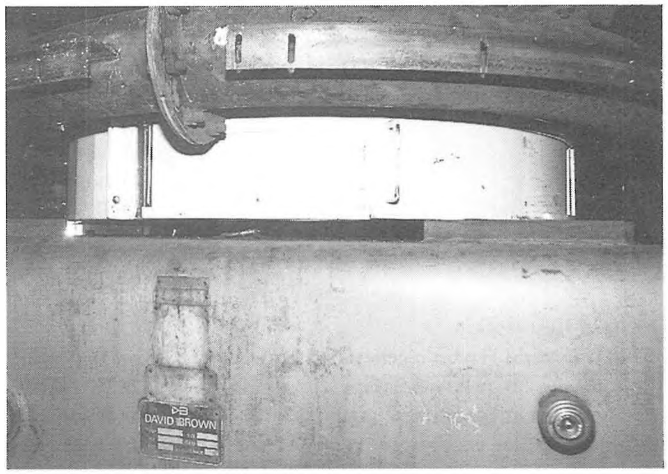

Photo 1. Acoustic Shroud around Coupling

Photo 2. Front Closure Panel - Gearbox visible through door.

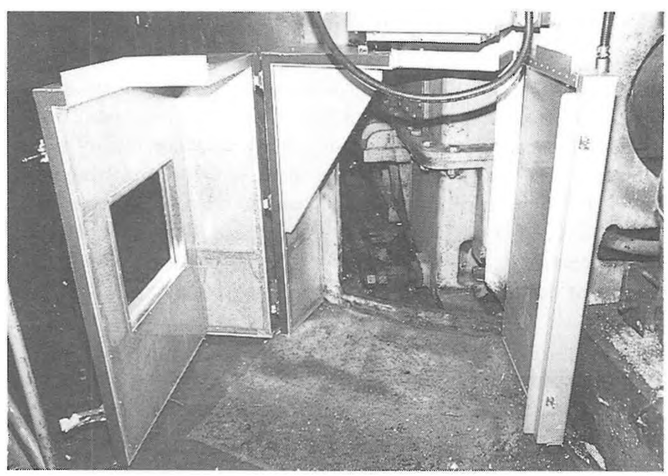

Photo 3. Lined Extraction Duct - Fully opened to access gearbox bolts.