QUALITY

ENVIRONMENTAL SOLUTIONS...

SOUND ADVICE FOR INDUSTRY

UNDERSTANDING ENVIRONMENTAL ISSUES

HUMEX
EXHAUST CONTROL

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EXHAUST CONTROL

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EXHAUST SOUND **SUPPRESSION** KITS

Who are Humex?

Humex Exhaust Control are leading manufacturers and suppliers of specialized exhaust products to meet the need for improved emission both for noise and gas pollution. Humex has a reputation for engineering excellence and our products are designed and manufactured to the highest standards. Our products include various grades of mufflers and silencers for power generating sets, lighting plants, mining and earth moving machinery. We are specialists in diesel and gas engine exhaust system design, manufacture and installation. Our range of sound suppression silencers offer reductions of up to 40dBA. These silencers are suitable for application to inlet and discharge emissions from Diesel and gas engines, Turbines and compressors and are available with integrated diesel oxidation catalysts and particulate filters where required.

Our expertise includes:

- **Critical level exhaust silencers, piping , bellows and mounting systems for power generating installations, and for mining and earth moving machinery used in environmentally sensitive areas.**
- **Complete range or emission control solutions for reduction of CO,HC, NOx and diesel particulates for power generators installed below ground or in high rise buildings.**
- **Silencers with in-built diesel purifiers and particulate filters for gensets, mining, construction road transport and materials handling applications.**
- **Spark arresting silencers for on and off road machinery to AS1019.**
- **Manufacture and installation or thermal blankets installation for all types of machinery including gensets, marine and underground mining machinery.**
- **Exhaust silencers for rail and marine including custom fabrication in various grades of aluminum, stain-less and mild steel.**
- **Double walled pipes for thermal reduction and increased durability.**
- **Explosion proof silencers for LNG Engines.**

Humex also offers a full CAD design service, whereby we can adapt our standard range of silencers to meet specific installation requirements. This is particularly useful for earth moving and mining applications where space within the machine engine bay may be restricted. Our highly successful exhaust attenuation packages includes system for many models of haul trucks, scrapers, loaders, dozers and excavators. Predominantly work has been completed utilizing existing space within the engine bay, and with minimal or no change to the exhaust mounting system.

SOUND SUPPRESSION ADVANTAGES

Humex works very closely with the mining/ heavy duty industry, site managers and with all relevant health and safety personnel to ensure that all manufactured and installed equipment creates the healthiest and safest environment possible for your team.

Humex offers on-site service of the removal of the existing exhaust system and the installation of the new exhaust systems and sound suppression kits.

Our highly successful exhaust attenuation packages include systems for many models of haul trucks, scrapers, loaders, dozers and excavators. Predominantly work has been completed utilizing existing space within the engine bay, and with minimal or no change to the exhaust mounting system.

Manufacture and installation of thermal blanket insulation for all types of machinery including gensets, marine and underground mining applications.

SOUND SUPPRESSION ADVANTAGES

The **Humex** business model involves total concept, custom design, heavy duty quality of product, installation and fast response to achieve the optimum solutions. We believe in offering our customers a complete solution, rather than simply offering supply of catalogue items, so that the end result will last for years to come.

Humex offers a full custom CAD design service, whereby we can adapt our standard range of silencers to meet specific installation requirements. This is particularly useful for earth moving and mining applications where space within the machine engine bay may be restricted.

Humex offers tube bending and cutting, precision welding and roll forming, expanding, notching and press/die forming, roll beading and dimpling, plasma cutting, mild, stainless and aluminized tubing, explosive proof silencers and indeed many other solutions.

Our Exhaust attenuation packages come complete as a kit with all required accessories ensuring ease of fitment and ease of mind.

WHAT IS SOUND SUPPRESSION?

The exhaust systems on machines/vehicles have many varied designs. These sometimes have inherent designs or have the need to be altered to accommodate the need for Noise reductions recommended for the machine by deed or by personnel. There are many areas that need to be looked at when seeking to suppress noise by altering or changing the exhaust system. When silencing elements are inserted into an exhaust system there is an Insertion Loss (IL) .Insertion Loss is defined as the reduction of noise level that occurs when a silencing element is inserted into the system. Because engines generate strong tonal components, the IL of any one muffler will not be the same with different engines, different loads, or different piping configurations. Engine noise varies significantly with Loading. Typically the noise level at full load is about 10 dBA higher than the no-load condition.

The majority of the engine noise is at low frequencies. The Overall noise from most un-silenced engine exhaust systems vary from about 110dBA to 120 dBA , when measured 1 meter from the pipe outlet. Exhaust noise can also be affected by engine turbo charges and after coolers. Humex always obtains exhaust noise data from the engine manufacturers before any system is designed. The most common element used to silences exhaust systems are reactive mufflers.

Reactive mufflers are available in a wide ranges of dimensions. The noise is reduced by forcing the exhaust air to pass through a series of tubes and chambers. Each element in the muffler has sound reduction properties that vary greatly with acoustic frequency, and it is the mixing and matching of these elements that constitutes muffler design and what constitutes a sound suppression kit. Normally the higher Insertion Loss mufflers will be physically larger than the lower quality units.

The first step in designing a suppression kit to replace a standard system is to understand the project requirements. In this process we always obtain the un-silenced noise levels from the engine manufacturers. This is typically given as a sound pressure level at 1 meter or similar distance. We then determine the noise criteria at the receiver. The next step is to calculate the un-silenced exhaust noise at the receiver location. The next step is to calculate the insertion loss of the muffler by subtracting the receiver noise criteria from the un-silenced receiver noise level. Once this is completed the exhaust system is designed to reduce the standard exhaust system by the required dBA reduction sought for.

WHAT IS NOISE?

Noise is typically defined as “unwanted sound”, sound being the human sensation of pressure fluctuations in the air. Sound levels are expressed in decibels (dB) on a logarithmic scale, where 0dB is nominally the “threshold of hearing” and 120dB is nominally the “threshold of pain”.

Depending upon the circumstances and characteristics of the sound in question, a change in level of 3dB is just perceptible, whereas an increase of 10dB is perceived as a subjective doubling of loudness (as noise is measured on a logarithmic scale).

The frequency of sound is the rate at which a sound wave oscillates, and is expressed in Hertz (Hz). The frequency of a sound produces it’s distinctive tone. The rumble of distant thunder has a low frequency, while a whistle has a high frequency. The normal range of hearing for a healthy young person extends from approximately 20 Hz up to 20 000 Hz (or 20 kHz) while the range from the lowest to highest note of a piano is 27,5 Hz to 4186 Hz. The sensitivity of the human ear to different frequencies in the audible range is not uniform. For example, hearing sensitivity decreases markedly as frequency falls below 250Hz.

A mechanism known as “A-weighting” has been adopted in order to account for this non-linearity of the human ear. Sound levels expressed using “A-weighting” are typically denoted dBA.

Noise levels are usually assessed in terms of A-weighted decibels dBA. If you have to shout to get yourself heard the background noise level is 75-80dBA. An average living room would typically have a noise level of about 40dB(A) while busy road traffic would generate about 70-80dB(A) measured on the pavement (approx. 3m from the vehicles).

The study of sound is called acoustics and covers all fields of sound production, sound propagation and sound reception, whether created and received by human beings or by machines and measuring instruments. Noise generally radiates in all directions, but can bend around and over walls and buildings and can reflect back from solid surfaces. Significantly careful positioning of noisy plant and equipment can be very effective in reducing noise levels.

785 DUMP TRUCK SOUND SUPPRESSION

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Installation of Sound Suppression System

785 DUMP TRUCK SOUND SUPPRESSION

Removal of old system including all pipework

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An indication of the level of some common sounds is shown below:

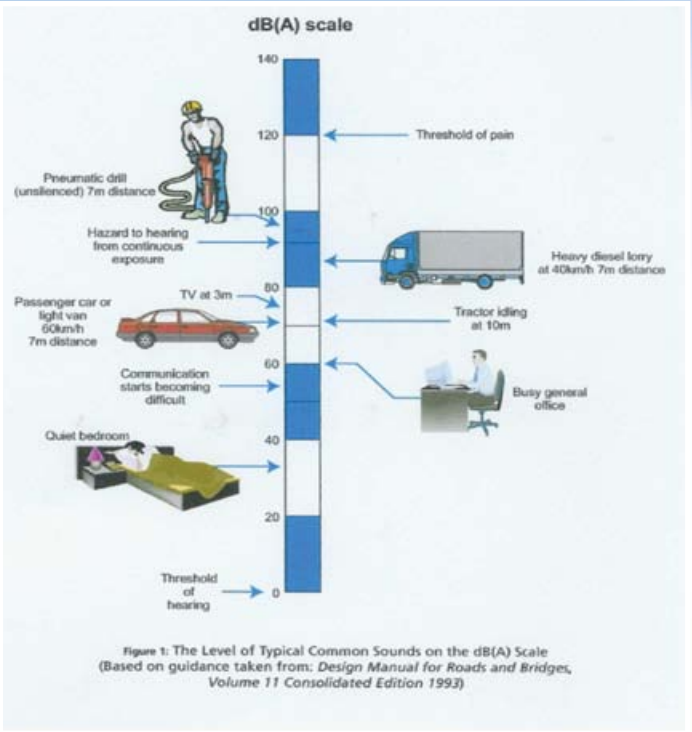

Figure 1: The Level of Typical Common Sounds on the dB(A) Scale (Based on guidance taken from: *Design Manual for Roads and Bridges, Volume 11 Consolidated Edition 1993*)

OCCUPATIONAL NOISE

It is well established that prolonged exposure to high noise levels can result in permanent and irreversible damage to hearing. It is also recognized that the only effective preventative measure is to control noise exposure before hearing loss occurs.

Noise induced or occupational deafness involves regular exposure to noise over a long period with gradually acquired sensory-neural hearing loss – damage to the inner ear and nerve pathways to the brain.

Acoustic trauma involves exposure to a very high noise level over a short period such as an explosion perforating the eardrum.

40 out of every 100 workers who have worked all their lives at high noise levels (>90db9A) will at the age of 65 years find it difficult to hear other people talking

THIS TYPE OF DEAFNESS IS INCURABLE

WHAT IS LOW FREQUENCY NOISE?

We have defined noise as unwanted sound. We are all aware of the noises that surround us in our everyday lives, many of which are a source of nuisance. The effect of low frequency noise (LFN), however, is often not recognized as a nuisance, even though it may have a profound effect on the psychological and physiological well being of some people.

Sound The frequency of a sound is the number of sound waves which pass a particular point in one second, and is measured in Hertz (Hz). Sound audible to the adult human ear is in the range 5 - 18000 Hz. Low frequency sound may be loosely defined as having a frequency below 150 Hz. Sound in the lower frequency range is around us all the time, but we are not always aware of it as people's sensitivity varies considerably. Problems arise when the levels of low frequency noise are such that they interfere with our everyday lives.

Low Frequency Noise There are many sources of low frequency noise which can cause disturbance and/or annoyance both indoors and outdoors. Sound enters buildings through their structure, through open windows, or can be generated inside the building. Sound with a very long wavelength may be heard as noise (primary noise), cause rattling windows, doors or furniture (secondary noise), and may be difficult to distinguish from a structural vibration. Both of these forms of noise can cause disturbance, particularly at night.

LFN can be more noticeable indoors, which is why it is often associated with disturbed sleep. In the open air other noises such as traffic may mask the annoying low frequencies. Indoors, middle and high frequency noise from out-side is reduced because the insulating effect of the building increases with sound frequency. Noises from the lower frequency bands, however, may remain the same, or even increase - hence rattling windows etc. Another problem is that LFN travels further than higher frequencies, so the source is often difficult to trace. Sleep may be disturbed by the hum of a distant boiler, or the rattle of a window caused by passing traffic.

Sources The following may all be sources of LFN: Amplified music , pumps, fans, boilers , ventilation plant, foundries blasting/quarrying, road, rail, air traffic and mining machinery

Effects of Low Frequency Noise A low frequency noise is very often characterized by a hum or rumble. It may be confused with tinnitus (ringing/hissing in the ears with no obvious cause).

Health Issues related to Noise

The hearing sensitivity range of people varies; therefore people who are disturbed by LFN may feel isolated if no one else is annoyed by the noise. Symptoms of LFN annoyance are those associated with stress. These include feelings of irritation and unease, fatigue, headache, nausea and disturbed sleep.

It is not clear at what level Low Frequency Noise may be physically damaging; however, the unpleasant symptoms it can induce are sufficient to cause disruption and significant social and economic penalties to sufferers.

EXAMPLE OF PLANT NOISE TESTING AND RESULTS

This raises the important consideration that noise levels at testing distance (i.e., 16m) are dominated by the mid to high frequencies of non-exhaust components and therefore only modest (2-3 dB) reduction of total sound power level is achievable from the exhaust system alone. It is well established, however, that these same mid to high frequencies are attenuated by the ground surface and air (O2 molecular excitation) over larger distances. It is for this reason that many coal mines have real time monitoring systems with a low-frequency cut-off to capture "mine hum" and eliminate extraneous sources at higher frequencies.

As an estimate of noise levels differences between the pre- and post-test results projected to a distance in the order of 900m - 1km from the source, frequencies up to 500 Hz in Table 1 can be logarithmically added together to give the following values.

Test Before	(<630 Hz)	After (<630 Hz)	Difference (<630 Hz)
Stationery:	116.7 dB (A)	111.9 dB (A)	4.8 dB
Dynamic:	120.2 dB (A)	114.9 dB (A)	5.3 dB

This total noise level reduction (i.e., with the sound suppressing system fitted) of approximately 5 dB is likely to be achieved in practice at a distance in the order of 900m - 1 km from the source (after ground and atmospheric absorption have attenuated the mid to higher frequencies from non-exhaust components of the truck) and would increase as the distance from the source increases.

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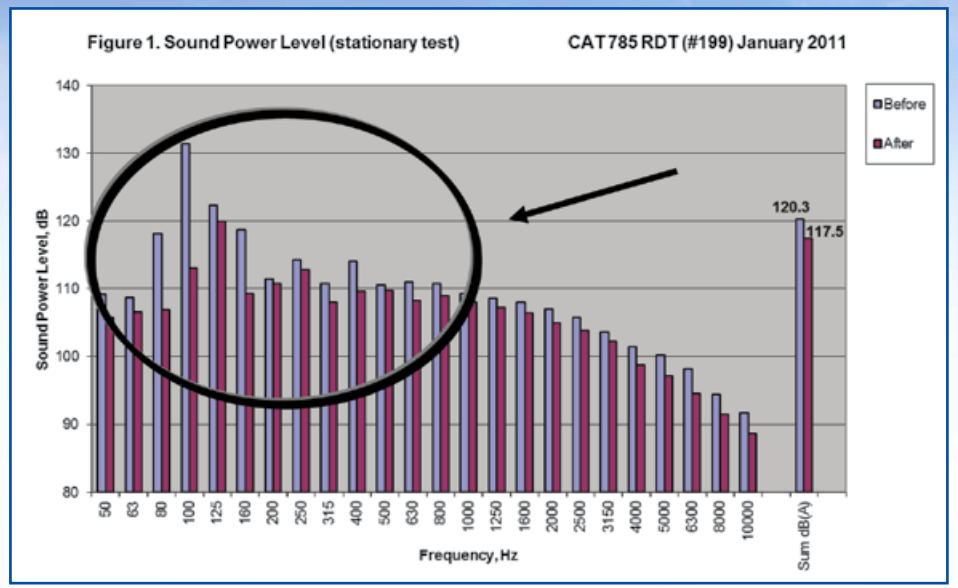
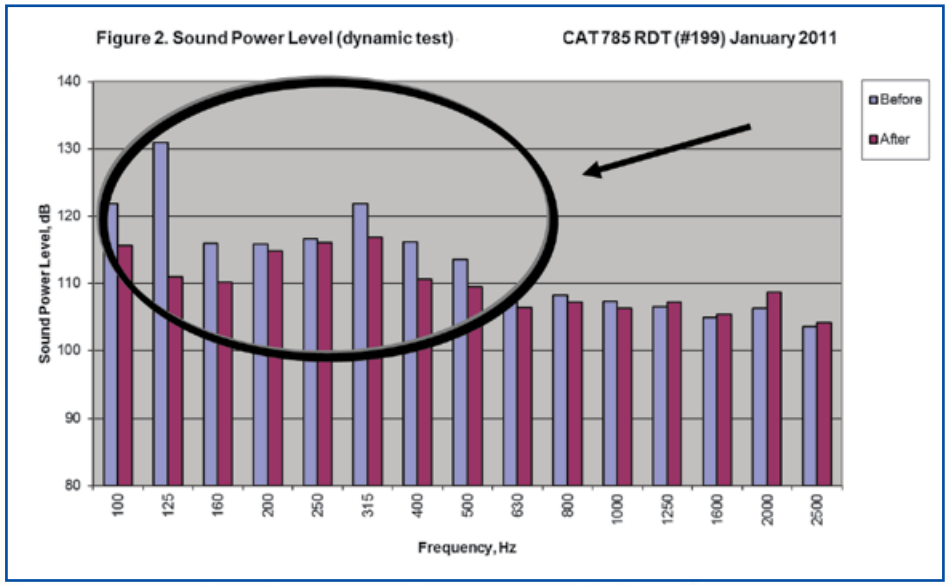
EXAMPLE OF PLANT NOISE TESTING AND RESULTS





The above results circled show significant noise reduction at the lower frequencies (up to 400 Hz) that are typically dominated by muffler noise. Generally, mid to high frequency noise is dominated by other components of the truck and therefore are not significantly affected by fitment of the muffler system.

HUMEX EXHAUST

Noise can cause annoyance and fatigue, interfere with communication and sleep, reduce efficiency and damage hearing. Physiological effects of exposure to noise include constriction of blood vessels, tightening of muscles, increased heart rate and blood pressure and changes in stomach and abdomen movement. The effects of exposure to noise are personal as hearing sensitivity varies. Exposure to constant or very loud noise – either occupational or leisure – can cause temporary or permanent damage to hearing.

There is an increasing body of research linking prolonged exposure to transport noise to health impacts. A major impact of noise is sleep disturbance – and disrupted sleep has been linked to effects on cardiac health. A number of reports have made direct links between transport/machinery noise and cardiac health.

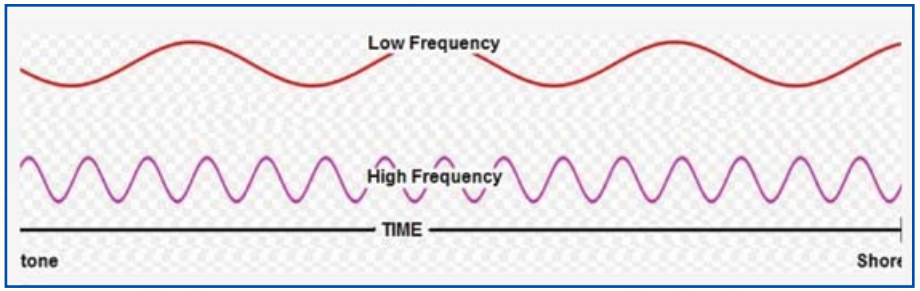
Nuisance

How far low frequency noise presents a serious nuisance problem is uncertain, but it is often a source of irritation. Assessing the level of nuisance caused by low frequency noise is difficult. Ordinary sound level meters may not be able to detect LFN on the decibel scale as its decibel level is often lower than background noise. A narrow band frequency analyzer is required to measure it. Noise nuisance is determined by the magnitude of the noise on the decibel scale.

Controlling Low Frequency Noise

Apart from the difficulties of tracking down the source of low frequency noise, and assessing its magnitude, practical methods of control are technically difficult and often prohibitive in cost. Sound proofing in buildings is usually impracticable as the design - particularly of modern buildings - can enhance the effect. Enclosing or silencing the noise source is a better option and will provide a more comprehensive solution. This is often difficult and expensive as it involves enclosing the source in a combination of massive structures to reduce sound transmission. LFN from machinery can normally be reduced by the use of sound suppression silencers and pipework.

The answer to eliminating low frequency noise lies in the design of the sources themselves...



EXAMPLE OF PLANT NOISE TESTING AND RESULTS

This letter report presents the results of a plant noise testing conducted at a Coal Mine on 10 and 12 January 2011. The purpose of these tests was are to measure the sound power levels (Lw, B(A)) of a CAT 785 rear dump truck (#199) to determine the noise reduction achieved by fitment of a Humex sound suppression exhaust system.

MONITORING PROCEDURES

Dynamic testing of the truck in motion was conducted using ISO 6395:2008. The layout of the machinery path of motion and measurement points is shown in Figure 1. When applied to dump trucks in motion, the forward measurement path is uphill from point A to point B and the reverse path from B to A has the machine travelling down-hill. The truck was loaded for both directions of motion.

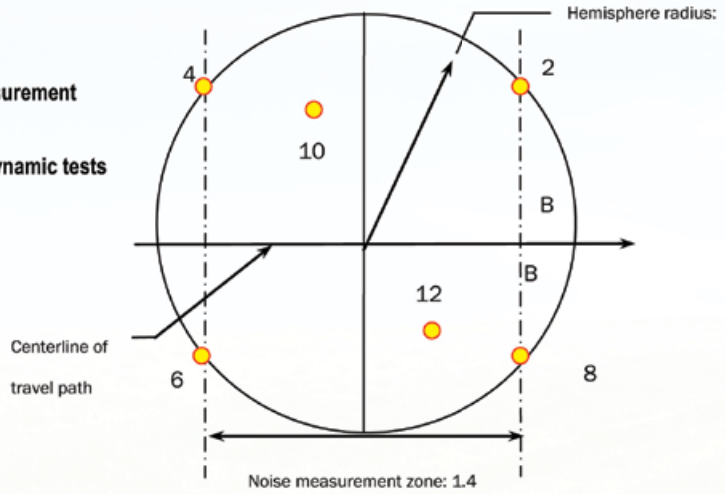


Figure 1. Measurement points for ISO 6395 dynamic tests

EXAMPLE OF PLANT NOISE TESTING AND RESULTS

Sound power levels (in third-octave bands) calculated in accordance with the methodologies of AS2012-1 and ISO 6395 are summarized in Table 1, along with the noise level difference achieved after fitment of the sound suppression exhaust system. Third-octave data for the stationary (AS2012) test are presented in Figure 1, with results for the dynamic test presented in Figure 2.

TABLE 1
MEASURED TRUCK SOUND POWER LEVELS (DB) – CAT 785 UNIT #199 (JAN 2011)

FREQUENCY (HZ)	STATIONARY (BEFORE)	STATIONARY (AFTER)	STATIONARY (DIFFERENCE)	DYNAMIC (BEFORE)	DYNAMIC (AFTER)	DYNAMIC (DIFFERENCE)
50	109.1	105.8	3.4	–	–	–
63	108.7	106.6	2.1	–	–	–
80	118.2	107.0	11.2	–	–	–
100	131.4	113.0	18.4	121.9	115.7	6.2
125	122.3	120.0	2.3	131.0	111.0	20.0
160	118.7	109.3	9.4	116.0	110.2	5.8
200	111.5	110.8	0.7	115.9	114.9	1.0
250	114.3	112.8	1.5	116.7	116.1	0.6
315	110.8	108.1	2.7	121.9	116.9	5.0
400	114.1	109.6	4.5	116.2	110.7	5.5
500	110.5	109.7	0.8	113.6	109.5	4.1
630	111.0	108.3	2.8	107.4	106.5	0.9
800	110.7	108.9	1.8	108.2	107.3	0.9
1000	109.2	108.0	1.2	107.3	106.4	0.9
1250	108.7	107.2	1.4	106.5	107.2	-0.7
1600	108.1	106.4	1.6	105.0	105.5	-0.5
2000	107.1	105.0	2.1	106.4	106.8	-0.4
2500	105.7	103.8	1.9	103.7	103.7	0.6
3150	103.6	102.3	1.4	–	–	–
4000	101.4	98.7	2.7	–	–	–
5000	100.3	97.1	3.1	–	–	–
6300	98.1	94.5	3.6	–	–	–
8000	94.4	91.5	2.9	–	–	–
10,000	91.7	88.6	3.0	–	–	–
Sum dB (A)	120.3	117.5	2.8	121.6	118.5	3.1