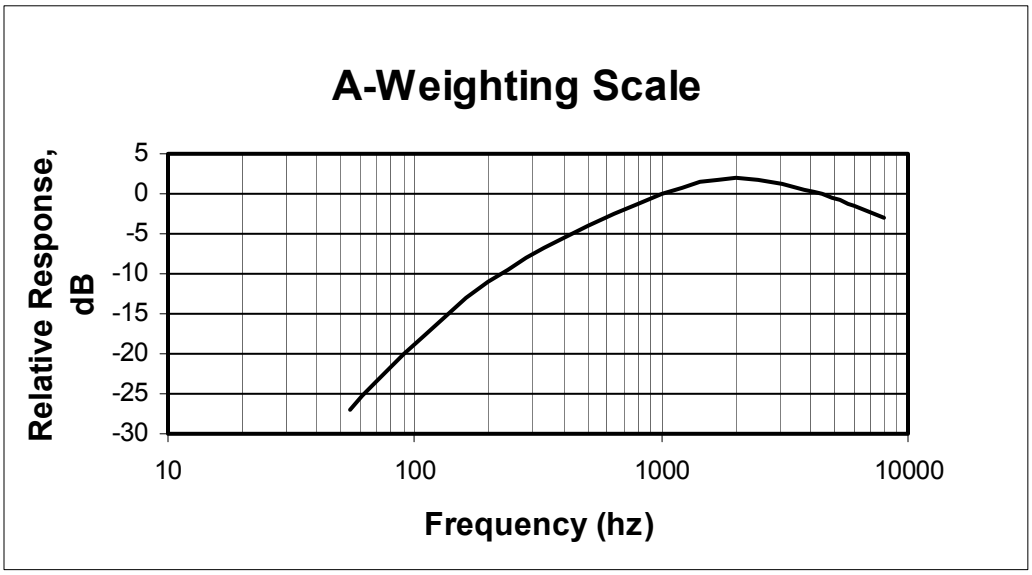
Cold Jet Dry Ice Blasting Acoustics Guide

Today, CO_2 blasting is being effectively used in a wide array of applications from heavy slag removal to delicate semiconductor and circuit board cleaning. Imagine a process that can be used on-line without damaging equipment or requiring a machine "teardown". Unlike conventional toxic chemicals, high pressure water blasting and abrasive grit blasting, CO_2 blasting uses dry ice particles in a high velocity air flow to remove contaminates from surfaces without the added costs and inconvenience of secondary waste treatment and disposal.

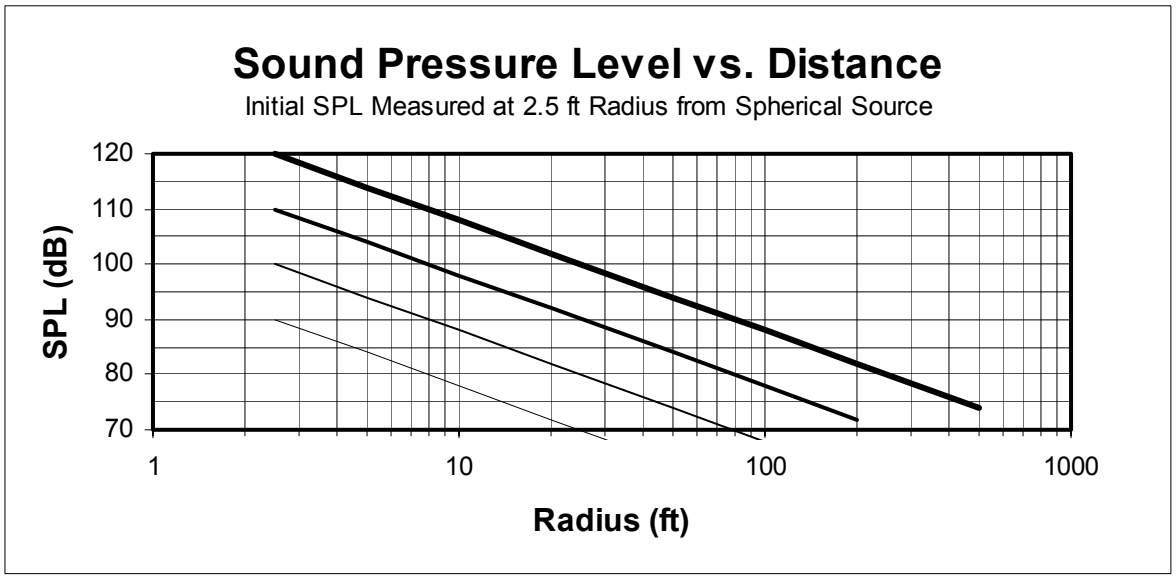
This paper supplies answers to many common acoustic questions such as noise measurements, characteristics of noise fields, and OSHA regulations.

Noise Measurements

In an industrial environment, noise sound pressure levels are generally measured on the A-weighted decibel scale (dBA). Raw noise data is weighted according to the below curve, generally calculated automatically by a good quality "Level 2" sound meter. In the A-weighting scale, very low frequencies are heavily discounted, frequencies between 1000 and 4500 hz are slightly overweighted, and frequencies above 4500 hz are slightly discounted. This is done to account for the most noise-vulnerable range of human hearing.

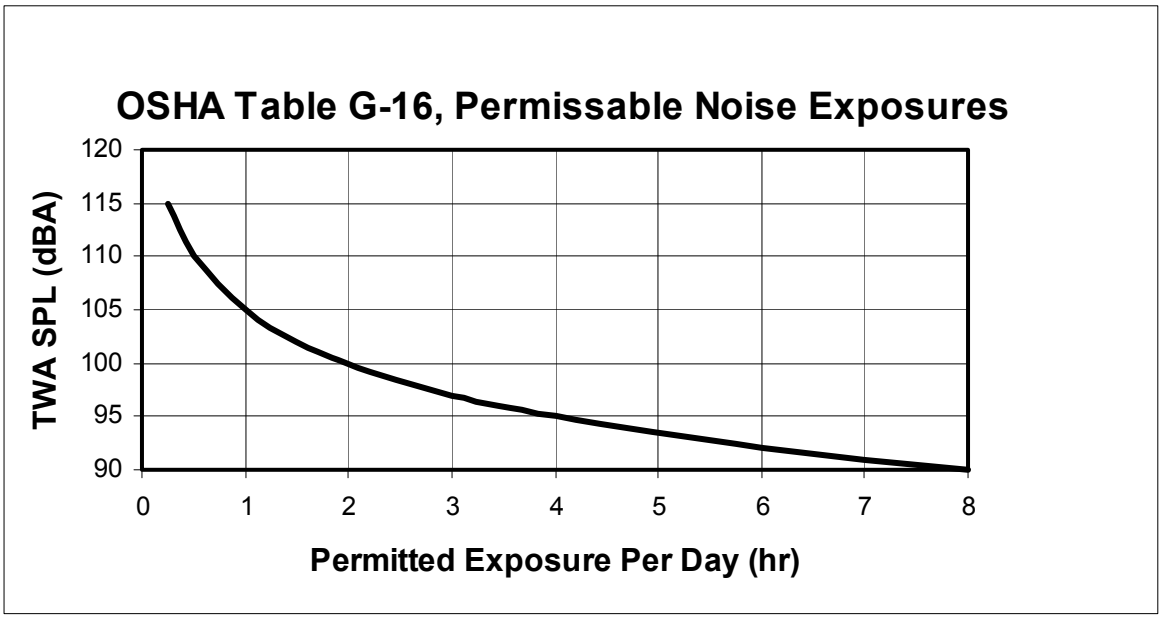


A noise measurement produced by a sound meter is a number like 90 dBA, and this number only has meaning when stated with the measurement location, for example, "measured at the operator's ear", or "measured 25 feet from the blasting operation". The noise reading says little about the noise spectrum (the distribution of noise levels across the range of different pitches), which may be heavily loaded towards high or low frequencies. A more sophisticated spectrum analyzer would be required for taking direct noise spectrum measurements. Noise levels will fall off from a source rapidly with distance, due to spherical spreading of wave energy, as shown in the following chart.



OSHA Regulations

Federal regulations related to noise issued by the Occupational Health and Safety Administration (OSHA) are generally stated in terms of Time-Weighted Average sound pressure levels (TWA SPL). A noise dosimeter, essentially a sound level meter which averages over time, is required to accurately measure TWA values. The averaging process is logarithmic, so that high noise levels are more heavily weighted than low noise levels. The regulations state that noise exposure to workers shall be restricted to the below exposure limits:



These limits apply directly for a worker with no hearing protection, but apply *after* hearing protection is accounted for via the effective Noise Reduction Rating (NRR_{eff}) of devices worn by protected employees. These values are generally *not* equal to the rating on the package, but are instead derated significantly, per the following equation in the simplest form of this derating system:

$$NRR_{eff}=(NRR_{earplug}-7)+5_{(for\ earmuffs)}$$

Other derating schemes exist if more spectral information is available.

It is important to establish good practices with regard to proper use of earplugs and earmuffs in order to be given regulatory credit for the performance of hearing protection. In other words, regulators who notice improperly worn or missing hearing protection, or a plant with no training process, may apply a more substantial derate to the hearing protection.

In general, if blasting is not conducted in a dedicated booth, it will be necessary to supply personnel near the blasting operation with single protection earplugs in order to keep their noise exposure under the OSHA limits. This generally does *not* require double protection. Cold Jet supplies each customer with a safety kit consisting of a face shield, earmuffs and gloves for the operator, and a box of Howard Leight Max earplugs for the operator and surrounding personnel. For customers with specific questions related to blasting noise, or who may be in need of having acoustic measurements taken, Cold Jet has equipment and engineering personnel capable of helping to provide information and solutions.

Blasting Noise Levels

It is important to realize that the noise levels measured at the operator may increase by up to 7 decibels when blasting an object with numerous pits or sharp edges and a concave, sound-focusing shape such as a tire mold. Blasting inside a rubber press, however, may produce some shielding to counteract this effect. The noise spectrum produced leans towards the high frequency end of the human hearing range.

Most foam earplugs have best performance at high frequencies, and therefore, if one looks at the actual hearing protection performance against a dry ice blasting nozzle, the earplug's effective Noise Reduction Ratings (NRR_{eff}) will be fairly high compared to the performance of the same earplug against a low frequency noise generator like a punch press.

Factors which affect the noise level produced by a nozzle include the shape and surface texture of the surface being blasted, the amount of moisture present in the compressed air supply, the humidity of the day, and of course, the distance and location at which the reading is taken. It is not unusual to have ± 2 dB variability in a blast noise reading when taken on two different days. Pitted surfaces raise noise levels due to jet screech and whistle. High humidity raises noise levels due to better sound transmission than dry air, and also due to addition of moisture to the compressed air supply, which raises noise levels because the moisture is frozen into ice crystals and expelled with the blast stream.

The actual Time Weighted Average (TWA) noise levels that an operator or the surrounding plant employees may experience will depend strongly on the duty cycle of the blasting operation, i.e., what percentage of the time the blast is actually on. Dosimeter equipment should be used to determine accurate TWA values for a particular blast operation.

Summary

Concerns that industrial customers may have regarding the noise produced by the dry ice blast cleaning process can be addressed with the proper selection of blast nozzles, the proper use of hearing protection equipment, and the proper training of employees in the use of the equipment.