

Experience in his own field will enable the plant and manufacturing engineer to recognize and avoid the use of noisy machines and processes when possible.

Personal Protection

The use of ear protectors may be indicated under conditions where noise cannot be controlled by engineering. Nearly all ear protectors are effective in the high frequency region, but at low frequencies, where a tight fit is important, there is less need for attenuation. Contrary to usual opinion, speech understanding in a high noise level is often improved by ear protectors. The noise is reduced as well as the speech, and the speech-to-noise ratio is unchanged, but the levels at the ear are in a region where there is less distortion and better understanding.

The principal difficulties in using ear protectors are sanitation and discomfort, but these handicaps are being overcome. Enforcing the wearing of ear protectors is usually more difficult than enforcing safety goggles or shoes, but alert management can popularize and enforce their acceptance.

Reduction at the Source

Prevention of noise at its source appears to be a promising method of noise reduction. It is often difficult or impossible, since noise energy may be an unavoidable portion of the mechanical work done. Methods of reduction which follow are listed under types of noise sources:

Impacts: Where a material is hammered, sheared, tumbled or peened, the impact is a necessary part of the work and is always accompanied by noise. It is difficult to reduce this noise. However, if an impact can be made less sudden, the noise will tend to change from a sharp crack to a thud and will be less objectionable.

In a punching operation, one portion of the die can be made to enter the work first and convert the process into a shearing action. When punching involves a multiple die which makes several holes at one stroke, the die can be stepped to convert a single intense impact noise to several lesser noises.

Prevention of unnecessary bounces from a hammer-type blow also will be effective. In tumbling, impact noise on the containing cylinder can be decreased by suitable lining.

Rattles, Lost Motion, and so forth: This type of impact noise can be classed as minor

impact and the remedies are fairly obvious. Proper inspection and maintenance, securing, stiffening or damping of loose panels, and replacement of worn parts, are effective. Elimination of rattles prevents low frequency energy from being transformed into more undesirable high frequency energy. Significant noise reduction can be obtained by these simple control means as great as 10 decibels.

Friction: Considerable noise can be made by frictional forces in general and in grinding, clutches or brakes. Part of the noise of cutting metal and wood can be classed as frictional noise. Motion along a contact surface creates force variation if the surfaces are not well lubricated. The frequency characteristic is rich in high frequencies, usually because of resonances in the part excited. Clutches and brakes tend to squeal, grinding produces broad band noise, and other friction noises are of the squeaking and scraping type which have objectionable high frequency energy.

Remedies include lubrication, substitution of materials, especially in brakes and clutches, changes in shapes of cutting tools and sharpening of tools which become noisy with wear. Gear noise is caused partly by frictional forces as well as variable forces at tooth impact frequency. Some improvement can be obtained by lubrication, substitution of helical or worm gears for direct gears, use of plastic or fibre gears, and reduction in speed.

Fluctuations in Gas Flow: Turbulence in the escape of compressed air or steam causes a loud hissing or roaring noise. When the air velocity is not being used, a simple muffler is effective. This, for outlets having small air flow, may consist of a can filled with steel wool or any other means of slowing down the escaping gas. Reductions of 10 to 15 decibels are possible.

When the air velocity serves a purpose, such as cleaning out chips, stripping or removing parts, noise appears to be unavoidable at the present state of knowledge. The least that can be done is to keep the air flow at the minimum velocity necessary for the operation by using a reducer valve in the line.

Sound Absorption

Total Enclosure: Noise in the air can be kept from spreading by almost any type of enclosure. Porous sound absorbing mate-

rials are of direct use in reducing sound transmission through a wall, but of little value on the inside of an enclosure to reduce the sound level which must be contained. Transmission loss can be greatly reduced by using double walls with an air space. In some cases, an extremely noisy machine or area can be totally enclosed to take advantage of large noise reductions of 20-45 decibels.

Complete covers over a noisy part of a machine are another useful method in noise reduction. Whether a small enclosure over part of a machine will do a good job of noise reduction should be checked by trial with an improvised cover first. If such a cover gives promise, a cover made of: (1) an impervious barrier such as sheet metal, 16 gauge or thicker, (2) rubber-like material to seal the edges and vibration isolated fasteners, and (3) absorbing material inside the cover to absorb sound and prevent build-up of noise, should be designed.

Partial Enclosure: The term "partial enclosure" is used for noise shields and enclosures which have openings greater than a few per cent of their area. Noise radiation from these openings is the principal path of noise flow from partial enclosures, since the transmission loss of the barrier is at least 20

decibels. Sound absorbing linings must always be used inside these partial enclosures, or there will be little noise attenuation.

This type of enclosure is useful mainly in giving a shadow effect for workers who otherwise would be in the high level direct noise field. Basically, an operator is not protected in this type enclosure, but nearby operators are.

Space Absorption: The most common use of sound absorbing material is a general or overall method of reducing noise in enclosed spaces. However, absorptive materials used on ceilings and walls of a general work area give a reduction of noise levels in the reverberant field at a distance from the noise source, but absorption will not decrease the level for workers less than five to 10 feet from the source.

In most practical installations of area-treatment with absorbing walls or ceilings, there would be a maximum reduction of about 10 decibels. In addition, area treatment will "push back" distant noises and allow an operator to hear his own machine better.

Specific Noise Control Measures

Following are a few examples of noise control attempts made in certain industries:

HEAVY DUTY DRILLING OF TRANSMISSION HOUSINGS

Frequency in cycles per second	Noise Intensity in Decibels				Both A & B	
	Machine A		Machine B		Before	After
	Before	After	Before	After	112-117	89-92
Overall					112	87
20-75	106	86	102	86	108	90
75-150	104	87	98	87	108	86
150-300	102	85	100	84	110	89
300-600	102	88	101	82	112	84
600-1200	112	83	107	77	106	77
1200-2400	105	82	104	76	104	77
2400-4800	103	75	999	72	100	66
4800-10K	98	65	94	63	1485	193
Sones	1268	173	999	129		

The before readings refer to a dry drilling of this cast iron housing. The after readings refer to drilling with an oil lubricant. This change from dry to oil-lubricated drilling has reduced the loudness by approximately 87 per cent.