NOISE CONTROL SOLUTIONS

FOR THE

TEXTILE INDUSTRY

By Wayne V. Montone, Richard K. Miller,
and Mark D. Oviatt

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ABOUT THE AUTHORS

This report was developed by Richard K. Miller & Associates, Inc., Consultants in Acoustics, 464 Armour Circle, N.E., Atlanta, Ga. 30324. Established in 1972, the firm is the oldest and largest in the Southeast providing consulting services exclusively in the areas of industrial noise control, architectural acoustics, and environmental noise.

The firm has extensive experience in administering noise control programs in the textile industry for clients such as Wellington Puritan Mills, Vanity Fair Mills, Forsyth Twine & Cordage, Goodyear Tire and Rubber Company, Charlie Company, Majestic Carpet Mills, and the American Footwear Industries Association.

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INTRODUCTION

The approaches to noise control which are presented in this report are designed to address noise problems in the textile industry in a specific manner. It should be recognized, however, that machinery usage will vary from plant to plant. While the general approaches to noise reduction presented in this report should be applicable to a wide variety of plants, careful engineering judgement should be made for each potential application to insure acoustical, production, and safety constraints are considered and dealt with.

1 - GENERAL APPROACHES TO NOISE CONTROL

Three approaches to noise control should be considered for any noise problem:

1. The noise *source* may be modified.

2. Noise may be blocked or reduced along the *path* from the source to the receiver.

3. Sound may be isolated from the *receiver* by means of barriers, operator location, or hearing protection.

The optimum approach for any operation must be determined based on acoustical effectiveness, production compatibility and economics. It should be pointed out that OSHA recognizes hearing protective devices as only a temporary solution to noise exposure, and stipulates that other engineering methods must be employed as permanent compliance measures.

The first step in reducing noise is to define specifically how the acoustic energy is being generated. All noise sources generate sound by one of the following two mechanisms:

1. Acoustical radiation from a vibrating surface.

2. Aerodynamic turbulence.

Six types of noise control systems may be considered to solve any noise problem:

1. Sound barriers.

2. Sound absorbers.

3. Vibration damping.

4. Vibration isolation.

5. Mufflers.

6. Machine redesign, process modification, or noise source elimination.

Each of these six conceptual approaches is considered in the noise control solutions for specific items of machinery discussed in this report.

2 - OSHA

The Williams-Steiger Occupational Safety and Health Act of 1970 (Public Law 91-596) was established "to assure safe and healthful working conditions for working men and women...." The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor is delegated the responsibility of implementing and enforcing the law.

Title 29 CFR, Section 1910.95 promulgates regulations for the protection of employees from potentially dangerous noise exposure. A copy of the section is presented in Figure 2.1. Proposed revisions to this regulation were published in the Federal Register of October 24, 1974. This revision is still under consideration.

While the OSHA regulations establish a maximum noise level of 90 dBA for a continuous 8 hour exposure during a working day, higher sound levels are allowed for shorter exposure times. Thus, for cyclic operations, it is necessary to compute the employee's noise dose, or percent allowable exposure for actual operation.

Example:

A machine generates sound levels of 95 dBA for 1 minute during each cycle, 200 times per day. From Figure 2.1, the operator's daily noise dose is:

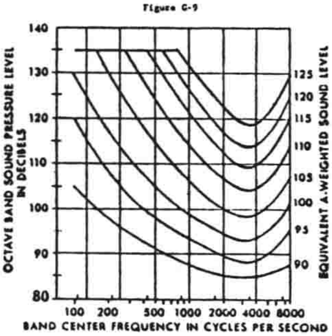
$$D = \frac{C}{T} = \frac{200 \text{ minutes}}{4 \text{ hours}} = \frac{3.33}{4} = 83\%$$

This dosage is within the OSHA limit of 100%.

§ 1910.95 Occupational noise exposure.

(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table G-16 when measured on the A scale of a standard sound level meter at slow response. When noise levels are determined by octave band analysis, the equivalent A-weighted sound level may be determined as follows:

Figure G-9



Equivalent sound level contours. Octave band sound pressure levels may be converted to the equivalent A-weighted sound level by plotting them on this graph and noting the A-weighted sound level corresponding to the point of highest penetration into the sound level contours. This equivalent A-weighted sound level, which may differ from the actual A-weighted sound level of the noise, is used to determine exposure limits from Table G-16.

[1910.95 amended at 39 FR 19468, June 3, 1974]

(b) (1) When employees are subjected to sound exceeding those listed in Table G-16, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table G-16, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

(2) If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous.

(3) In all cases where the sound levels exceed the values shown herein, a continuing, effective hearing conservation program shall be administered.

TABLE G-16—PERMISSIBLE NOISE EXPOSURES [1]

Duration per day, hours	*Sound level dBA slow response*
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

[1] **When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 + \cdots C_n/T_n$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. *Cn* indicates the total time of exposure at a specified noise level, and *Tn* indicates the total time of exposure permitted at that level.**

[1910.95 Table G16 amended at 39 FR 19468, June 3, 1974]

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

Figure 2.1. OSHA noise regulation.

3 - OVERVIEW OF NOISE PROBLEMS IN THE TEXTILE INDUSTRY

The present state-of-the-art of noise control in the textile industry is well-stated by Bailey and Brown in the following excerpt from their study:

> High noise levels have traditionally been taken for granted by the textile industry. The broad-band noise of air handling systems, clatter of gears, high speed whine of spinning and twisting machinery, and impact noise of looms have long been regarded as necessary evils of the trade. ... Much of the machinery in use today is virtually unchanged from designs of three or more decades ago. One obvious difference in textile operations of today, however, is that these same machines now run at significantly higher speeds. As might be anticipated, this trend toward greater speeds has resulted in higher noise levels, often exceeding 100 dBA and occasionally reaching 110 dBA in some operations. Despite the fact that spinners and weavers have been found to have significantly greater hearing loss than a control population not exposed to similar noise levels, little progress has been made in quieting textile machinery. ...[1]

A summary of the noise levels of major types of textile equipment is presented in Table 3.1.

Reference

1. Bailey, J. R., Brown, C. M., "Guidelines for Textile Industry Noise Control," ASME Paper No. 73-TEX-A.

TABLE 3.1

SUMMARY OF TYPICAL NOISE LEVELS OF TEXTILE EQUIPMENT

Machine	*Sound Level, dBA*
Gill Box	95-100
Draw Frame	85-90
Card	75-85
Speed Frame	85-90
Noble Comb	90-95
Spinning Frame:	
Ring	85-100
Apron Draft	95-100
Mule	80-90
Twist Frame	85-100
Winding	90-100
Fully Fashioned Knitting	85-95
Warp Knitting (Raschel)	90-95
Co-We-Nit	80-85
Lace:	
Bobbinet	80-85
Furnishing	85-90
Leavers	85-90
Looms:	
With Shuttles	90-105
Stationary Weft	80-95
False Twist:	
200,000 - 300,000 rpm	95-105
360,000 rpm	100-115
600,000 rpm	100-110

4 - FEASIBILITY

To establish that solution of a noise control problem is feasible, one must consider three areas:

- Acoustical Feasibility
- Production Feasibility
- Economic Feasibility

To establish acoustical feasibility, it must be shown that designs exist which would provide adequate noise reduction.

Each proposed noise control design must be reviewed to insure suitability to the application for which it is intended, and to establish production feasibility. Non-acoustical considerations related to any design include:

a. Employee safety and hygiene.

b. Fire code compliance.

c. Operational integrity:
   1. accessibility to equipment
   2. maintenance serviceability assurance
   3. product quality assurance

d. Machine system compatibility:
   1. mechanical (power, speed, etc.)
   2. service life
   3. ventilation and cooling

Figure 4.1 illustrates the matrix of decisions to be made in determining feasibility. In cases where doubt arises as to acoustical or production feasibility, a design prototype may be required.

The authors of this study, as acoustical consultants, have utilized the following design investigation procedure to establish a basis for acoustical non-feasibility for several industrial operations:

1. A literature search is performed of all available publications in the noise control field and in the general field of the alleged violation.

2. The problem is discussed with colleagues within the professional community to identify where potential solutions to the problem may have been attempted.

3. Recognized authorities in the academic community are solicited for ideas.

4. The literature of all manufacturers of acoustical materials and systems is reviewed for solution approaches, and many are contacted personally.

Feasibility

5. The manufacturer of the noise-producing equipment is contacted, as are several manufacturers of similar equipment.

6. Trade associations are contacted, and the industry-wide state-of-the-art is sought.

7. Solution approaches are solicited from the OSHA personnel involved in the citation.

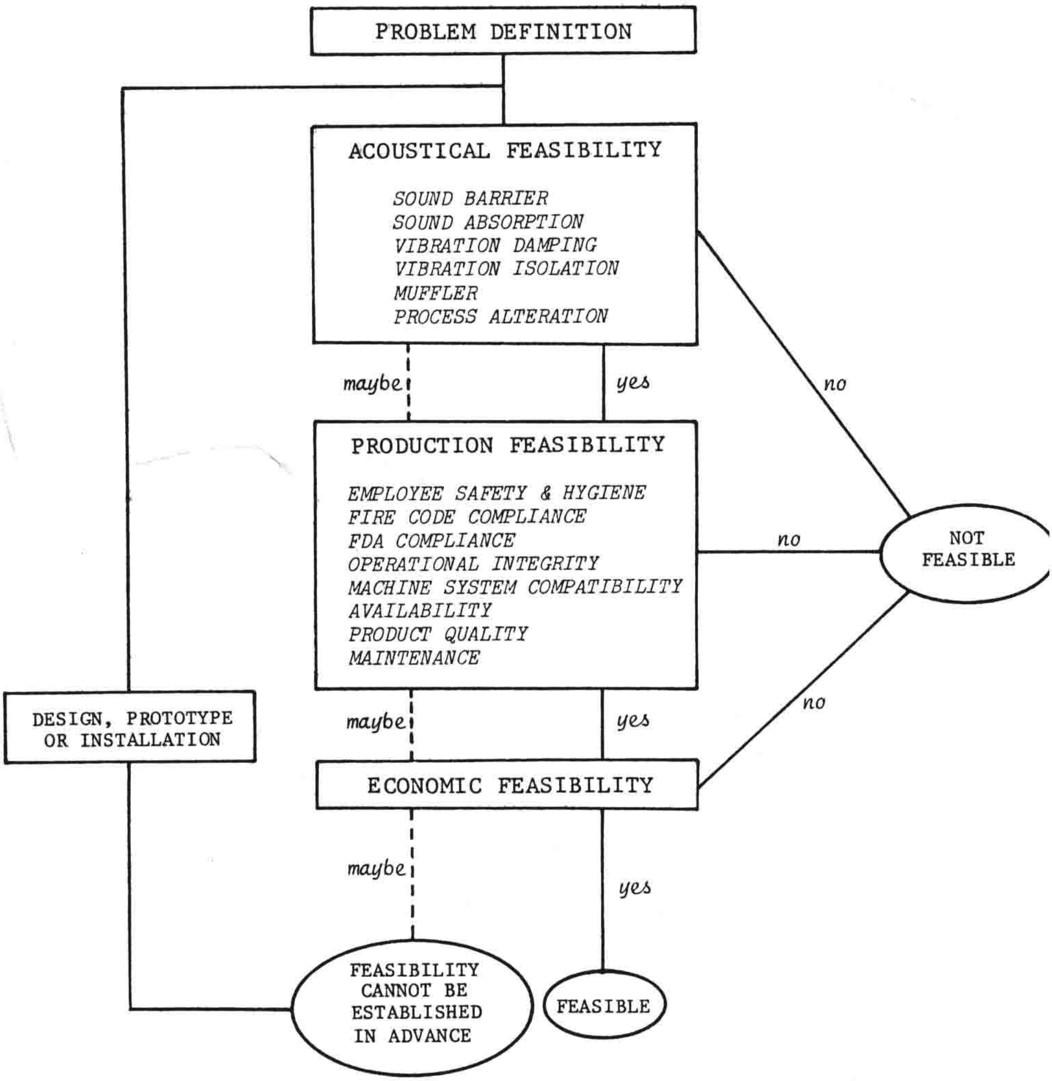


Figure 4.1. Decision matrix for determining noise abatement feasibility.

5 - LITERATURE SEARCH

A complete literature search revealed 48 articles relating to noise control of textile machinery. The search included review of periodicals serving both the textile industry and the noise control community.

The following bibliography summarizes publications relating to noise control in the textile industry.

1. Atherly, G. R. C., Noble, W. G., "Review of Studies of Weaver's Deafness," *Applied Acoustics*, Vol. 1, No. 1, March 14, 1968.

2. Bailey, J. R., Brown, C. M., "Guidelines for Textile Industry Noise Control," ASME Paper No. 73-Tex-a.

3. Bolt, Beranek and Newman, Inc., Report No. 2671, F.3, "Textile Mill Products."

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13. Cudworth, A., Hanson, W. I., "Noise Reduction Test on the Textiles Industries' Fly Shuttle Loom," American Industrial Hygiene Conference, May 21, 1976.

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22. "Feasible Engineering Controls for Textile Equipment," Operational Procedure Notice 21, North Carolina Department of Labor, Occupational Safety and Health Division, Raleigh, NC, October 30, 1976.

23. Gubitose, N. F., "Noise Control for a Textile Ringtwister Machine," presented to the American Society of Mechanical Engineers.

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