MINING MACHINERY NOISE CONTROL GUIDELINES, 1983

By Roy C. Bartholomae and Robert P. Parker

A BUREAU OF MINES HANDBOOK

UNITED STATES DEPARTMENT OF THE INTERIOR

1983

Library of Congress Cataloging in Publication Data:

Bartholomae, R. C

Mining machinery noise control guidelines, 1983.

(Bureau of Mines handbook)

Includes bibliographical references.

Supt. of Docs. no.: I 28.16/2:M66/8.

1. Mining machinery–Noise. 2. Mineral industries–Noise control. I. Parker, Robert P. (Robert Paul). II. Title. III. Series.

TN345.B3 1983 622s [622'.4] 83-600114

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. BuMines HB 2-83	2.	3. Recipient's Accession No. PB84 152958
4. Title and Subtitle Mining Machinery Noise Control Guidelines, 1983			5. Report Date December 1983 6.
7. Author(s) Roy C. Bartholomae and Robert P. Parker			8. Performing Organization Rept. No.
9. Performing Organization Name and Address U.S. Bureau of Mines Pittsburgh Research Center Cochrans Mill Road, P.O. Box 18070 Pittsburgh, PA 15236			10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address Office of Assistant Director--Mining Research Bureau of Mines U.S. Department of the Interior Washington, DC 20241			13. Type of Report & Period Covered Handbook 14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Mine Health and Safety Act of 1977 seeks to protect miners by regulating their exposure to excessive noise in the mining environment. When a worker's exposure is found to be excessive, the utilization of existing engineering noise control measures are required to abate the noise. Over the past decade, the Bureau of Mines has undertaken a number of noise control programs aimed at establishing a technology base that can be used by industry to effect solutions to noise problems. Many of these hardware-oriented programs have provided the development and demonstration of retrofit noise control treatments for mining machinery. The purpose of this Handbook is to synthesize evolving and available noise control information and disseminate it within the mining industry.

17. Document Analysis a. Descriptors

Mining research
Handbook - Occupational noise control
Mining machinery
Mining equipment

b. Identifiers/Open-Ended Terms

State-of-the-art in mining machinery
Noise control

c. COSATI Field/Group 20A 06Q 13I 13L

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release unlimited by NTIS.	Unclassified	87
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

CONTENTS

MINING MACHINERY NOISE CONTROL GUIDELINES, 1983

By Roy C. Bartholomae[1] and Robert P. Parker[2]

ABSTRACT

The Mine Health and Safety Act of 1977 seeks to protect miners by regulating their exposure to excessive noise in the mining environment. When a worker's exposure is found to be excessive, the utilization of existing engineering noise control measures are required to abate the noise. Over the past decade, the Bureau of Mines has undertaken a number of noise control programs aimed at establishing a technology base that can be used by industry to effect solutions to noise problems. Many of these hardware-oriented programs have provided the development and demonstration of retrofit noise control treatments for mining machinery. The purpose of this Handbook is to synthesize evolving and available noise control information and disseminate it within the mining industry.

[1] Supervisory electrical engineer, Pittsburgh Research Center, Bureau of Mines, Pittsburgh, PA.
[2] Senior staff engineer, Wyle Laboratories, Huntsville, AL.

INTRODUCTION

This Handbook presents evolving and currently available noise control information for major pieces of mining equipment. The format is a concise data sheet. Descriptive text has been purposely abbreviated to facilitate a quick-look survey of available information. No attempt has been made to discuss the research activities that have led to the development or demonstration of the noise control technology. Rather, the technology is summarized in terms of what should be done and what results may be realized. Also, this Handbook does not present how-to-do-it engineering instructions, but rather makes reference to technical reports that address the details of how to implement noise control treatments as well as available sources for noise control components, retrofit kits, and raw materials.

Individual data sheets are presented for each major type of mining machinery or system, and the data sheets are grouped into sections according to the following types of operations:

- Surface mining.
- Undergroud mining.
- Preparation and processing

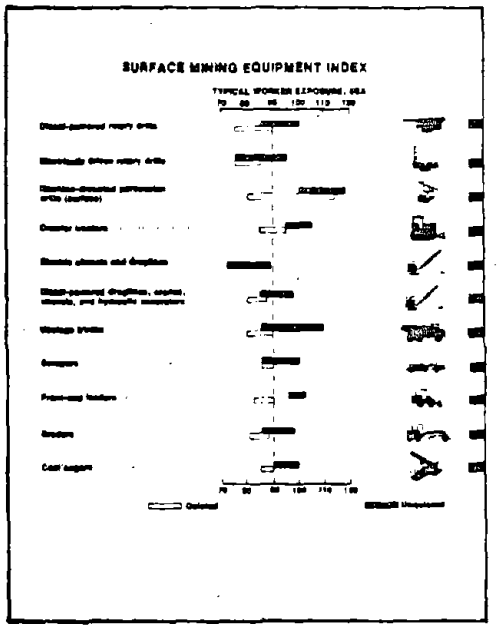
The individual data sheets provide information in three areas

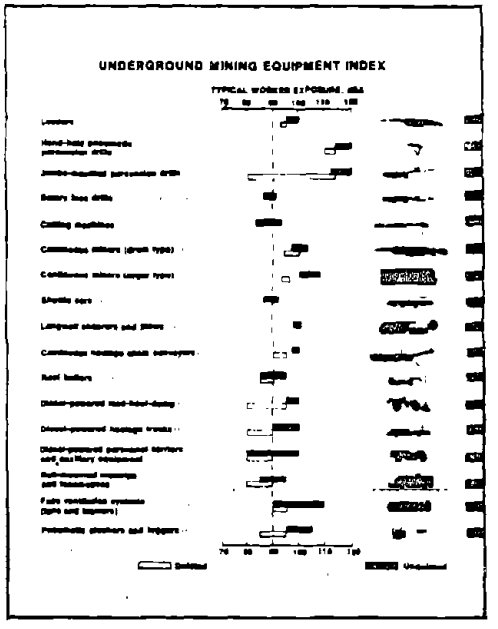
1. Noise characteristics of the particular mining machine.
2. Noise control treatments, benefits, and costs together with information on the state of the technology.
3. References for commercially available noise control components, kits, and raw materials; technical reports documenting research that led to the development of the noise control technology, and, as applicable, case histories where the noise control measures have been demonstrated.

In some cases the data sheets identify noise control measures that are under development. In such cases it is the intent of this Handbook to advise of promising concepts as well as to stimulate interest in exploring all available avenues to achieve quiet mining machinery.

HOW TO USE THIS HANDBOOK

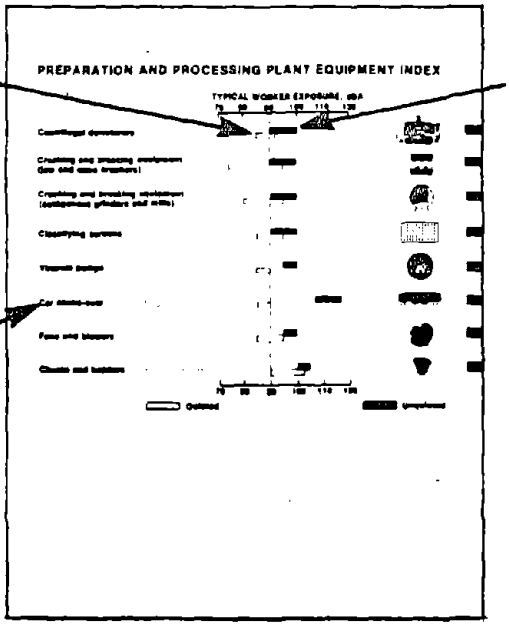
The index pages for surface, underground, and plant equipment list the equipment categories along with the range of noise levels for acoustically treated and untreated equipment.





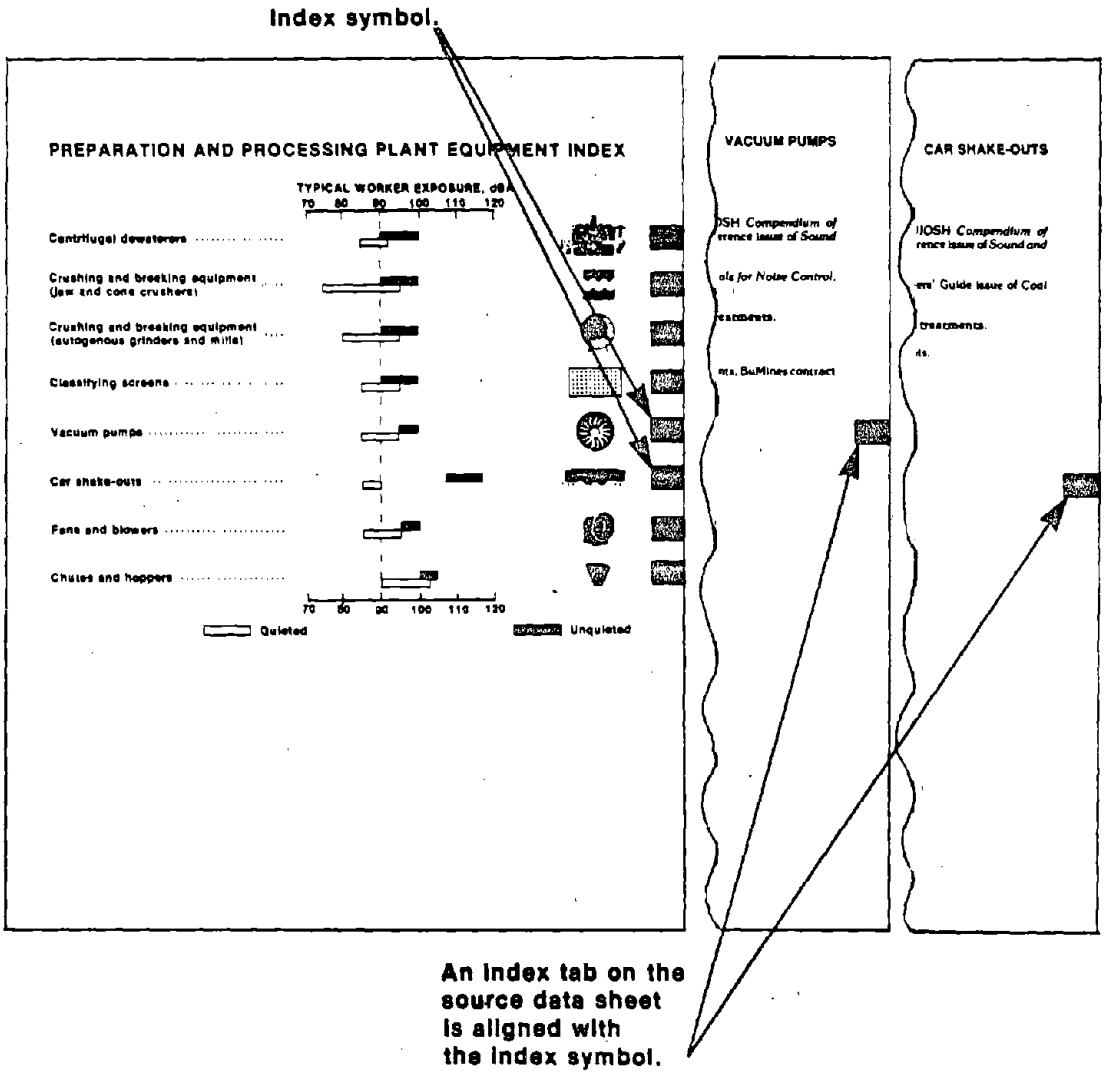
Typical range of noise levels for treated equipment.

Typical range of noise levels for untreated equipment.



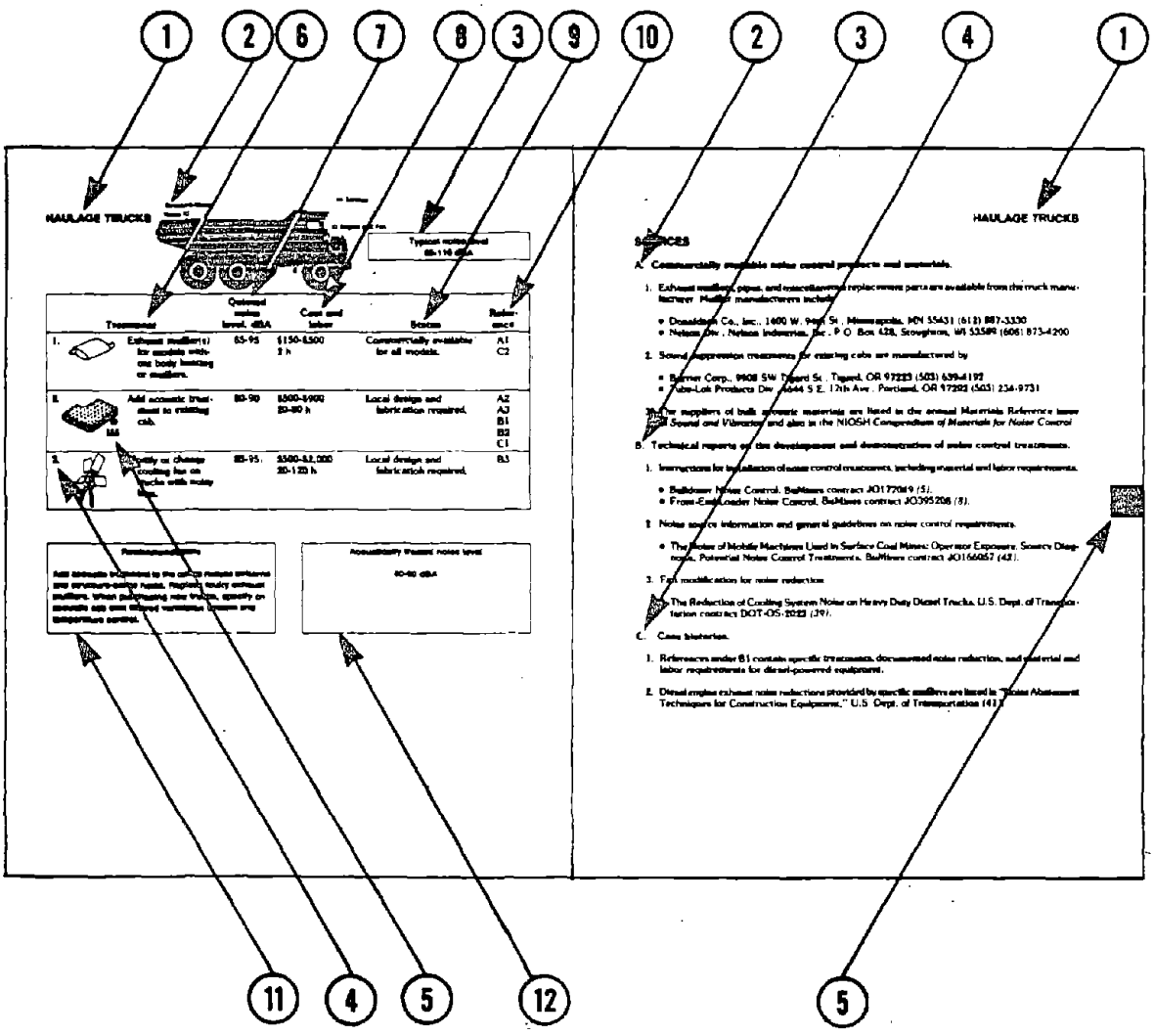
Equipment category.

In addition, there are index symbols that will aid the user in locating the data sheet of interest, as illustrated below.



The features of the illustrated data sheets are given in the following listing.

Treatment data sheet **Source data sheet**



Treatment Data Sheets

1. Identification of machine category.

2. Generalized machine schematic showing major noise sources.

3. Untreated noise level. Typical level at the operator's position unless noted otherwise. This noise level is also shown on the equipment index page.

4. Treatment number. Each numbered treatment is a separate treatment package.

5. Schematic representation of each treatment.

6. Treatment and explanation of each treatment.[3]

7. Quieted noise level. Expected range of noise levels with treatment installed.

8. Cost and labor. Estimated cost to install each treatment based on estimated 1983 material costs and estimated labor requirements. The material and labor requirements for a given treatment often vary widely, and an inspection of the equipment may be necessary for an accurate estimate to be made. The mine superintendent will usually know whether the cost for his or her equipment will be greater than an average cost.

9. Status. Gives the availability status of the specific noise control treatment, based on the following five categories:

   Commercially available for all models. Available for all models or the vast majority of models.

   Commercially available for some models.

   Local fabrication using well-documented methods. Noise control techniques have been developed that typically can be used by mining personnel to fabricate and install noise control treatments.

   Local design and fabrication required. Documented noise control techniques have been developed that typically can be used to locally fabricate and install noise control treatments. Assistance of machine design personnel and/or material and component suppliers may be required.

   Limited demonstration of methods; further development required. The noise control techniques have been shown to provide noise reduction, but durability and commercial fabrication techniques have not been established.

10. References. Alphanumeric codes refer to sources of information for the treatment. The sources are given on the facing source data sheet.

11. Recommendations. The recommended noise control treatments will include one or more of the listed treatments for the machine category.

---

[3] Further assistance may be available from the original equipment manufacturer, suppliers of acoustical materials, or Mine Safety and Health Administration (MSHA) technical support personnel. MSHA technical support personnel may be contacted at 4800 Forbes Avenue, Pittsburgh, PA 15213 (412) 621-4500; or at P.O. Box 25367, Denver, CO 80225 (303) 234-4824.

12. Acoustically treated noise level. Expected range of noise levels with the recommended treatment installed. This noise level is also shown on the equipment index page.

Source Data Sheet

1. Identification of machine category.

2. Commercially available noise control products and materials. Lists selected suppliers of noise control treatments made specificially for this category of machinery. Extensive lists of basic noise control material are available in the 1980 edition of the NIOSH "Compendium of Materials for Noise Control."[4] Additional material lists are available from the annual Materials Reference and Systems Reference issues of *Sound and Vibration*. An extensive listing of mining equipment suppliers is available in the annual Buyers' Guide issue of *Coal Age*.

3. Technical reports on the development and demonstration of noise control treatments. Lists brief information on applicable reports and contracts. Italicized numbers in parentheses refer to more detailed information in the list of references at the end of the Handbook.

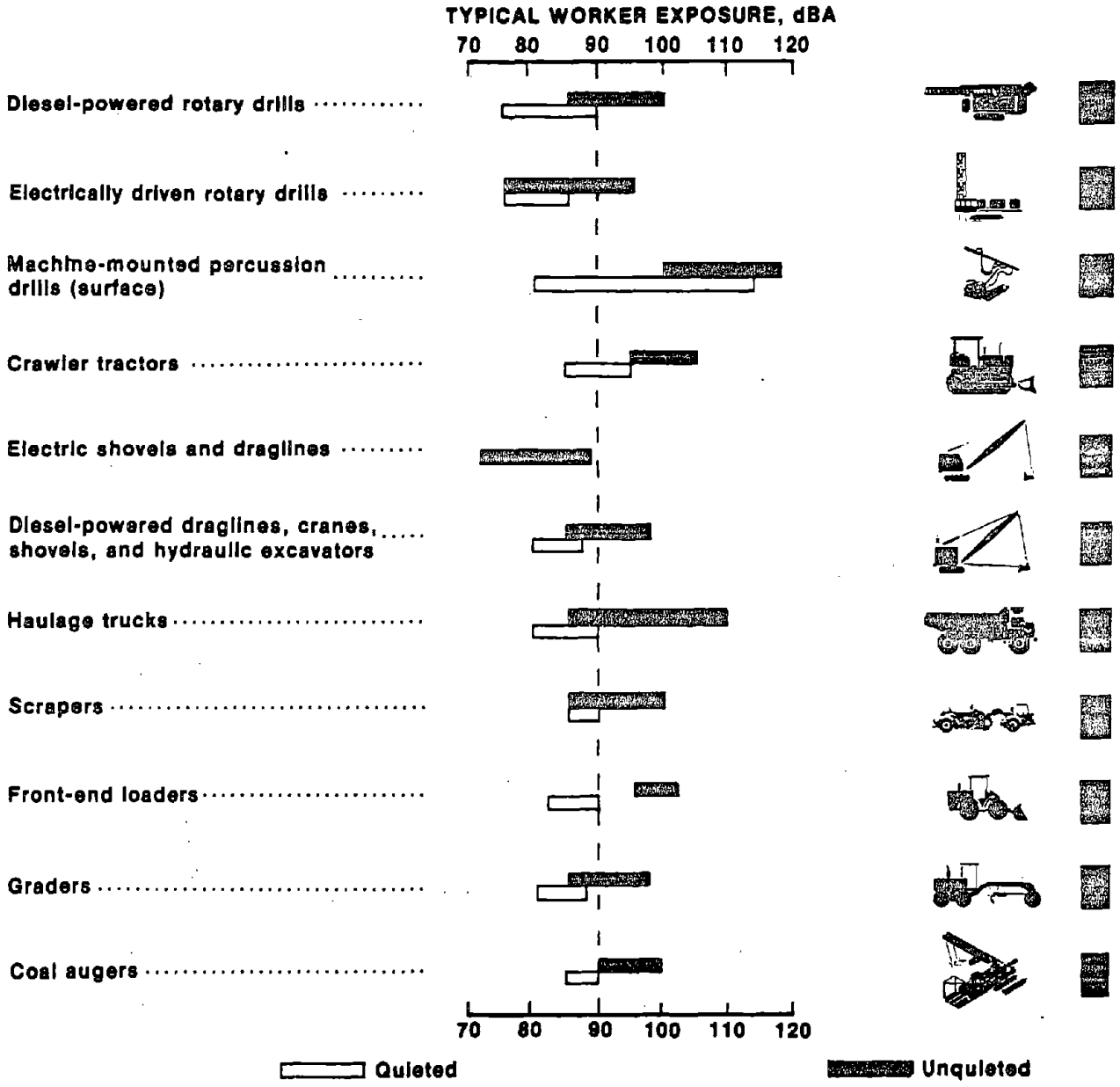
4. Case histories. Lists selected cases where the subject noise controls have been implemented.

5. Index Tabs. These are keyed to the equipment index page.

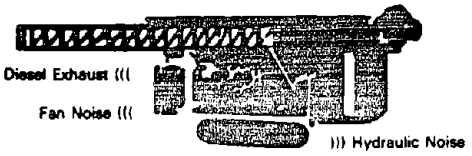
---

[4] U.S. Department of Health and Human Services, National Institute of Occupational Safety and Health (Cincinnati, OH). Rept. 80-116, 1980, 380 pp., U.S. Government Printing Office, Washington, DC, Stock No. 017-003-00359-9; National Technical Information Service, Springfield, VA, PB-298-307.

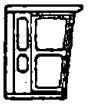
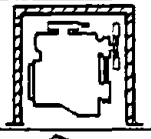
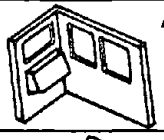
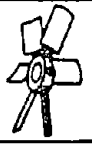
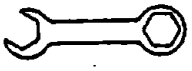
SURFACE MINING EQUIPMENT INDEX



DIESEL-POWERED ROTARY DRILLS



Typical noise level
85-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Add mufflers(s) to engine exhaust	85-95	$100-$450 2 h	Commercially available for all models.	A1 C2
2. 	Modify existing cab.	75-90	$500-$900 20-80 h	Local design and fabrication required.	A4 B1 B2
3. 	Add acoustic cab.	70-85	$10,000-$15,000 80-140 h	Commercially available for some models.	A2 A4 B2
4. 	Add enclosure for engine with mufflers.	75-90	$1,500-$8,000 140-280 h	Local design and fabrication required.	B2 B4
5. 	Add partial barrier at operator with mufflers.	80-95	$500-$2,000 20-120 h	Local design and fabrication required.	A4 B1 B2
6. 	Modify cooling fan with mufflers for models with noisy fans.	85-95	$500-$2,000 20-120 h	Local design and fabrication required.	B3
7. 	Install item 5 along with covers for hydraulic valves, dust collector for blow air, and isolated centralizer or drill pipe snubber.	80-90	$5,000-$10,000 200-250 h	Local design and fabrication required.	A3 A4 B1 B2 B3

Recommendations

Reduce engine noise using a muffler, cab, or barrier as appropriate.

Acoustically treated noise level

75-90 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the machinery manufacturer. Muffler manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Acoustic cabs for some models are available from the drill manufacturer.

3. Dust collectors are available from

   - Donaldson Co., Inc., P.O. Box 1299, Minneapolis, MN 55440 (612) 887-3950
   - Joe Tipton, Inc., P.O. Box 2968, Garland, TX 75041 (214) 494-0297
   - Ventor, Inc., 191 Eglinton, Toronto, Canada (416) 481-3882

4. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

B. Technical reports on the development and demonstration of noise control treatments.

1. Instructions for installation of noise control treatments on diesel-powered equipment, including material and labor requirements.

   - Bulldozer Noise Control, BuMines contract J0177049 *(5)*.
   - Front-End Loader Noise Control, BuMines contract JO395028 *(8)*.

2. Noise source information and general guidelines on noise control requirements.

   - The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract JO166057 *(42)*.

3. Fan noise reduction concepts and design.

   - The Reduction of Cooling System Noise on Heavy Duty Diesel Trucks, U.S. Dept. of Transportation contract DOT-OS-2022 *(39)*.
   - Noise and Performance of Automotive Cooling Fans, SAE Tech. Paper 800031 *(29)*.

4. Evaluation of noise reduction from a diesel engine enclosure.

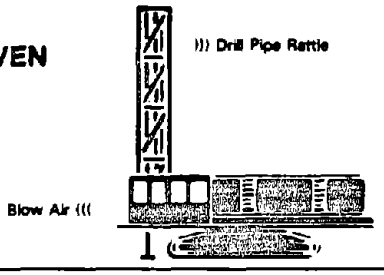
   - Quieting Portable Air Compressors, Noise Control Eng. *(31)*.

C. Case Histories.

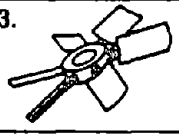
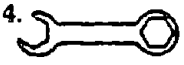
1. References under B1 contain specific treatments for diesel-powered equipment, documented noise reduction, and material and labor requirements.

2. Diesel engine exhaust noise reductions provided by specific mufflers are listed in "Noise Abatement Techniques for Construction Equipment," U.S. Dept. of Transportation *(41)*.

ELECTRICALLY DRIVEN ROTARY DRILLS



Typical noise level
75-95 dBA

Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.  Modify existing cab.	75-85	$500-$1,000 20-60 h	Local design and fabrication required.	B1 B3 C1
2.  Muffle air inlet to compressor (s).	75-90	$1,000-$3,000 20-30 h	Commercially available for some models.	A1
3.  Modify ventilation fans.	([1])	$300-$1,500 20-30 h	Local design and fabrication required.	B2
4.  Install treatments 2 and 3 plus a drill pipe snubber and isolated centralizer.	75-85	$2,000-$4,000 40-80 h	Commercially available for some models. For other models, local design and fabrication required.	A1 A2 B2

[1]Little in-cab noise reduction alone.

Recommendations

Block noise paths by improving existing cabs.
Reduce machinery house noise.

Acoustically treated noise level

75-85 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Silencers for air compressor exhaust are available from the compressor manufacturer or

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Farr Co., 2301 Rosecrans, El Segundo, CA 90245 (213) 772-5221

2. Drill pipe accessories are available from the original equipment manufacturer or

   - B. J. Hughes, Inc., Box 2198, Houston, TX 77001 (713) 926-8321
   - Drilco Industrial Div., Smith International Inc., Drawer 3135, Midland, TX 79702 (915) 682-6239
   - Reed Tubular Products Co., P.O. Box 620, Sugar Land, TX 77478 (713) 491-2811

B. Technical reports on the development and demonstration of noise control treatments.

1. Noise source information and general guidelines on noise control requirements.

   - The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract JO166057 *(42)*.

2. Fan noise reduction concepts and design.

   - Guide and Data Book, Systems, American Soc. of Heating, Refrigeration and Air Conditioning Engineers *(2)*.

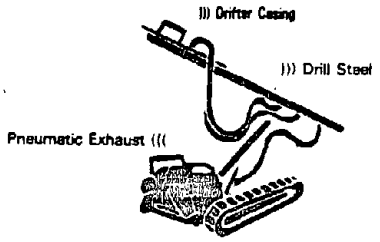
3. Instructions for installation of noise control treatments in existing cabs, including material and labor requirements.

   - Front-End Loader Noise Control, BuMines contract JO395028 *(8)*.

C. Case histories.

1. Hanna Mining Co., Hibbing, MN 55746

MACHINE-MOUNTED PERCUSSION DRILLS (SURFACE)



Typical noise level
Unmuffled pneumatic, 116-118 dBA
Hydraulic, 100-114 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	Add-on muffler (pneumatic drills only).	112-114	$300-$500 2 h	Commercially available for some models.	A1
2.	Piped away exhaust (pneumatic drills only).	112-114	$1,000-$2,000 10 h	Commercially available for some models.	A1
3.	Wraparound muffler (pneumatic drills only).	110-112	$150-$500 10 h	Commercially available for some models.	A1 B2
4.	Add acoustic cab.	80-90	$9,000-$15,000 40-120 h	Commercially available for some models.	A4
5.	Drill steel cover or sheath with exhaust muffler.	105-110	Unknown	Limited demonstration of method; further development required.	B1 C1
6.	Enclosure for drill with drill steel cover and isolated centralizer.	100-105	Unknown	Limited demonstration of method; further development required.	A2 B1 C1
7.	Total enclosures for feed and drill assembly with dust collector.	95-100	$6,000-$10,000 100-150 h	Local design and fabriction required	A3 C2

Recommendations
Add a muffler or acoustic cab.

Acoustically treated noise level
Muffled pneumatic drill, 110-114 dBA
Acoustic cab installed (hydraulic or pneumatic), 80-90 dBa
when drilling holes larger than 3.5-in-diam, a down-hole hammer may be substituted, 90-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Drill mufflers are available from drill manufacturers or parts vendors, including

   - APEX Equipment, Inc., 4001 21st Ave. W, Seattle, WA 98199 (206) 283-7380
   - dBA Inc., P.O. Box 413, Dept. S, Buford, GA 30518 (404) 945-2929
   - Innovation Supply, 1655 Jasper St., Aurora, CO 80011 (303) 341-0284

2. Drill accessories are available from

   - Atlas-Copco Inc., 70 Demarest Drive, Wayne, NJ 07470 (201) 696-0554

3. Dust collectors are available from drill manufacturers or

   - Donaldson Co., Inc., P.O. Box 1299, Minneapolis, MN 55440 (612) 887-3950
   - Joe Tipton, Inc., P.O. Box 2968, Garland, TX 75041 (214) 494-0297

4. Acoustic cabs are available from the drill manufacturer.

B. Technical reports on the development and demonstration of noise control treatments.

1. Fabrication and design of drill enclosures.

   - Noise Reduction of Jumbo Mounted Percussive Drills: Phase II, Development of Noise Treatment, BuMines contract HO366024 *(3)*.
   - Development of Noise Control Technology for Pneumatic Jumbo Drills, BuMines contract HO395029 *(17)*.

2. Construction of wraparound mufflers.

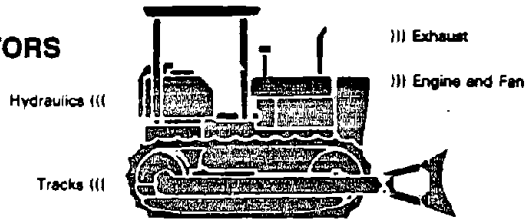
   - Noise Abatement of Pneumatic Rock Drill, BuMines RI 7998 *(40)*.

C. Case histories.

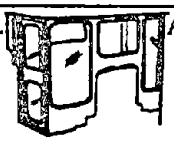
1. Prototype retrofit noise treatment for jumbo drills—Bolt Beranek & Newman Inc., 10 Moulton St., Cambridge, MA 02238.

2. Ingersoll-Rand Corp., 200 Chestnut Ridge Rd., Woodcliff Lake, NJ 07675.

CRAWLER TRACTORS



Typical noise level
95-105 dBA

Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.  For dozers with ROPS only add noise barriers and absorption to ROPS—windshield, floormat, canopy absorption, seals, vibration isolation.	92-94	$500-$1,500 60-120 h	Local fabrication using well-documented methods. Commercially available for some models.	A3 A4 A5 B1 C1
2.  Add complete acoustical cab with pressurization and air conditioning.	85	$12,000-$15,000 60-140 h	Commercially available for most models.	A2 B1
3.  Add sound suppression to existing cab.	90-91	$500-$1,500 30-80 h	Commercially availble for most models or can be locally fabricated using well-documented methods.	A3 A4 A5 B1 C1
4.  Install an acoustically effective exhaust system.	100-103	$200-$400 2 h	Commercially available for all models	A1 C2

Recommendations

Add an acoustic cab or use the appropriate treatmeant detailed in the "Bulldozer Noise Control" manual (B1).

Acoustically treated noise level

85-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the tractor manufacturer. Muffler manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Acoustic cabs are generally available from grader dealers. Manufacturers include

   - Medford Steel, P.O. Box 1588, Medford, OR 97501 (503) 779-1970
   - Palm Industries, Inc., P.O. Box 562, Litchfield, MN 55355 (612) 693-2492
   - Saf-T-Cab, Inc., P.O. Box 2587, Fresno, CA 93745 (209) 268-5541
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

3. Sound suppression treatments for open ROPS or existing cabs are manufactured by

   - Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Industrial Cab Co., Inc., 76 Eastern Ave., Essex, MA 01929 (617) 768-6931
   - Medford Steel, P.O. Box 1588, Medford, OR 97501 (503) 779-1970
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

4. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

5. Retrofit noise control kits and field installation for bulldozers and front-end loaders, based on reference B1, are available from

   - Tech Enterprises, P.O. Box 2397, Littleton, CO 80161 (303) 779-4387

B. Technical reports on the development and demonstration of noise control treatments.

1. Instructions for installation of noise control treatments, including material and labor requirements.

   - Bulldozer Noise Control, BuMines contract JO177049 *(5).*
   - Front-End Loader Noise Control, BuMines contract JO395028 *(8).*

2. Noise source information and general guidelines on noise control requirements.

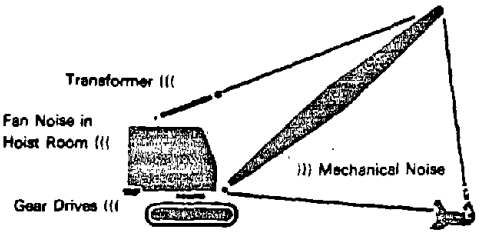
   - The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract JO166057 *(42).*

C. Case histories.

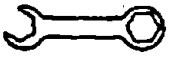
1. References under B1 contain specific treatments, documented noise reduction, and material and labor requirements for diesel-powered equipment.

2. Diesel engine exhaust reductions provided by specific mufflers are listed in "Noise Abatement Techniques for Contruction Equipment," U.S. Dept. of Transportation *(41).*

ELECTRIC SHOVELS AND DRAGLINES



Typical noise level 72-89 dBA

Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.  Replace worn or damaged parts that generate unusual noise.	72-89	Varied	Commercially available for all models.	None

NOTE—Electric shovels and draglines are typically not a noise problem. Operator noise exposure problems in electric shovels and draglines are normally due to poor maintenance. The oiler may be overexposed but typically can be brought into compliance by administrative controls.

SOURCES

A. Commerically available noise control products and materials.

None. Only normal maintenance required.

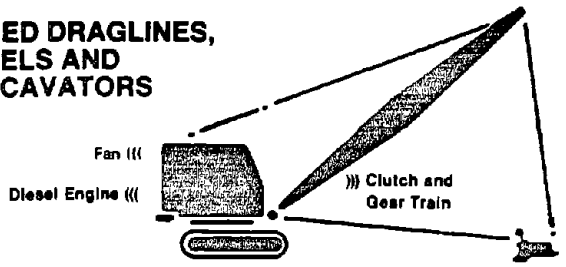
B. Technical reports on the development and demonstration of noise control treatments.

None. Electric shovels and draglines are typically not a problem.

C. Case histories.

None. Electric shovels and draglines are typically not a problem.

DIESEL-POWERED DRAGLINES, CRANES, SHOVELS AND HYDRAULIC EXCAVATORS



Typical noise level
85-98 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Add sound suppression to the cab—acoustical absorption, seals	80-90	$500-$1,500 30-80 h	Commercially available for some models, also local fabrication using well-documented methods.	A2 A3 B1 B2 C1
2. 	Install or replace exhaust system parts.	80-90	$200-$400 2 h	Commercially available for for all models.	A1 C2

Recommendations

Add sound suppression to the cab.

Acoustically treated noise level

80-88 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the equipment manufacturer. Muffler manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Sound suppression treatments for existing cabs are manufactured by

   - Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

3. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

B. Technical reports on the development and demonstration of noise control treatments.

1. Instructions for installation of noise control treatments, including material and labor requirements.

   - Bulldozer Noise Control, BuMines contract J0177049 *(5)*.
   - Front-End Loader Noise Control, BuMines contract J0395028 *(8)*.

2. Noise source information and general guidelines on noise control requirements.

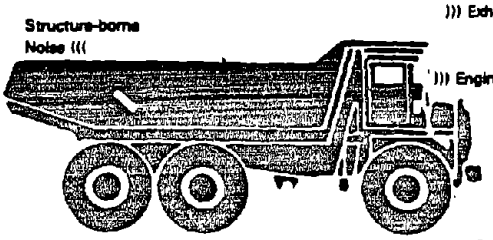
   - The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract JO166057 *(42)*.
   - Noise Control on a Heavy Duty Mobile Crane, SAE Tech. Paper 760601 *(4)*.

C. Case histories.

1. References under B1 contain specific treatments, documented noise reduction, and material and labor requirements for diesel-powered equipment.

2. Diesel engine exhaust noise reductions provided by specific mufflers are listed in "Noise Abatement Techniques for Construction Equipment," U.S. Dept. of Transportation *(41)*.

HAULAGE TRUCKS



Typical noise level
85-110 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	Exhaust muffler(s) for models without body heating or mufflers.	85-95	$150-$500 2 h	Commercially available for all models.	A1 C2
2.	Add acoustic treatment to existing cab.	80-90	$500-$900 20-80 h	Local design and fabrication required.	A2 A3 B1 B2 C1
3.	Modify or change cooling fan on trucks with noisy fans.	85-95	$500-$2,000 20-120 h	Local design and fabrication required.	B3

Recommendations

Add acoustic treatment to the cab to reduce airborne and structure-borne noise. Replace faulty exhaust mufflers. When purchasing new trucks, specify an acoustic cab with filtered ventilaton system and temperature control.

Acoustically treated noise level

80-90 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the truck manufacturer. Muffler manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Sound suppression treatments for existing cabs are manufactured by

   - Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

3. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

B. Technical reports on the development and demonstration of noise control treatments.

1. Instructions for installation of noise control treatments, including material and labor requirements.

   - Bulldozer Noise Control, BuMines contract JO177049 *(5)*.
   - Front-End Loader Noise Control, BuMines contract JO395208 *(8)*.

2. Noise source information and general guidelines on noise control requirements.

   - The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract JO166057 *(42)*.

3. Fan modification for noise reduction.

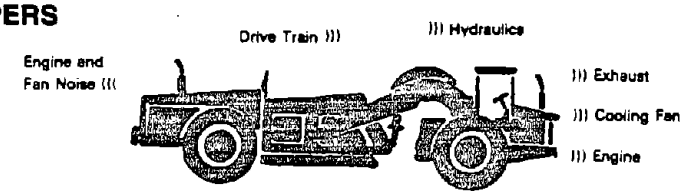
   - The Reduction of Cooling System Noise on Heavy Duty Diesel Trucks, U.S. Dept. of Transportation contract DOT-OS-2022 *(39)*.

C. Case histories.

1. References under B1 contain specific treatments, documented noise reduction, and material and labor requirements for diesel-powered equipment.

2. Diesel engine exhaust noise reductions provided by specific mufflers are listed in "Noise Abatement Techniques for Construction Equipment," U.S. Dept. of Transportation *(41)*.

SCRAPERS



Typical noise level
85-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	 For scrapers without a cab, install an operator cab with sound suppression.	85-90	$12,000-$15,000 60-140 h	Commercially available for most models.	A2 B2
2.	 For scraper without a cab, fabricate open ROPS noise barriers, sound absorption and vibration isolation to reduce the operator exposure.	90-95	$500-$1,500 60-120 h	Local design and fabrication required.	A4 B1 B2 C1
3.	 Add sound suppression to existing cab.	85-90	$500-$1,500 30-80 h	Commercially available for some models.	A3 B1 B2 C1
4.	 Replace exhaust components if faulty or missing.	85-98	$200-$400 2 h	Commercially available for all models	A1 C2

Recommendations

Add sound suppression treatments to existing cabs. Install a cab with sound suppression under open ROPS.

Acoustically treated noise level

85-90 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the scraper manufacturer. Muffler manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Acoustic cabs are generally available from scraper dealers. Manufacturers include

   - Industrial Cab Co., Inc., 76 Western Avenue, Essex, MA 01929 (617) 768-6931
   - Palm Industries, Inc., P.O. Box 562, Litchfield, MN 55355 (612) 693-2492
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

3. Sound suppression treatments for existing cabs are manufactured by

   - Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503)234-9731

4. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

B. Technical reports on the development and demonstration of noise control treatments.

1. Instructions for installation of noise control treatments, including material and labor requirements.

   - Bulldozer Noise Control, BuMines contract JO177049. *(5).*
   - Front-End Loader Noise Control, BuMines contract J0395028 *(8).*

2. Noise source information and general guidelines on noise control requirements.

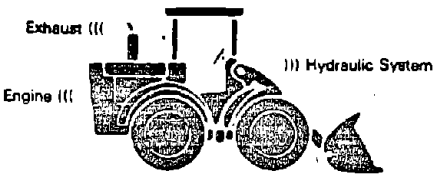
   - The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract JO166057 *(42).*

C. Case histories.

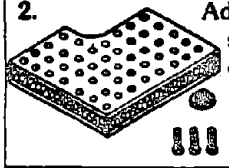
1. References under B1 contain specific treatments, documented noise reduction, and material and labor requirements for diesel-powered equipment.

2. Diesel engine exhaust noise reductions provided by specific mufflers are listed in "Noise Abatement Techniques for Construction Equipment," U.S Dept. of Trnasportation *(41).*

FRONT-END LOADERS



Typical noise level
95-102 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Add complete noise control cab with pressurization and air conditioning.	82-90	$12,000-$15,000 60-140 h	Commercially available for some models.	A2 B2
2. 	Add sound suppression to existing cab.	82-90	$500-$1,000 30-80 h	Commercially available for some models or can be locally fabricated using well-documented methods.	A3 A4 A5 B1 B2 C1
3. 	Replace exhaust system components if missing or faulty.	90-100	$200-$400 2 h	Commercially available for all models.	A1 C2

Recommendations

Install a cab with sound suppression under an open ROPS, or use the appropriate treatment detailed in "Front-End Loader Noise Control" (B1).

Acoustically treated noise level

82-90 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the loader manufacturer. Muffler manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 535890 (608) 873-4200

2. Acoustic cabs are generally available from loader dealers. Manufacturers include

   - Industrial Cab Co., Inc., 76 Western Avenue, Essex, MA 01929 (617) 768-6931
   - Medford Steel, P.O. Box 1588, Medford, OR 97501 (503) 779-1970
   - Palm Industries, Inc., P.O. Box 562, Litchfield, MN 55355 (612) 693-2492
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

3. Sound suppression treatments for existing cabs are manufactured by

   - Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Medford Steel, P.O. Box 1588, Medford, OR 97501 (503) 779-1970
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

4. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

5. Retrofit noise control kits and field installation for bulldozers and front-end loaders, based on reference B1, are available from

   - Tech Enterprises, P.O. Box 2397, Littleton, CO 80161 (303) 779-4387

B. Technical reports on the development and demonstration of noise control treatments.

1. Instructions for installation of noise control treatments, including material and labor requirements.

   - Front-End Loader Noise Control, BuMines contract JO395028 *(8).*
   - Bulldozer Noise Control, BuMines contract JO177049 *(5).*

2. Noise source information and general guidelines on noise control requirements.

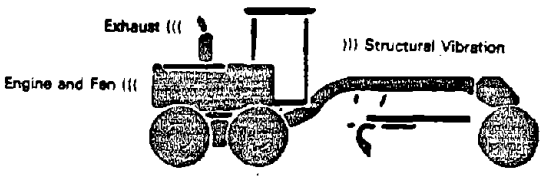
   - The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract JO166057 *(42).*

C. Case histories.

1. References under B1 contain specific treatments, documented noise reduction, and material and labor requirements for diesel-powered equipment.

2. Diesel engine exhaust noise reductions provided by specific mufflers are listed in "Noise Abatement Techniques for Construction Equipment," U.S. Dept. of Transportation *(41).*

GRADERS



Typical noise level
85-98 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	Install an exhaust muffler if missing or faulty.	85-95	$200-$400 2 h	Commercially available for all models.	A1 C2
2.	Add complete noise control cab with pressurization and air conditioning.	80-90	$12,000-$15,000 60-140 h	Commercially available for some models.	A2 B2
3.	Add sound suppression to existing cab.	80-90	$500-$1,500 30-80 h	Commercially available for some models or can be locally fabricated using well-documented methods.	A3 A4 B1 C1

Recommendations

Add sound suppression to the cab and a muffler, if needed.

Acoustically treated noise level

80-88 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the grader manufacturer. Muffler manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Acoustic cabs are generally available from grader dealers. Manufacturers include

   - Industrial Cab Co., Inc., 76 Western Avenue, Essex, MA 01929 (617) 768-6931
   - Palm Industries, Inc., P.O. Box 562, Litchfield, MN 55355 (612) 693-2492
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

3. Sound suppression treatments for existing cabs are manufactured by

   - Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Tub-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

4. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

B. Technical reports on the development and demonstration of noise control treatments.

1. Instructions for installation of noise control treatments, including material and labor requirements.

   - Bulldozer Noise Control, BuMines contract JO177049 *(5)*.
   - Front-End Loader Noise Control, BuMines contract JO395028 *(8)*.

2. Noise source information and general guidelines on noise control requirements.

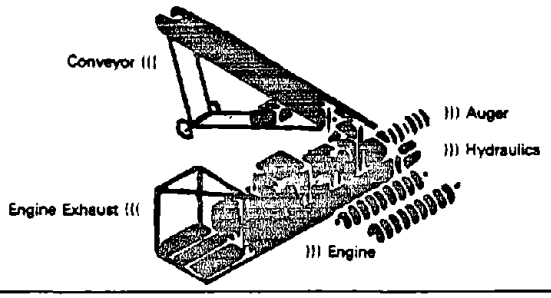
   - The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract JO166057 *(42)*.

C. Case histories.

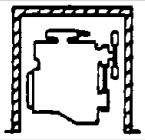
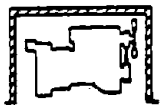
1. References under B1 contain specific treatments, documented noise reduction, and material and labor requirements for diesel-powered equipment.

2. Diesel engine exhaust noise reductions provided by specific mufflers are listed in "Noise Abatement Techniques for Construction Equipment," U.S. Dept. of Transportation *(41)*.

COAL AUGERS



Typical noise level
90-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Install engine exhaust muffler.	90-95	$50-$150 2 h	Commercially availble for all models.	A1 C2
2. 	Enclosure for engine and drive system.	85-95	$1,500-$8,000 140-280 h	Local design and fabrication required.	B2
3. 	Enclosure for hydraulic drives and engine (treatment 2).	85-90	$1,500-$8,000 160-300 h	Local design and fabrication required.	A4 B2
4. 	Treatments 2 and 3 plus modification of auger for damping.	85	$3,000-$11,000 180-340 h	Local design and fabrication required.	C3
5. 	Install acoustic cab.	80-90	$10,000-$15,000 60-140 h	Commercially available for some models.	A2 A3 B1 C1

Recommendations

Install muffler and engine enclosure and/or barrier. If the noise level is still above 90 dBA, enclose the hydraulic drive for the auger.

Acoustically treated noise level

85-90 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the drill manufacturer. Muffler manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Acoustic cabs for some models are available from the drill manufacturer.

3. Sound suppression treaments for open ROPS or existing cabs are manufactured by

   - Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Tube-Lock Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

4. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

B. Technical reports on the development and demonstration of noise control treatments.

1. Instructions for installation of noise control treatments on diesel-powered equipment, including treatment of the hydraulic system.

   - Bulldozer Noise Control, BuMines contract JO177049 *(5).*

2. Engine enclosure evaluation.

   - Quieting Portable Air Compressors, Noise Control Eng. *(31).*

3. Hydraulic system treatment.

   - Effect of a Pulse Damper on a Hydraulic System on Operator Ear Noise, SAE Tech. Paper 750829 *(33).*

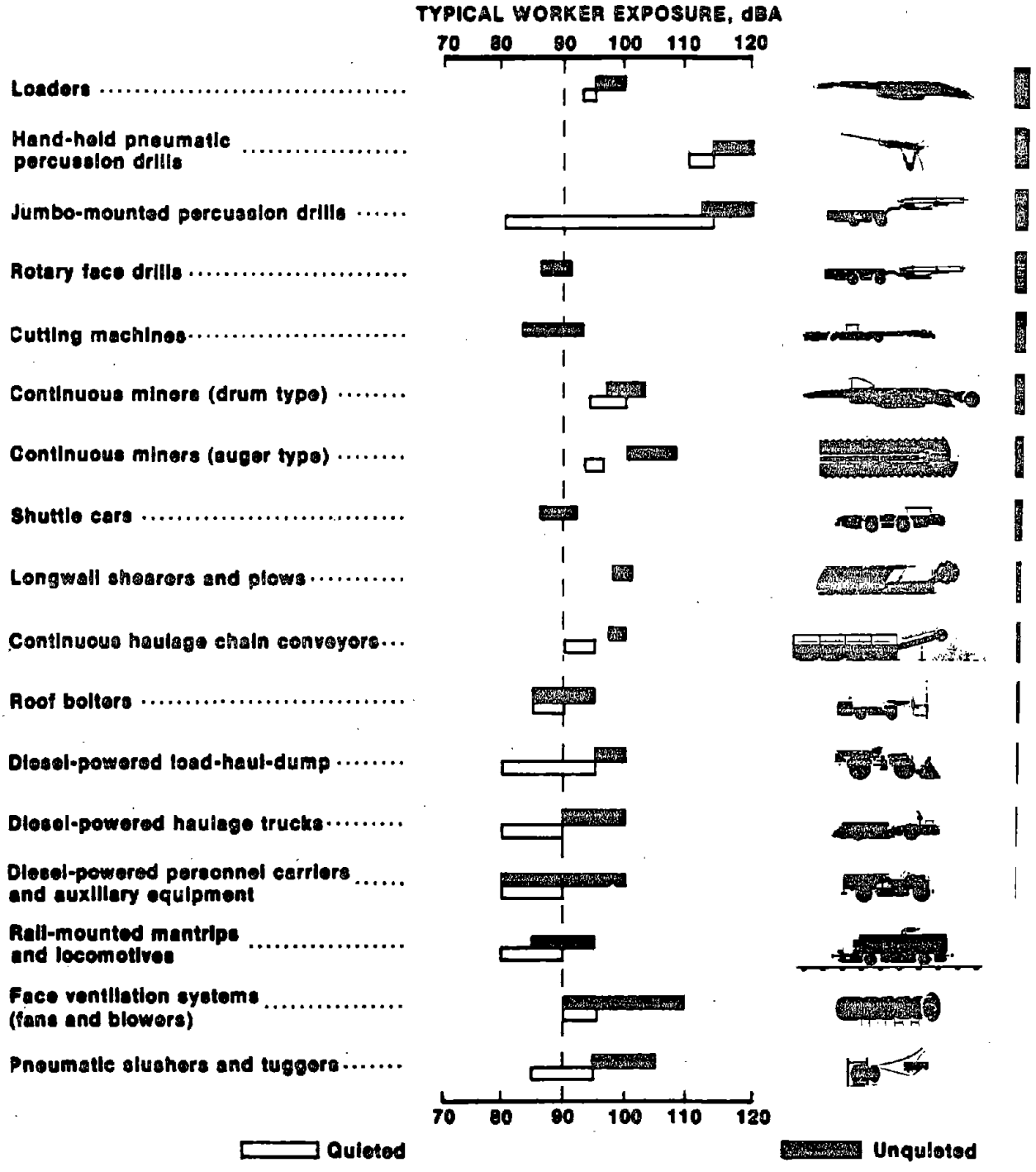
C. Case histories

1. Reference under B1 contains specific treatments for diesel-powered equipment, documented noise reduction, and material and labor requirements.

2. Diesel engine exhaust noise reductions provided by specific mufflers are listed in "Noise Abatement Techniques for Construction Equipment," U.S. Dept. of Transportation *(41).*

3. Control of Noise From Auger Miners, BuMines contract HO188065 *(46).*

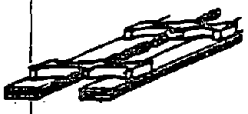
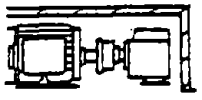
UNDERGROUND MINING EQUIPMENT INDEX



Preceding page blank

LOADERS

Typical noise level
95-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Modify the conveyor with isolated pan wear strips, pan damping treatment, elimination of sideboard and pan discontinuities, impact pads on return pan.	93-95	$6,000-$10,000 80-160 h ([1])	Local design and fabrication required.	A1 B1 B2 C1
2. 	Treat the hydraulic pump compartment for acoustical absorption, enclose and seal it.	([2])	$50-$300 8-40 h	Local fabrication using well-documented methods.	B3

[1]When done during rebuild above ground.
[2]Effective only to control machine idling.

Recommendations

Apply conveyor system noise control—particularly applicable during machine rework.

Acoustically treated noise level

93-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Isolated wear strips for the conveyor are available from

   - Fairchild, Inc., P.O. Box 1184, Beckley, WV 25801 (304) 255-2131
   - PI Mine Service, P.O. Box 1716, Beckley, WV 25801 (304) 252-6321

B. Technical reports on the development and demonstration of noise control treatments.

1. Specific noise control treatments and evaluation.

   - Noise Reduction of Chain Conveyors, BuMines contract HO155113 *(15)*.
   - Noise Control of an Underground Continuous Miner, Auger-Type, MESA IR 1056 *(18)*.
   - Noise Control Report and Modification Manuals, BuMines contract HO166012 *(34-36)*.

2. Noise source information and general guidelines on noise control requirements.

   - Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract HO357085 *(24)*.

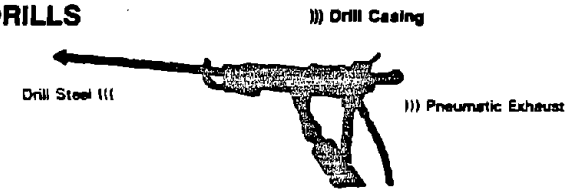
3. Treatment of noise in the hydraulic system.

   - Bulldozer Noise Control, BuMines contract JO177049 *(5)*.

C. Case histories.

1. References under B1 and B3 contain case histories.

HAND-HELD PNEUMATIC PERCUSSION DRILLS



Typical noise level
114-120 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	Add-on muffler.	112-114	$30-$350 24 h	Commercially available for some models.	A1 A2 B1
2.	Wraparound muffler.	110-112	$100-$400 8-12 h	Commercially available for some models.	A1 B1 B2
3.	Drill steel sheath.	([1])	Unknown	Limited demonstration of method; further development required.	B2
4.	Add-on muffler plus drill steel sheath.	108-112	Unknown	Limited demonstration of method; further development required.	B1 B2
5.	New technology drill.	95-100	$3,000	Commercially available.	A2 C1

[1]No reduction in noise levels without muffler.

Recommendations

Noise control treatments center on adding a muffler to the drill. An alternative is the new technology drill.

Acoustically treated noise level

Wraparound or add-on muffler, 110-114 dBA
New technology drill, 95-100 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Drill mufflers are available from the original equipment manufacturer or after-market suppliers.

   - APEX Equipment, Inc., 4001 21st Ave. W., Seattle, WA 98199 (206) 283-7380
   - dBA Inc., P.O. Box 413, Dept. S, Buford, GA 30518 (404) 945-2929
   - Innovation Supply, 1655 Jasper St., Aurora, CO 80011 (303) 341-0284

2. New technology drills

   - Tech Enterprises, P.O. Box 2397, Littleton, CO 80161 (303) 779-4387

B. Technical reports on the development and demonstration of noise control treatments.

1. Description of wraparound muffler fabrication.

   - Muffler for Pneumatic Drill, BuMines contract HO220048 *(26)*.
   - Noise Control of Stoper Drills, BuMines contract HO220048 *(27)*.
   - Noise Abatement of Pneumatic Rock Drill, BuMines RI 7998. *(40)*.

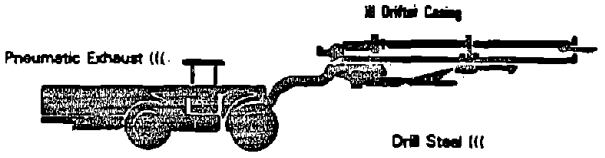
2. Noise source analysis and design of new technology rock drill.

   - Development of a Quiet Rock Drill, BuMines contract JO155099 *(19-20)*.

C. Case histories.

1. Development of Six Prototype Production Stoper Drills, BuMines contract JO177125 (11).

JUMBO-MOUNTED PERCUSSION DRILLS



Typical noise level
Unmuffled pneumatic, 116-120 dBA
Hydraulic, 112-114 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	Add-on muffler.	112-114	$300-$500 2 h	Commercially available for some models.	A1
2.	Piped away exhaust.	112-114	$1,000-$2,000 10 h	Commercially available for some models	A1
3.	Wraparound muffler.	110-112	$150-$500 10 h	Commercially available for some models.	A1 B1
4.	Add acoustic cab.	80-90	$10,000-$20,000 80-160 h	Commercially available for some models.	A2
5.	Drill steel cover or shroud with exhaust muffler.	105-110	Unknown	Limited demonstration; further development required.	B1 C1
6.	Enclosure for drill with drill steel cover and isolated centralizer.	100-105	Unknown	Limited demonstration; further development required.	A3 B1 C1
7.	Enclosure for drill and feed assembly.	95-100	Unknown	Limited demonstration; further development required.	B1 C1

Recommendations

Add a muffler to the drill. Add an acoustic cab where possible. Substitute a downhole hammer for holes larger than 3.5-inch diam.

Acoustically treated noise level

Add-on muffler, 110-114 dBA
Add acoustic cab where possible, 80-90 dBA
Substitute a downhole hammer, 90-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Drill mufflers are available from the original drill manufacturer or parts vendors including

   - APEX Equipment, Inc., 4001 21st Ave. W., Seattle, WA 98199 (206) 283-7380
   - dBA Inc., P.O. Box 413, Dept. S, Buford, GA 30518 (404) 945-2929
   - Innovation Supply, 1655 Jasper St., Aurora, CO 80011 (303) 341-0284

2. Acoustic cabs for some models are available from the drill manufacturer or

   - Metroplex Products, Inc., 2901 St. Louis Ave., Ft. Worth, TX 76110 (817) 923-8241

3. Isolated centralizer collars are available for some models from

   - Atlas-Copco Inc., 70 Demarest Drive, Wayne, NJ 07470 (201) 696-0554

B. Technical reports on the development and demonstration of noise control treatments.

1. Specific noise control treatments and evaluation.

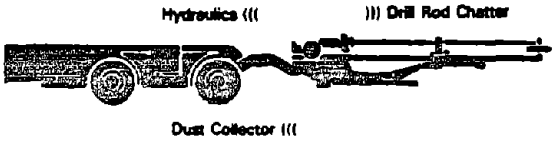
   - Noise Reduction of Jumbo Mounted Percussive Drills: Phase II, Development of Noise Treatment, BuMines contract HO366024 *(3)*.
   - Development of Noise Control Technology for Pneumatic Jumbo Drills, BuMines contract HO395029 *(17)*.
   - Noise Abatement of Pneumatic Rock Drill, BuMines RI 7998 *(40)*.

C. Case histories.

1. Case histories are reported in

   - Development of a Prototype Retrofit Noise Treatment for Jumbo Drills, BuMines contract HO387006 *(7)*.
   - Development of Noise Control Treatment for Jumbo Drills, BuMines contract HO395025 *(10)*.

ROTARY FACE DRILLS



Typical noise level
86-92 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	Replace worn or damaged parts that generate unusual noise.	86-92	Varied	Commercially available for all models.	None

NOTE.—Noise problems in rotary face drills are normally due to poor maintenance.

SOURCES

A. Commercially available noise control products and materials.

None. Only normal maintenance required.

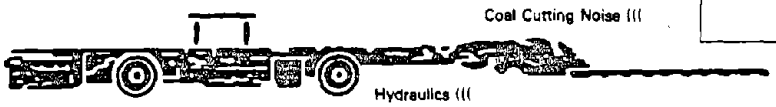
B. Technical reports on the development and demonstration of noise control treatments.

None. Rotary face drills are typically not a problem.

C. Case histories

None. Rotary face drills are typically not a problem.

CUTTING MACHINES



Typical noise level
83-93 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	Replace worn or damaged parts that generate unusual noise.	83-93	Varied	Commercially available for all models.	None

NOTE.—Noise problems in cutting machines are normally due to poor maintenance.

SOURCES

A. **Commercially available noise control products and materials.**

None. Only normal maintenance required.

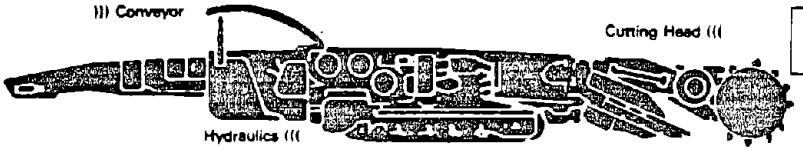
B. **Technical reports on the development and demonstration of noise control treatments.**

None. Cutting machines are typically not a problem.

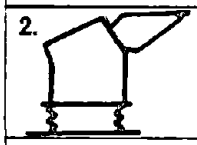
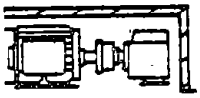
C. **Case histories.**

None. Cutting machines are typically not a problem.

CONTINUOUS MINERS (DRUM TYPE)



Typical noise level
97-103 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Modify the conveyor with isolated pan wear strips, pan damping treatment, elimination of sideboard and pan discontinuities, impact pads on return pan.	94-100	$6,000-$10,000 160 h ([1])	Commercially available for some models; others require local fabrication using well-documented methods.	A1 A2 B1 B2
2. 	Isolated bit blocks.	94-100	([2])	Limited demonstration of methods; further development required.	None
3. 	Treat the hydraulic pump compartment for acoustical absorption, enclose and seal it.	([3])	$50-$300 8-40 h	Local fabrication using well-documented methods.	B3

[1]When done at rebuild above ground.
[2]Not established.
[3]Effective only to control machine idling noise.

Recommendations

Loaded conveyor and cutterhead noise are approximately equal noise sources. Acoustic treatment of conveyors is within current technology and leads to 3-dBA noise reduction. Cutterhead noise control using resilient mounted bit blocks is a developing technology. Once developed, cutterhead noise control should be used in combination with conveyor noise control. Noise control should be a prime consideration during machine rework.

Conveyor treatment only

94-100 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Isolated wear strips for the conveyor are available from

   - Fairchild, Inc., P.O. Box 1184, Beckley, WV 25801 (304) 255-2131
   - PI Mine Service, P.O. Box 1716, Beckley, WV 25801 (304) 252-6321

2. Damped conveyor pan construction is available for Jeffrey models 122M, 120L, 120HZ, 101MC, and 120HR through rebuild from

   - Jeffrey Mining Machinery Div., Dresser Industries, Inc., P.O. Box 1879, Columbus, OH 43216 (614) 297-3123

B. Technical reports on the development and demonstration of noise control treatments.

1. Specific noise control treatments and evaluation.

   - Noise Reduction of Chain Conveyors, BuMines contract HO155113 *(15)*.
   - Noise Control of an Underground Continuous Miner, Auger-Type, MESA IR 1056 *(18)*.
   - Noise Control Report and Modification Manuals, BuMines contract HO166012 *(34-36)*.

2. Noise source information and general guidelines on noise control requirements.

   - Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract HO357085 *(24)*.

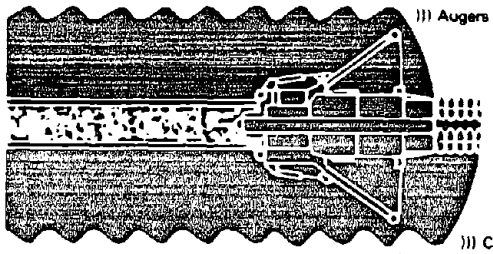
3. Treatment of noise in the hydraulic system.

   - Bulldozer Noise Control, BuMines contract JO177049 *(5)*.

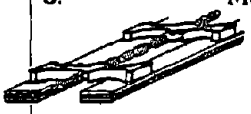
C. Case histories.

1. References under B1 and B3 contain case histories.

CONTINUOUS MINER (AUGER TYPE)



Typical noise level
Operator, 100-103 dBA
Jacksetter, 104-108 dBA

Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.  Quiet augers (rubber clad).	[1]100-105	Contact vendor	Commercially available for some models	A2 B1
2.  Quiet augers (sand filled).	[2]95-97 [1]95-98	$15,000 (pair) 2 h	Expected to be commercially available in 1983.	A2 B1 C2
3.  Modify the conveyor with isolated pan wear strips, pan damping treatment, elimination of sideboard and pan discontinuities, impact pads.	[2]98-100 [1]102-106	([3])	Local fabrication using well-developed technology; also commercially available for 1962 and later Fairchild and Wilcox models.	A1 B1 B2 C1
4.  Quiet gear drive.	([4])	([5])	Developed by Fairchild for post-1962 models.	A2

[1]Jacksetter.
[2]Operator.
[3]Prices vary widely and are based on inspection of equipment.
[4]Effective for idling noise only.
[5]Tear down of each reducer at rebuild.

Recommendations

Predominant noise source is auger cutting heads. Quiet augers are expected to be available in 1983 for Fairchild and Wilcox auger miners. Most effective noise control is achieved with quiet augers in combination with conveyor acoustic treatment. Conveyor treatment should be a prime consideration during machine rework.

Acoustically treated noise level

Operator, 93-94 dBA
Jacksetter, 95-96 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Rebuild services with extensive noise control treatments of the conveyor are available from

   - Fairchild, Inc., P.O. Box 1184, Beckley, WV 25801 (304) 255-2131
   - PI Mine Service, P.O. Box 1716, Beckley, WV 25801 (304) 252-6321

2. Quiet auger cutterheads and rebuild services with noise control treatments of the drive mechanism are available from

   - Fairchild, Inc., P.O. Box 1184, Beckley, WV 25801 (304) 252-2131

B. Technical reports on the development and demonstration of noise control treatments.

1. Specific noise control treatments and evaluation.

   - Noise Reduction of Chain Conveyors, BuMines contract HO155113 *(15)*.
   - Noise Control of an Underground Continuous Miner, Auger-Type, MESA IR 1056 *(18)*.
   - Noise Control Report and Modification Manuals, BuMines contract HO166012 *(34-36)*.

2. Noise source information and general guidelines on noise control requirements.

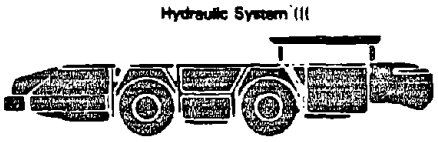
   - Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract HO357085 *(24)*.

C. Case histories

1. References under B1 contain case histories.

2. Control of Noise From Auger Miners, BuMines contract HO188065 *(46)*.

SHUTTLE CARS



Typical noise level
86-92 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Replace worn or damaged parts that generate unusual noise.	86-92	Varied	Commercially available for all models.	None

NOTE.—Shuttle cars are typically not a noise problem. Noise problems are normally due to poor maintenance.

SOURCES

A. Commercially available noise control products and materials.

None. Only normal maintenance required.

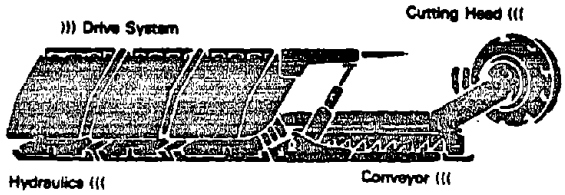
B. Technical reports on the development and demonstration of noise control treatments.

None. Shuttle cars are typically not a problem.

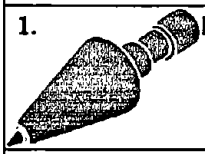
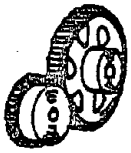
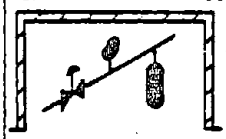
C. Case histories.

None. Shuttle cars are typically not a problem.

LONGWALL SHEARERS AND PLOWS



Typical noise level
98-101 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Isolated bit blocks for shearers.	90-94	[1]	Limited demonstration of methods; further development required.	B1
2. 	Install quiet gear drive for shearer.	[2]	[1]	Limited demonstration of methods; further development required.	C1
3. 	Minimize or eliminate impact points and misalignments in the chain conveyor.	[2]	[1]	Local design and fabrication required.	B2
4. 	Treat noisy hydraulic components with noise barriers, enclosures, vibration isolation as appropriate.	[2]	[1]	Local design and fabrication required.	B3

[1]Not established.
[2]No significant reduction without treatment of cutting noise.

NOTE.—Significant reduction of longwall shearer noise is in experimental stages.

SOURCES.

A. Commercially available noise control products and materials.

None.

B. Technical reports on the development and demonstration of noise control treatments.

1. Product modifications including cutting head for noise reduction.

   - Noise Control of Longwall Shearer, BuMines contract JO188072 *(47)*.

2. Noise source information and general guidelines on noise control requirements.

   - Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract HO357085 *(24)*.

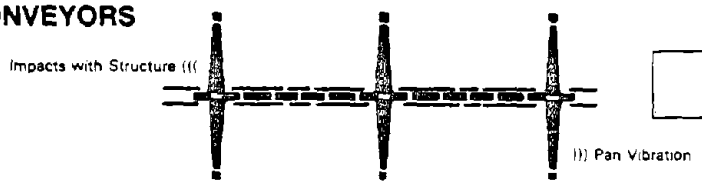
3. Treatment of noise in the hydraulic system.

   - Bulldozer Noise Control, BuMines contract JO177049 *(5)*.

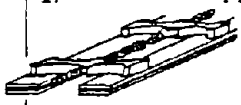
C. Case histories.

1. Modifications to high-speed gear sets for noise reduction have been done by Fairchild, Inc., P.O. Box 1184, Beckley, WV 25801 (304) 255-2131.

CONTINUOUS HAULAGE CHAIN CONVEYORS



Typical noise level
97-100 dBA

Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.  Modify the conveyor as follows: Eliminate surface discontinuities in sideboards and pans, add damping in wear strips or as sandwiched panels, add damped impact and wear pads.	90-95	$4,000-$10,000 80-160 h ([1])	Local design and fabrication required.	A1 B1 B2 C1

[1]When done at rebuild above ground.

Recommendations

Noise associated with chain conveyor operation results from several sources—typically flight impact at conveyor sideboard and pan discontinuities. Elimination of surface discontinuities and the addition of damped impact pads and wear strips are effective noise control measures. Modifications which cannot be made in the field should be incorporated at the time of major machine maintenance or rework.

Acoustically treated noise level

90-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Isolated wear strips for the conveyor are available from

   - Fairchild, Inc., P.O. Box 1184, Beckley, WV 25801 (304) 255-2131
   - PI Mine Service, P.O. Box 1716, Beckley, WV 25801 (304) 252-6321

B. Technical reports on the development and demonstration of noise control treatments.

1. Specific noise control treatments and evaluation.

   - Noise Reduction of Chain Conveyors, BuMines contract HO155113 *(15)*.
   - Noise Control of an Underground Continuous Miner, Auger-Type, MESA IR 1056 *(18)*.
   - Noise Control Report and Modification Manuals, BuMines contract HO166012 *(34-36)*.

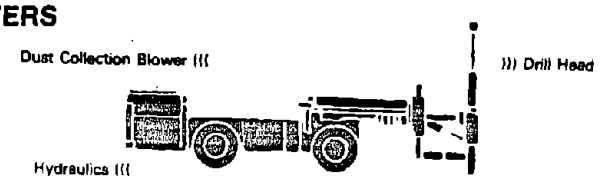
2. Noise source information and general guidelines on noise control requirements.

   - Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract HO357085 *(24)*.

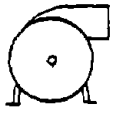
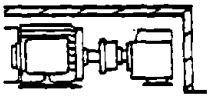
C. Case histories.

1. References under B1 contain case histories.

ROOF BOLTERS



Typical noise level
85-95 dBA

Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.  Modify dust collection blower or change to quieter model.	85-90	$500-$1,500 20-40 h	Local design and fabrication required.	A1 A3 B1
2.  Cover or enclose hydraulic pump.	85-90	$200-$500 20-40 h	Local design and fabrication required.	A2 B2
3.  Seal the enclosure around motor and pump-blower drives using existing cover panels.	85-90	$200-$500 30-80 h	Local design and fabrication required.	A2 B3

Recommendations

Modify dust collection blower and hydraulic pump to reduce the noise radiated by these sources.

Acoustically treated noise level

85-90

SOURCES

A. Commercially available noise control products and materials.

1. Dust collection blowers are available from the roof bolter manufacturer.

2. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

3. The suppliers of pneumatic mufflers are listed in the annual Systems Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

B. Technical reports on the development and demonstration of noise control treatments.

1. Information on fan silencing.

   - Silencers, Their Design and Application, Sound and Vibration *(38).*

2. Information on enclosures or covers for noisy hydraulic components.

   - Bulldozer Noise Control, BuMines contract JO177049 *(5).*

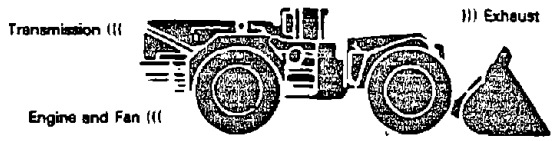
3. Information on sealing panels.

   - Reducing the Operator Sound Level of a Mining Service Vehicle—A Demonstration Project, BuMines contract HO346046 *(23).*

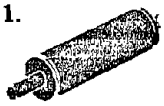
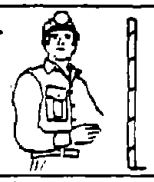
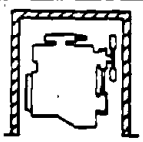
C. Case histories

None.

DIESEL-POWERED LOAD-HAUL-DUMP



Typical noise level
97-102 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Engine exhaust mufflers.	95-98	$100-$300 2 h	Commercially available for all models	A1
2. 	Partial sealed barriers around operator with exhaust muffling.	92-96	$2,000-$4,000 180-320 h	Commercially available for some models; local design and fabrication required for others.	A1 A2 A3 C1 C2
3. 	Engine and transmission enclosures and isolators, partial operator barrier, exhaust muffling.	90-95	$4,000-$7,000 240-380 h	Commercially available for some models; local design and fabrication required for others.	A1 A2 A3 B1 C1 C2
4. 	Install acoustic cab where possible.	80-88	$10,000-$15,000 80-160 h	Commercially available for some models.	A2

Recommendations

Install an exhaust muffler or wet scrubber. Enclose the engine and transmission. Install a noise barrier between the engine and the operator.

Acoustically treated noise level

With treatment 3, 88-95 dBA
With acoustic cab, 80-85 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the equipment manufacturer. Muffler manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Information on acoustic cabs and operator station kits is generally available from equipment dealers. Manufacturers and distributors include

   - Barrier Corp., 9980 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Lake Shore, Inc., P.O. Box 809, Iron Mountain, MI 49801 (906) 774-1500
   - Wagner Mining Equipment Co., 4424 N.E. 158th Ave., Portland, OR 97230 (503) 255-2863

3. The suppliers of bulk acoustic materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

B. Technical reports on the development and demonstration of noise control treatments.

1. Description of noise sources and treatments.

   - Noise of Diesel-Powered Underground Mining Equipment: Impact, Prediction, and Control, BuMines contract HO346046 *(32)*.
   - Noise Control of an Underground Load-Haul-Dump Machine, BuMines contract HO262013 *(22)*.
   - Reducing the Operator Sound Level of a Mining Service Vehicle—A Demonstration Project, BuMines contract HO345046 *(23)*.

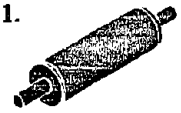
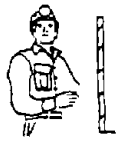
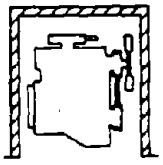
C. Case histories.

1. Noise Control of Underground Load-Haul-Dump Machines, BuMines contract HO395076 *(12)*.

2. Retrofit of Underground Load-Haul-Dump Machines With Noise Control Packages, BuMines contract HO395041 *(25)*.

DIESEL-POWERED HAULAGE TRUCKS

Typical noise level
90-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Engine exhaust muffler.	85-95	$100-$300 2 h	Commercially available for all models	A1
2. 	Sealed partial barriers around operator with exhaust muffling.	85-92	$2,000-$4,000 180-280 h	Local design and fabrication required.	A1 A3 A4 B1 C1 C2
3. 	Engine and transmission enclosures and isolation, partial sealed operator barrier, and exhaust muffling.	80-90	$4,000-$7,000 220-320 h	Local design and fabrication required.	A1 A4 B1 C1 C2
4. 	Install acoustic cab.	80-85	$10,000-$15,000 80-160 h	Commercially available for some models.	A2

Recommendations

Install exhaust mufflers on all catalytic scrubber equipped models with engine and transmission enclosures and partial sealed operator compartment.

Acoustically treated noise level

With treatment 3, 80-90 dBa
With acoustic cab, 80-85 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the machinery manufacturer. Muffler manufacturers are listed in the NIOSH *Compendium of Materials for Noise Control.* Manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Acoustic cabs for some models are available from machinery dealers.

3. Sound suppression treatments for existing cabs are manufactured by

   - Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

4. The suppliers of bulk acoustic barrier and sealing materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

B. Technical reports on the development and demonstration of noise control treatments.

1. General description of noise sources and treatments.

   - Noise of Diesel-Powered Underground Mining Equipment: Impact, Prediction, and Control, BuMines contract HO346046 *(32).*
   - Reducing the Operator Sound Level of a Mining Service Vehicle—A Demonstration Project, BuMines contract HO346046 *(23).*

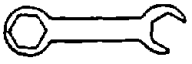
C. Case histories.

1. Noise Control of Underground Load-Haul-Dump Machines, BuMines contract HO395076 *(12).*

2. Retrofit of Underground Load-Haul-Dump Machines, BuMines contract H0395041 *(25).*

DIESEL-POWERED PERSONNEL CARRIERS AND AUXILIARY EQUIPMENT

Typical noise level
80-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Engine exhaust muffler.	80-95	$50-$150 2 h	Commercially available for all models.	A1
2. 	Sealed partial barriers around operator with exhaust muffling.	80-90	$1,000-$3,000 160-240 h	Local design and fabrication required.	A1 A3 A4 B1 C1 C3
3. 	Install acoustic cab where possible.	80-85	$10,000-$15,000 80-160 h	Commercially available for some models	A2 A3
4. 	Proper maintenance. Many models operate with noise levels under 90 dBA when properly maintained.				

Recommendations

Install exhaust muffler on all catalytic scrubber equipped models with a sealed noise barrier between the engine and the operator.

Acoustically treated noise level

With treatment 2, 80-90 dBA
With acoustic cab, 80-85 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the machinery manufacturer. Muffler manufacturers are listed in the NIOSH *Compendium of Materials for Noise Control*. Manufacturers include

   - Donaldson Co., Inc., 1400 W. 94th St., Minneapolis, MN 55431 (612) 887-3330
   - Nelson Div., Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589 (608) 873-4200

2. Acoustic cabs for some models are available from machinery dealers.

3. Sound suppression treatments for existing cabs are manufactured by

   - Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192
   - Tube-Lok Products Div., 4644 S.E. 17th Ave., Portland, OR 97202 (503) 234-9731

4. The suppliers of bulk acoustic barrier and sealing materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control*.

B. Technical reports on the development and demonstration of noise control treatments.

1. General description of noise sources and treatments.

   - Noise of Diesel-Powered Underground Mining Equipment: Impact, Prediction, and Control, BuMines contract H0346046 (*32*).

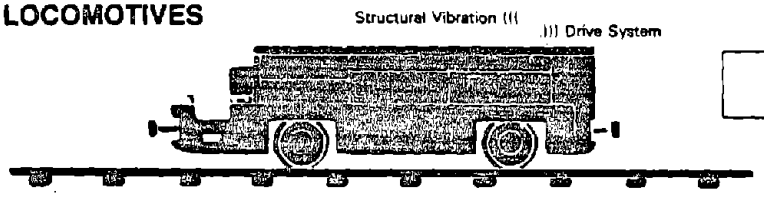
C. Case histories.

1. Reducing the Operator Sound Level of a Mining Service Vehicle—A Demonstration Project, BuMines contract H0346046 (*23*).

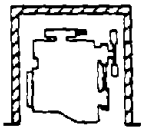
2. Noise Control of Underground Load-Haul-Dump Machines, BuMines contract H0395076 (*12*).

3. Retrofit of Underground Load-Haul-Dump Machines With Noise Control Packages, BuMines contract H0395041 (*25*).

RAIL-MOUNTED MANTRIPS AND LOCOMOTIVES



Typical noise level
85-95 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Apply damping treatment to structural panels of car assembly.	81-91	$200-$1,000 20-100 h	Local design and fabrication required.	A1 A2
2. 	Enclose drive motor and transmission	85-93	$100-$200 20-40 h	Local design and fabrication required.	B1 C1
3. 	Replace existing solid steel wheels with resilient wheels.	85-92	$1,800-$2,500 20 h	Commercially available for some models.	A3 B1
4. 	Replace spur gear drive with helical gears.	85-94	Unknown	Commercially available for some models.	A5 C1

Recommendations

Apply damping treatments as in treatment 1 and enclose motor and transmission. New quieted mantrips are available (A-4).

Acoustically treated noise level

80-90 dBA

SOURCES

A. Commercially available noise control products and materials.

1. The suppliers of bulk acoustic barrier and sealing materials are listed in the annual Materials Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

2. Materials for damped panels are available from

   - Antiphon Inc., 290 New Churchman's Road, 290-T, New Castle, DE 19720 (302) 322-7666
   - E.A.R. Div., Cabot Corp., 7911 Zionsville Road, Indianapolis, IN 46268 (317) 872-1111
   - Joseph T. Ryerson & Son, Inc., P.O. Box 8000A, Chicago, IL 60680 (312) 762-2121

3. Low-noise wheels are available from

   - Penn Machine Co., 102 Station Street, Johnstown, PA 15905 (814) 288-1547

4. Quieted mantrips are available from

   - FMC Corp., Mining Equipment Div., Box 992, Fairmont, WV 26554 (304) 363-7700

5. Helical gear drives are available from

   - FMC Corp., Mining Equipment Div., Box 992, Fairmont, WV 26554 (304) 363-7700

B. Technical reports on the development and demonstration of noise control treatments.

1. Mantrip noise control.

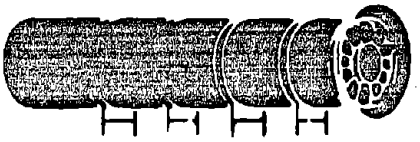
   - Noise Control of a Mine Operated Rail Personnel Carrier, BuMines contract H0166090 (*14, 16*).

C. Case histories.

1. Noise Control of a Mine Operated Rail Personnel Carrier, BuMines contract H0166090 (*14, 16*).

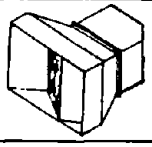
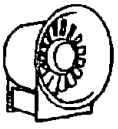
FACE VENTILATION SYSTEMS (FANS AND BLOWERS)

Structural Resonance (((



))) Aerodynamic Noise

Typical noise level
90-110 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	 Install muffler ducts for inlet and discharge ends of fan.	90-95	$100-$500 2-8 h	Commercially available for some models	A1 B1
2.	 Replace noisy fan with quieted model.	85-90	$5,000-$12,000	Commercially available for all models.	A2

Recommendations

Install mufflers at the inlet and discharge ends of the fan. Replace noisy fans. When ordering new fans specify noise levels to be less than 90 dBA at 1 meter.

Acoustically treated noise level

90-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Manufacturers and suppliers of duct mufflers are listed in the annual Systems Reference issue of *Sound and Vibration* and also in the NIOSH *Compendium of Materials for Noise Control.*

2. Manufacturers and suppliers of fans listed in the Buyer's Guide issue of *Coal Age.*

B. Technical reports on the development and demonstration of noise control treatments.

1. Fan noise reduction concepts and design.

   - Guide and Data Book, Systems, American Soc. of Heating, Refrigeration and Air Conditioning Engineers (*2*).
   - Silencing Noisy Fans, Aeroacoustic Corp. (*1*).

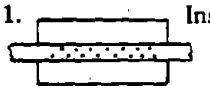
C. Case histories.

None.

PNEUMATIC SLUSHERS AND TUGGERS

Pneumatic Exhaust (((

Typical noise level
95-105 dBA

Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.  Install an air exhaust muffler (flexible to shed ice).	85-95	$50-$150 2 h	Commercially available for all models.	A1
2.  Install a piped away exhaust.	85-95	$200-$400 4 h	Commercially available for all models.	A1

Recommendations	Acoustically treated noise level
Muffle the air exhaust using pneumatic mufflers designed to shed ice during expansion.	85-95 dBA

NOTE.—Electric slushers and tuggers do not normally pose a noise hazard.

SOURCES

A. Commercially available noise control products and materials.

1. Suppliers of air exhaust mufflers are listed in the Systems Reference issue of *Sound and Vibration* and in the NIOSH *Compendium of Materials for Noise Control*, category 29. Suppliers include

   - APEX Equipment, Inc., 4001 21st Ave. W., Seattle, WA 98199 (206) 283-7380
   - Innovation Supply, 1655 Jasper St., Aurora, CO 80011 (303) 341-0284

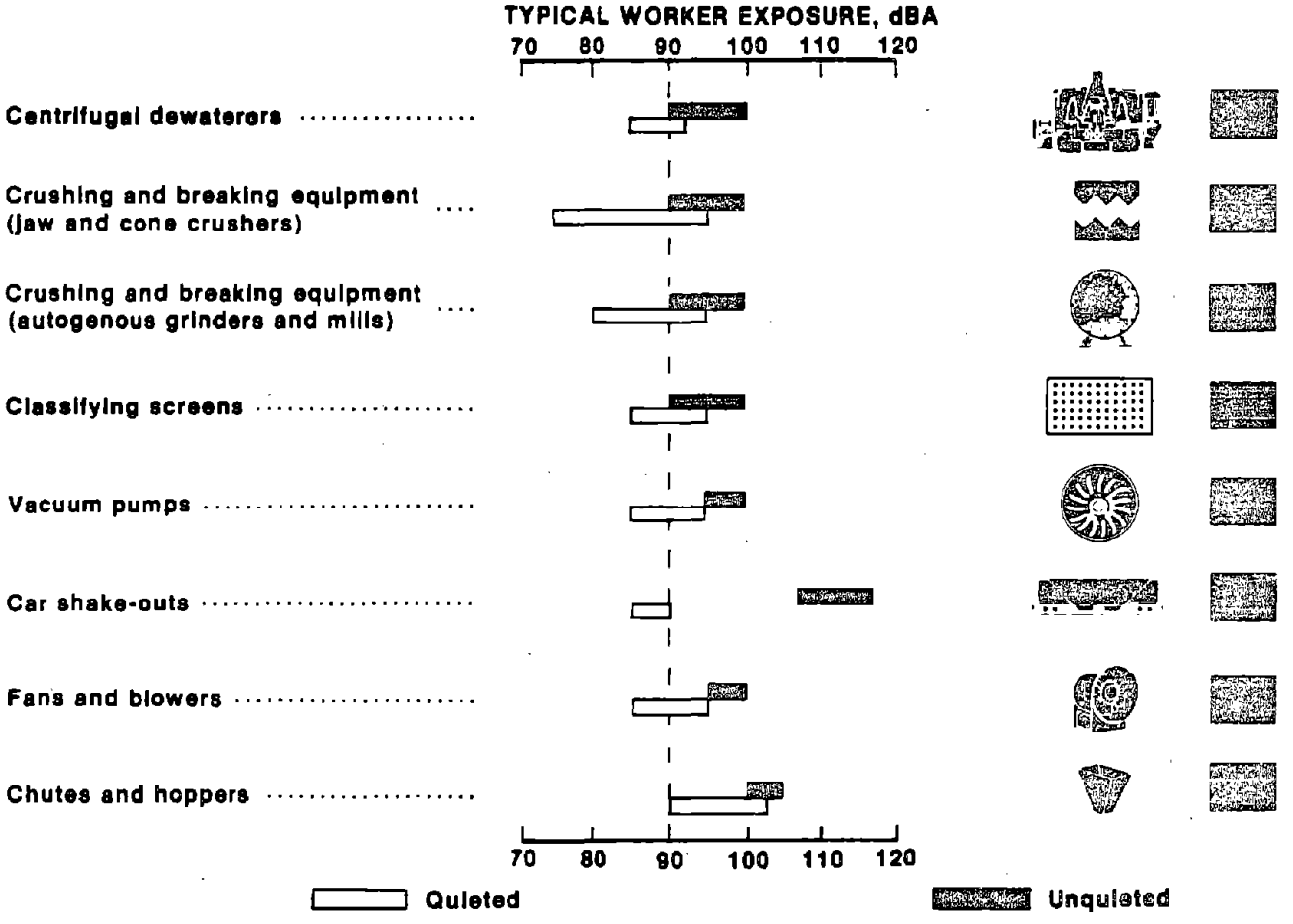
B. Technical reports on the development and demonstration of noise control treatments.

None.

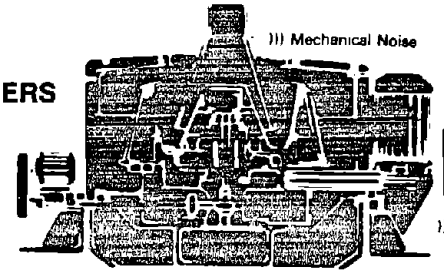
C. Case histories.

None.

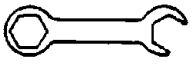
PREPARATION AND PROCESSING PLANT EQUIPMENT INDEX



CENTRIFUGAL DEWATERERS



Typical noise level
90-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Tighten loose parts. Replace worn bearings.	85-95	Varied		B1
2. 	Install an acoustical enclosure around the centrifuge.	80-85	$10,000-$20,000 380-600 h	Local design and fabrication required.	A1 B1
3. 	Install lead-vinyl curtains around the centrifuge.	85-92	$\$5/ft^2$ $0.1\ h/ft^2$	Commercially available for all models.	A1 B1

Recommendations

Significant reduction of noise level requires an enclosure or use of noise barrier curtains.

Acoustically treated noise level

85-92 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Suppliers of curtains, operator booths, and enclosures are listed in the NIOSH *Compendium of Materials for Noise Control*, categories 15 and 19, and the annual Systems Reference issue of *Sound and Vibration*.

B. Technical reports on the development and demonstration of noise control treatments.

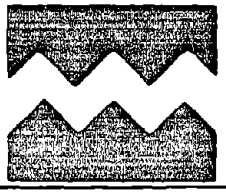
1. Demonstration of specific treatments.

   - Demonstrating the Noise Control of a Coal Preparation Plant, BuMines contract H0155155 (*6, 37*).

C. Case histories.

None.

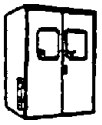
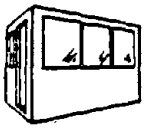
CRUSHING AND BREAKING EQUIPMENT (JAW AND CONE CRUSHERS)



))) Coal Fracture

))) Impacts

Typical noise level
90-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Enclosure around crusher body.	85-90	$10,000-$50,000 240-1,200 h	Local design and fabrication required.	A1 B1 B2 B4 C1
2. 	Curtain barrier around crusher.	85-95	$5/ft^2 0.1 h/ft^2	Local fabrication using well-documented methods.	A1 B2 B3 B4 C1
3. 	Operator booth-enclosure.	75-80	$1,500-$4,000 20-80 h	Commercially available for all models	A2 B4

Recommendations

Install an enclosure, barrier curtain, or operator booth.

Acoustically treated noise level

Operator booth, 75-80 dBA
Enclosure or barrier, 85-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Suppliers of curtains, operator booths, and enclosures are listed in the NIOSH *Compendium of Materials for Noise Control*, categories 15 and 19, and the annual Systems Reference issue of *Sound and Vibration*.

2. Suppliers of air intake mufflers are listed in the NIOSH *Compendium of Materials for Noise Control* and the annual Systems Reference issue of *Sound and Vibration*.

B. Technical reports on the development and demonstration of noise control treatments.

1. Design and construction of a modular panel enclosure for a specific crusher.

   - Taconite Crusher Noise Reduction—Study of Acoustical Enclosure for Symons 7-Foot, Standard Head, Extra-Heavy Duty Cone Crusher, BuMines contract H0387016 (*30*).

2. Noise source information and general guidelines on noise control requirements.

   - Source Diagnosis and Abatement Techniques for Noise Control in Taconite Plants, BuMines contract J0377014 (*9*).

3. Enclosure and curtain barrier construction and cost.

   - Demonstrating the Noise Control of a Coal Preparation Plant, BuMines contract H0155155 (*37*).

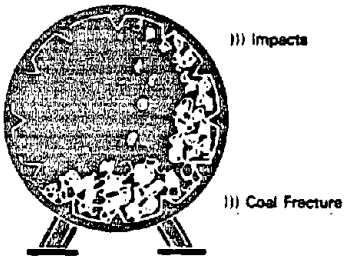
4. Noise control treatments for sand and gravel crushing and screening plants.

   - Demonstration of Noise Control Techniques for the Crushing and Screening of Nonmetallic Minerals, BuMines contract J0199037 (*13*).

C. Case histories.

1. B1, B2, and B4 detail specific methods for building acoustical enclosures and barriers.

CRUSHING AND BREAKING EQUIPMENT (AUTOGENOUS GRINDERS AND MILLS)



Typical noise level
Measured 5 meters from the grinder
90-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	Resiliently backed linings.	85-95	([1])	Commercially available for some models.	A1 B1
2.	Enclosure for grinder or mill.	85-90	$10,000-$30,000 240-800 h	Local design and fabrication required.	A2 B2 C1
3.	Operator control booth-enclosure.	80-85	$1,500-$4,000 20-80 h	Commercially available for all models.	A2

[1]Depends on application.

Recommendations

Install a barrier, enclosure, or control booth.

Acoustically treated noise level

Control booth, 80-85 dBA
Enclosure or barrier, 85-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Suppliers of resilient liners are listed in the annual Buyer's Guide issue of *Coal Age*.

2. Suppliers of curtains, operator booths, and enclosures are listed in the NIOSH *Compendium of Materials for Noise Control*, categories 15 and 19, and the annual Systems Reference issue of *Sound and Vibration*.

B. Technical reports on the development and demonstration of noise control treatments.

1. Noise source information and general guidelines on noise control requirements.

   - Source Diagnosis and Abatement Techniques for Noise Control in Taconite Plants, BuMines contract J0377014 (*9*).

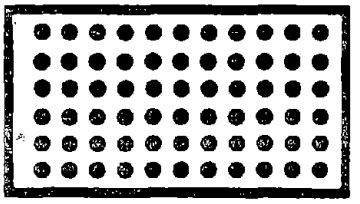
2. Demonstration of specific treatments.

   - Demonstration of Noise Control Techniques for the Crushing and Screening of Nonmetallic Minerals, BuMines contract J0199037 (*13*).
   - Taconite Crusher Noise Reduction—Study of Acoustical Enclosure for Symons 7-Foot, Standard Head, Extra-Heavy Duty Cone Crusher, BuMines contract H0387016 (*30*).

C. Case histories.

1. References under B2 contain specific case history information.

CLASSIFYING SCREENS



))) Impacts

Typical noise level 90-100 dBA

))) Mechanical Noise

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.	Substitute resilient decking and bottoms.	90-97	$25-$65/ft^2 Varied labor	Commercially available for some models.	A1 B1 B2 C2
2.	Construct an acoustical enclosure for the screen and drive mechanism.	85-90	$2,500-$5,000 120-360 h	Local design and fabrication required.	A4 B1
3.	Install barrier curtains.	85-90	$5/ft^2 0.1 h/ft^2	Local design and fabrication required.	A4 B1 B2
4.	Enclose the drive mechanism.	90-97	$200-$700 20-80 h	Local design and fabrication required.	A4 B1
5.	If the suspension springs chatter, reseat the springs using a rubber cushion, or replace coil springs with air bags.	90-100	$400-$1,600 8-60 h	Local fabrication using well-documented methods.	A2 B1
6.	For fine screen rappers, install an exhaust silencer and enclosure, or substitute an electric rapper.	90	$50-$150 4-16 h	Commercially available for all models.	A3

Recommendations

All treatments listed are effective.

Acoustically treated noise level

Resilient screens and enclosed drive mechanism, 85-95 dBA
For fine screen rappers, install a pneumatic exhaust silencer and enclose the rapper, 90 dBA

SOURCES

A. Commercially available noise control products and materials.

1. The manufacturers and suppliers of resilient screens are listed in the annual Buyers' Guide issue of *Coal Age*. Suppliers include

   - A-S-H Pump Div., Envirotech Corp., P.O.Box 635, Paoli, PA 19301 (215) 644-8400
   - BF Goodrich Co., 500 S. Main Street, Akron, OH 44318 (216) 374-2000
   - C-E Tyler, Combustion Engineering, Inc., 8215 Tyler Blvd., Mentor, OH 44060 (216) 255-9131
   - Hendrick Manufacturing Co., 7th Avenue and Clidco Dr., Carbondale, PA 18407 (717) 282-1010
   - Laubenstein Mfg. Co., 417 S. Hoffman Blvd., Ashland, PA 17921 (717) 875-2151
   - Linatex Corp. of America, 20 Spring St., Stafford Springs, CT 06076 (203) 684-2756
   - Trelleborg Inc., 30702 Solon Industrial Parkway, Solon, OH 44139 (216) 248-8600

2. Air bags are available from the screen manufacturer.

3. Information on exhaust silencers and enclosures for pneumatic screen rappers is available from the rapper manufacturer, Martin Engineering Co., Rte. 34, Dept. TR, Neponset, IL 61345 (309) 594-2384.

4. Curtain barrier, operator booth, and enclosure suppliers are listed in the NIOSH *Compendium of Materials for Noise Control*, categories 15 and 19.

B. Technical reports on the development and demonstration of noise control treatments.

1. Noise source information and general guidelines on noise control requirements.

   - Source Diagnosis and Abatement Techniques for Noise Control in Taconite Plants, BuMines contract J0377014 (*9*).
   - Coal Cleaning Plant Noise, BuMines contract J0377014 (*44*).
   - Practical Reduction of Noise From Chutes and Screens in Coal Cleaning Plants, BuMines contract H0144079 (*43*).

2. Demonstration of specific treatments.

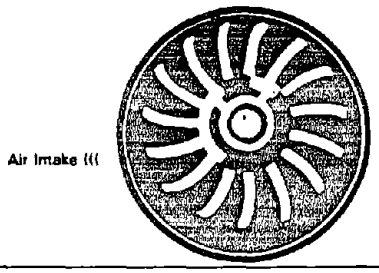
   - Demonstration of Noise Control Techniques for the Crushing and Screening of Nonmetallic Minerals, BuMines contract J0199037 (*13*).
   - Noise Control in Surface Mining Facilities: Chutes and Screens, BuMines contract H0144079 (*45*).
   - Noise Abatement of Vibrating Screens, BuMines contract H0387018 (*21*).

C. Case histories.

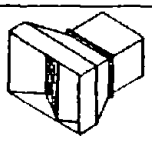
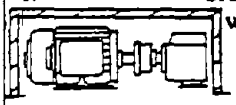
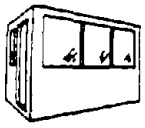
1. **References under B2 contain specific case history information.**

2. Field Evaluation of Resiliently Clad Screen Decks, BuMines contract J0100047 (*28*).

VACUUM PUMPS



Typical noise level
95-100 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Air inlet muffler.	90-95	$50-$300 2 h	Commercially available for all models.	A2
2. 	Plenum enclosure.	85-90	$200-$1,000 20-80 h	Commercially available for some models.	A1
3. 	Curtain barrier.	85-90	$5/ft^2 0.1 h/ft^2	Local fabrication using well-documented methods.	A1
4. 	Close fitting cover with muffler.	85-90	$200-$1,000 20-120 h	Local design and fabrication required.	B1
5. 	Operator station-booth with noise attenuation construction	75-85	$1,500-$4,000 40-80 h	Commercially available for all models.	A1 B1

Recommendations

Noise control treatments center on constructing or installing a plenum enclosure or cover to attenuate both air intake and casing-radiated noise.

Acoustically treated noise level

85-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Suppliers of curtains, operator booths, and enclosures are listed in the NIOSH *Compendium of Materials for Noise Control*, categories 15 and 19, and the annual Systems Reference issue of *Sound and Vibration*.

2. Suppliers of air intake mufflers are listed in the NIOSH *Compendium of Materials for Noise Control*, and the annual Systems Reference issue of *Sound and Vibration*.

B. Technical reports on the development and demonstration of noise control treatments.

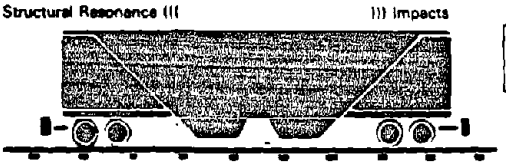
1. Noise source information and general guidelines on noise control requirements.

   - Source Diagnosis and Abatement Techniques for Noise Control in Taconite Plants, BuMines contract J0377014 (*9*).
   - Coal Cleaning Plant Noise, BuMines contract J0377014 (*44*).

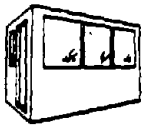
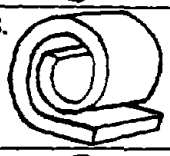
C. Case histories.

None.

CAR SHAKE-OUTS



Typical noise level
107-120 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Operator control booth or enclosure.	85-90	$1,500-$6,000 40-160 h	Commercially available for all models.	A1 B1
2. 	Acoustic treatment applied to shake-out building.	100-110	$5,000-$10,000 240-500 h	Local design and fabrication required.	A1 B1
3. 	Resilient impact pads mounted to shaker.	105-115	$1,000 Unknown	Limited demonstration of method; further development required.	B1
4. 	Install car roll-dump to replace car shake-out.	90-95	$200,000- $1,000,000 Unknown	Commercially available.	A2

Recommendations

Install an operator control booth.

Acoustically treated noise level

85-90 dBA

DURCES

Commercially available noise control products and materials.

1. Suppliers of curtains, operator booths, and enclosures are listed in the NIOSH *Compendium of Materials for Noise Control*, categories 15 and 19, and the annual Systems Reference issue of *Sound and Vibration*.

2. Manufacturers and suppliers of railcar dumpers are listed in the annual Buyers' Guide issue of *Coal Age*.

Technical reports on the development and demonstration of noise control treatments.

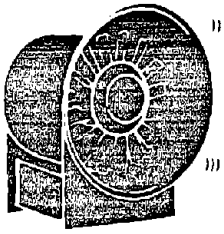
1. Noise source information and general guidelines on noise control requirements.

   - Coal Cleaning Plant Noise, BuMines contract J0377014 (44).

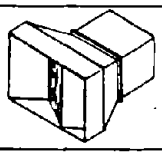
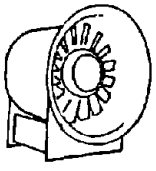
Case histories.

None.

FANS AND BLOWERS



Typical noise level
95-100 dBA

Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1.  Install an acoustically lined inlet duct or commercial silencer.	90-95	$200-$1,000 8-60 h	Commercially available for some models; local design and fabrication required for installation.	A2 B1
2.  Duct the inlet to the outside, or other area which is not sensitive to noise.	85-95	([1])	Local design and fabrication required.	B1 B2
3.  Replace noisy fans with quieted models. Specify noise level to be less than 90 dBA at 1 meter when ordering new fans.	85-90	([2])	Commercially available for all models.	A1

[1]Depends on length of duct.
[2]Depends on fan size and capacity.

Recommendations

All treatments listed are effective.

Acoustically treated noise level

85-95 dBA

SOURCES

A. Commercially available noise control products and materials.

1. Manufacturers and suppliers of fans are listed in the annual Buyers' Guide issue of *Coal Age*.

2. Suppliers of fan silencers are listed in the NIOSH *Compendium of Materials for Noise Control* and the annual Systems Reference issue of *Sound and Vibration*.

B. Technical reports on the development and demonstration of noise control treatments.

1. Noise source information and general guidelines on noise control requirements.

   - Coal Cleaning Plant Noise, BuMines contract J0377014 (*44*).

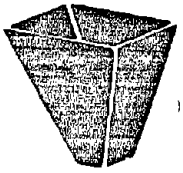
2. Fan noise reduction concepts and design.

   - Guide and Data Book, Systems, American Soc. of Heating, Refrigeration and Air Conditioning Engineers (*2*).
   - Silencing Noisy Fans, Aeroacoustic Corp. (*1*).

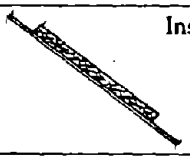
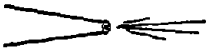
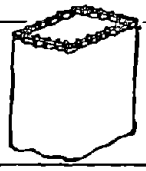
C. Case histories.

None.

CHUTES AND HOPPERS



Typical noise level
Measured 3 feet from the chute, 100-105 dBA

	Treatment	Quieted noise level, dBA	Cost and labor	Status	Reference
1. 	Weld ledges into the chute to retain a layer of fines along the chute.	[1]99-100	$2/ft^2 1 h/ft^2	Local design and fabrication required.	B1
2. 	Install a resilient liner to cushion impacts.	[1]90-100	$10-$30/ft^2 0.5 h/ft^2	Commercially available for some models; local fabrication using well-documented methods for other applications.	A1 B1 B2
3. 	Minimize the use of tappers and air blasts.	Varied	None		
4. 	Install barrier curtains.	94-96	$5/ft^2 0.1 h/ft^2	Commercially available. Installation requires local design and fabrication.	A2 B2

[1]For closed chutes.

Recommendations

Well-designed ledges or resilient liners are recommended. Barrier curtains can be used if further noise reduction is needed.

Acoustically treated noise level

Closed chutes, 90-100 dBA
Open chutes, 99-103 dBA

SOURCES

A. **Commercially available noise control products and materials.**

1. Suppliers of resilient chute lining are listed in the annual Buyers' Guide issue of *Coal Age*.

2. Suppliers of sound barrier curtains, operator booths, and enclosures are listed in the NIOSH *Compendium of Materials for Noise Control*, categories 15 and 19, and the annual Systems Reference issue of *Sound and Vibration*.

B. **Technical reports on the development and demonstration of noise control treatments.**

1. Noise source information and general guidelines on noise control requirements.

   - Coal Cleaning Plant Noise, BuMines contract J0377014 (*44*).

2. Demonstration of specific treatments.

   - Demonstrating the Noise Control of a Coal Preparation Plant, BuMines contract H0155155 (*37*).

C. **Case histories.**

1. Reference under B2 contains specific case history information.

2. Demonstration of Noise Control Techniques for the Crushing and Screening of Nonmetallic Minerals, BuMines contract J0199037 (*13*).

REFERENCES

1. Aeroecoustic Corp. (Jacksonville, FL). Silencing Noisy Fans. Bull. B-529, 1982, 12 pp.

2. American Society of Heating, Refrigeration and Air Conditioning Engineers. Noise and Vibration Control. Ch. 35 in Guide and Data Book, Systems (current issue); available from ASHRAE, United Engineering Center, New York.

3. Bender, E. K., D. B. Crulkshank, and M. N. Rubin. Noise Reduction of Jumbo Mounted Percussive Drills: Phase II, Development of Noise Treatment (contract HO366024, Bolt Beranek & Newman Inc.). BuMines OFR 106-78, 1977, 109 pp.; NTIS PB 286 109.

4. Bernhagen, J. R. Noise Control on a Heavy Duty Mobile Crane. SAE Tech. Paper 760601, 1976; available from Society of Automotive Engineers, Warrendale, PA.

5. Bolt Beranek & Newman, Inc. Bulldozer Noise Control. Ongoing BuMines contract JO177049; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

6. ——— Demonstrating the Noise Control of a Coal Preparation Plant. Ongoing BuMines contract HO155155; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

7. ——— Development of a Prototype Retrofit Noise Treatment for Jumbo Drills. Ongoing BuMines contract HO387006; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

8. ——— Front-End Loader Noise Control. Ongoing BuMines contract JO395028; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

9. ——— Source Diagnoisis and Abatement Techniques for Noise Control in Taconite Plants. Ongoing BuMines contract JO377014; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

10. Creare Products, Inc. Development of Noise Control Treatment for Jumbo Drills. Ongoing BuMines contract HO395025; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

11. ——— Development of Six Prototype Production Stoper Drills. Ongoing BuMines contract JO177125; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

12. ELMCO Mining Machinery Co. Noise Control of Underground Load-Haul-Dump Machines. Ongoing BuMines contract HO395076; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

13. Foster-Miller Associates, Inc. Demonstration of Noise Control Techniques for the Crushing and Screening of Nonmetallic Minerals. Ongoing BuMines contract JO199037; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

14. Galaitsis, A. G., and D. Andersen. Noise Control of a Mine Operated Rail Personnel Carrier. Volume II. Underground Evaluation (contract HO166090, Bolt Beranek & Newman Inc.). BuMines OFR 155-81, 1980, 35 pp.; NTIS 82-137019.

15. Galaitsis, A., R. Madden, and D. Andersen. Noise Reduction of Chain Conveyors (contract HO155113, Bolt Beranek & Newman Inc.). BuMines OFR 133-80, 1979, 144 pp.; NTIS PB 81-130833.

16. Galaitsis, A. G., P. J. Remington, and M. M. Myles. Noise Control of a Mine Operated Rail Personnel Carrier. Volume I. Design and Performance of Noise Control Treatments (contract HO166090, Bolt Beranek & Newman Inc.). BuMines OFR 133-78, 1977, 116 pp.; NTIS PB 289 711.

17. George, D. L., and N. J. Matteo. Development of Noise Control Technology for Pneumatic Jumbo Drills (contract HO395029, Ingersoll-Rand Res., Inc.). BuMines OFR 100-81, 1980, 61 pp.; NTIS 81-237414.

18. Giardino, D. A., T. G. Bobick, and L. C. Marraccini. Noise Control of an Underground Continuous Miner, Auger-Type. MESA IR 1056, 1977, 57 pp.

19. Hawkes, I., and D. D. Wright. Development of a Quiet Rock Drill. Volume 1: Evaluation of Design Concepts (contract JO155099, Ivor Hawkes Associates). BuMines OFR 70-78, 1977, 95 pp.; NTIS PB 283 774.

20. Hawkes, I., D. D. Wright, and P. K. Dutta. Development of a Quiet Rock Drill. Volume 2: Sources for Drill Rod Noise (contract JO155099, Ivor Hawkes Associates). BuMines OFR 132-78, 1977, 77 pp.; NTIS PB 289 716.

21. Hennings, K. Noise Abatement of Vibrating Screens. Using Non-Metallic Decks and Vibration Treatments (contract HO387018, Allis-Chalmers Corp.). BuMines OFR 120-82, 1980, 63 pp.; NTIS 82-251919.

22. Huggins, G. G., R. Madden, and B. S. Murray. Noise Control of an Underground Load-Haul-Dump Machine (contract HO262013, Bolt Beranek & Newman Inc.). BuMines OFR 125-78, 1977, 79 pp.; NTIS PB 288 854.

23. Huggins, G. G., and W. N. Patterson. Reducing the Operator Sound Level of a Mining Service Vehicle—A Demonstration Project (contract HO346046, Bolt Beranek & Newman Inc.). BuMines OFR 47-77, 1975, 75 pp.; NTIS PB 265 037.

24. Huggins, G. G., and P. J. Remington. Noise Reduction of Conveyors Used in Underground Coal Mining Machinery (contract HO357085, Bolt Beranek & Newman Inc.). BuMines OFR 109-77, 1976, 132 pp.; NTIS PB 267 787.

25. Lake Shore Inc. Retrofit of Undergound Load-Haul-Dump Machines With Noise Control Packages.

[1] References with NTIS designations can be ordered from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161 (703) 487-4650. Cost of the report is based on the number of pages; a current price list should be obtained. Reports with an OFR designation may be consulted during working hours at Bureau of Mines facilities.

Ongoing BuMines contract HO395041; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

26. Manning, R. E. Muffler for Pneumatic Drill (contract HO220048, U.S Steel). BuMines OFR 28-73, 1973, 81 pp.; NTIS PB 220 372.

27. _____. Noise Control of Stoper Drills (contract HO220048, USS Engineers and Consultants). BuMines OFR 91-75, 1975, 153 pp; NTIS PB 246 381.

28. Markel, M. V. Field Evaluation of Resiliently Clad Screen Decks (contract JO100047, BF Goodrich Co.). BuMines OFR 67-82, 1981, 37 pp.; NTIS 82-204876.

29. Mellin, R. C. Noise and Performance of Automotive Cooling Fans. SAE Tech. Paper 800031, 1980; available from Society of Automotive Engineers, Warrendale, PA.

30. Morgan, J. A. Taconite Crusher Noise Reduction—Study of Acoustical Enclosure for Symons 7-Foot, Standard Head, Extra-Heavy Duty Cone Crusher (contract HO387016, Industrial Acoustics Co., Inc.). BuMines OFR 64-82, 1980, 40 pp.; NTIS 82-202649.

31. Patterson, W. N. Quieting Portable Air Compressors. Noise Control Eng., v. 5, No. 1, July-August 1975, pp. 41-47.

32. Patterson, W. N., G. G. Huggins, and A. G. Galaitsis. Noise of Diesel-Powered Underground Mining Equipment: Impact, Prediction, and Control (contract HO346046, Bolt Beranek & Newman Inc.). BuMines OFR 58-75, 1975, 227 pp.; NTIS PB 243 896.

33. Rainwater, K. L. Effect of a Pulse Damper on a Hydraulic System on Operator Ear Noise. SAE Tech. Paper 750829, 1975; available from Society of Automotive Engineers, Warrendale, PA.

34. Retka, T., F. Snidarich, and R. Golembeski. Noise Control Report. Jeffrey 100-L Auger Miner and Jeffrey 94-L Bridge Conveyor. Final Report Volume I (contract HO166012, Donaldson Co., Inc.). BuMines OFR 10(1)-79, 125 pp.; NTIS PB 292 387.

35. _____. Noise Control Modification Manual. Jeffrey 100-L Auger Miner. Final Report Volume II (contract HO166012, Donaldson Co., Inc.). BuMines OFR 10(2)-79, 1978, 82 pp; NTIS PB 292 388.

36. _____. Noise Control Modification Manual. Jeffrey 94-L Bridge Conveyor. Final Report Volume III (contract HO166012, Donaldson Co., Inc.). BuMines OFR 10(3)-79, 1978, 38 pp.; NTIS PB 292 389.

37. Rubin, M. N. Demonstrating the Noise Control of a Coal Preparation Plant. Volume I. Initial Installation and Treatment Evaluation (contract HO155155, Bolt Beranek & Newman Inc.). BuMines OFR 104-79, 1977, 182 pp.; NTIS PB 299 963.

38. Sanders, G. Silencers, Their Design and Application. Sound and Vibration, v. 3, No. 2, Feb. 1968, pp. 6-13.

39. Shrader, J. T., and W. H. Page. Truck Noise IV-C: The Reduction of Cooling System Noise on Heavy Duty Diesel Trucks (contract DOT-OS-2022, Int. Harvester). U.S. Dept of Transportation Rept. DOT-TST-74-22, May 1974, 157 pp.; NTIS PB 234501/5GA.

40. Summers, C. R., and J. N. Murphy. Noise Abatement of Pneumatic Rock Drill. BuMines RI 7998, 1974, 45 pp.

41. Toth, W. Noise Abatement Techniques for Construction Equipment. U.S. Dept. of Transportation Rept. DOT-TSC-NHTSA 79-45 (HS 803-293), August 1979, 192 pp.; available from Transportation Systems Center, Cambridge, MA.

42. Ungar, E. E., D. W. Andersen, and M. N. Rubin. The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments (contract JO166057, Bolt Beranek & Newman Inc.). BuMines OFR 98-79, 1978, 117 pp.; NTIS PB 299 538.

43. Ungar, E. E., C. L. Dym, and M. H. Rubin. Practical Reduction of Noise From Chutes and Screens in Coal Cleaning Plants (contract H0144079, Bolt Beranek & Newman Inc.). BuMines OFR 59-77, 1976, 74 pp.; NTIS PB 265 344.

44. Ungar, E. E., G. E. Fax, W. N. Patterson, and H. L. Fox. Coal Cleaning Plant Noise (contract JO377014, Bolt Beranek & Newman Inc.). BuMines OFR 44-74, 1974, 99 pp.: NTIS PB 235 852.

45. Ungar, E. E., W. N. Patterson, C. L. Dym, and A. Galaitsis. Noise Control in Surface Mining Facilities: Chutes and Screens (contract HO144079, Bolt Beranek & Newman Inc.). BuMines OFR 64-76, 1975, 156 pp.; NTIS PB 253 257.

46. Wyle Laboratories. Control of Noise From Auger Miners. Ongoing BuMines contract HO188065; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

47. _____. Noise Control of Longwall Shearer. Ongoing BuMines contract JO188072; for inf. contact R. C. Bartholomae, BuMines, Pittsburgh Res. Center, Pittsburgh, PA.

INFORMATION SOURCES FOR COMMERCIALLY AVAILABLE NOISE CONTROL PRODUCTS AND MATERIALS

U.S. Department of Health and Human Services, National Institute of Occupational Safety and Health (Cincinnati, OH). Rept. 80-116, 1980, 380, pp., U.S. Government Printing Office, Washington, DC, Stock No. 017-003-00359-9; NTIS PB-298-307.

Acoustical Publications, Inc. (Bay Village, OH). Annual Materials Reference and Systems Reference issues of *Sound and Vibration*.

McGraw-Hill, Inc. (New York). Annual Buyers' Guide issue of *Coal Age*.

☆ U.S. Government Printing Office: 1983—705-536/A547