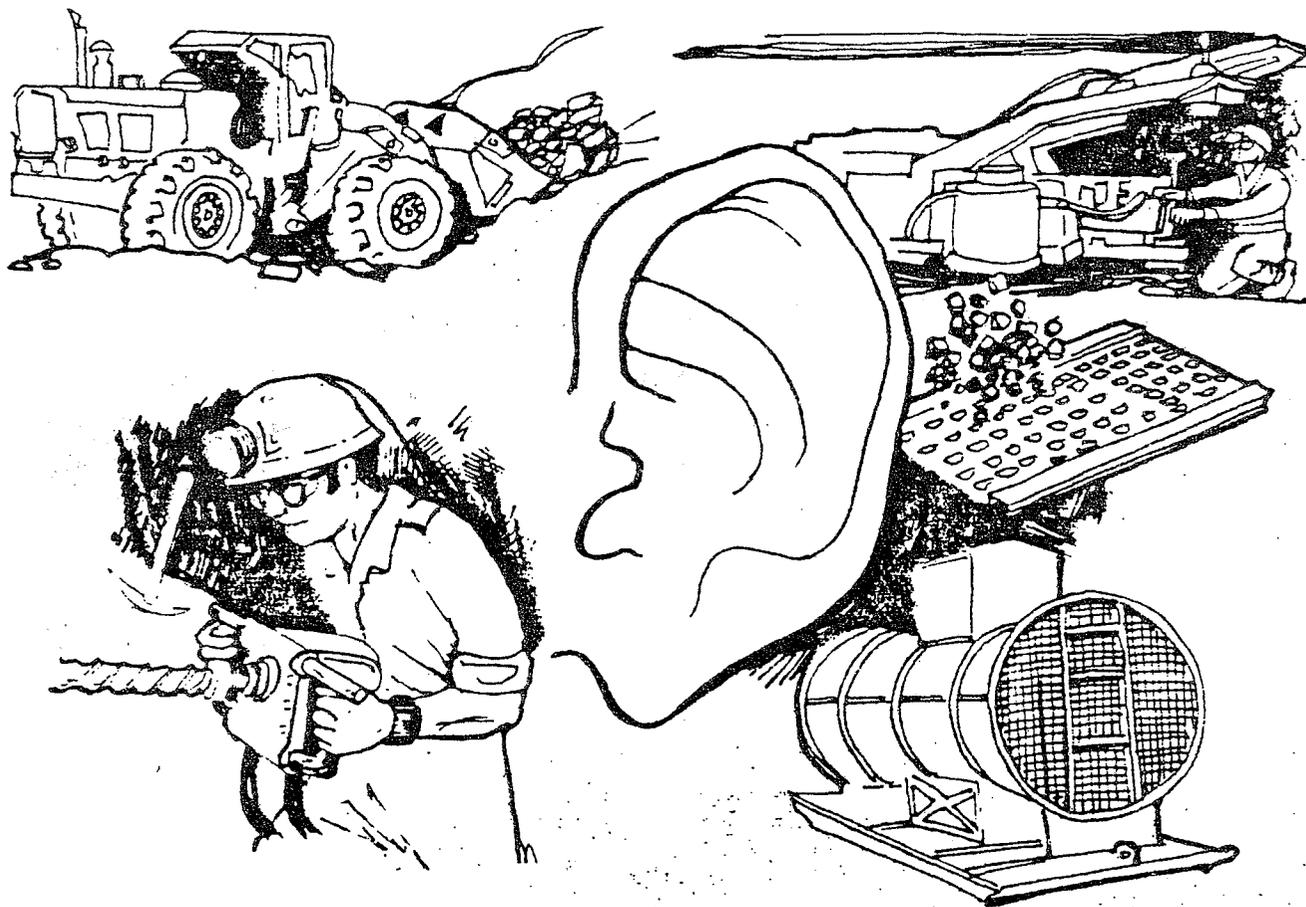


# SUMMARY OF NOISE CONTROLS FOR MINING MACHINERY

U.S. Department of Labor  
Mine Safety and Health Administration



**FOR OFFICIAL  
USE ONLY**

SUMMARY OF NOISE CONTROLS FOR MINING MACHINERY

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## INTRODUCTION

This publication presents effective noise control treatments that are currently available for major types of coal and metal/nonmetal mining and processing equipment. An effective noise control treatment is one which results in at least a 3 dB noise reduction at the operator's position once the control is applied to an untreated machine. Noise control technology is summarized in terms of what can be done and the results that should be realized. Also, this document does not present how-to-do-it engineering instructions; rather, it identifies the technical reports that address the details of implementation, as well as available sources for noise control components, retrofit kits, and raw materials.

The information on noise control treatments are grouped into sections according to the following types of operations:

- III. Surface Mining
- IV. Underground Mining
- V. Preparation and Processing

Information for noise control on each major piece of mining machinery is presented in three ways:

1. A data sheet containing noise characteristics of the particular machine, noise control treatments, costs and a brief statement describing the availability of the treatment;
2. A page which details commercially available noise control materials and lists reports describing the application of specific treatments;
3. Noise control case histories that document noise reduction actually achieved in field studies by the Pittsburgh and Denver Technology Centers. Note that these case histories are not available for all types of mining machinery and noise control treatments.

It is not recommended that untrained individuals attempt to apply the noise control treatments in this publication without obtaining additional information in the form of specific reports detailing their application and/or assistance from equipment manufacturers, consultants or one of the following MSHA Technology Centers:

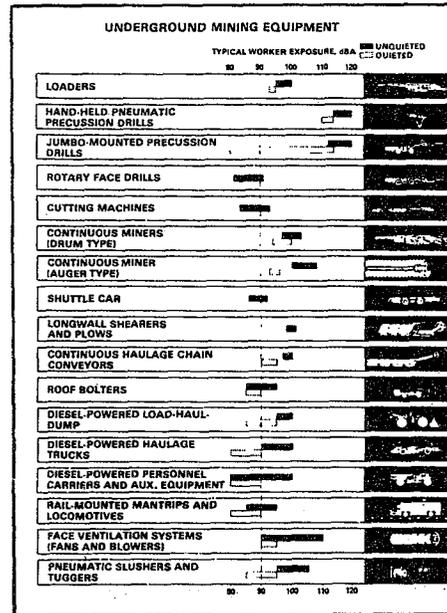
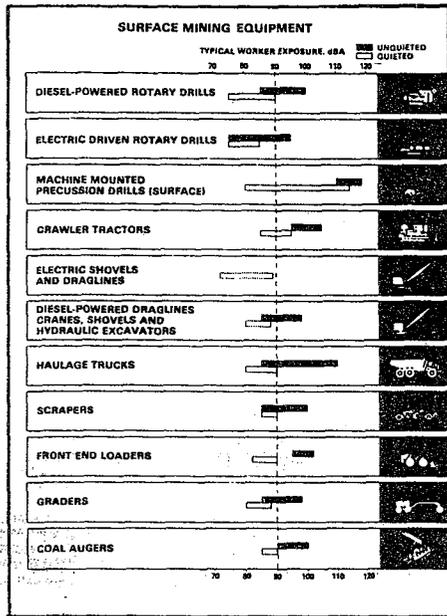
Pittsburgh Health Technology Center  
Physical and Toxic Agents Division  
4800 Forbes Avenue  
Pittsburgh, PA 15213  
412-621-4500 FTS 721-8620

Safety and Health Technology Center, Denver  
Physical Agents Division  
P. O. Box 25367, DFC  
Denver, CO 80225  
303-234-4822 FTS 234-4822

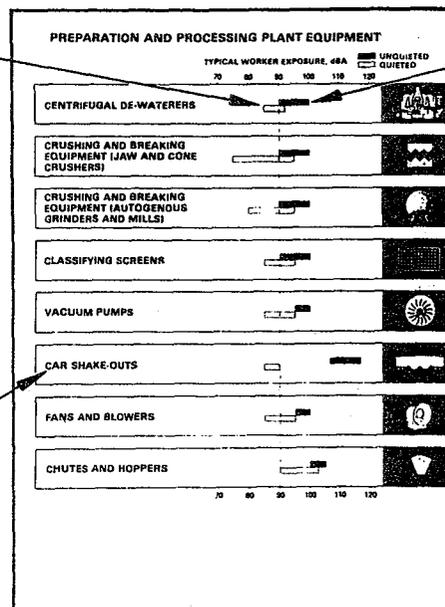
References made to specific brands, equipment, or trade names in this document is made to facilitate understanding and does not constitute endorsement by the Mine Safety and Health Administration.

## How to Use This Document

The index pages for surface, underground, and plant equipment are shown below. Each index page lists the equipment categories along with the range of noise levels for acoustically treated and untreated equipment.



Typical range of noise levels for centrifugal de-waterers that have been treated for sound suppression.



Typical range of noise levels for untreated centrifugal de-waterers.

Equipment category.

# Treatment data sheet

**HAULAGE TRUCKS**

Typical Noise Level  
85 dBA

NOISE CONTROL	TREATMENT	COST	STATUS
1	Exhaust mufflers for models without body heating or mufflers	\$150-500 2 hours	Commercially available for all models.
2	Add acoustic treatment to existing cab	\$500-900 20-80 hours	Local design and fabrication required.
3	Modify or change cooling fan on trucks with noisy fans	\$500-2000 20-120 hours	Local design and fabrication required.

**Recommendations**  
Add acoustic treatment to the cab to reduce airborne and structureborne noise. Replace faulty exhaust mufflers. When purchasing new trucks, specify and acoustic cab with filters, ventilation system and temperature control.

Callouts: 1, 2, 6, 7, 3, 8, 9, 4, 5

## TREATMENT DATA SHEET

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.
7. 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.
8. Availability. Gives the availability status of the specific noise control treatment, based on the following four categories:
  - a. Commercially available for all models. Available for all models or the vast majority of models.
  - b. Commercially available for some models.
  - c. 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.
  - d. 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.
9. Most effective treatment. The noise control treatment(s) producing the maximum reduction in noise level is specified. In certain situations such as with an acoustic cab, it is assumed that the proper exhaust muffler and vibration isolators are included.

# Technology Availability data sheet

2
3
4
1

**HAULAGE TRUCKS**

**REFERENCES**

**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 Street, Minneapolis, MN 55440 — (612) 897 3258
  - Nelson Muffler, P O Box 428, Stoughton, WI 53589 — (608) 873-4231
- 2 Acoustic cabs are generally available from truck dealers
- 3 Sound suppression treatments for existing cabs are available from
  - Barner Corp., 9908 SW Tiger Street Tigard, OR 97223 — (503) 639-4182
  - Tube-Lok Products, 6844 S 17th Avenue, Portland, OR 97202 — (503) 234-9731

The Suppliers of bulk acoustic materials are listed in the annual Materials Reference Issue of Sound and Vibration magazine and also in the NIOSH Compendium of Materials for Noise Control

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

- 1 Investigations for installation of noise control treatments with material and labor requirements
  - "Rulhoner Noise Control"
  - Bolt, Beranek and Newman Inc. U.S. Bureau of Mines Contract J0117049
  - "Lester Noise Control"
  - Bolt, Beranek and Newman Inc. U.S. Bureau of Mines Contract J0370628
- 2 Noise Source Information and general guidelines on noise control requirements
  - "The Noise of Mobile Machines Used in Surface Coal Mining: Operator Exposure, Source Diagnosis, Potential Treatments"
  - Bolt, Beranek and Newman Inc. U.S. Bureau of Mines Contract J0186057 NTIS PB 297 538
- 3 An Modification for noise reduction
  - Truck Noise IVC: Reduction of Cooling Systems Noise on Heavy Duty Trucks
  - DOT TSC-75-23 DOT Transportation Systems Center, Cambridge, MA

**C. Case Histories.**

- 1 Data on case under B3 contain specific treatments, documented noise reduction and material and labor requirements for diesel powered equipment
- 2 These engine exhaust reductions provided by specific mufflers are listed in
  - Noise Abatement Techniques for Construction Equipment
  - W. T. J. SAE U.S. DOT Report DOT TSC, NHTSA 78-45, August 1974

## TECHNOLOGY AVAILABLE DATA SHEET

1. Identification of machine category. Identifies the machine type, such as bulldozers, continuous miners, etc.
2. Commercially available noise control products and materials. Lists selected suppliers of noise control treatments made specifically 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."<sup>1</sup> 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.
4. Case histories. Lists selected cases where the subject noise controls have been implemented.

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<sup>1</sup> 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.

CASE HISTORY # 1 , DATE: 2

- 3 MINE LOCATION (County, State):
- 4 MINE TYPE (Metal/Nonmetal, Coal):
- 5 MACHINE MANUFACTURER, MODEL:
- 6 MACHINE ACTIVITY:
  
- 7 DESCRIPTION OF CONTROLS:

CONTROLS USED:

TOTAL MATERIAL COSTS:

MANHOURS:

- 8 NOISE REDUCTION OBTAINED:

OPERATING MODE

NOISE LEVEL  
BEFORE                      AFTER

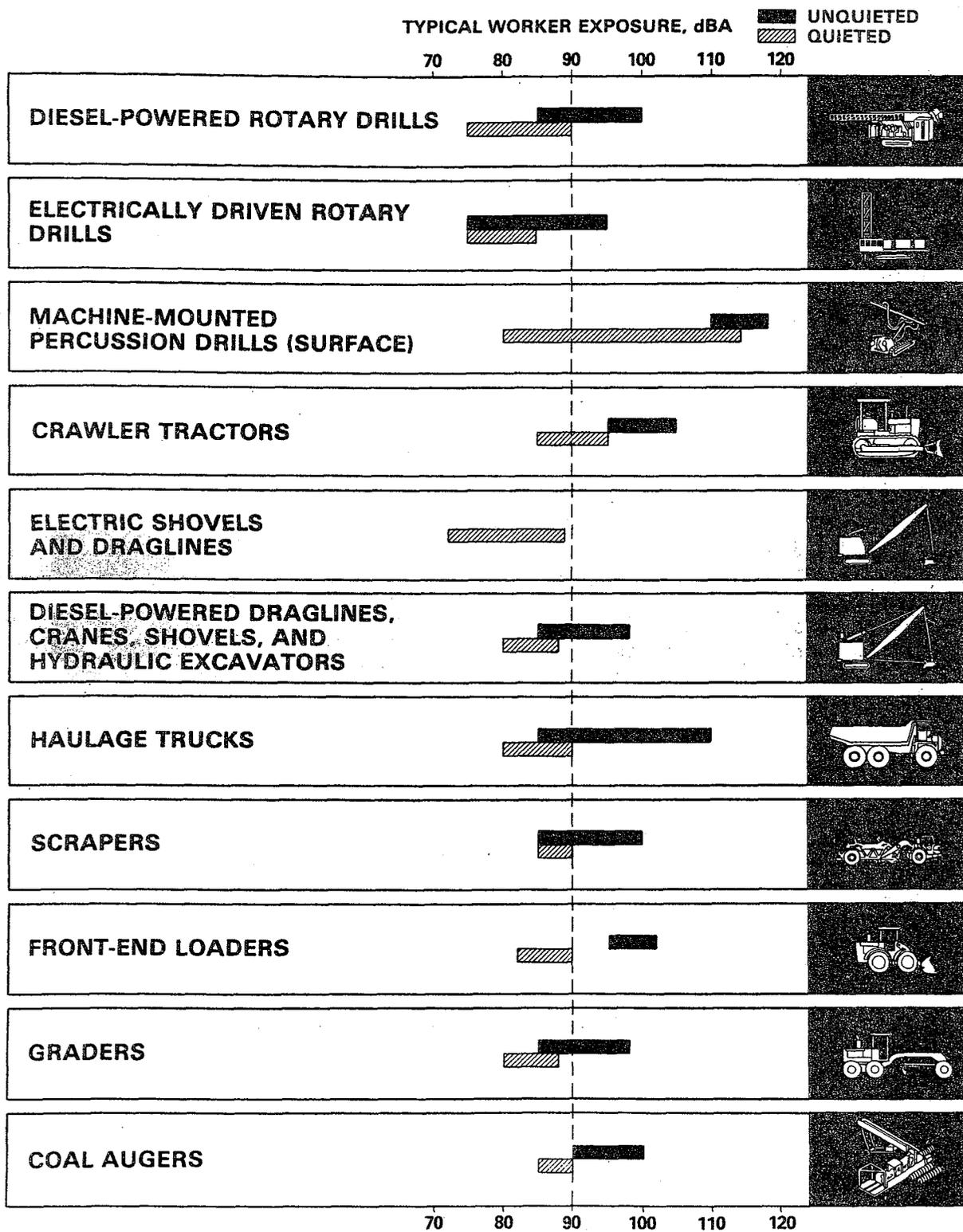
REDUCTION

- 9 NOTES:

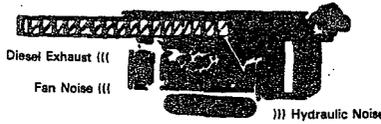
## CASE HISTORY DATA SHEET

1. Case History # - Each case history has been assigned a number by MSHA for accession purposes.
2. Date - The time frame in which the field work was conducted is identified.
3. Mine Location - The geographic location of the mine where the noise control work took place is specified.
4. Mine Type - Each mine is characterized by the type of ore produced, whether coal, metal or nonmetal.
5. Machine Manufacturer, Model - Identifies the machine by manufacturer and model, if available.
6. Machine Activity - The primary activity or use of the machine at the mine is identified.
7. Description of Controls - A brief description of the noise control treatment is provided. This includes estimates of the material costs and labor required. The material and labor requirements may vary for a given treatment, and an inspection of the equipment may be necessary for an accurate estimate to be made.
8. Noise Reduction - The actual noise reduction obtained at the operator's position is presented as a function of the machine test condition or operating mode. For reference purposes, pre- and post-treatment levels are shown.
9. Notes - Other information of interest and related to the noise control treatment involved is noted for the user.

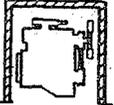
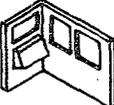
# SURFACE MINING EQUIPMENT



# DIESEL-POWERED ROTARY DRILLS



Typical Noise Level  
85-100 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
1.	 Add muffler(s) to engine exhaust.	\$100-\$450 2 h	Commercially available for all models.
2.	 Modify existing cab.	\$500-\$900 20-80 h	Local design and fabrication required.
3.	 Add acoustic cab.	\$10,000-\$15,000* 80-140 h	Commercially available for some models.
4.	 Add enclosure for engine with mufflers.	\$1,500-\$8,000 140-280 h	Local design and fabrication required.
5.	 Add partial barrier at operator with mufflers.	\$500-\$2,000 20-120 h	Local design and fabrication required.
6.	 Modify cooling fan with mufflers for models with noisy fans.	\$500-\$2,000 20-120 h	Local design and fabrication required.
7.	 Install item 5 along with covers for hydraulic valves, dust collector for blow air, and isolated centralizer or drill pipe snubber.	\$5,000-\$10,000 200-250 h	Local design and fabrication required.

Maximum noise reduction can be achieved by installing an acoustic cab.

(\* )Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

## DIESEL-POWERED ROTARY DRILLS

### TECHNOLOGY AVAILABILITY

#### 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

- \* Vantor, 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 (6).

- \* Front-End Loader Noise Control, BuMines contract J0395028 (9).

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 J0166057 (44).

## DIESEL-POWERED ROTARY DRILLS

### 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 (42).
- \* Noise and Performance of Automotive Cooling Fans, SAE Tech. Paper 800031 (29).

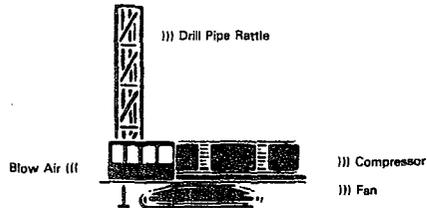
### 4. Evaluation of noise reduction from a diesel engine enclosure.

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

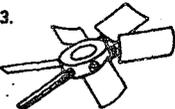
### C. Case Histories.

If case histories are available, they can be found on the following pages.

## ELECTRICALLY DRIVEN ROTARY DRILLS



**Typical Noise Level**  
75-95 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
1.  Modify existing cab or add a cab.	\$500-\$1,000 20-60 h	Local design and fabrication required.
2.  Muffle air inlet to compressor(s).	\$1,000-\$3,000 20-30 h	Commercially available for some models.
3.  Modify ventilation fans.	\$300-\$1,500 20-30 h	Local design and fabrication required.
4.  Install treatments 2 and 3 plus a drill pipe snubber and isolated centralizer.	\$2,000-\$4,000 40-80 h	Commercially available for some models. For other models, local design and fabrication required.

Maximum noise reduction can be achieved by acoustical modification of the existing cab.

## ELECTRICALLY DRIVEN ROTARY DRILLS

### TECHNOLOGY AVAILABILITY

#### 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 629, 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 J0166057 (44).

2. Fan noise reduction concepts and design.

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

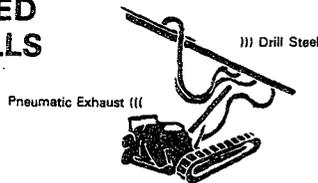
3. Instructions for installation of noise control treatments in existing cabs, including material and labor requirements.

- \* Front-End Loader Noise Control, BuMines contract J0395028 (9).

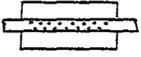
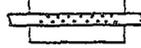
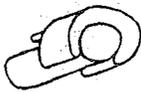
#### C. Case Histories.

If case histories are available, they can be found on the following pages.

**MACHINE-MOUNTED  
PERCUSSION DRILLS  
(SURFACE)**



Typical Noise Level	
Unmuffled Pneumatic	116 - 118 dBA
Hydraulic	100 - 114 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.</p>  <p>Add-on muffler (pneumatic drills only).</p>	<p>\$300-\$500 2 h</p>	<p>Commercially available for some models.</p>
<p>2.</p>  <p>Piped away exhaust (pneumatic drills only).</p>	<p>\$500-\$1,000 5 h</p>	<p>Commercially available for some models.</p>
<p>3.</p>  <p>Wraparound muffler (pneumatic drills only).</p>	<p>\$150-\$500 10 h</p>	<p>Commercially available for some models.</p>
<p>4.</p>  <p>Add acoustic cab.</p>	<p>\$9,000-\$15,000* 40-120 h</p>	<p>Commercially available for some models.</p>
<p>5.</p>  <p>Partial barrier along drill mast.</p>	<p>\$100-\$200 8 h</p>	<p>Local design and fabrication required.</p>
<p>6.</p>  <p>Enclosure for drill.</p>	<p>\$200-\$500 40-80 h</p>	<p>Local design and fabrication required.</p>

Maximum noise reduction can be achieved by installing an acoustic cab.

(\* ) Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

MACHINE-MOUNTED PERCUSSION DRILLS  
(SURFACE)

TECHNOLOGY AVAILABILITY

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 H0366024 (4).
- \* Development of Noise Control Technology for Pneumatic Jumbo Drills, BuMines contract H0395029 (19).

2. Construction of wraparound mufflers.

- \* Noise Abatement of Pneumatic Rock Drill, BuMines RI 7998 (43).

C. Case Histories.

If case histories are available, they can be found on the following pages.



CASE HISTORY # MPD-1 , DATE: 1980

MINE LOCATION (County, State): El Paso County, Colorado

MINE TYPE (Metal/Normetal, Coal): Metal/normetal - limestone quarry

MACHINE MANUFACTURER, MODEL: Gardner Denver PR123 drill

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Operator purchased a cylinder with exhaust swivel prior to work. A section of 3 inch flexible hose was clamped to exhaust swivel and extended to top of mast.

TOTAL MATERIAL COSTS: \$100 not including the cylinder with the swivel

MANHOURS: 2

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while drilling	107.5 dBA	100.5 dBA	7 dBA

NOTES:



CASE HISTORY # MPD-2 , DATE: 1983

MINE LOCATION (County, State): Grant County, South Dakota

MINE TYPE (Metal/Nonmetal, Coal): Metal/nonmetal - granite quarry

MACHINE MANUFACTURER, MODEL: Gardner Denver 93 drill

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Plywood sheet bolted to drill mast as barrier between operator and cylinder.

TOTAL MATERIAL COSTS: \$50.00

MANHOURS: 6

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while drilling	114-119 dBA	104-107 dBA	10-12 dBA

NOTES:

Drill noise increases as drill cylinder moves down mast.



CASE HISTORY # MPD-3 , DATE: 1980

MINE LOCATION (County, State): El Paso County, Colorado

MINE TYPE (Metal/Nonmetal, Coal): Metal/nonmetal - surface limestone

MACHINE MANUFACTURER, MODEL: Gardner Denver PR123 drill

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Operator purchased a cylinder with exhaust swivel prior to work. A section of 3 inch flexible hose was clamped to exhaust swivel and extended to top of mast.

TOTAL MATERIAL COSTS: \$100 not including the cylinder with the swivel.

MANHOURS: 2

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while drilling	114 dBA	105 dBA	9 dBA

NOTES:



CASE HISTORY # MPD-4 , DATE: 1980

MINE LOCATION (County, State):

MINE TYPE (Metal/Nonmetal, Coal): Metal/nonmetal - surface stone quarry

MACHINE MANUFACTURER, MODEL: Gardner Denver PR80 drill

MACHINE ACTIVITY:

Drill blast holes.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Operator enclosure constructed on 2x4 framing and 1/2 inch plywood.

Covered with aluminum sheets.

Interior lined with 2 inch fiberglass.

Enclosure constructed on rear of drill chassis.

TOTAL MATERIAL COSTS: \$1,000.00

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while drilling	115 dBA	94 dBA	21 dBA

NOTES:



CASE HISTORY # MPD-5 , DATE: 1980

MINE LOCATION (County, State): Pennington County, South Dakota

MINE TYPE (Metal/Nonmetal, Coal): Metal/nonmetal - sand and gravel

MACHINE MANUFACTURER, MODEL: Joy VCR 260 drill

MACHINE ACTIVITY:  
Quarry drilling.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

3/4 inch plywood barrier was placed between operator and drill steel.  
Barrier stopped 2 feet from ground to allow unobstructed view of  
the hole.

TOTAL MATERIAL COSTS: \$40.00

MANHOURS: 2

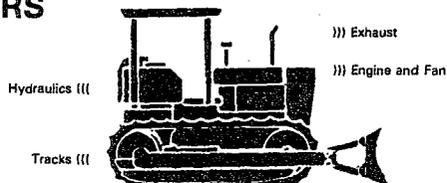
NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while drilling	107-109 dBA	101-104 dBA	3-7 dBA

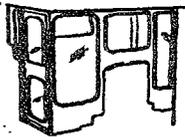
NOTES:

The installation of a muffler could provide additional reduction as well as lining the barrier with a sheet of lead vinyl and using rubber isolation mounts.

## CRAWLER TRACTORS



**Typical Noise Level**  
95-105 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.</p>  <p>For dozers with ROPS only add noise barriers and absorption to ROPS--windshield, floormat, canopy absorption, seals, vibration isolation.</p>	<p>\$500-\$1,500 60-120 h</p>	<p>Local fabrication using well-documented methods. Commercially available for some models.</p>
<p>2.</p>  <p>Add complete acoustical cab with pressurization and air conditioning.</p>	<p>\$12,000-\$15,000* 60-140 h</p>	<p>Commercially available for most models.</p>
<p>3.</p>  <p>Add sound suppression to existing cab.</p>	<p>\$500-\$1,500 30-80 h</p>	<p>Commercially available for most models or can be locally fabricated using well-documented methods.</p>
<p>4.</p>  <p>Install an acoustically effective exhaust system.</p>	<p>\$200-\$400 2 h</p>	<p>Commercially available for all models.</p>

Maximum noise reduction can be achieved by installing an acoustic cab.

(\*)Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

## CRAWLER TRACTORS

### TECHNOLOGY AVAILABILITY

#### 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 through the manufacturer. Manufacturers include

- \* Medford Steel, P.O. Box 1588, Medford, OR 97501 (503) 779-1970

- \* Palm Industries, Inc., P.O. 562, Litchfield, MN 55355  
(612) 693-2492

- \* Saf-T-Cab, Inc., P.O. Box 2587, Fresno, CA 93745 (209) 268-5541

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

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 J0177049 (6).

- \* Front-End Loader Noise Control, BuMines contract J0395028 (9).

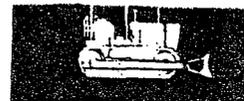
## CRAWLER TRACTORS

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 J0166057 (44).

C. Case Histories.

If case histories are available, they can be found on the following pages.



CASE HISTORY # CTR-1 , DATE: 1983

MINE LOCATION (County, State): Thomas County, Georgia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - fullers earth

MACHINE MANUFACTURER, MODEL: Caterpillar D-8-K bulldozer

MACHINE ACTIVITY:

Stripping top soil and reclamation at a fullers earth quarry.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

1. Front portion of a skin kit installed as a barrier.
2. Sound absorbing fiberglass material attached to ceiling.
3. Composite acoustical material to firewall, etc.
4. Flexible barrier material for the floor with a protective floormat on top.

TOTAL MATERIAL COSTS: Barrier - \$1,100; Acoustical material - \$700

MANHOURS: Approximately 50

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Reverse tram	102.8 dBA	94.8 dBA	8 dBA
Pushing dirt	101.5 dBA	94.5 dBA	7 dBA
High idle	101.2 dBA	91.2 dBA	10 dBA

NOTES:

Machine had an exhaust muffler before noise controls were installed.



CASE HISTORY # CTR-2 , DATE: 1983

MINE LOCATION (County, State): Frederick County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Caterpillar D-8-H dozer

MACHINE ACTIVITY:

Stripping, reclamation, etc. at a limestone operation.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Fiberglass acoustical material installed in the operator's cab to the walls, ceiling, firewall. The floor was treated with conveyor belting covered by an acoustical floormat. Exhaust muffler was in place but the exhaust stack was extended 1 foot above cab.

TOTAL MATERIAL COSTS: \$700.00

MANHOURS: Approximately 40

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Tram forward	99.0 dBA	95.5 dBA	3.5 dBA
High idle	97.5 dBA	90.2 dBA	7.3 dBA

NOTES:



CASE HISTORY # CTR-3 , DATE: 1984

MINE LOCATION (County, State): Franklin County, Ohio

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - aggregate

MACHINE MANUFACTURER, MODEL: Komatsu D-85E bulldozer

MACHINE ACTIVITY:

Dozer was used in stripping, reclamation, etc. at an aggregate operation

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Neoprene acoustical materials installed to inside area of the operator's area (floor, ceiling, firewall). The vehicle had a front partial barrier previously installed along with an exhaust muffler.

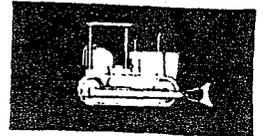
TOTAL MATERIAL COSTS: \$700.00

MANHOURS: Approximately 50

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Pushing dirt	101.0 dBA	92.2 dBA	9.0 dBA
Forward tram	97.2 dBA	92.5 dBA	4.7 dBA
High idle	96.0 dBA	91.5 dBA	4.5 dBA

NOTES:



CASE HISTORY # CTR-4 , DATE: 1981

MINE LOCATION (County, State): Somerset County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - fire clay

MACHINE MANUFACTURER, MODEL: Caterpillar D9 bulldozer

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Fiberglass installed on roof and walls of cab.

Fiberglass/barrier material on floor and covered with protective mat.

TOTAL MATERIAL COSTS: \$400.00

MANHOURS: 30

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear, tramming	103 dBA	94 dBA	9 dBA

NOTES:

Equipped with cab and muffler.  
Old and in poor mechanical condition.



CASE HISTORY # CTR-5 , DATE: 1979

MINE LOCATION (County, State): Frederick County, Maryland

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Caterpillar D9 bulldozer

MACHINE ACTIVITY:

Used to push mined material.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Muffler installed.  
Fiberglass installed on ceiling and walls inside cab.  
Floormat with protective cover installed.

TOTAL MATERIAL COSTS: \$500.00

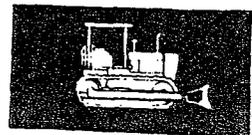
MANHOURS: 50

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear scraping rock			
Muffler installed	103 dBA	102 dBA	1 dBA
All controls	103 dBA	92 dBA	11 dBA

NOTES:

Equipped with untreated cab.



CASE HISTORY # CTR-6 , DATE: 1979

MINE LOCATION (County, State): Lawrence County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Caterpillar D9 bulldozer

MACHINE ACTIVITY:

Dozer pushed dirt on reclamation work.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Foam/barrier material placed on floor.  
Foam and form/barrier material lined interior of cab.

TOTAL MATERIAL COSTS: \$400.00

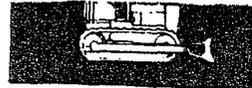
MANHOURS: 40

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while pushing dirt (doors closed)	99.5 dBA	90.0 dBA	9.5 dBA
(doors open)	100.0 dBA	91.0 dBA	9.0 dBA

NOTES:

Due to fire hazard, fiberglass should be used instead of foam.  
Equipped with untreated cab and muffler.



CASE HISTORY # CTR-7 , DATE: 1982

MINE LOCATION (County, State): Belmont County, Ohio

MINE TYPE (Metal/Nonmetal, Coal): Surface coal

MACHINE MANUFACTURER, MODEL: Caterpillar D9G bulldozer

MACHINE ACTIVITY:

Remove overburden in strip pit.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Composite fiberglass/vinyl barrier placed on rear wall, sidewalls, and firewall.

Fiberglass placed inside roof.

Vibration dampening pads in ROP seats.

Barrier material placed on floor.

New seals installed around doors, fuel tank, and between cab and chassis.

Rubber boots installed around steering lever.

TOTAL MATERIAL COSTS: \$1,300.00

MANHOURS: 160

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear, tramming	103.0 dBA	92.0 dBA	11.0 dBA
At operator's ear, pushing dirt	100.0 dBA	93.0 dBA	7.0 dBA
TWA for full shift	96.5 dBA	91.1 dBA	5.4 dBA

NOTES:

Equipped with untreated cab and muffler.

Inflated costs are due to additional materials and labor required for diagnostic testing.



CASE HISTORY # CTR-8 , DATE: 1979

MINE LOCATION (County, State): Fayette County, Pennsylvania

MINE TYPE (Metal/Normetal, Coal): Metal/Normetal - stone quarry

MACHINE MANUFACTURER, MODEL: Komatsu 155A bulldozer

MACHINE ACTIVITY:

Pushing dirt on reclamation work.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Absorptive material placed on roof inside cab.

Absorptive/barrier material placed on rest of cab interior and on engine side of firewall.

All cracks sealed with silicone based caulking compound.

TOTAL MATERIAL COSTS: \$500.00

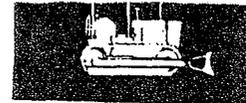
MANHOURS: 44

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while pushing (doors open)	103 dBA	91 dBA	12 dBA
(doors closed)	102 dBA	92 dBA	10 dBA

NOTES:

Equipped with exhaust muffler and untreated full cab.



CASE HISTORY # CTR-9 , DATE: 1979

MINE LOCATION (County, State): Pike County, Kentucky

MINE TYPE (Metal/Nonmetal, Coal): Surface coal

MACHINE MANUFACTURER, MODEL: International Harvester TD-25C bulldozer

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Machine did not have a cab. A partial barrier was constructed.  
Absorptive material installed in ROPS canopy.  
Floormat  
Seat seal and hydraulic bar seal.  
Dashboard barrier seal.  
Windshield

TOTAL MATERIAL COSTS: \$1,300.00

MANHOURS: 87

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear, high idle	102 dBA	91 dBA	11 dBA

NOTES:

310 HP, manufactured in 1974.  
Equipped with exhaust muffler.  
Work performed under BuMines contract.  
High idle may not be indicative of actual work conditions.



CASE HISTORY # CTR-10, DATE: 1978

MINE LOCATION (County, State): Harrison County, Ohio

MINE TYPE (Metal/Nonmetal, Coal): Surface coal

MACHINE MANUFACTURER, MODEL: Caterpillar D9G bulldozer

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Absorptive material installed in FOPS canopy.
- Cab wall seals
- Floormat and seals
- Sound absorptive material installed on cab interior.
- Dashboard seals and vibration isolation.

TOTAL MATERIAL COSTS: \$950.00

MANHOURS: 90

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear, high idle			
doors open	99 dBA	89 dBA	10 dBA
doors closed	100 dBA	91 dBA	9 dBA

NOTES:

Equipped with cab. Manufactured in 1973.  
 Work performed under BuMines contract.  
 Levels are slightly higher with doors closed because of reverberation.  
 High idle measurements may not be indicative of actual working conditons.



CASE HISTORY # CTR-11, DATE: 1976

MINE LOCATION (County, State): Walker County, Alabama

MINE TYPE (Metal/Nonmetal, Coal): Surface coal

MACHINE MANUFACTURER, MODEL: Caterpillar D9G bulldozer

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Machine did not have a cab. A partial barrier was constructed.
- Absorptive material installed on FOPS canopy.
- Exhaust muffler
- Dashboard seals and vibration isolation
- Floormat and seals
- Seat seals
- Hydraulic valve cover and tank seal
- Windshield

TOTAL MATERIAL COSTS: \$1,000.00

MANHOURS: 106

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear, high idle	105 dBA	94 dBA	11 dBA

NOTES:

- 385 HP, manufactured in 1974.
- Equipped with FOPS/ROPS.
- Work performed under BuMines contract.
- High idle measurements may not be indicative of actual working conditions.



CASE HISTORY # CTR-12, DATE: 1981

MINE LOCATION (County, State): Jefferson County, Colorado

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - surface crushed stone

MACHINE MANUFACTURER, MODEL: Caterpillar D8H bulldozer

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Absorptive material placed inside of canopy.  
Absorptive/barrier material placed on operator side of firewall.  
Lead vinyl placed on engine side of firewall.  
Barrier material placed on floor.  
Barrier material fastened to hydraulic cover.  
Piece of 1/4" steel was shaped to fit from floor to the top of the hood  
on the left side and was covered with barrier material.  
Angle iron welded to engine cowling for dampening.  
Belting fastened to hood and draped over one side of the engine.  
TOTAL MATERIAL COSTS: \$279.00

MANHOURS: 29

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while tramming	97 dBA	93 dBA	4 dBA

NOTES:

Dozer equipped with FOPS.



CASE HISTORY # CTR-13, DATE: 1980

MINE LOCATION (County, State): Pulaski County, Arkansas

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - surface crushed granite

MACHINE MANUFACTURER, MODEL: Caterpillar D7 bulldozer

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Lead vinyl was placed on engine side of firewall.
- Fuel tank covered with fiberglass.
- Absorptive material was put on roof inside cab.
- Lead vinyl was placed beneath seat blocking transmission noise.
- Absorptive/barrier material was placed on floor.
- Absorptive/barrier material was placed over the front wall/floor.

TOTAL MATERIAL COSTS: \$300.00

MANHOURS: 8

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while tramming	101-103 dBA	97-99 dBA	4 dBA

NOTES:

Equipped with untreated cab.



CASE HISTORY # CTR-14, DATE: 1980

MINE LOCATION (County, State): Garland County, Arkansas

MINE TYPE (Metal/Normetal, Coal): Metal/Normetal - surface vanadium

MACHINE MANUFACTURER, MODEL: International Harvester TD-25E bulldozer

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Fiberglass/lead/fiberglass was placed under instrument panel.  
Lead vinyl was hung on engine side of firewall.  
Lead vinyl was placed beneath the operator's seat.  
Fiberglass was placed inside cab over fuel tank.

TOTAL MATERIAL COSTS: \$120.00

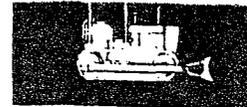
MANHOURS: 6

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while tramming	98-101 dBA	94-96 dBA	4-5 dBA

NOTES:

Equipped with untreated cab.  
Additional reduction could be achieved if repair gaskets around cowling.



CASE HISTORY # CTR-15, DATE: 1983

MINE LOCATION (County, State): Frederick County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - surface limestone

MACHINE MANUFACTURER, MODEL: Caterpillar D8H bulldozer

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Barrier material fitted behind instrument cluster.

Boots installed around lever.

Muffler removed because of engine problems.

Exhaust stack extended 1 foot.

2" absorptive material placed on inside of roof.

2" fiberglass/lead composite placed on rear wall and firewall.

Barrier placed on engine side of firewall.

TOTAL MATERIAL COSTS: Unknown

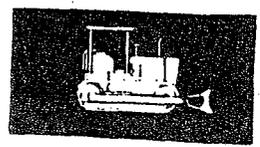
MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while tramming	98.5 dBA	95.0 dBA	3.5 dBA

NOTES:

Equipped with operator's cab and muffler.



CASE HISTORY # CTR-16, DATE: 1981

MINE LOCATION (County, State): Stevens County, Washington

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - surface silica

MACHINE MANUFACTURER, MODEL: Caterpillar D8H bulldozer

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Barrier/absorptive material placed on the floor.
- Barrier material placed on operator's side of firewall
- Lead vinyl fastened on engine side of firewall.
- Absorptive material placed on transmission cover.
- Muffler was installed.

TOTAL MATERIAL COSTS: \$150.00 not including muffler

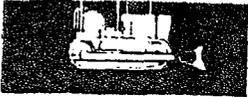
MANHOURS: 8

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while pushing dirt			
all controls	105 dBA	98 dBA	7 dBA
all controls except muffler	105 dBA	103 dBA	2 dBA

NOTES:

Absorptive material cemented to inside of FOPS.  
 Not equipped with cab or muffler.



CASE HISTORY # CTR-17, DATE: 1980

MINE LOCATION (County, State): Little River County, Arkansas

MINE TYPE (Metal/Normetal, Coal): Metal/Normetal - limestone quarry

MACHINE MANUFACTURER, MODEL: Caterpillar D9 bulldozer

MACHINE ACTIVITY:

Dozer used for ripping.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Exhaust stack extended over FOPS.
- Barrier material placed on floor.
- Underside of FOPS treated with barrier/absorptive material.
- FOPS dampened by bolting to it 1/4" steel plate with layer of belting.
- Engine cowling dampened with welded iron.
- Lead vinyl beneath engine seat to block off transmission noise.
- Operator side of firewall covered with barrier material.
- Muffler installed.

TOTAL MATERIAL COSTS: \$600.00 including muffler.

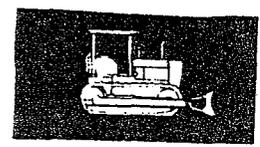
MANHOURS: 23

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while ripping	105 dBA	98 dBA	7 dBA

NOTES:

Dozer equipped with FOPS and without a muffler. While reduction was impressive, controls subsequently came off due to the violent nature of the ripping operation. These controls should be very effective for dozers used just to push dirt.



CASE HISTORY # CTR-18, DATE: 1980

MINE LOCATION (County, State): Little River County, Arkansas  
MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone quarry  
MACHINE MANUFACTURER, MODEL: Caterpillar D9 bulldozer  
MACHINE ACTIVITY:

Dozer used in ripping operations.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Company installed a factory built retrofit cab equipped with air conditioning which is mandatory in summer.

TOTAL MATERIAL COSTS: \$8,137.00

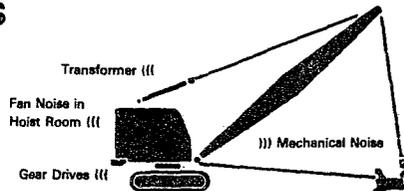
MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

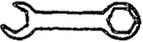
<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear during ripping operation with door closed	103 dBA	95 dBA	8 dBA

NOTES:  
Because of the violent nature of the ripping operation, the air conditioner kept breaking down. Consequently, the dozer was frequently in the shop to repair the air conditioner. These controls should be very effective for dozers used to push dirt.

## ELECTRIC SHOVELS AND DRAGLINES



**Typical Noise Level**  
72-89 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
1.	 <p>Replace worn or damaged parts that generate unusual noise.</p>	Varied	Commercially available for all models.

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.

## ELECTRIC SHOVELS AND DRAGLINES

### TECHNOLOGY AVAILABILITY

A. Commercially available noise control products and materials.

None. Only normal maintenance required.

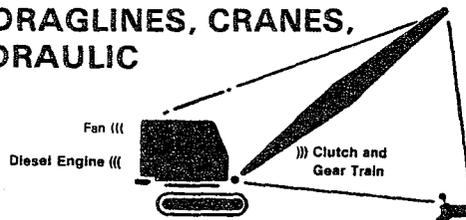
B. Technical reports on the development and demonstration of noise control treatments.

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

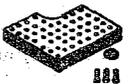
C. Case Histories.

If case histories are available, they can be found on the following pages.

**DIESEL-POWERED DRAGLINES, CRANES,  
SHOVELS AND HYDRAULIC  
EXCAVATORS**



**Typical Noise Level  
85-98 dBA**

	TREATMENT	COST AND LABOR	AVAILABILITY
1. 	Add sound suppression to the cab-acoustical absorption, seals.	\$500-\$1,500 30-80 h	Commercially available for some models, also local fabrication using well-documented methods.
2. 	Install or replace exhaust system parts.	\$200-\$400 2 h	Commercially available for all models.

Maximum noise reduction can be achieved by acoustically modifying the existing cab.

NOTE.--The oiler may be overexposed but typically can be brought into compliance by administrative controls.

DIESEL-POWERED DRAGLINES, CRANES, SHOVELS,  
AND HYDRAULIC EXCAVATORS

TECHNOLOGY AVAILABILITY

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

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 (6).

- \* Front-End Loader Noise Control, BuMines contract J0395028 (9).

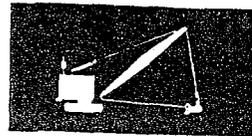
2. Noise source information and general guidelines on noise control requirements.

- \* The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract J0166057 (44).

- \* Noise Control on a Heavy Duty Mobile Crane, SAE Tech. Paper 760601 (5).

C. Case Histories.

If case histories are available, they can be found on the following pages.



CASE HISTORY # DSD-1 , DATE: 1981

MINE LOCATION (County, State): Somerset County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - fire clay

MACHINE MANUFACTURER, MODEL: Marion 362 shovel

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Curtain barrier installed behind operator.  
Area around operator treated with composite of fiberglass/vinyl.

TOTAL MATERIAL COSTS: \$580.00

MANHOURS: 24

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear, high idle	98.2 dBA	86.0 dBA	12.2 dBA

NOTES:

Not equipped with muffler.  
High idle measurements may not be indicative of actual operating conditions.



CASE HISTORY # DSD-2 , DATE: 1981

MINE LOCATION (County, State): Somerset County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - fire clay

MACHINE MANUFACTURER, MODEL: P&H 6658 shovel

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Leaded vinyl curtain hung behind operator using uni-track and roller hooks.

Area around operator covered with composite of fiberglass/vinyl.

TOTAL MATERIAL COSTS: \$390.00

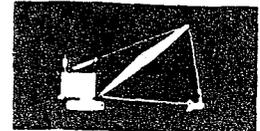
MANHOURS: 20

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear at high idle door opened	92.5 dBA	82.8 dBA	9.7 dBA

NOTES:

Not equipped with muffler.  
High idle measurements may not be indicative of actual operating conditions.



CASE HISTORY # DSD-3 , DATE: 1979

MINE LOCATION (County, State): Lawrence County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Bucyrus Erie 88B shovel

MACHINE ACTIVITY:

Diesel powered shovel used to load trucks in limestone pit.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Lead vinyl curtain was placed behind operator.  
Lead vinyl material blocked opening at operator's left.  
Absorptive material was installed inside cab.

TOTAL MATERIAL COSTS: \$300.00

MANHOURS: 42

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear during actual production	102 dBA	93 dBA	9 dBA

NOTES:

Welder needed to construct a frame work for the curtain.





CASE HISTORY # DSD-4 , DATE: 1980

MINE LOCATION (County, State): Rockingham County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Northwest NW6 shovel

MACHINE ACTIVITY:

Used to load haulage trucks in limestone pit.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Vinyl curtain was hung behind operator.  
Openings on operator's left side were covered.  
Quilted fiberglass was put on left front panel.

TOTAL MATERIAL COSTS: \$200.00

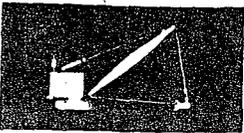
MANHOURS: 42

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear, high idle			
in neutral	101 dBA	90 dBA	11 dBA
in gear	101 dBA	89 dBA	12 dBA

NOTES:

Approximately 15 years old and in poor mechanical condition. High idle measurements may not be indicative of conditions during an actual production cycle.



CASE HISTORY # DSD-5 , DATE: 1981

MINE LOCATION (County, State): Franklin County, Missouri  
MINE TYPE (Metal/Normetal, Coal): Metal/Normetal - gravel plant  
MACHINE MANUFACTURER, MODEL: Unknown  
MACHINE ACTIVITY:

Used to load portable crusher.  
Operate 4-1/2 hours per day.  
DESCRIPTION OF CONTROLS:

CONTROLS USED:

Lead vinyl curtain hung between operator and engine.  
Barrier/absorptive material was hung next to engine.  
Leaks in cab were sealed.  
Cylindrical muffler attached to exhaust.

TOTAL MATERIAL COSTS: \$600.00

MANHOURS: 15

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear during actual operation with door opened	101 dBA	96 dBA	5 dBA

NOTES:



CASE HISTORY # DSD-6 , DATE: 1980

MINE LOCATION (County, State): Beaver County, Pennsylvania  
MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone  
MACHINE MANUFACTURER, MODEL: Bucyrus Erie 71B dragline  
MACHINE ACTIVITY:

Removes overburden at open pit limestone mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Vinyl curtain was installed between diesel engine and operator.  
Openings to operator's left were covered by vinyl material.

TOTAL MATERIAL COSTS: \$200.00

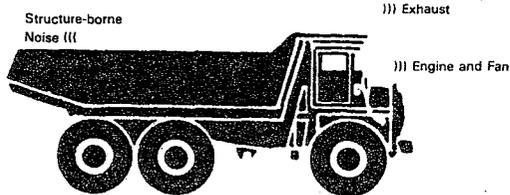
MANHOURS: 6

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while loading door open	99 dBA	87 dBA	12 dBA

NOTES:  
Equipped with muffler. Because the heat from the engine will be blocked by the curtain, it may be necessary to install a heater in winter.

## HAULAGE TRUCKS



**Typical Noise Level**  
85-110 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
1.  Exhaust muffler(s) for models without body heating or mufflers.	\$150-\$500 2 h	Commercially available for all models.
2.  Add acoustic treatment to existing cab.*	\$500-\$900 20-80 h	Local design and fabrication required.
3.  Modify or change cooling fan on trucks with noisy fans.	\$500-\$2,000 20-120 h	Local design and fabrication required.

Maximum noise reduction can be achieved by using treatments 1 through 3.

(\* ) May need to add cab to older trucks.

## HAULAGE TRUCKS

### TECHNOLOGY AVAILABILITY

#### 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

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 (6).

- \* Front-End Loader Noise Control, BuMines contract J0395028 (9).

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

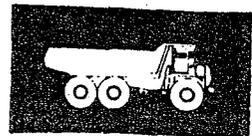
- \* The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract J0166057 (44).

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 (42).

#### C. Case Histories.

If case histories are available, they can be found on the following pages.



CASE HISTORY # HTR-1 , DATE: 1983

MINE LOCATION (County, State): Logan County, Ohio

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Euclid R-18 haulage truck

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Barrier material/floor matting placed on floor.
- 2" Toyad LS-200 neoprene foam installed on studs welded to cab roof.
- 1" Toyad LS-200 neoprene foam stud welded to doors, walls and firewall.
- 1" fiberglass replaced 2" LS-200 neoprene foam on cab roof.
- 2" composite fiberglass/vinyl replaced 1" LS-200 neoprene foam on doors, walls, and firewall.

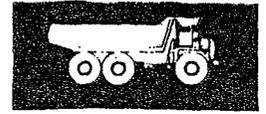
TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear			
FOAM:			
high idle, doors open	93.5 dBA	89.2 dBA	4.3 dBA
tram, doors closed	94.8 dBA	87.5 dBA	7.3 dBA
tram, doors open	95.2 dBA	90.5 dBA	4.7 dBA
FIBERGLASS:			
high idle, doors open	93.5 dBA	88.0 dBA	5.5 dBA
tram, doors closed	94.8 dBA	87.8 dBA	7.0 dBA
tram, doors open	95.2 dBA	88.1 dBA	7.1 dBA

NOTES:



CASE HISTORY # HTR-2 , DATE: 1978

MINE LOCATION (County, State): Montgomery County, Maryland

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - crushed stone

MACHINE MANUFACTURER, MODEL: Euclid 30 ton haulage truck

MACHINE ACTIVITY:

Haul stone from quarry to crusher.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Exhaust stack extended 8" above cab.

2" absorptive material installed on ceiling.

1" absorptive material installed on rear wall, sidewall, and door.

1" barrier/absorptive composite installed on firewall and dashboard.

Floormat placed on floor.

TOTAL MATERIAL COSTS: \$500.00

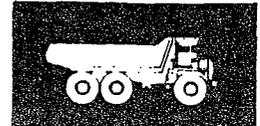
MANHOURS: 40

NOISE REDUCTION OBTAINED:

OPERATING MODE	NOISE LEVEL		REDUCTION
	BEFORE	AFTER	
At operator's ear while tramming (doors open)	94.5 dBA	85.0 dBA	9.5 dBA
(doors closed)	98.5 dBA	90.0 dBA	8.5 dBA

NOTES:

Equipped with full cab and muffler. In good mechanical condition.



CASE HISTORY # HTR-3 , DATE: 1981

MINE LOCATION (County, State): Spokane County, Washington

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - uranium

MACHINE MANUFACTURER, MODEL: Kenworth Dart haulage truck

MACHINE ACTIVITY:

Haul ore.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Moved exhaust pipes away from cab.  
Sealed window shut near exhaust pipes.

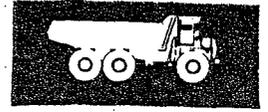
TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Truck #159 at operator's ear tramping loaded, window closed	102.0 dBA	92.8 dBA	9.2 dBA

NOTES:



CASE HISTORY # HTR-4 , DATE: 1978

MINE LOCATION (County, State): Fairfax County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - crushed stone

MACHINE MANUFACTURER, MODEL: Caterpillar 773 haulage truck

MACHINE ACTIVITY:

Haul rock from quarry to crusher.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

2" vinyl covered foam with plastic barrier attached to roof.

1" vinyl covered foam with plastic barrier attached to walls.

A floor mat barrier material covered with a skid resistant vinyl surface.

TOTAL MATERIAL COSTS: \$600.00

MANHOURS: 96

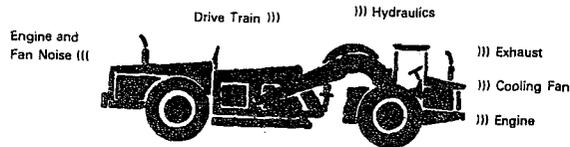
NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear loaded, traveling uphill, windows open	95.8 dBA	89.4 dBA	6.4 dBA
loaded, traveling uphill, windows closed	91.6 dBA	81.1 dBA	10.5 dBA
loaded, traveling level, windows open	96.1 dBA	90.0 dBA	6.1 dBA
loaded, traveling level, windows closed	91.7 dBA	79.5 dBA	12.2 dBA
empty, traveling level, windows open	90.9 dBA	79.0 dBA	11.9 dBA
empty, traveling level, windows closed	86.8 dBA	75.7 dBA	11.1 dBA

NOTES:

Truck cab manufactured from fiberglass so stick-on studs employed.  
Truck equipped with a cab.

# SCRAPERS



**Typical Noise Level**  
85-100 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.  For scrapers without a cab, install an operator cab with sound suppression.</p>	\$12,000-\$15,000 * 60-140 h	Commercially available for most models.
<p>2.  For scraper without a cab, fabricate open ROPS noise barriers, sound absorption and vibration isolation to reduce the operator exposure.</p>	\$500-\$1,500 60-120 h	Local design and fabrication required.
<p>3.  Add sound suppression to existing cab.</p>	\$500-\$1,500 30-80 h	Commercially available for some models.
<p>4.  Replace exhaust components if faulty or missing.</p>	\$200-\$400 2 h	Commercially available for all models.

Maximum noise reduction can be achieved by installing an acoustic cab.

(\* ) Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

## SCRAPERS

### TECHNOLOGY AVAILABILITY

#### 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 Ave., Essex, MA 01929  
(617) 768-6931

- \* Palm Industries, Inc., P.O. Box 562, Litchfield, MN 55355  
(612) 693-2492

3. Sound suppression treatments for existing cabs are manufactured by

- \* Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192

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 J0177049 (6).

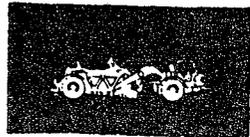
- \* Front-End Loader Noise Control, BuMines contract J0395028 (9).

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 J0166057 (44).

#### C. Case Histories.

If case histories are available, they can be found on the following pages:



CASE HISTORY # SCR-1 , DATE: 1983

MINE LOCATION (County, State): Frederick County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Caterpillar 621 water truck

MACHINE ACTIVITY:

Vehicle was used to apply water to the haulage roads at a limestone operation.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

1. Relocation of switches and controls.
2. Construction of a plywood barrier between engine and cab.
3. Fiberglass acoustical material installed in cab to walls and ceiling.



TOTAL MATERIAL COSTS: \$600.00

MANHOURS: Approximately 80

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
High idle	93.0 dBA	86.7 dBA	6.3 dBA

NOTES:



CASE HISTORY # SCR-2 , DATE: 1983

MINE LOCATION (County, State): Frederick County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - surface limestone

MACHINE MANUFACTURER, MODEL: Caterpillar 621 truck

MACHINE ACTIVITY:

Used as a water truck, modified scraper.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Switches/controls relocated from outside to inside cab.
- Barrier built between engine and cab.
- Broken glass replaced.
- Fiberglass/lead composite added to cab walls/roof.
- Barrier placed in instrument panel to block off engine noise.

TOTAL MATERIAL COSTS: Unknown

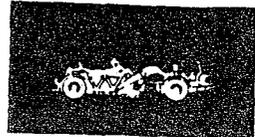
MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear at high idle	93 dBA	87 dBA	6 dBA

NOTES:

Equipped with operator's cab.



CASE HISTORY # SCR-3 , DATE: 1981

MINE LOCATION (County, State): Spokane County, Washington

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - surface clay

MACHINE MANUFACTURER, MODEL: Michigan 110-15 scraper

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Metal box was placed over exhaust system located next to window.  
Hood area between operator cab and exhaust was covered with barrier material.

Firewall inside cab was covered with barrier material.

Underside of canopy was covered with absorptive material.

TOTAL MATERIAL COSTS: \$300.00

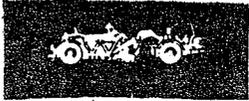
MANHOURS: 6

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear during production cycle, window open	99.9 dBA	95.1 dBA	4.8 dBA

NOTES:

Equipped with operator cab.



CASE HISTORY # SCR-4 , DATE: 1980

MINE LOCATION (County, State): Little River County, Arkansas  
MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone quarry  
MACHINE MANUFACTURER, MODEL: Terex TS-24 scraper  
MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Exhaust stack extended over FOPS.  
Air deflector stiffened with angle iron.  
Barrier material placed on operator's right side to block engine noise.  
Underside of FOPS treated with absorptive material.  
FOPS dampened with a layer of belting sandwiched between steel plates.

TOTAL MATERIAL COSTS: \$100.00

MANHOURS: 8

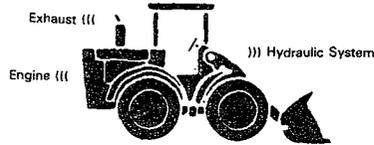
NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear tramming unloaded	104.9 dBA	100.1 dBA	4.8 dBA

NOTES:

Equipped with FOPS.

## FRONT-END LOADERS



**Typical Noise Level**  
95-102 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.  Add complete noise control cab with pressurization and air conditioning.</p>	<p>\$12,000-\$15,000 * 60-140 h</p>	<p>Commercially available for some models.</p>
<p>2.  Add sound suppression to existing cab.</p>	<p>\$500-\$1,000 30-80 h</p>	<p>Commercially available for some models or can be locally fabricated using well-documented methods.</p>
<p>3.  Replace exhaust system components if missing or faulty.</p>	<p>\$200-\$400 2 h</p>	<p>Commercially available for all models.</p>

Maximum noise reduction can be achieved by installing an acoustic cab.

(\*)Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

## FRONT-END LOADERS

### TECHNOLOGY AVAILABILITY

#### 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 53589 (608) 873-4200

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

- \* Industrial Cab Co., Inc., 76 Western Ave., 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

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

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 J0395028 (9).

- \* Bulldozer Noise Control, BuMines contract J0177049 (6).

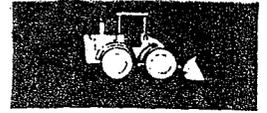
2. Noise source information and general guidelines on noise control requirements.

- \* The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract J0166057 (44).

## FRONT-END LOADERS

### C. Case Histories

If case histories are available, they can be found on the following pages.



CASE HISTORY # FEL-1 , DATE: 1984

MINE LOCATION (County, State): Buckingham County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - slate

MACHINE MANUFACTURER, MODEL: Kawasaki front-end loader, KSS-70

MACHINE ACTIVITY:

Vehicle used to load slate material into trucks.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Neoprene foam acoustical material, covered by perforated aluminum was installed in the operator's cab to the ceiling, walls, etc. The floor was treated with a flexible barrier covered by a protective floormat.

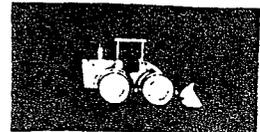
TOTAL MATERIAL COSTS: \$800.00

MANHOURS: Approximately 48

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Loading cycle	99.2 dBA	93.0 dBA	6.2 dBA

NOTES:



CASE HISTORY # FEL-2 , DATE: 1983

MINE LOCATION (County, State): Frederick County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - surface limestone

MACHINE MANUFACTURER, MODEL: Caterpillar 988 front-end loader

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Absorptive material added to cab enclosure.  
Acoustical floormatting was placed on floor, shifter box, and bucket control box.

TOTAL MATERIAL COSTS: Unknown

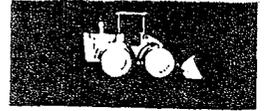
MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while tramming	93-94 dBA	84-85 dBA	9 dBA

NOTES:

Equipped with full cab and muffler.



CASE HISTORY # FEL-3 , DATE: 1980

MINE LOCATION (County, State): Randolph, West Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - underground limestone

MACHINE MANUFACTURER, MODEL: Caterpillar 988 front-end loader

MACHINE ACTIVITY:

Used to load trucks in underground limestone mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Installed prefabricated cab.  
Added acoustical material to cab.

TOTAL MATERIAL COSTS: \$2,825.00

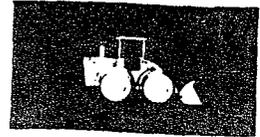
MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator ear while loading			
with cab doors open	97 dBA	94 dBA	3 dBA
with cab doors closed	97 dBA	95 dBA	2 dBA
with cab, acoustical material and doors closed	97 dBA	87 dBA	10 dBA

NOTES:

Equipped with FOPS, muffler and no cab.



CASE HISTORY # FEL-4 , DATE: 1979

MINE LOCATION (County, State): Jefferson County, Alabama

MINE TYPE (Metal/Nonmetal, Coal): Surface coal

MACHINE MANUFACTURER, MODEL: Caterpillar 988 front-end loader

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Installed cab wall seals
- Installed absorptive material on canopy and rear cab wall
- Installed floormat
- Installed pedestal seals
- Installed additional absorptive material on cab interior

TOTAL MATERIAL COSTS: \$600.00

MANHOURS: 29

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear, high idle			
doors open	101 dBA	90 dBA	11 dBA
doors closed	99 dBA	91 dBA	8 dBA

NOTES:

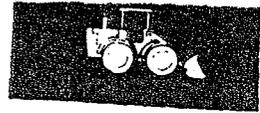
375 HP, manufactured in 1970.

Equipped with operator's cab and mufflers.

High idle measurements may not be indicative of working conditions.



CASE HISTORY # FEL-5 , DATE: 1979



MINE LOCATION (County, State): Pike County, Kentucky

MINE TYPE (Metal/Nonmetal, Coal): Surface coal

MACHINE MANUFACTURER, MODEL: International Harvester H-400B front-end loader

MACHINE ACTIVITY:

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Installed cab wall seals.

Installed floormat.

Installed absorptive material inside cab.

TOTAL MATERIAL COSTS: \$600.00

MANHOURS: 19

NOISE REDUCTION OBTAINED:

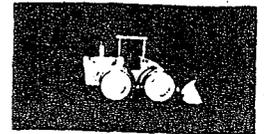
<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear, high idle			
doors open	95 dBA	87 dBA	8 dBA
doors closed	95 dBA	83 dBA	12 dBA

NOTES:

635 HP, manufactured in 1971.

Equipped with operator's cab and muffler.

High idle measurements may not be indicative of actual work conditions.



CASE HISTORY # FEL-6 , DATE: 1980

MINE LOCATION (County, State): Granite County, Montana

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - underground silver

MACHINE MANUFACTURER, MODEL: Caterpillar 950 front-end loader

MACHINE ACTIVITY:

Load ore trucks underground.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Steel box placed over catalytic scrubber to direct engine exhaust behind the operator.

Steel barrier was erected between operator and engine.

TOTAL MATERIAL COSTS: Only scrap metal was used.

MANHOURS: 12

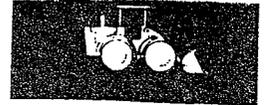
NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear during production cycle on surface	97 dBa	91 dBA	6 dBA

NOTES:

Not equipped with muffler or other controls.





CASE HISTORY # FEL-7 , DATE: 1983

MINE LOCATION (County, State): Frederick County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Caterpillar 988 front-end loader

MACHINE ACTIVITY:

Vehicle loaded material into trucks at a limestone operation.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Fiberglass acoustical material was installed in the operator's cab to the walls, ceiling, firewall. The floor was treated with an acoustical floormat. An exhaust muffler was previously installed.

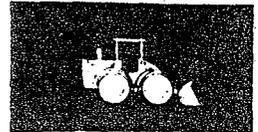
TOTAL MATERIAL COSTS: \$600.00

MANHOURS: Approximately 32

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Loading	93.0 dBA	83.8 dBA	9.2 dBA
Forward tram	94.1 dBA	88.0 dBA	6.1 dBA

NOTES:



CASE HISTORY # FEL-8 , DATE: 1983

MINE LOCATION (County, State): Lincoln County, Montana

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - silver mine

MACHINE MANUFACTURER, MODEL: Caterpillar 980 front-end loader

MACHINE ACTIVITY:

Loads haulage trucks in underground silver mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Absorptive material installed under FOPS.  
Barrier sheet placed over engine cover.  
Covered opening behind the operator's seat.  
Open-sided box around air intake filter.

TOTAL MATERIAL COSTS: \$300.00

MANHOURS: 10

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
At operator's ear while tramming uphill	104 dBA	99 dBA	5 dBA
downhill	103 dBA	102 dBA	1 dBA

NOTES:

## GRADERS



**Typical Noise Level**  
85-98 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
1. 	Install an exhaust muffler if missing or faulty.	\$200-\$400 2 h	Commercially available for all models.
2. 	Add complete noise control cab with pressurization and air conditioning.	\$12,000-\$15,000 60-140 h	Commercially available for some models.
3. 	Add sound suppression to existing cab.	\$500-\$1,500 30-80 h	Commercially available for some models or can be locally fabricated using well-documented methods.

Maximum noise reduction can be achieved by installing an acoustic cab.

## GRADERS

### TECHNOLOGY AVAILABILITY

#### 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 Ave., Essex, MA 01929  
(617) 768-6931

- \* Palm Industries, Inc., P.O. Box 562, Litchfield, MN 55355  
(612) 693-2492

3. Sound suppression treatments for existing cabs are manufactured by

- \* Barrier Corp., 9908 SW Tigard St., Tigard, OR 97223 (503) 639-4192

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 J0177049 (6).

- \* Front-End Loader Noise Control, BuMines contract J0395028 (9).

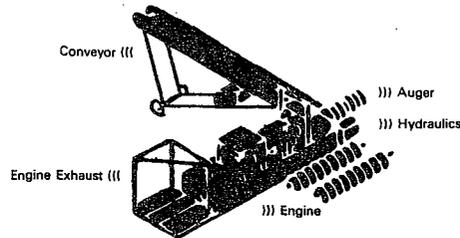
2. Noise source information and general guidelines on noise control requirements.

- \* The Noise of Mobile Machines Used in Surface Coal Mines: Operator Exposure, Source Diagnosis, Potential Noise Control Treatments, BuMines contract J0166057 (44).

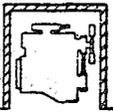
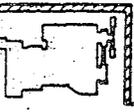
#### C. Case Histories.

If case histories are available, they can be found on the following pages.

## COAL AUGERS



**Typical Noise Level**  
**90-100 dBA**

	TREATMENT	COST AND LABOR	AVAILABILITY
1.	 Install engine exhaust muffler.	\$50-\$150 2 h	Commercially available for all models.
2.	 Enclosure for engine and drive system.	\$1,500-\$8,000 140-280 h	Local design and fabrication required.
3.	 Enclosure for hydraulic drives and engine (treatment 2).	\$1,500-\$8,000 160-300 h	Local design and fabrication required.
4.	 Install acoustic cab.	\$10,000-\$15,000 * 60-140 h	Commercially available for some models.

Maximum noise reduction can be achieved by installing an acoustic cab.

(\*) Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

## COAL AUGERS

### TECHNOLOGY AVAILABILITY

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

1. Exhaust mufflers, pipes, and miscellaneous replacement parts are available from the auger 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 auger manufacturer.

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

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 J0177049 (6).

2. Engine enclosure evaluation.

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

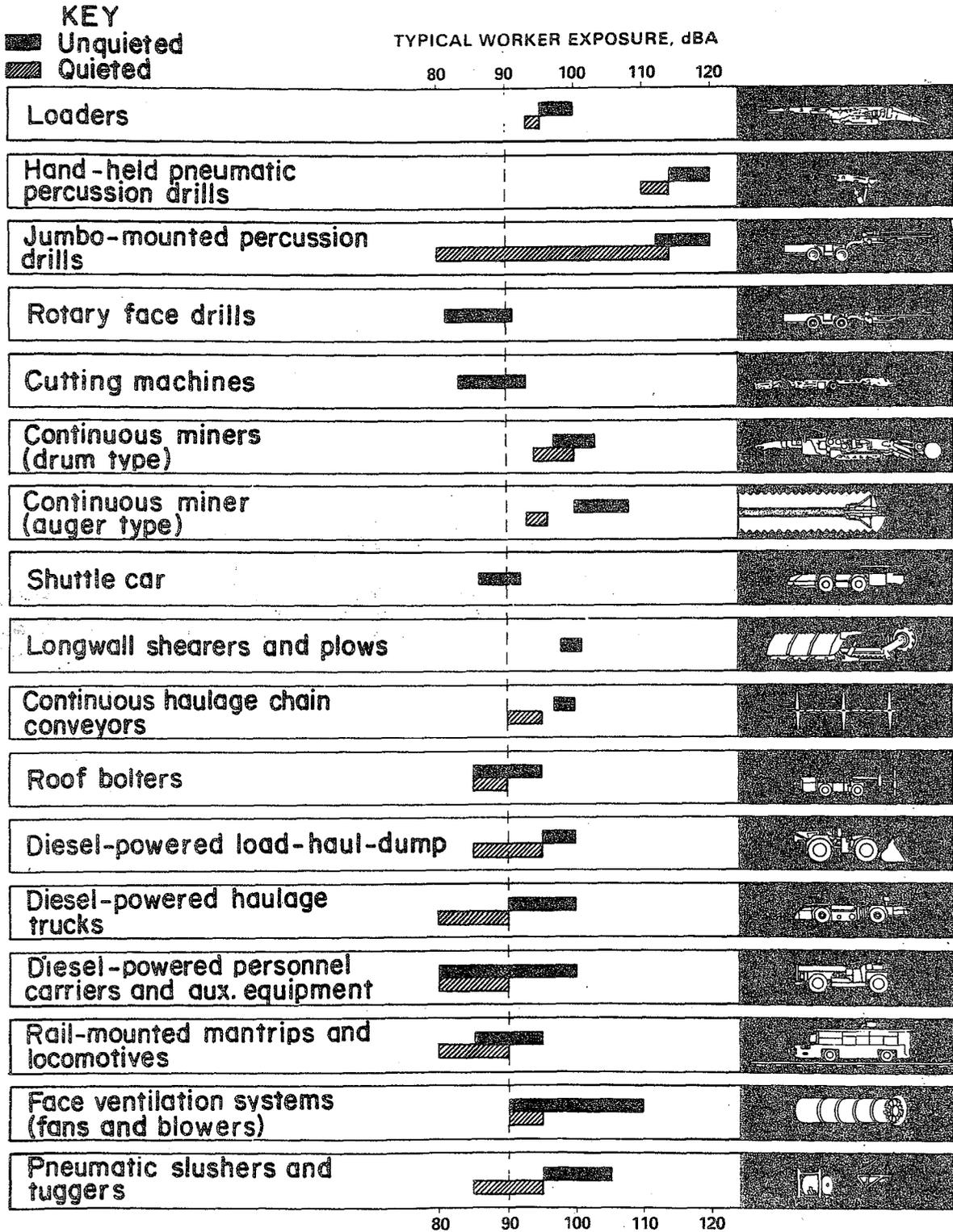
3. Hydraulic system treatment.

- \* Effect of a Pulse Damper on a Hydraulic System on Operator Ear Noise, SAE Tech. Paper 750829 (36).

#### C. Case Histories.

If case histories are available, they can be found on the following pages.

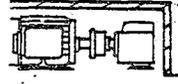
# UNDERGROUND MINING EQUIPMENT



# LOADERS



**Typical Noise Level**  
95-100 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.</p> 	<p>Modify the conveyor with isolated pan wear strips, pan damping treatment, elimination of side board and pan discontinuities, impact pads on return pan.</p>	<p>\$6,000-\$17,000 80-160 h</p>	<p>Local design and fabrication required.</p>
<p>2.</p> 	<p>Treat the hydraulic pump compartment for acoustical absorption, enclose and seal it.</p>	<p>\$50-\$300 8-40 h</p>	<p>Local fabrication using well-documented methods.</p>
<p>3.</p> 	<p>Quiet gear drive.</p>	<p>\$1,000-\$2,000</p>	<p>Some manufacturers offer retrofit packages.</p>

Maximum noise reduction can be achieved by treating the conveyor as noted in treatment 1 above.

## LOADERS

### TECHNOLOGY AVAILABILITY

#### 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 deck panels for the conveyor are available from

- \* Joy Manufacturing Co., 325 Buffalo St., Franklin, PA 16323  
(814) 437-5731

##### 3. Quiet tram gear system is available from

- \* Joy Manufacturing Co., 325 Buffalo St., Franklin, PA 16323  
(814) 437-5731

#### 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 (17).
- \* Noise Control of an Underground Continuous Miner, Auger-Type, MESA IR 1056 (20).
- \* Noise Control Report and Modification Manuals, BuMines contract HO166012 (37-39).

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

- \* Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract HO357085 (27).

##### 3. Treatment of noise in the hydraulic system.

- \* Bulldozer Noise Control, BuMines contract JO177049 (6).

#### C. Case Histories.

If case histories are available, they can be found on the following pages.

CASE HISTORY # LDR-1 , DATE: 1983

MINE LOCATION (County, State): Union County, Kentucky

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Joy 14BU10-41 loader

MACHINE ACTIVITY:

Loading coal.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

1. Damping material was placed on upper pan and covered with wear strips
2. Constrained layer damping was applied to underside portion of boom
3. Small inclined plane installed on upper pan immediately after sprocket.
4. Motor was realigned.
5. Lubricant was added to gear box.

TOTAL MATERIAL COSTS: Approximately \$100.00

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator's ear:			
tramming forward	90.2 dBA	88.8 dBA	1.4 dBA
tramming reverse	96.8 dBA	97.0 dBA	0
loading coal	98.0 dBA	94.3 dBA	3.7 dBA

NOTES:

Prior to treatment loader was disassembled.  
Top pan of conveyor cleaned to bare metal and wear strips were completely removed.

# HAND-HELD PNEUMATIC PERCUSSION DRILLS



**Typical Noise Level**  
114-120 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
1.	 Add-on muffler.	\$30-\$350 2-4 h	Commercially available for some models.
2.	 New technology drill.*	\$3,000-\$3,500	Commercially available.

Maximum noise reduction can be achieved by replacing existing drills with quieter, new-technology drills.

(\*Hard rock drill still in development stage.

## HAND-HELD PNEUMATIC PERCUSSION DRILLS

### TECHNOLOGY AVAILABILITY

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

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

- \* 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, Inc., P.O. Box 390098, Denver, CO 80239  
(303) 371-6383

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

1. Description of add-on muffler fabrication.

- \* Noise Abatement of Pneumatic Rock Drill, BuMines RI 7998 (43).
- \* Rubber Tire Muffler for Noise Control, MSHA T-Gram TD-1 (35).

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

- \* Development of a Quiet Rock Drill, BuMines contract J0155099 (21-22).
- \* Development of Commercial Quiet Rock Drills, BuMines contract J0177125 (12).
- \* Development of a Prototype Quiet Hard Rock Stoper Drill, BuMines contract H0113034 (23).
- \* Development of Concentric Drill Steels for Noise Control of Percussion Drills, BuMines contract H0338022 (33).

#### C. Case Histories.

If case histories are available, they can be found on the following pages.

CASE HISTORY # HPD-1 , DATE: 1974

MINE LOCATION (County, State): Greene County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Ingersoll-Rand - RP 38E-stoper

MACHINE ACTIVITY:

Used to drill holes for roof bolts.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

BOM wrap around muffler installed.  
Drill steel damped.

TOTAL MATERIAL COSTS: \$70.00

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, drilling:			
no controls	117 dBA	---	---
muffler/undamped steel	---	110 dBA	7 dBA
muffler/damped steel	---	107 dBA	10 dBA

NOTES:

Results based on limited testing.

CASE HISTORY # HPD-2 , DATE: 1975

MINE LOCATION (County, State): Washington County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Leroi - LSC 75 stoper

MACHINE ACTIVITY:

Used for drilling holes in roof for roof bolts.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Commercial muffler installed.

TOTAL MATERIAL COSTS: \$75.00

MANHOURS: < 1 hour

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, drilling	119-121 dBA	110-111 dBA	9-10 dBA

NOTES:

Freezing did not occur during testing.



CASE HISTORY # HPD-3 , DATE: 1979

MINE LOCATION (County, State): Pitkin County, Colorado

MINE TYPE (Metal/Nonmetal, Coal): Unknown

MACHINE MANUFACTURER, MODEL: Gardner/Denver S83F jackleg drill

MACHINE ACTIVITY:

Drilling.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Rubber tire muffler.

TOTAL MATERIAL COSTS: \$25.00

MANHOURS: 1

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, drilling	118 dBA	110 dBA	8 dBA

NOTES:

CASE HISTORY # HPD-4 , DATE: 1980

MINE LOCATION (County, State): Colorado

MINE TYPE (Metal/Normetal, Coal): Metal/Normetal - granite

MACHINE MANUFACTURER, MODEL: Gardner/Denver MDL S83F jackleg drill

MACHINE ACTIVITY:

Drilling in underground granite mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

New muffler.

TOTAL MATERIAL COSTS: \$150.00

MANHOURS: < 1 hour

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling underground	120 dBA	113 dBA	7 dBA

NOTES:

Freezing did not occur during testing.

CASE HISTORY # HPD-5 , DATE: 1974

MINE LOCATION (County, State): Russell County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Leroi MDL S12VT stoper

MACHINE ACTIVITY:

Drilling holes for roof bolts.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Commercial muffler installed.

TOTAL MATERIAL COSTS: \$175.00

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, drilling	121 dBA	112 dBA	9 dBA

NOTES:

Drilling time increased 11% with muffler.

CASE HISTORY # HPD-6 , DATE: 1984

MINE LOCATION (County, State): Ferry County, Washington

MINE TYPE (Metal/Normmetal, Coal): Metal/Normmetal

MACHINE MANUFACTURER, MODEL: Gardner/Denver GD83 drill (2)

MACHINE ACTIVITY:

Drilling underground.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Rubber tire muffler.

TOTAL MATERIAL COSTS: 0

MANHOURS:

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Running, not drilling	118.5 dBA	114.0 dBA	4.5 dBA
Running, not drilling	122.0 dBA	114.0 dBA	8.0 dBA

NOTES:

155x13 tire was used for muffler.

CASE HISTORY # HPD-7 , DATE: 1979

MINE LOCATION (County, State): Pitkin County, Colorado

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Gardner/Denver S83 drill

MACHINE ACTIVITY:

Drilling underground

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Rubber tire muffler.

TOTAL MATERIAL COSTS: 0

MANHOURS: < 2 hours

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, drilling	120-123 dBA	113-115 dBA	7-8 dBA

NOTES:

Did not freeze up during tests.

CASE HISTORY # HPD-8 , DATE: 1979

MINE LOCATION (County, State): Pitkin County, Colorado

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - granite

MACHINE MANUFACTURER, MODEL: Leroi MDL-H10AL jackleg drill

MACHINE ACTIVITY:

Drilling in underground granite mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

New muffler.

TOTAL MATERIAL COSTS: \$150.00

MANHOURS: < 1 hour

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling underground	117-118 dBA	108-109 dBA	9 dBA

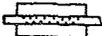
NOTES:

Freezing did not occur during testing.

# JUMBO-MOUNTED PERCUSSION DRILLS



**Typical Noise Level**  
112- 120 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
1.  Add-on muffler.	\$300-\$500 2 h	Commercially available for some models.
2.  Piped away exhaust.	\$500-\$1,000 5 h	Commercially available for some models.
3.  Enclosure for drill body.	\$200-\$500 40-80 h	Local fabrication using readily-available materials and techniques.
4.  Add acoustic cab.	\$10,000-\$20,000 * 80-160 h	Commercially available for some models. Local fabrication using well-documented methods also possible.

Maximum noise reduction can be achieved by installing an acoustic cab. If an acoustic cab is unavailable, treatments 1, 2, and 3 above should be installed.

(\* )Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

## JUMBO-MOUNTED PERCUSSION DRILLS

### TECHNOLOGY AVAILABILITY

#### 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

#### 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 H0366024 (4).
- \* Development of Noise Control Technology for Pneumatic Jumbo Drills, BuMines contract H0395029 (19).
- \* Development of a Prototype Retrofit Noise Treatment for Jumbo Drills, BuMines contract H0387006 (8).
- \* Development of Noise Control Treatment for Jumbo Drills, BuMines contract H0395025 (11).
- \* Development of Concentric Drill Steels for Noise Control of Percussion Drills, BuMines contract H0338022 (33).

#### C. Case Histories.

If case histories are available, they can be found on the following pages.

CASE HISTORY # JPD-1 , DATE: 1982

MINE LOCATION (County, State): Jasper County, Missouri

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Gardner/Denver PR123 jumbo (mounted on truck chassis)

MACHINE ACTIVITY:

Drilling in limestone mine underground.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Company built cab with door in rear.  
Interior lined with 1" foam.  
Fan installed for circulating air.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling:			
outside of cab	---	112 dBA	---
inside, door opened	---	94 dBA	18 dBA
inside, door closed	---	91 dBA	21 dBA

NOTES:

CASE HISTORY # JPD-2 , DATE: 1982

MINE LOCATION (County, State): Unknown

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Atlas-Copco H-232 jumbo

MACHINE ACTIVITY:

Drilling in limestone mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Factory built cab.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling:			
outside cab	---	106 dBA	---
inside cab, doors open	---	96 dBA	10 dBA
inside cab, doors closed	---	86 dBA	20 dBA

NOTES:

CASE HISTORY # JPD-3 , DATE: 1982

MINE LOCATION (County, State): Polk County, Tennessee

MINE TYPE (Metal/Normetal, Coal): Unknown

MACHINE MANUFACTURER, MODEL: Gardner/Denver PR123 jumbo drill

MACHINE ACTIVITY:

Used underground for drilling and smooth walling.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Rubber muffler.  
Company designed muffler.

TOTAL MATERIAL COSTS: 0 for tire muffler; unknown for company muffler.

MANHOURS: < 2 hours for tire muffler; unknown for company muffler.

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling, operator ear:			
no muffler	111 dBA	---	---
rubber tire muffler	---	106 dBA	5 dBA
company muffler	---	107 dBA	4 dBA

NOTES:

Although both mufflers reduced noise levels, they both kept coming off due to smooth walling technique.

CASE HISTORY # JPD-4 , DATE: 1982

MINE LOCATION (County, State): Anchorage, Alaska

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - gold

MACHINE MANUFACTURER, MODEL: Tamroc L-40 jumbo drill

MACHINE ACTIVITY:

Used in underground gold mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Muffler was installed but caused visibility problems due to oil mist.  
Exhaust was piped further down drift.

TOTAL MATERIAL COSTS: \$240.00 for the muffler; cost of hose unknown

MANHOURS: 1 hour for muffler; 1 hour for hose

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, drilling:			
unmuffled	113-116 dBA	---	---
muffled	---	110-113 dBA	3 dBA
no muffler; with hose	---	110-112 dBA	3-4 dBA

NOTES:

Exhaust hose ended at operator's position. By extending it further down the drift, the level at the operator's position would be reduced more.

CASE HISTORY # JPD-5 , DATE: 1982

MINE LOCATION (County, State): Muscatine County, Iowa

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Gardner/Denver PR66 jumbo drill

MACHINE ACTIVITY:

Drilling.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Company built operator cab.  
Installed acoustical 1" foam in cab.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, drilling	109.4 dBA	88.3 dBA	21.1 dBA

NOTES:

Large undivided windshield provided good visibility.  
Ventilation system marginal with doors open.



CASE HISTORY # JPD-6 , DATE: 1984

MINE LOCATION (County, State): Mason County, Kentucky

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Ingersoll-Rand twin-boom jumbo

MACHINE ACTIVITY:

Drilling underground.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Three sided enclosure installed.  
Acoustical material installed in enclosure.

TOTAL MATERIAL COSTS:

MANHOURS:

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling, operator position	110 dBA	100 dBA	10 dBA

NOTES:

CASE HISTORY # JPD-7 , DATE: 1982

MINE LOCATION (County, State): Unknown

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Joy VCR 150 jumbo

MACHINE ACTIVITY:

Drilling in limestone.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Mufflers installed.

Rigid canopy with front windshield and rear panel.

Two sliding curtains on sides.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling:			
outside in front of windshield	---	101.3 dBA	---
inside, curtains closed	---	93.9 dBA	7.4 dBA

NOTES:

CASE HISTORY # JPD-8 , DATE: 1982

MINE LOCATION (County, State): Unknown

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Joy VCR 150 (mounted on truck chassis)

MACHINE ACTIVITY:

Drilling in limestone mine underground.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Company built cab lined with 1" foam.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling:			
outside cab	---	109 dBA	---
inside cab, doors open	---	95 dBA	14 dBA

NOTES:

CASE HISTORY # JPD-9 , DATE: 1982

MINE LOCATION (County, State): Iron County, Missouri

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - lead

MACHINE MANUFACTURER, MODEL: Atlas-Copco H-232 jumbo

MACHINE ACTIVITY:

Drilling in lead mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Factory built cab.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling:			
outside cab	---	103 dBA	---
inside cab, door open	---	92 dBA	11 dBA
inside cab, door closed	---	88 dBA	15 dBA

NOTES:

CASE HISTORY # JPD-10, DATE: 1982

MINE LOCATION (County, State): Iron County, Missouri

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - lead

MACHINE MANUFACTURER, MODEL: Atlas-Copco H-232 jumbo

MACHINE ACTIVITY:

Drilling in lead mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Factory built cab.

TOTAL MATERIAL COSTS: Unknown

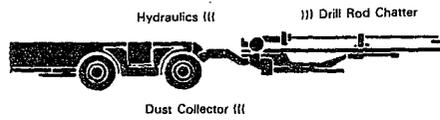
MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Drilling:			
outside cab	---	101 dBA	---
inside cab, door open	---	92 dBA	9 dBA
inside cab, door closed	---	86 dBA	15 dBA

NOTES:

## ROTARY FACE DRILLS



**Typical Noise Level**  
86-92 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
1.  Replace worn or damaged parts that generate unusual noise.	Varied	Commercially available for all models.

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

## ROTARY FACE DRILLS

### TECHNOLOGY AVAILABILITY

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.

If case histories are available, they can be found on the following pages.

## CUTTING MACHINES

**Typical Noise Level**  
83-93 dBA



TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.  Replace worn or damaged parts that generate unusual noise.</p>	<p>Varied</p>	<p>Commercially available for all models.</p>

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

## CUTTING MACHINES

### TECHNOLOGY AVAILABILITY

- 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.

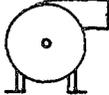
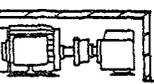
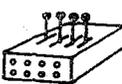
- C. Case Histories.

If case histories are available, they can be found on the following pages.

**CONTINUOUS MINERS  
(DRUM TYPE)**

**Typical Noise Level  
97-103 dBA**



TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.</p> 	<p>Modify the conveyor with isolated pan wear strips, pan damping treatment, elimination of side-board and pan discontinuities, impact pads on return pan.</p>	<p>\$6,000-\$10,000 160 h</p> <p>Commercially available for some models; others require local fabrication using well-documented methods.</p>
<p>2.</p> 	<p>Install muffler on dust scrubber's exhaust.</p>	<p>\$350-\$1,000</p> <p>Commercially available for some models.</p>
<p>3.</p> 	<p>Quiet gear drive for gathering head.</p>	<p>\$400-\$800</p> <p>Commercially available for some models.</p>
<p>4.</p> 	<p>Enclose and seal hydraulic pump compartment; treat with acoustical absorption.</p>	<p>\$50-\$300 8-40 h</p> <p>Local fabrication using well-documented methods.</p>
<p>5.</p> 	<p>Install sound-attenuated cutting head.</p>	<p>\$4,000 per drum</p> <p>Commercially available for some models.</p>
<p>6.</p> 	<p>Remote control of mining machine.</p>	<p>\$32,000 new \$40,000 retrofit</p> <p>Commercially available for many models.</p>

Maximum noise reduction can be achieved by treating the conveyor as noted in treatment 1 above.

CONTINUOUS MINERS  
(DRUM TYPE)

TECHNOLOGY AVAILABILITY

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 from

- \* Jeffrey Mining Machinery Div., Dresser Industries, Inc., P.O. Box 1879, Columbus, OH 43216 (614) 297-3123 (for Jeffrey models 122M, 120L, 120H2, 101MC, and 120HR). Damped conveyor pans are standard equipment on Jeffrey models 1028 and 1036.
- \* Joy Manufacturing Co., 325 Buffalo St., Franklin, PA 16323 (814) 437-5731

3. Dust collector exhaust mufflers available from

- \* Joy Manufacturing Co., 325 Buffalo St., Franklin, PA 16323 (814) 437-5731

4. Quiet gathering head drive available from

- \* Joy Manufacturing Co., 325 Buffalo St., Franklin, PA 16323 (814) 437-5731

5. Sound attenuated cutting head available from

- \* Joy Manufacturing Co., 325 Buffalo St., Franklin, PA 16323 (814) 437-5731

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 H0155113 (17).
- \* Noise Control of an Underground Continuous Miner, Auger-Type, MESA IR 1056 (20).
- \* Noise Control Report and Modification Manuals, BuMines contract H0166012 (37-39).

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

- \* Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract H0357085 (27).
- \* Investigation and Control of Noise Generated During Coal Cutting, BuMines contract J0387229 (3).

CONTINUOUS MINERS  
(DRUM TYPE)

3. Treatment of noise in the hydraulic system.

\* Bulldozer Noise Control, BuMines contract J0177049 (6).

C. Case Histories.

If case histories are available, they can be found on the following pages.

CASE HISTORY # CMD-1 , DATE: 1985

MINE LOCATION (County, State): Armstrong County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Jeffrey 1028 continuous miner

MACHINE ACTIVITY:

Mining a 5-entry development heading, taking roof rock.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Constrained-layer damped conveyor decks; sound attenuated cutting head.

TOTAL MATERIAL COSTS: Conveyor - standard OEM equipment;  
cutting head - \$15,000 - \$20,000

MANHOURS: 4 to install new cutting head.

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Cutting coal only - no conveyor	96.0 dBA	91.4 dBA	4.6 dBA
Conveyor only - empty	98.0 dBA	---	---
Conveyor only - loaded	94.3 dBA	---	---
Cutting and loading	96.0 dBA	---	---

NOTES:

This case history demonstrates the effectiveness of the sound-attenuated cutting head (see "cutting only" mode above). Note also that conveyor noise was 98 dBA compared to 100-101 dBA for most untreated conveyors.

CASE HISTORY # CMD-2 , DATE: 1981

MINE LOCATION (County, State): Eddy County, New Mexico

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - sylvite

MACHINE MANUFACTURER, MODEL: Marietta drum miner

MACHINE ACTIVITY:

Used to mine sylvite ore.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Constrained layer damping of conveyor pan (full coverage).  
Barrier panel at articulation point to shield operator.

TOTAL MATERIAL COSTS: Not available

MANHOURS: Not available

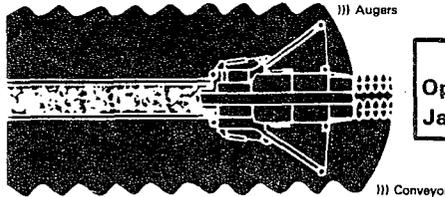
NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Full shift dosimeter data on operators	216% (96 dBA)	125% (92 dBA)	91% (4 dBA)

NOTES:

Untreated and treated machines were two different units.  
Actual reduction may vary due to inherent differences in machines.

**CONTINUOUS MINER  
(AUGER TYPE)**



Typical Noise Level	
Operator	100 - 103 dBA
Jacksetter	104 - 108 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.</p>  <p>Quiet augers (sand filled).</p>	<p>\$15,000 (pair) 2 h</p>	<p>Commercially available; can also be retrofitted in-house using well-documented techniques.</p>
<p>2.</p>  <p>Modify the conveyor with isolated pan wear strips, pan damping treatment, elimination of side-board and pan discontinuities, impact pads.</p>	<p>(1)</p>	<p>Local fabrication using well-documented technology; also commercially available for 1962 and later Fairchild and Wilcox models.</p>
<p>3.</p>  <p>Quiet gear drive. (2)</p>	<p>(3)</p>	<p>Developed by Fairchild for post-1962 models.</p>

- (1) Prices vary widely and are based on inspection of equipment.
- (2) Effective for idling noise only.
- (3) Tear down of each reducer at rebuild.

Maximum noise reduction can be achieved by installing both treatments 1 and 2 above.

CONTINUOUS MINERS  
(AUGER TYPE)

TECHNOLOGY AVAILABILITY

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 cutter heads and rebuild services with noise control treatments of the drive mechanism are available from

- \* Fairchild, Inc., P.O. Box 1184, Beckley, WV 25801 (304) 255-2131

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 H0155113 (17).
- \* Noise Control of an Underground Continuous Miner, Auger-Type, MESA IR 1056 (20).
- \* Noise Control Report and Modification Manuals, BuMines contract H)166012 (37-39).
- \* Development of a Reduced-Noise Auger Miner Cutting Head, BuMines contract H0188065 (48)
- \* Fabrication Manual for a Reduced-Noise Auger Miner Cutting Head, BuMines IC 8971 (34).

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

- \* Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract H0357085 (27).

C. Case Histories.

If case histories are available, they can be found on the following pages.

CASE HISTORY # CMA-1 , DATE: 1983

MINE LOCATION (County, State): Armstrong County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Fairchild Wilcox MK-20 auger miner

MACHINE ACTIVITY:

Mining coal.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Noise controlled cutting heads.

TOTAL MATERIAL COSTS: Approximately \$5,000.00

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Cutting coal:			
operator position	103.3 dBA	98.6 dBA	4.7 dBA
right jacksetter position	104.0 dBA	98.8 dBA	5.2 dBA

NOTES:

CASE HISTORY # CMA-2 , DATE: 1975

MINE LOCATION (County, State): Wise County, Virginia

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Fairchild Wilcox MK-20 auger miner

MACHINE ACTIVITY:

Mining coal.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Constrained layer damping on upper and lower conveyor pans.
- Motors and gears vibration isolated.
- Constrained layer damping on chain hold-downs.
- Acoustic material under motor cover panels.
- Installed operator control panel barrier.

TOTAL MATERIAL COSTS: \$2,500.00

MANHOURS: Approximately 240

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator position, cutting coal	101.9 dBA	96.7 dBA	5.2 dBA

NOTES:

CASE HISTORY # CMA-3 , DATE: 1982

MINE LOCATION (County, State): Indiana County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Fairchild Wilcox MK-22 auger miner

MACHINE ACTIVITY:

Mining coal.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Noise controlled cutting heads.

TOTAL MATERIAL COSTS: Approximately \$8,000.00

MANHOURS: Not Available

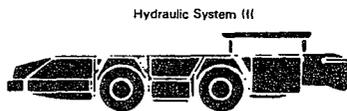
NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Mining coal, operator	97.0 dBA	95.5 dBA	1.5 dBA
front of miner	105.0 dBA	98.0 dBA	7.0 dBA

NOTES:

Auger heads developed through BOM contract.  
Jacksetters and timberman are located towards front of machine where greatest reduction was achieved.

**SHUTTLE CAR  
(ELECTRIC)**



**Typical Noise Level**  
86-92 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.  Replace worn or damaged parts that generate unusual noise.</p>	<p>Varied</p>	<p>Commercially available for all models.</p>

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

## SHUTTLE CARS

### TECHNOLOGY AVAILABILITY

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.

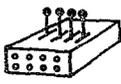
C. Case Histories.

If case histories are available, they can be found on the following pages.

# LONGWALL SHEARERS AND PLOWS



Typical Noise Level	
Lead drum	100 - 105 dBA
Trail drum	94 - 97 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.</p>  <p>Install sound-attenuated cutting head.</p>	\$15,000-\$20,000	Commercially available for most models.
<p>2.</p>  <p>Remote control of shearer.</p>	\$9,000-\$12,000	Commercially available for some models.
<p>3.</p>  <p>Install acoustical barriers or enclosures around noisy hydraulic components such as tram and headgate drive motors.</p>	\$400-\$1,000 20-40 h	Local design and fabrication using readily-available materials and simple techniques.
<p>4.</p>  <p>Minimize or eliminate impact points and mis-alignments in the chain conveyor.</p>	Varied	Local design and fabrication required.

Maximum noise reduction can usually be achieved by utilizing remote control. Treatments 3 and 4 should be installed if treatment 2 fails to reduce noise to the desired level.

## LONGWALL SHEARERS

### TECHNOLOGY AVAILABILITY

- A. Commercially available noise control products and materials.
1. Sound-attenuated shearer cutting heads are available from
    - \* Petitto Mine Equipment Inc., P.O. Box 758, Morgantown, WV 26505  
(304) 292-3936
  2. Remote control available from most original equipment manufacturers.
- B. Technical reports on the development and demonstration of noise control treatments.
1. Product modification including cutting head for noise reduction.
    - \* Noise Control of Longwall Shearer, BuMines contract J0188072 (49).
  2. Noise source information and general guidelines on noise control requirements.
    - \* Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract H0357085 (27).
  3. Treatment of noise in the hydraulic system.
    - \* Bulldozer Noise Control, BuMines contract J0177049 (6).
- C. Case Histories.
- If case histories are available, they can be found on the following pages.

CASE HISTORY # LSP-1 , DATE: 1983

MINE LOCATION (County, State): Indiana County, Pennsylvania

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Anderson/Maver AB16 longwall shearer

MACHINE ACTIVITY:

Cutting coal.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

1. Composite barrier/absorption material installed on top and operator side of shearer.
2. 1/4" belting placed over material for protection.

TOTAL MATERIAL COSTS: \$400.00

MANHOURS: 20

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Cutting coal:			
head shearer	106.8 dBA	99.7 dBA	7.1 dBA
tail shearer	106.3 dBA	100.5 dBA	5.8 dBA

NOTES:

This shearer was somewhat unique in that the major noise sources were the machine components rather than the cutting heads.



CASE HISTORY # LSP-2 , DATE: 1985

MINE LOCATION (County, State): Harrison County, West Virginia

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Eickhoff 300L longwall shearer

MACHINE ACTIVITY:

Cutting and loading coal.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Noise controlled cutting head.

TOTAL MATERIAL COSTS: \$15,000 - \$20,000

MANHOURS: 8 (for installation of new head)

NOISE REDUCTION OBTAINED:

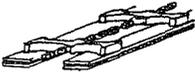
<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Full cutting at lead-drum operator position	100.5 dBA	95.0 dBA	5.5 dBA

NOTES:

**CONTINUOUS HAULAGE  
CHAIN CONVEYORS  
AND LONGWALL  
STAGE LOADERS**



**Typical Noise Level**  
92-100 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1. </p> <p>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.</p>	<p>\$4,000-\$10,000 80-160 h (1)</p>	<p>Local design and fabrication required.</p>

(1)When done at rebuild above ground.

Maximum noise reduction can be achieved by eliminating discontinuities and installing damped deck panels and wear pads.

CONTINUOUS HAULAGE CHAIN CONVEYORS  
AND LONGWALL STAGE LOADERS

TECHNOLOGY AVAILABILITY

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 H0155113 (17).
- \* Noise Control of an Underground Continuous Miner, Auger-Type, MESA IR 1056 (20).
- \* Noise Control Report and Modification Manuals, BuMines contract H0166012 (37-39).

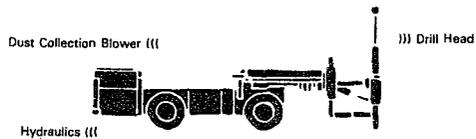
2. Noise source information and general guidelines on noise control requirements.

- \* Noise Reduction of Conveyors Used in Underground Coal Mining Machinery, BuMines contract H0357085 (27).

C. Case Histories.

See case histories under loaders, continuous miners (auger type).

## ROOF BOLTERS



Typical Noise Level  
85-95 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
1. 	Modify dust collection blower or change to quieter model.	\$500-\$1,500 20-40 h	Local design and fabrication required.
2. 	Cover or enclose hydraulic pump.	\$200-\$500 20-40 h	Local design and fabrication required.
3. 	Seal the enclosure around motor and pump-blower drives using existing cover panels.	\$200-\$500 30-80 h	Local design and fabrication required.

Maximum noise reduction can be achieved by modifying or changing the dust collection blower and enclosing the hydraulic pump.

## ROOF BOLTERS

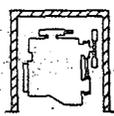
### TECHNOLOGY AVAILABILITY

- 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 (41).
  2. Information on enclosures or covers for noisy hydraulic components.
    - \* Bulldozer Noise Control, BuMines contract J0177049 (6).
  3. Information on sealing panels.
    - \* Reducing the Operator Sound Level of a Mining Service Vehicle- A Demonstration Project, BuMines contract H0346046 (26).
- C. Case Histories.
- If case histories are available, they can be found on the following pages.

## DIESEL-POWERED LOAD-HAUL-DUMP



Typical Noise Level  
97-102 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
1. 	Engine exhaust mufflers.	\$100-\$300 2 h	Commercially available for all models.
2. 	Partial, sealed barriers around operator with exhaust muffling.	\$2,000-\$4,000 180-320 h	Commercially available for some models; local design and fabrication required.
3. 	Engine and transmission enclosures* and isolators, partial operator barrier, exhaust muffling.	\$4,000-\$7,000 240-380 h	Commercially available for some models; local design and fabrication required.
4. 	Install acoustic cab where possible.	\$10,000-\$15,000** 80-160 h	Commercially available for some models.

Maximum noise reduction can be achieved by installing an acoustic cab. If an acoustic cab is not available, treatments 1, 2, and 3 above should be installed.

(\*Caution - engine enclosures used at high altitude locations may result in added heat.

(\*\*)Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

## DIESEL-POWERED LOAD-HAUL-DUMP

### TECHNOLOGY AVAILABILITY

#### 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 H0346046 (32).

- \* Noise Control of an Underground Load-Haul-Dump Machine, BuMines contract H0262013 (25).

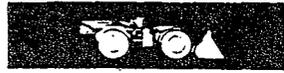
- \* Reducing the Operator Sound Level of a Mining Service Vehicle- A Demonstration Project, BuMines contract H0345046 (26).

- \* Noise Control of Underground Load-Haul-Dump Machines, BuMines contract H0395076 (13).

- \* Retrofit of Underground Load-Haul-Dump Machines with Noise Control Packages, BuMines contract H0395041 (28).

#### C. Case Histories.

If case histories are available, they can be found on the following pages.



CASE HISTORY # LHD-1 , DATE: 1979

MINE LOCATION (County, State): Cayuga County, New York

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - salt

MACHINE MANUFACTURER, MODEL: Wagner ST-5A L-H-D

MACHINE ACTIVITY:

Underground salt mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Composite barrier/absorption material installed on operator side of engine.

Damping/absorption material installed under engine hood.

Transmission cover treated with fiberglass on bottom, belting on top.

Lead vinyl attached to steering column guide.

Barrier installed inside engine compartment.

Damping/absorption material installed on panel in front of operator.

TOTAL MATERIAL COSTS: \$300.00

MANHOURS: 48

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
High idle, operator ear	102.0 dBA	97.0 dBA	5.0 dBA

NOTES:



CASE HISTORY # LHD-2 , DATE: 1980

MINE LOCATION (County, State): McKinley County, New Mexico

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Wagner ST-2D L-H-D

MACHINE ACTIVITY:

Hauling ore in underground mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Barrier material over transmission and articulation.  
Conveyor belting on engine cowling and on floor.

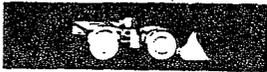
TOTAL MATERIAL COSTS: \$200.00

MANHOURS: 15

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Production cycle: operator ear	98.2 dBA	95.0 dBA	3.2 dBA

NOTES:



CASE HISTORY # LHD-3 , DATE: 1981

MINE LOCATION (County, State): Fergus County, Montana

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Wagner ST-5A L-H-D

MACHINE ACTIVITY:

Hauling ore in underground mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Absorption material under engine hood and transmission cover.  
Barrier panels attached to engine cowling.

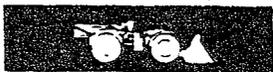
TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Production cycle: operator position	105 dBA	101 dBA	4 dBA

NOTES:



CASE HISTORY # LHD-4 , DATE: 1980

MINE LOCATION (County, State):

MINE TYPE (Metal/Normetal, Coal): Metal/Normetal - oil shale

MACHINE MANUFACTURER, MODEL: Eimco 915E L-H-D

MACHINE ACTIVITY:

Used in underground oil shale mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Engine enclosures.

Absorption material installed to enclosures, underside of engine compartment, transmission cover.

Installed larger radiator, surge tank, higher capacity fan and acoustically lined hood air inlets.

Barrier material installed around steering wheel, levels and gauges.

Barrier placed between engine and transmission.

Installed engine belly pan.

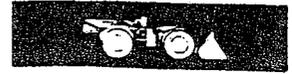
TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear	334	194	140
(8 hour dosimeter data, % NEI)	324	135	189
	300	145	155
	394	202	192
	376	214	162

NOTES:



CASE HISTORY # LHD-5 , DATE: 1981

MINE LOCATION (County, State): St. Mary County, Louisiana

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Wagner ST-8 L-H-D

MACHINE ACTIVITY:

Hauling ore.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Barrier between operator and engine.  
Lead vinyl draped over transmission.  
Flexible barrier covered articulation.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, tramming	99 dBA	96 dBA	3 dBA

NOTES:

This was a prototype treatment.



CASE HISTORY # LHD-6 , DATE: 1981

MINE LOCATION (County, State): Illinois  
MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal  
MACHINE MANUFACTURER, MODEL: Wagner ST-2B L-H-D  
MACHINE ACTIVITY:

Hauling ore in underground mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Barrier material on top of engine cowling.  
Barrier material on floor well.  
Belting material over transmission opening.

TOTAL MATERIAL COSTS: \$150.00

MANHOURS: 8

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Tramming:			
forward	102.5 dBA	98.0 dBA	4.5 dBA
reverse	104.6 dBA	99.9 dBA	4.7 dBA

NOTES:



CASE HISTORY # LHD-7 , DATE: 1981

MINE LOCATION (County, State): Montana

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Jarvis Clark JS-220 L-H-D

MACHINE ACTIVITY:

Hauling ore.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Flexible barrier hung over articulation.  
Transmission hood partially covered with composite acoustical material.  
Additional openings were covered.

TOTAL MATERIAL COSTS: \$250.00

MANHOURS: 8

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operating cycle: operator ear	107 LEQ	104 LEQ	3 LEQ

NOTES:

L-H-D had water cooled engine.  
LEQ means equivalent or average noise level.



CASE HISTORY # LHD-8 , DATE: 1981

MINE LOCATION (County, State): Graham County, Arizona

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Wagner ST-5A L-H-D

MACHINE ACTIVITY:

Hauling ore.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Barrier material on firewall, fuel tank, under transmission cover.  
Steering column opening covered.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

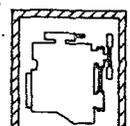
<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, tramping	108.6 dBA	105.1 dBA	3.5 dBA

NOTES:

# DIESEL-POWERED HAULAGE TRUCKS AND RAMCARS

Typical Noise Level  
90-100 dBA



	TREATMENT	COST AND LABOR	AVAILABILITY
1. 	Engine exhaust muffler.	\$100-\$300 2 h	Commercially available for all models.
2. 	Sealed, partial barriers around operator with exhaust muffling.	\$2,000-\$4,000 180-280 h	Local design and fabrication required.
3. 	Engine and transmission enclosures* and isolation, partial sealed operator barrier, and exhaust muffling.	\$4,000-\$7,000 220-320 h	Local design and fabrication required.
4. 	Install acoustic cab.	\$10,000-\$15,000** 80-160 h	Commercially available for some models.

Maximum noise reduction can be achieved by installing an acoustic cab. If an acoustic cab is not available, treatments 1, 2, and 3 above should be installed.

(\*)Caution - engine enclosures used at high altitude locations may result in added heat.

(\*\*)Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

## DIESEL-POWERED HAULAGE TRUCKS AND RAMCARS

### TECHNOLOGY AVAILABILITY

#### 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

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).

- \* Reducing the Operator Sound Level of a Mining Service Vehicle-A Demonstration Project, BuMines contract H0346046 (26).

- \* Noise Control of Underground Load-Haul-Dump Machines, BuMines contract H0395076 (13).

- \* Retrofit of Underground Load-Haul-Dump Machines, BuMines contract H0395041 (28).

#### C. Case Histories.

If case histories are available, they can be found on the following pages.



CASE HISTORY # DHT-1 , DATE: 1980

MINE LOCATION (County, State):

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Elmac 10T haul truck

MACHINE ACTIVITY:

Hauling ore.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- Engine cover vibration isolated.
- Oil dipstick cover was attached.
- Barriers installed around operator compartment.
- Engine cover was stiffened.
- Barrier installed over firewall.

TOTAL MATERIAL COSTS:

MANHOURS:

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Production cycle	98 dBA	93 dBA	5 dBA

NOTES:



CASE HISTORY # DHT-2 , DATE: 1982

MINE LOCATION (County, State): Floyd County, Kentucky

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Wagner MTT415

MACHINE ACTIVITY:

Hauling coal underground.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

1. Two inches of absorptive material installed in canopy and behind operator.
2. Damping material installed over grill work in front of instrument panel and other openings.
3. Access door beneath instrument adjusted to close tightly.

TOTAL MATERIAL COSTS: \$75.00

MANHOURS: 5

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operating ear, high idle	105 dBA	100 dBA	5 dBA

NOTES:

CASE HISTORY # DHT-3 , DATE: 1981

MINE LOCATION (County, State): Illinois

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Wagner MTT219

MACHINE ACTIVITY:

Hauling ore underground.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Barrier support cantilevered over much of engine.  
Composite material attached to support.

TOTAL MATERIAL COSTS: \$400.00

MANHOURS: 16

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, tramming	105.6 dBA	102.6 dBA	3.0 dBA

NOTES:

Additional construction of an engine cowling would be beneficial.



CASE HISTORY # DHT-4 , DATE: 1982

MINE LOCATION (County, State): Lea County, New Mexico

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Elmac 10T ram car

MACHINE ACTIVITY:

Load out ore.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Composite acoustical material applied under transmission cover and engine cover.  
Leaded vinyl draped over opening for hydraulic hoses on operator's left.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
High idle	105.0 dBA	101.5 dBA	3.5 dBA

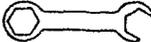
NOTES:

High idle measurements may not be indicative of levels under actual operating conditions.

## DIESEL-POWERED PERSONNEL CARRIERS AND AUX. EQUIPMENT

Typical Noise Level  
80-100 dBA



TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.  Engine exhaust muffler.</p>	<p>\$50-\$150 2 h</p>	<p>Commercially available for all models.</p>
<p>2.  Sealed partial barriers around operator with exhaust muffling.</p>	<p>\$1,000-\$3,000 160-240 h</p>	<p>Local design and fabrication required.</p>
<p>3.  Install acoustic cab where possible.</p>	<p>\$10,000-\$15,000 * 80-160 h</p>	<p>Commercially available for some models.</p>
<p>4.  Proper maintenance. Many models operate with noise levels under 90 dBA when properly maintained.</p>		

Maximum noise reduction can be achieved by installing an acoustic cab. If an acoustic cab is unavailable, treatments 1 and 2 should be installed.

(\*)Cost for retrofit "do-it-yourself" system will be less expensive in most situations.

DIESEL-POWERED PERSONNEL CARRIERS  
AND AUXILIARY EQUIPMENT

TECHNOLOGY AVAILABILITY

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

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).

\* Reducing the Operator Sound Level of a Mining Service Vehicle-A Demonstration Project, BuMines contract H0346046 (26).

\* Noise Control of Underground Load-Haul-Dump Machines, BuMines contract H0395076 (13).

\* Retrofit of Underground Load-Haul-Dump Machines with Noise Control Packages, BuMines contract H0395041 (28).

C. Case Histories.

If case histories are available, they can be found on the following pages.

CASE HISTORY # DPC-1 , DATE: 1975

MINE LOCATION (County, State): Oakland County, Michigan  
MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - salt mine  
MACHINE MANUFACTURER, MODEL: Getman dispatch vehicle  
MACHINE ACTIVITY:

Transport personnel and/or move equipment

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Engine enclosure lined with sound absorption material.

TOTAL MATERIAL COSTS: \$235.00

MANHOURS: 60

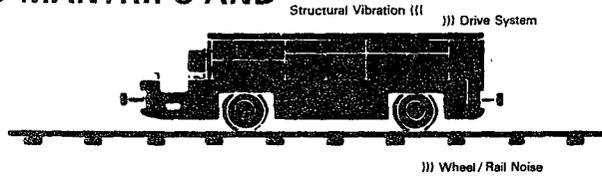
NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
High idle	101 dBA	87 dBA	14 dBA

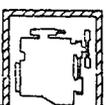
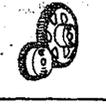
NOTES:

Noise source was a large diesel engine.  
Costs are given for work and material purchased in 1975.

# RAIL-MOUNTED MANTRIPS AND LOCOMOTIVES



**Typical Noise Level**  
85-95 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
1.  Apply damping treatment to structural panels of car assembly.	\$200-\$1,000 20-100 h	Local design and fabrication required.
2.  Enclose drive motor and transmission	\$100-\$200 20-40 h	Local design and fabrication required.
3.  Replace existing solid steel wheels with resilient wheels.	\$1,800-\$2,500 20 h	Commercially available for some models.
4.  Replace spur gear drive with helical gears.	Unknown	Commercially available for some models.
5.  Replace existing mantrip with quieter model.		Commercially available.

Maximum noise reduction can be achieved by replacing existing mantrips with quieter models. Treatments 1 through 4 needed to achieve maximum noise reduction on a retrofit basis.

## RAIL-MOUNTED MANTRIPS AND LOCOMOTIVES

### TECHNOLOGY AVAILABILITY

#### 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

\* Eimco Corp., Box 992, Fairmont, WV 26554 (304) 363-7700

5. Helical gear drives are available from

\* Emico Corp., Box 992, Fairmont, WV 26554 (304) 363-7700

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

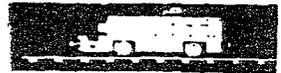
1. Mantrip noise control.

\* Noise Control of a Mine Operated Rail Personnel Carrier, BuMines contract H0166090 (16, 18).

\* Integration of Quieting Technology into New Mantrip Vehicles, BuMines contract J0199068 (14).

#### C. Case Histories.

If case histories are available, they can be found on the following pages.



CASE HISTORY # RML-1 , DATE: 1979

MINE LOCATION (County, State): Centre County, Pennsylvania  
MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone  
MACHINE MANUFACTURER, MODEL: Plymouth JMD-14 locomotive  
MACHINE ACTIVITY:

Pulling loaded ore cars.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Enclosure built around transmission, lined with absorption material.  
Barrier/absorption material installed in operator area.  
Barrier/absorption material installed on floor.

TOTAL MATERIAL COSTS: \$450.00

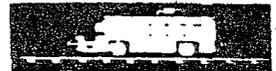
MANHOURS: 48

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Operator ear, pushing cars (8 hour dosimeter data, % NEI)	195	120	75

NOTES:

Approximately 8 manhours of the installation time was devoted to cleaning the machine in preparation for the installation.



CASE HISTORY # RML-2 , DATE: 1977

MINE LOCATION (County, State): Bureau of Mines Research Center, Bruceton, PA

MINE TYPE (Metal/Nonmetal, Coal): Coal (underground)

MACHINE MANUFACTURER, MODEL: FMC M-2190 portal bus

MACHINE ACTIVITY:

Mantrip

DESCRIPTION OF CONTROLS:

CONTROLS USED:

- (1) Resilient wheels
- (2) Panel damping
- (3) Motor enclosure

TOTAL MATERIAL COSTS: \$1,425.00

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Straight track	90.5-85 dBA	86-80 dBA	4.8 dBA
Curves	93.5-88 dBA	92-88 dBA	0.8 dBA

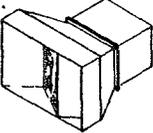
NOTES:

Costs given at 1977 prices.

## FACE VENTILATION SYSTEMS (FANS AND BLOWERS)

**Typical Noise Level**  
90-110 dBA



TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.  Install muffler ducts for inlet and discharge ends of fan.</p>	\$100-\$500 2-8 h	Commercially available for some models.
<p>2.  Replace noisy fan with quieted model.</p>	\$5,000-\$12,000	Commercially available for all models.

Maximum noise reduction can be achieved by replacing a noisy fan with a quieter model.

FACE VENTILATION SYSTEMS  
(FANS AND BLOWERS)

TECHNOLOGY AVAILABILITY

- 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 Society of Heating, Refrigeration and Air Conditioning Engineers (2).
    - \* Silencing Noisy Fans, Aeroacoustic Corp. (1).

C. Case Histories.

If case histories are available, they can be found on the following pages.

CASE HISTORY # FVS-1 , DATE: 1981

MINE LOCATION (County, State): McKinley County, New Mexico

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Joy 25 HP fan

MACHINE ACTIVITY:

Used for ventilation.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Various types of silencers tried.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
No silencer	105.5 dBA	---	---
Silencer on intake	---	94.0 dBA	11.5 dBA

NOTES:

CASE HISTORY # FVS-2 , DATE: 1974

MINE LOCATION (County, State): Franklin County, Illinois

MINE TYPE (Metal/Nonmetal, Coal): Coal

MACHINE MANUFACTURER, MODEL: Buffalo Forge MDL-TBBM auxiliary fan

MACHINE ACTIVITY:

Fan used to provide auxiliary ventilation across working face.  
Approximately 50' of duct between fan and face.  
DESCRIPTION OF CONTROLS:

CONTROLS USED:

Buffalo Forge manufactured silencer.

TOTAL MATERIAL COSTS: \$1,000.00

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Measurements at end of duct:			
no silencer	88-97 dBA	---	---
silencer on exhaust	---	90-101 dBA	2- 4 dBA
silencer on intake	---	69- 81 dBA	16-19 dBA

NOTES:

A decrease of 11.4% in air supply occurred with the silencer on the intake side.

CASE HISTORY # FVS-3 , DATE: 1981

MINE LOCATION (County, State): McKinley County, New Mexico

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal

MACHINE MANUFACTURER, MODEL: Hartzell MDLS 30 HP fan

MACHINE ACTIVITY:

Ventilation in underground mine.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Various types of silencers tried on fans.

TOTAL MATERIAL COSTS: Unknown

MANHOURS: Unknown

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
No silencer*	111 dBA	---	---
With Hartzell muffler*	---	102 dBA	9 dBA

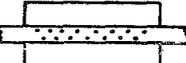
NOTES:

\*Levels measured at a distance of 3.5 feet from the exhaust.

## PNEUMATIC SLUSHERS AND TUGGERS

**Typical Noise Level**  
95-105 dBA



	TREATMENT	COST AND LABOR	AVAILABILITY
1.	 Install an air exhaust muffler (flexible to shed ice).	\$50-\$150 2 h	Commercially available for all models.
2.	 Install a piped away exhaust.	\$200-\$400 4 h	Commercially available for all models.

Maximum noise reduction can be achieved by installing both treatments 1 and 2 above.

## PNEUMATIC SLUSHERS AND TUGGERS

### TECHNOLOGY AVAILABILITY

#### 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

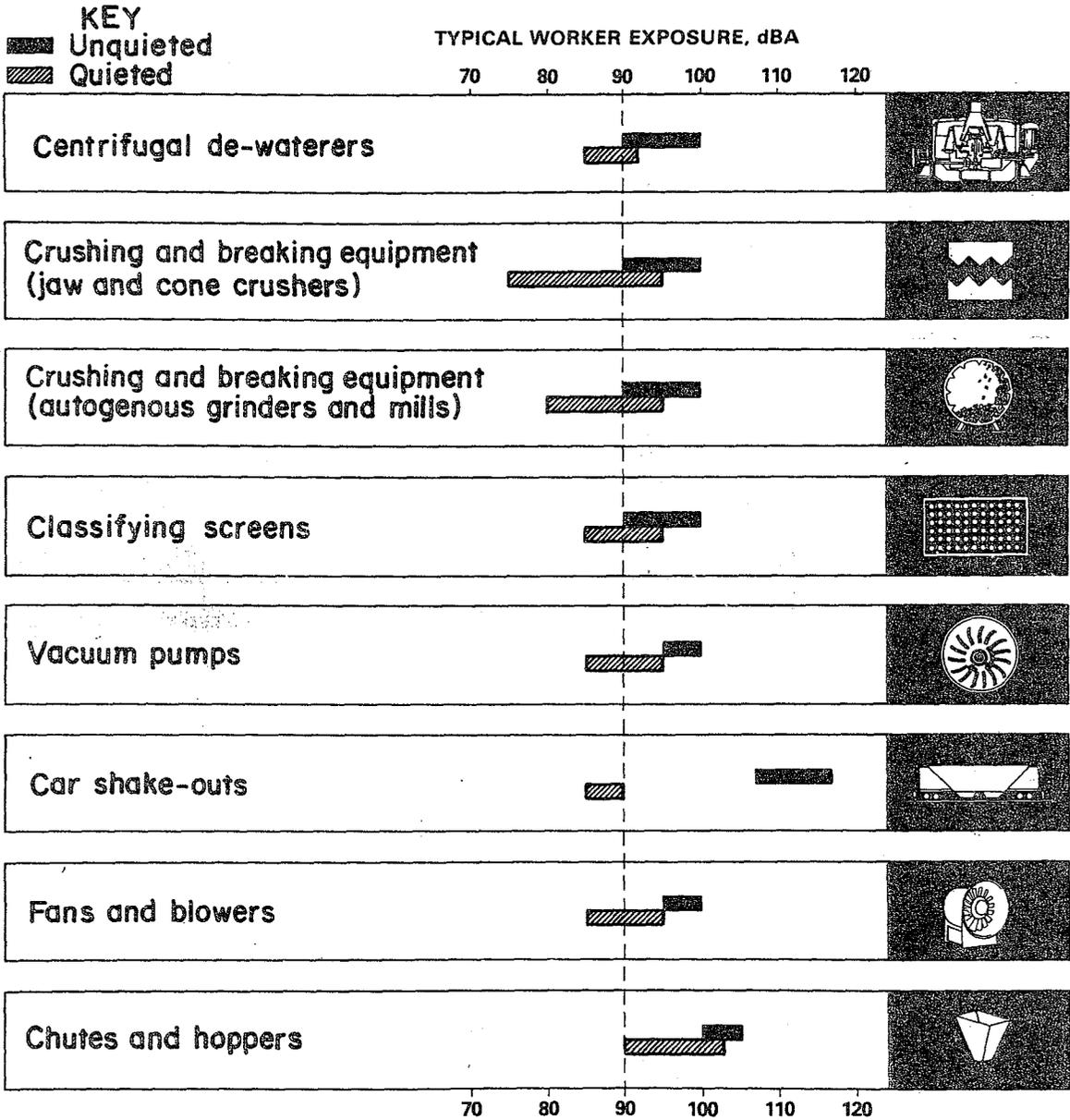
\* Innovation Supply, 1655 Jasper St., Aurora, CO 80011  
(303) 341-0284

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

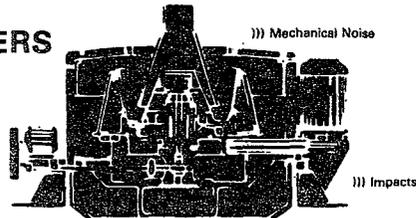
#### C. Case Histories.

If case histories are available, they can be found on the following pages.

# PREPARATION AND PROCESSING PLANT EQUIPMENT



# CENTRIFUGAL DE-WATERERS



**Typical Noise Level**  
90-100 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
1.  Tighten loose parts. Replace worn bearings.	Varied	Commercially available for all models.
2.  Install an acoustical enclosure around the centrifuge.	\$10,000-\$20,000 380-600 h	Local design and fabrication required.
3.  Install lead-vinyl curtains around the centrifuge.	\$5/ft <sup>2</sup> 0.1 h/ft <sup>2</sup>	Commercially available for all models.

Maximum noise reduction can be achieved by treatment 2. Install an acoustical enclosure around the centrifuge.

## CENTRIFUGAL DEWATERERS

### TECHNOLOGY AVAILABILITY

- A. Commercially available noise control products and materials.
  - 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. Demonstration of specific treatments.
    - \* Demonstrating the Noise Control of a Coal Preparation Plant, BuMines contract H0155155 (7, 40).
- C. Case Histories.

If case histories are available, they can be found on the following pages.

**CRUSHING AND BREAKING EQUIPMENT  
(JAW AND CONE CRUSHERS)**

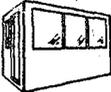


))) Coal Fracture



))) Impacts

**Typical Noise Level  
90-100 dBA**

	TREATMENT	COST AND LABOR	AVAILABILITY
1.	 <p>Enclosure around crusher body.</p>	<p>\$10,000-\$50,000 240-1,200 h</p>	<p>Local design and fabrication required.</p>
2.	 <p>Curtain barrier around crusher.</p>	<p>\$5/ft<sup>2</sup> 0.1 h/ft<sup>2</sup></p>	<p>Local fabrication using well-documented methods.</p>
3.	 <p>Operator booth-enclosure.</p>	<p>\$1,500-\$4,000 20-80 h</p>	<p>Commercially available for all models.</p>

Maximum noise reduction can be achieved by treatment 3, operator booth-enclosure.

CRUSHING AND BREAKING EQUIPMENT  
(JAW AND CONE CRUSHER)

TECHNOLOGY AVAILABILITY

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 (10).

3. Enclosure and curtain barrier construction and cost.

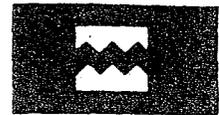
\* Demonstrating the Noise Control of a Coal Preparation Plant, BuMines contract H0155155 (40).

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 (15).

C. Case Histories.

If case histories are available, they can be found on the following pages.



CASE HISTORY # JCC-1 , DATE: 1977

MINE LOCATION (County, State): Brown County, Ohio  
MINE TYPE (Metal/Nonmetal, Coal): Coal preparation plant  
MACHINE MANUFACTURER, MODEL: Unknown  
MACHINE ACTIVITY:

Process coal.

DESCRIPTION OF CONTROLS:

Entire plant was quieted using five categories of noise control treatments.

CONTROLS USED:

1. resilient screen decks
2. resilient impact pads
3. chute liners
4. curtains
5. mufflers on jig blowers

TOTAL MATERIAL COSTS: Resilient screen deck - \$9,295; Mufflers - \$1,035  
Curtains - \$39,071; Impact pads - \$11,425;  
Chute liners - \$8,063

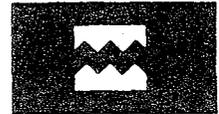
MANHOURS: Not available

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Wash box operator	92.4 dBA	90.0 dBA	2.4 dBA
Picker	93.8 dBA	90.0 dBA	3.8 dBA
Diester operator	92.9 dBA	90.0 dBA	2.9 dBA
Clean-up	95.9 dBA	89.2 dBA	6.7 dBA

NOTES:

These levels were given as equivalent noise levels based on full shift noise doses.



CASE HISTORY # JCC-2 , DATE: 1980

MINE LOCATION (County, State): Jackson County, Wisconsin

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - taconite processing plant

MACHINE MANUFACTURER, MODEL: Symons 7 foot, standard head, heavy duty cone crusher

MACHINE ACTIVITY:

Crusher for taconite

DESCRIPTION OF CONTROLS:

CONTROLS USED:

Acoustical machine enclosures

TOTAL MATERIAL COSTS: Approximately \$236,000.00

MANHOURS: Unknown

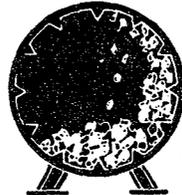
NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Secondary crushers	Unknown	<90 dBA	10-15 dBA
Tertiary crushers	102-106 dBA	95-100 dBA	6- 7 dBA

NOTES:

Costs given at 1980 prices.

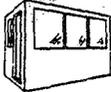
**CRUSHING AND  
BREAKING EQUIPMENT  
(AUTOGENOUS GRINDERS  
AND MILLS)**



))) Impacts

))) Coal Fracture

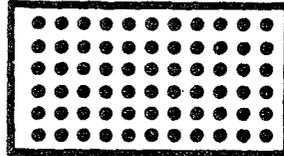
**Typical Noise Level**  
Measured 5 meters  
from the grinder **90 - 100 dBA**

TREATMENT	COST AND LABOR	AVAILABILITY
1.  Resiliently backed linings.	(1)	Commercially available for some models.
2.  Enclosure for grinder or mill.	\$10,000-\$30,000 240-800 h	Local design and fabrication required.
3.  Operator control booth-enclosure.	\$1,500-\$4,000 20-80 h	Commercially available for all models.

(1) Depends on application.

Maximum noise reductions can be achieved by treatment 3, operator control booth-enclosure.

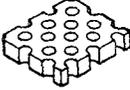
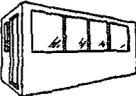
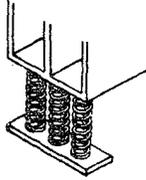
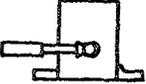
# CLASSIFYING SCREENS



))) Impacts

**Typical Noise Level**  
90-100 dBA

))) Mechanical Noise

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.</p>  <p>Substitute resilient decking and bottoms.</p>	<p>\$25-\$65/ft<sup>2</sup> Varied labor</p>	<p>Commercially available for some models.</p>
<p>2.</p>  <p>Construct an acoustical enclosure for the screen and drive mechanism.</p>	<p>\$2,500-\$5,000 120-360 h</p>	<p>Local design and fabrication required.</p>
<p>3.</p>  <p>Install barrier curtains.</p>	<p>\$5/ft<sup>2</sup> 0.1 h/ft<sup>2</sup></p>	<p>Local design and fabrication required.</p>
<p>4.</p>  <p>Enclose the drive mechanism.</p>	<p>\$200-\$700 20-80 h</p>	<p>Local design and fabrication required.</p>
<p>5.</p>  <p>If the suspension springs chatter, reseal the springs using a rubber cushion, or replace coil springs with air bags.</p>	<p>\$400-\$1,600 8-60 h</p>	<p>Local fabrication using well-documented methods.</p>
 <p>For fine screen rappers, install an exhaust silencer and enclosure, or substitute an electric rapper.</p>	<p>\$50-\$150 4-16 h</p>	<p>Commercially available for all models.</p>

Maximum noise reduction can be achieved by treatment 2, construct an acoustical enclosure for the screen and drive mechanism. Treatment 3 may be equally effective - install barrier curtains.

CRUSHING AND BREAKING EQUIPMENT  
(AUTOGENOUS GRINDERS AND MILLS)

TECHNOLOGY AVAILABILITY

- A. Commercially available noise control products and materials.
1. Suppliers of resilient liners are listed in the annual Buyers' 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 (15).
    - \* 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.
- If case histories are available, they can be found on the following pages.

CASE HISTORY # AGM-1 , DATE: 1984

MINE LOCATION (County, State): Wyandot County, Ohio

MINE TYPE (Metal/Nonmetal, Coal): Metal/Nonmetal - limestone

MACHINE MANUFACTURER, MODEL: Raymon Mills

MACHINE ACTIVITY:

Mills used to process limestone.

DESCRIPTION OF CONTROLS:

CONTROLS USED:

1. 12 foot high wood wall composed of 3/4" plywood nailed to 2x4 studs.
2. Fiberglass insulation installed between studs.
3. 12 foot high moveable wall made of acoustical barrier curtain - .75 lb/ft<sup>2</sup> density suspended by overhead channel track.

TOTAL MATERIAL COSTS: Flexible barrier curtain - \$2,500;  
Plywood wall - \$400; Insulation - \$100;  
Channel track, etc. - \$300

MANHOURS: 112

NOISE REDUCTION OBTAINED:

<u>OPERATING MODE</u>	<u>NOISE LEVEL</u>		<u>REDUCTION</u>
	<u>BEFORE</u>	<u>AFTER</u>	
Mill side of enclosure versus outside of enclosure	104 dBA	86 dBA	18 dBA

NOTES:

Final phase of work was to install 150 acoustical baffles over the mill enclosure area.

## CLASSIFYING SCREENS

### TECHNOLOGY AVAILABILITY

#### 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 St., Akron, OH 44318 (216) 374-2000
  - \* Hendrick Manufacturing Co., 7th Ave. 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 (10).
  - \* Coal Cleaning Plant Noise, BuMines contract J0377014 (46).
  - \* Practical Reduction of Noise From Chutes and Screens in Coal Cleaning Plants, BuMines contract H0144079 (45).
2. Demonstration of specific treatments.
  - \* Demonstration of Noise Control Techniques for the Crushing and Screening of Nonmetallic Minerals, BuMines contract J0199037 (15).
  - \* Noise Control in Surface Mining Facilities: Chutes and Screens, BuMines contract H0144079 (47).
  - \* Noise Abatement of Vibrating Screens, BuMines contract H0387018 (24).

## CLASSIFYING SCREENS

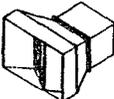
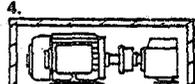
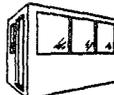
### C. Case Histories.

If case histories are available, they can be found on the following pages.

# VACUUM PUMPS



**Typical Noise Level**  
95-100 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
1.	 Air inlet muffler.	\$50-\$300 2 h	Commercially available for all models.
2.	 Plenum enclosure.	\$200-\$1,000 20-80 h	Commercially available for some models.
3.	 Curtain barrier.	\$5/ft <sup>2</sup> 0.1 h/ft <sup>2</sup>	Local fabrication using well-documented methods.
4.	 Close fitting cover with muffler.	\$200-\$1,000 20-120 h	Local design and fabrication required.
5.	 Operator station-booth with noise attenuation construction.	\$1,500-\$4,000 40-80 h	Commercially available for all models.

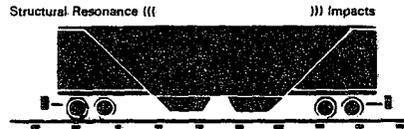
Maximum noise reduction can be achieved by treatment 5, operator station-booth with noise attenuation construction.

## VACUUM PUMPS

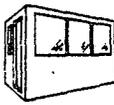
### TECHNOLOGY AVAILABILITY

- 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 (10).
    - \* Coal Cleaning Plant Noise, BuMines contract J0377014 (46).
- C. Case Histories.
- If case histories are available, they can be found on the following pages.

## CAR SHAKE-OUTS



**Typical Noise Level**  
110-125 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
1.	 <p>Operator control booth or enclosure.</p>	\$1,500-\$6,000 40-160 h	Commercially available for all models.
2.	 <p>Acoustic treatment applied to shake-out building.</p>	\$5,000-\$10,000 240-500 h	Local design and fabrication required.
3.	 <p>Resilient impact pads mounted to shaker.</p>	\$1,000 Unknown	Limited demonstration of method; further development required.
4.	 <p>Install car rotary-dump to replace car shake-out.</p>	\$200,000-\$1,000,000 Unknown	Commercially available.

Maximum noise reduction can be achieved by treatment 1, operator control booth or enclosure.

## CAR SHAKE-OUTS

### TECHNOLOGY AVAILABILITY

#### 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. Manufacturers and supplies of railcar dumpers are listed in the annual Buyers' Guide issue of "Coal Age".

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

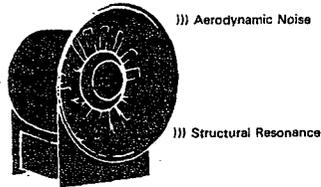
1. Noise source information and general guidelines on noise control requirements.

\* Coal Cleaning Plant Noise, BuMines contract J0377014 (46).

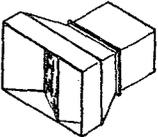
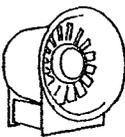
#### C. Case Histories.

If case histories are available, they can be found on the following pages.

## FANS AND BLOWERS



**Typical Noise Level**  
95-100 dBA

TREATMENT	COST AND LABOR	AVAILABILITY
<p>1.</p>  <p>Install an acoustically lined inlet duct or commercial silencer.</p>	<p>\$200-\$1,000 8-60 h</p>	<p>Commercially available for some models, local design and fabrication required for installation.</p>
<p>2.</p>  <p>Duct the inlet to the outside, or other area where noise would not be a problem.</p>	<p>(1)</p>	<p>Local design and fabrication required.</p>
<p>3.</p>  <p>Replace noisy fans with quieted models. Specify noise level to be less than 90 dBA at 1 meter when ordering new fans.</p>	<p>(2)</p>	<p>Commercially available for all models.</p>

(1) Depends on length of duct.

(2) Depends on fan size and capacity.

Maximum noise reduction can be achieved by treatment 3. Replace noisy fans with quieted models.

## FANS AND BLOWERS

### TECHNOLOGY AVAILABILITY

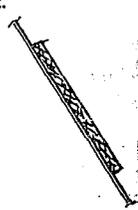
- A. Commercially available noise control products and materials.
  - 1. Manufacturers and suppliers of fans are listed in the annual Buyers' Guide issue of "Coal Age".
  - 2. Suppliers of fans silencers are listed in the NIOSH "Compendium of Materials for Noise Control" and the annual Systems Reference 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 (46).
  - 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.

If case histories are available, they can be found on the following pages.

## CHUTES AND HOPPERS



Typical Noise Level	
Measured 3 feet from the chute	100 - 105 dBA

	TREATMENT	COST AND LABOR	AVAILABILITY
1.	 <p>Weld ledges into the chute to retain a layer of fines along the chute.</p>	<p>\$2/ft<sup>2</sup> 1 h/ft<sup>2</sup></p>	Local design and fabrication required.
2.	 <p>Install a resilient liner to cushion impacts</p>	<p>\$10-\$30/ft<sup>2</sup> 0.5 h/ft<sup>2</sup></p>	Commercially available for some models; local fabrication using well-documented methods for other applications.
3.	 <p>Minimize the use of tappers and air blasts.</p>	None	
4.	 <p>Install barrier curtains.</p>	<p>\$5/ft<sup>2</sup> 0.1 h/ft<sup>2</sup></p>	Commercially available. Installation requires local design and fabrication.

Maximum noise reduction can be achieved by treatment 2. Install a resilient liner to cushion impacts. Further reduction can be achieved, if needed, by the addition of treatment 4. Install barrier curtains.

## CHUTES AND HOPPERS

### TECHNOLOGY AVAILABILITY

- 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 (46).
  - 2. Demonstration of specific treatments.
    - \* Demonstrating the Noise Control of a Coal Preparation Plant, BuMines contract H0155155 (40).
- C. Case Histories.

If case histories are available, they can be found on the following pages.

## REFERENCES

1. Aeroacoustic 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. Becker, L. and M. Pettitt. Investigation and Control of Noise Generated during Coal Cutting. BuMines contract JO387229.
4. Bender, E. K., D. B. Cruikshank, 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.
5. Bernhagen, J. R. Noise Control on a Heavy Duty Mobile Crane. SAE Tech. Paper 760601, 1976; available from Society of Automotive Engineers, Warrendale, PA.
6. Bolt Beranek & Newman, Inc. Bulldozer Noise Control. Ongoing BuMines contract JO177049; for inf. contact R. C. Bartholomae, BuMines Pittsburgh Res. Center, Pittsburgh, PA.
7. \_\_\_\_\_. 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.
8. \_\_\_\_\_. 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.
9. \_\_\_\_\_. Front-End Loader Noise Control. Ongoing BuMines contract JO395028; for inf. contact R. C. Bartholomae, BuMines Pittsburgh Res. Center, Pittsburgh, PA.
10. \_\_\_\_\_. Source Diagnosis 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.
11. 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.
12. \_\_\_\_\_. Development of Six Prototype Production Stoper Drills. Ongoing BuMines contract JO177125; for inf. contact R. C. Bartholomae, BuMines Pittsburgh Res. Center, Pittsburgh, PA.
13. EIMCO 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.
14. Ferrari, V. and A. Galaitsis. Integration of Quieting Technology into New Mantrip Vehicles. BuMines contract JO199068.
15. 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.
16. 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.
17. Galaitsis, A. G., 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.

18. 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.
19. George, D. L., and N. J. Matteo. Development of Noise Control Technology for Pneumatic Jumbo Drills (contract H)395k029, Ingersoll-Rand Res., Inc.) BuMines OFR 100-81, 1980, 61 pp.; NTIS 81-237414.
20. 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.
21. Hawkes, I., and D. D. Wright. Development of a Quiet Rock Drill. Volume I: Evaluation of Design Concepts (contract JO155099, Ivor Hawkes Associates). BuMines OFR 70-78, 1977, 95 pp.; NTIS PB 283 774.
22. 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.
23. Hawkes, I. Development of a Prototype Quiet Hard Rock Stop Drill. BuMines contract HO113034.
24. 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.
25. 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.
26. 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.
27. 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.
28. Lake Shore Inc. Retrofit of Underground Load-Haul-Dump Machines With Noise Control Packages. Ongoing BuMines contract HO395041; for inf. contact R. C. Bartholomae, BuMines Pittsburgh Res. Center, Pittsburgh, PA.
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. Patterson, W. N. Development of Concentric Drill Steels for Noise Control of Percussion Drills. BuMines contract HO338022.
34. Pettitt, M. and W. Aljoe. Fabrication Manual for a Reduced-Noise Auger Miner Cutting Head. BuMines IC-8971.
35. Rabius, J. L. and R. J. Goff. Rubber Tire Muffler for Noise Control. MSHA T-Gram, TD-1.
36. 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.

37. 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 H0166012, Donaldson Co., Inc.). BuMines OFR 10(1)-79, 125 pp.; NTIS PB 292 387.

38. \_\_\_\_\_. Noise Control Modification Manual. Jeffrey 100-L Auger Miner. Final Report Volume II (contract H0166012, Donaldson Co., Inc.). BuMines OFR 10(2)-79, 1978, 82 pp.; NTIS PB 292 388.

39. \_\_\_\_\_. Noise Control Modification Manual. Jeffrey 94-L Bridge Conveyor. Final Report Volume III (contract H0166012, Donaldson Co., Inc.). BuMines OFR 10(3)-79, 1978, 38 pp.; NTIS PB 292 389.

40. Rubin, M. N. Demonstrating the Noise Control of a Coal Preparation Plant. Volume I. Initial Installation and Treatment Evaluation (contract H0155155, Bolt Beranek & Newman Inc.). BuMines OFR 104-79, 1977, 182 pp.; NTIS PB 299 963.

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

42. 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.

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

44. 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 J0166057, Bolt Beranek & Newman Inc.). BuMines OFR 98-79, 1978, 117 pp.; NTIS PB 299 538.

45. 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.

46. Ungar, E. E., G. E. Fax, W. N. Patterson, and H. L. Fox. Coal Cleaning Plant Noise (contract J0377014, Bolt Beranek & Newman Inc.). BuMines OFR 44-74, 1974, 99 pp.; NTIS PB 235 852.

47. Ungar, E. E., W. N. Patterson, C. L. Dym, and A. Galaitsis. Noise Control in Surface Mining Facilities: Chutes and Screens (contract H0144079, Bolt Beranek & Newman Inc.). BuMines OFR 64-76, 1975, 156 pp.; NTIS PB 253 257.

48. Wyle Laboratories. Control of Noise From Auger Miners. Ongoing BuMines contract H0188065; for inf. contact R. C. Bartholomae, BuMines Pittsburgh Res. Center, Pittsburgh, PA.

49. \_\_\_\_\_. Noise Control of Longwall Shearer. Ongoing BuMines contract J0188072; for inf. contact R. C. Bartholomae, BuMines Pittsburgh Res. Center, Pittsburgh, PA.