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REPORT NO. DOT-TSC-OST-73-38

TRUCK NOISE - VI B
A BASELINE STUDY OF THE PARAMETERS AFFECTING DIESEL ENGINE INTAKE AND EXHAUST SILENCER DESIGN

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JANUARY 1974
FINAL REPORT

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Prepared For
DEPARTMENT OF TRANSPORTATION
OFFICE OF THE SECRETARY
OFFICE OF NOISE ABATEMENT
WASHINGTON D C 20590

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TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT-TSC-OST-73-38	PB 230317	

4. Title and Subtitle	5. Report Date
TRUCK NOISE VI B A BASELINE STUDY OF THE PARAMETERS AFFECTING DIESEL ENGINE INTAKE AND EXHAUST SILENCER DESIGN	January 1974
	6. Performing Organization Code
7. Author(s) THOMAS DONNELLY, JOSEPH TOKAR WAYNE WAGNER	8. Performing Organization Report No.
9. Performing Organization Name and Address Donaldson Company, Inc.* 1400 West 94th Street Minneapolis, Minnesota 55431	10. Work Unit No. OS-407/ R-4520
	11. Contract or Grant No. DOT-TSC-532
12. Sponsoring Agency Name and Address Department of Transportation Office of the Secretary Office of Noise Abatement Washington DC 20590	13. Type of Report and Period Covered Final Report Sep 1972 - Jan 1973
	14. Sponsoring Agency Code TST-50

15. Supplementary Notes

*Under Contract to: Department of Transportation, Transportation Systems Center, Kendall Square, Cambridge MA 02142

16. Abstract

A survey of diesel engine, truck, intake system, and exhaust system manufacturers was made for the purpose of compiling detailed information on 1) all major mass-produced diesel engines currently used in the United States for trucks and buses, and on 2) existing or available-for-order diesel engine intake and exhaust silencers. This survey was conducted by written questionnaire.

Survey information was supplemented with comparative data on the acoustic characteristics of diesel engines and the acoustic performance of selected intake and exhaust systems. These data were obtained through engine dynamometer and vehicle drive-by tests.

All survey and test information was compiled and presented in tabular form by engine model to allow data comparison and silencer system selection.

17. Key Words	18. Distribution Statement
Diesel Engine Exhaust Noise, Diesel Engine Intake Noise, Intake Silencers, Exhaust Silencers, Vehicle Noise Reduction	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	232	

Form DOT F 1700.7 (8-69)

FOREWORD

As part of the United States Department of Transportation (DOT) program to develop truck noise control technology, the Transportation Systems Center (TSC) awarded contracts to the Donaldson Company of Minneapolis, Minnesota and the Stemco Manufacturing Company of Longview, Texas. The objective of these contracts was to study intake and and exhaust noise emissions from diesel engines presently used for truck and bus propulsion. As part of this effort a variety of commercially available air cleaners and exhaust silencers, mounted on engines in dynamometer facilities and in vehicles, were evaluated to determine their noise reduction effectiveness.

The reports resulting from these contracts are intended to provide a ready reference to manufacturers, owners, service organizations, operators and noise regulation and enforcement agencies on the performance and present state of development of various types of intake and exhaust silencers.

Since many other segments of industry utilize similar diesel engines as sources of rotary power, it is hoped that the information obtained in the DOT "Truck Noise" program will also be useful to them in their noise abatement efforts. Other reports in the "Truck Noise" series are listed below.

Report Title	DOT Report No.	NTIS* Accession No.
Truck Noise-I, Peak A-Weighted Sound Levels due to Truck Tires	OST/ONA-71-9	PB 204-188
Truck Noise-I, Addendum	OST/ONA 72-1	
Truck Noise-II, Interior and Exterior A-Weighted Sound Levels of Typical Highway Trucks	OST/ONA 72-2	PB 213-941
Truck Noise-IIIA, Preliminary Noise Diagnosis of Freightliner Datum Truck-Trailer	DOT-TST-73-6	PB 223-253
Truck Noise-IIIB, Acoustic and Performance Test Comparison of Initial Quieted Truck with Contemporary Production Trucks	DOT-TST-74-2	PB 224-953/OAS

Truck Noise-IV, Reserved for documentation of the work performed by International Harvester Co. under Contract DOT-OS-20222.

Truck Noise-V, Reserved for documentation of the work performed by White Motor Corp. under Contract DOT-OS-20221.

Truck Noise-VIA, Diesel Exhaust and Air Intake Noise (Stemco Mfg. Co.)	DOT-TSC-OST-73-12	PB 222-624

Trade and manufacturers names appear in this report because they assist the reader to identify the evaluated noise suppression components. The United States Government does not endorse any manufacturers products or assume liability for the content of or the accuracy of the data contained within this report.

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Transportation Systems Center
U. S. Department of Transportation

* National Technical Information Service, Springfield, Virginia 22151.

PREFACE

This report summarizes and concludes the contractual effort on U.S. Department of Transportation Contract DOT-TSC-532, A Baseline Study of the Parameters Affecting Diesel Engine Intake and Exhaust Silencer Design. Contract activities began on 29 September 1972 and continued through 31 January 1973. Objectives of the contract were to 1) compile detailed information on all major mass-produced diesel engines currently utilized within the United States for bus and highway applications, 2) develop a comparative system to allow selection of existing or available-for-order intake and exhaust silencer types, recommended geometry, and required inlet and exhaust pipe size best suited to the particular engine, and 3) prepare a tabular presentation of current price schedules, expected performance, and predicted life for each recommended silencer type.

Donaldson Company, Inc., in the performance of Contract DOT-TSC-532, relied heavily on the cooperation of many manufacturers associated with the trucking industry. For their cooperation, we wish to acknowledge the contributions made by:

- Alexander-Tagg Industries, Inc.
- Canadian Filter (Division of Fram Corporation)
- Caterpillar Tractor Company
- Cummins Engine Company, Inc.
- Detroit Diesel Allison Division
- Freightliner Corporation
- International Harvester Company
- Kenworth Motor Truck
- Mack Trucks, Inc.
- Peterbilt
- Riker Manufacturing, Inc.
- Stemco Manufacturing Company, Inc.
- Vortox Company
- Walker Manufacturing Company

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Section 1
INTRODUCTION

This report summarizes and concludes the contractual effort on U.S. Department of Transportation Contract DOT-TSC-532, A Baseline Study of the Parameters Affecting Diesel Engine Intake and Exhaust Silencer Design. Contract activities began on 29 September 1972 and continued through 31 January 1973. The contract effort, as summarized in this report, addresses the following activities:

- Compilation of detailed information of all major mass-produced diesel engines currently utilized within the United States for bus and highway applications.

- Development of a comparative system to allow selection of existing or available-for-order intake and exhaust silencer types and provide system geometry best suited to the particular engine.

- Tabulate acoustic performance and current material price schedules for each recommended silencer system.

Backup data supporting and supplementing the tables persented in this report are contained in two additional volumes, "Supporting Data for a Baseline Study of the Parameters Affecting Diesel Engine Intake and Exhaust Silencer Design." These two volumes have been submitted to the Department of Transportation but are not considered part of this final report.

Section 2
CONCLUSIONS

The major end item of this program is a cataloging, by diesel engine, of the available-for-order intake and exhaust systems that may contribute to effectively reducing truck and bus noise. In the course of this program, a great deal of data was recorded. Since this material has been condensed in the process of cataloging the data, certain general conclusions have been drawn and are presented below as an aid to the user of the report:

1) Donaldson Company feels that the manufacturer survey for data was successful. The number of replies and amount of data received indicates that the industry is aware of the problems and is concerned. In most cases, not all the data requested was received. However, these voids in data probably resulted from two factors: 1) the amount of time allowed for responding to the inquiry, approximately 30 days, and 2) the cost that would be incurred by the manufacturer if he had been 100 percent responsive.

2) SAE Recommended Practice J366a was found to be an excellent method to evaluate truck exhaust noise. Good correlation was established between exhaust noise from carefully controlled engine dynamometer testing and truck drive-by tests per SAE J366a.

3) Properly selected intake systems should attenuate the intake noise below 75 dB(A) at rated rpm when observed at 50 ft. The majority of intake systems fell below 72 dB(A) with a few as low as 57 dB(A). However, it is important to give proper consideration to the style of air cleaner and its location on the vehicle, since this can influence the amount of noise reduction realized by as much as 15 dB(A).

4) Straight-pipe exhaust noise levels on diesel engines range from the mid 80's to approximately 110 dB(A) at 50 ft. Turbo-charged engines are quieter than naturally-aspirated engines.

5) For the most popular diesel engines, exhaust systems are currently available to control exhaust noise to the 77 dB(A) to 80 dB(A) range at 50 ft and down as low as 70 dB(A) for a few less noisy turbo-charged diesels. On the other hand, mufflers are available that provide lesser degrees of silencing; to the mid 80 to 90 dB(A) range on naturally-aspirated diesel engines.

6) Standard production trucks tested for total truck noise were in the mid 80 to low 90 dB(A) range at 50 ft.

7) In-cab noise with the windows closed ranged from 85 dB(A) to 92 dB(A). With windows open, in-cab noise levels were as high as 95 dB(A).

8) Vertical-mounted mufflers with vertical tailpipes (V-V) are more numerous, and in general, silenced exhaust noise levels are lower than for horizontal systems (H-H). However, the selection of an exhaust system based on its configuration alone is not recommended because of the wide variation in noise levels and exhaust back pressures found within the group of mufflers tested.

9) Dynamic engine-brake exhaust noise (Jacobs brake) is several dB(A) louder than normal exhaust noise and has different tonal qualities. Some mufflers control both exhaust and "brake" noise well; some mufflers are ineffective on "brake" noise.

10) Back pressure is generally higher as measured on a dynamometer test than on a drive-by test. This occurs because steady-state conditions on the "dyno" test allow the engine to reach maximum full-rated engine air flows and temperature.

11) Continuous plotting of data from the sound level meter on both "dyno" test and drive-by tests show the data to be very repeatable. Plotted data shows the resonances or sound level variations vs. rpm or elapsed time on the SAE track.

Section 3
TECHNICAL DISCUSSION

The technical effort on this contract was divided into three tasks:

- Manufacturers Survey
- Dynamometer Tests
- Drive-by Tests

The goal of this effort was the cataloging of available-for-order intake and exhaust silencers that may be applied to diesel engines currently used for truck and bus propulsion in the United States. Cataloged information includes a definition of type, location geometry, and expected performance. These are presented in Appendix A; Engine, Intake, and Exhaust System Data Summary.

The methodology and equipment used by Donaldson Company in compiling this data is discussed in the following paragraphs.

3.1 Manufacturer Survey

The objective of the manufacturer survey was to collect basic data on the parameters affecting intake and exhaust noise emissions. Two approaches were used in soliciting the data. Donaldson Company's customers were approached first by verbal communications through the Donaldson Company's Sales Account Executive working with that manufacturer. This was then followed by a letter and questionnaire.

Manufacturers that were not customers of Donaldson Company were solicited for data by letter only. In many cases, however, telephone conversations discussing the solicitation resulted.

In evaluating the effectiveness of the survey, the following items should be considered:

- A large amount of data was requested.
- Supplying this data would result in an expense to the manufacturer.
- In many cases, positive replies involved supplying information to a competitor.

All written correspondence and replies obtained during the manufacturer survey were submitted to the Department of Transportation.

3.1.1 Engine Manufacturer Survey

Questionnaire forms of the type shown in figure 1 were sent to five diesel engine manufacturers. The majority of the information requested is generally available from engine manufacturers. Not all of this data was directly pertinent to the primary objective of the program but was requested for descriptive completeness.

3.1.2 Truck Manufacturer Survey

The type of questionnaire sent to truck manufacturers concerning intake and exhaust systems is shown in figures 2 and 3. These questionnaires were sent to nine truck manufacturers. Information was solicited on the geometric location and configuration of the intake and exhaust system used. Data was also solicited on the make and model numbers of the system supplied with the truck.

3.1.3 Intake System Manufacturer Survey

The questionnaire form sent to intake system manufacturers is shown in figure 4. Inquiries were sent to eight intake system manufacturers. Since intake noise attenuation has received little attention until the last few years, not a great deal of data are available. Cost data are difficult to compile since there are

DONALDSON CO. DOT CONTRACT TSC-532
DIESEL ENGINE TRUCK & BUS
INTAKE & EXHAUST NOISE STUDY

The objective of this contract is to compile information on all mass produced diesel engines and the intake and exhaust systems currently utilized within the United States for truck and bus application.

Engine Manufacturer_____ Engine Model No._____

Number of Cylinders_____ Configuration Vee_____ Inline_____

2 Cycle_____ 4 Cycle_____

N.A._____ Turbo Chg_____ Blown_____(Blower No. Lobes_____ RPM____

Cubic Inch Displ._____ Bore_____ Stroke_____

Intake Valves/Cyl 2 Cycle

No. Valves_____, Dia_____, Lift_____; or No. Ports_____,Area____

Degrees open_____; Degrees open_____

Exhaust Valves/Cyl

No. Valves_____, Dia_____, Lift_____, Degrees open_____

Intake/Exhaust Valves overlap degrees_____

Fuel Inj Method Direct_____ PreComb. Ch._____ Dia Injector_____MM

Max. Rated HP_____ @ _____ RPM

Max. Rated Torque_____ @ _____ RPM

Engine Brake Model_____

A/F Ratio_____: 1 @ Rated Speed and Load

Exh. Temp_____ ^{o}F @ Rated Speed and Load

Exh. Temp_____ ^{o}F @ Hi Idle

Recommended Exh System Dia_____" Single_____" Dual

Exhaust System Backpressure Limit_____" Hg.

Intake Air Flow @ Rated Speed and Load_____ CFM

Intake Air Flow @ Hi Idle_____ CFM

Intake System Restriction Limit_____" H_2O

Exh. Noise dbA @ 50'
Open Pipe_____dbA

Intake Noise dbA @ 50'
Open Pipe_____dbA

Approx. Exh. Gas Comp. @ Rated Speed and Load
_____% N_2
_____% O_2
_____% Co
_____% Co_2

Current Annual Production Level
Approximate Number Engines/Full 12 Mo. (1971-1972)_____
(U.S. Diesel Automotive Trk and Bus)
Est. overall Mkt Status_____%
(U.S. Diesel Automotive Trk and Bus)

Engine Data Form
Project 21-9700P
WMW 10/6/72

Figure 1. Engine Manufacturer Questionnaire Form

REQUEST FOR INTAKE SYSTEM INFORMATION

Department of Transportation Contract # DOT-TSC-532

"Parameters Affecting Intake and Exhaust Noise Emissions from Diesel Engines"

Contractor - Donaldson Co., Inc.

Truck Mfg. _____

Survey Engine: _____ (Mfg. Name), _____ (Number), _____ (Rating)

System No. _____

Estimated quantity manufactured of this engine, intake system, and truck style combination -

___ 1972, ___ 71, ___ 70, ___ 69, ___ 68,
___ 67, _____ Older than 67 still on road

AIR CLEANER(S) USED FOR ABOVE ENGINE AND SYSTEM

Air Cleaner - No. _____	Air Cleaner - No. _____
- Mfg. _____	- Mfg. _____
- Type _____Dry_____Oil Bath	- Type _____Dry_____Oil Bath
- Wt. _____ Lbs.	- Wt. _____ Lbs.
- Size _____	- Size _____
Intake System Piping _____ in. inlet, _____ in. outlet	Intake System Piping _____ in. inlet, _____ in. outlet
Initial Rest. - Cleaner _____ $"H_2O$	Initial Rest. - Cleaner _____ $"H_2O$
System _____ $"H_2O$	System _____ $"H_2O$
Service Level: _____ $"H_2O$	Service Level: _____ $"H_2O$
Accessories Used - Cap _____	Accessories Used - Cap _____
(Size & Quantity) Elbows _____	(Size & Quantity) Elbows _____
_____	_____
_____	_____
Intake System Noise Level (db(A) @ 50') - Hi Idle _____	Intake System Noise Level (db(A) @ 50') - Hi Idle _____
- Rated RPM _____	- Rated RPM _____
Intake Noise Data (attach data)	Other Intake Noise Data (attach data)
Octave Analysis _____	Octave Analysis _____
1/3 Octave _____	1/3 Octave _____
Narrow Band _____	Narrow Band _____
Magnetic Tape _____	Magnetic Tape _____

INTAKE DATA FORM
Project 21-9700P
JCT 10/6/72

Figure 2. Truck Manufacturer Intake Questionnaire Form

DONALDSON/DOT CONTRACT TSC-532
DIESEL ENGINE EXHAUST SYSTEM SURVEY
FOR
U.S. TRUCK AND BUS
(Fill out one sheet for each Engine/Exhaust System)

Vehicle Manufacturer_____ for Trucks:

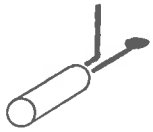
Vehicle Series_____ Conventional: Short_____Long_____

Engine_____ Cab-over : Short_____Long_____

_____Hp @_____RPM G.V.W._____#

Exhaust System (check one)

☐ V-V ☐ Single ☐ Dual



☐ H-V ☐ Single ☐ Dual

☐ H-V ☐ Single ☐ Dual

Estimated quantity manufactured of this engine, system, and truck style combination

____1972,_____71,_____70,_____69,_____68,_____67_____Older than 67 still on ro

Exhaust System Data

Exhaust Pipe Diameter_____inches Tail Pipe Diameter_____ inches

Exhaust Pipe Length_____ feet Tail Pipe Length _____ feet

Number of Elbows_____45°_____90° Number of Elbows_____45°_____90°

Muffler Data

	Muffler #1	Muffler #2	Muffler #3
Muffler P/N			
Muffler Size			
Muffler Weight	_____lbs.	_____lbs.	_____lbs.
Muffler Material			
Other attenuating Devices in System P/N			

Exhaust Noise and Backpressure (Bp) Data

	Muffler #1	Muffler #2	Muffler #3
. Exhaust Noise Only (dbA @ 50 ft)	_____dbA	_____dbA	_____dbA
. Overall Vehicle Noise (SAE J 366)	_____dbA	_____dbA	_____dbA
. Dyno Test dbA @ _____ ft.	_____dbA	_____dbA	_____dbA
. System Bp @ rated	_____" Hg	_____" Hg	_____" Hg

Other (attach data)

☐ Octave Analysis: ☐ 1/3 octave, ☐ N.B.

☐ Magnetic Tape

☐ Straight Pipe Data

☐ Other

Exhaust System Form
Project 21-9700P
VPR 10/6/72

Figure 3. Truck Manufacturer Exhaust Questionnaire Form

REQUEST FOR INTAKE SYSTEM INFORMATION

Department of Transportation Contract # DOT-TSC-532

"Parameters Affecting Intake and Exhaust Noise Emissions from Diesel Engines"

Contractor - Donaldson Co., Inc.

Air Cleaner Mfg. _____

Survey Engine _____ (Mfg. Name), _____ (Number), _____ (Airflow Rating)

System _____ #1, _____ #3 (Check One) _____ #2, _____ #4

Note: This sheet for one engine/intake system only.

AIR CLEANER(S) AVAILABLE FOR ABOVE ENGINE AND SYSTEM

Model No. _____	Model No. _____
Type _____ Dry, _____ Oil Bath	Type _____ Dry, _____ Oil Bath
Restriction - @ Airflow for engine	Restriction - @ Airflow for engine
Total system _____ "H_2O _____ Calc. _____ Act.	Total System _____ "H_2O _____ Calc., _____ Act.
Cleaner only _____ "H_2O _____ Calc. _____ Act.	Cleaner only _____ "H_2O _____ Calc., _____ Act.
Piping Size (dia.) _____ in. inlet; _____ in. outlet	Piping size (dia.) _____ in. inlet _____ in. outlet
Overall Size of Cleaner _____	Overall Size of Cleaner _____
Weight _____ lbs.	Weight _____ lbs.
Service Life _____ Lab hrs. @ "0" Vis (ACF)	Service Life _____ Lab hrs. @ "0" Vis (ACF)
Intake System Noise Level (db(A) @ 50') _____ db(A) _____ Calc., _____ Act.	Intake System Noise Level (db(A) @50') _____ db(A) _____ Calc., _____ Act.
Other Intake Noise Data (Please attach data)	Other Intake Noise Data (Please attach data)
_____ Octave Analysis	_____ Octave Analysis
_____ Narrow Band	_____ Narrow Band
_____ Open Pipe	_____ Open Pipe
Fleet Price _____ ea.	Fleet Price _____ ea.
_____ ea. (Qty. 10)	_____ ea. (Qty. 10)
_____ ea. (Qty. 100)	_____ ea. (Qty. 100)

INTAKE DATA FORM
Project 21-9700P
JCT 10/6/72

Figure 4. Intake System Manufacturer Questionnaire Form

many different price schedules, e.g., OEM prices, fleet price, distributor price, etc. Also, the quantity prices requested might not conform to the price schedule of the manufacturer.

Companies supplying data were also asked if they would be willing to submit test items.

3.1.4 Exhaust System Manufacturers Survey

Copies of the questionnaire form shown in figure 5 were sent to six exhaust system manufacturers. Most of these data are available from the exhaust system manufacturer's catalogs. However, the amount of data can be overwhelming. For example, Donaldson Company can supply as many as 31 different exhaust systems for a single engine. Cost data for exhaust systems, as for intake systems, is difficult to obtain in a general inquiry such as this. Each manufacturer has several price schedules based on sales quantity and customer, e.g., fleet sales, distributor sales, OEM, etc.

Companies supplying data were also asked to submit test items. Test items were obtained from those manufacturers expressing a willingness to supply hardware.

3.2 Selective Testing

Selective testing under this program consisted of dynamometer tests and drive-by tests per SAE Recommended Practice J366a. The dynamometer tests were conducted on two engines, a Cummins NTC 335 and Detroit Diesel Allison Division 8V-71N (318 hp). A total of nine trucks and one bus were used in the drive-by tests (see table 6 for list of vehicles and engines).

The purpose of the test effort was to establish a "confidence" level in the noise data received in the manufacturer's survey. This was necessary because of the different

DONALDSON/DOT CONTRACT TSC-532
DIESEL ENGINE EXHAUST SYSTEM SURVEY
FOR
U.S. TRUCK & BUS

(Fill out one sheet for each muffler)

Muffler Data:

Manufacturer_____ Material_____

Part Number _____ Service Life_____ hrs/miles

Body Diameter_____inches Fleet Price, each

Body Length _____inches Qty 1_____

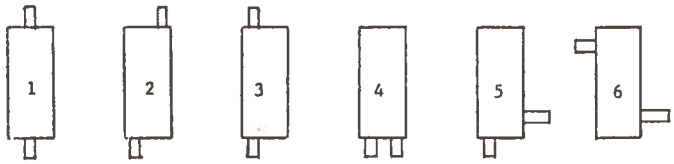
Overall Length_____inches 10_____

Tube Diameter: In_____inches 100_____

Out_____inches Style_____Round ☐ Oval ☐
(see below)

Weight_____ lbs

Muffler Style:



other sketch

Engine Exhaust Systems (for above muffler)

Engine	Engine Power Rating	Exhaust System (see below)	Back Pressure ("Hg)	Noise Data Per SAE J 366 Exh.	Noise Data Per SAE J 366 Vehicle	Exhaust System Diameter	Exhaust System Length
	___Hp@___rpm						
	___Hp@___rpm						
	___Hp@___rpm						
	___Hp@___rpm						
	___Hp@___rpm						
	___Hp@___rpm						

Exhaust System

V-V
S= Single
D= Dual

H-V
S= Single
D= Dual

H-H
S= Single
D= Dual

other

Muffler Form
Project 21-9700P
VPB 10/6/72

Figure 5. Exhaust System Manufacturer Questionnaire Form

test procedure and methods of presenting the data used by the various manufacturers. For example, one exhaust system manufacturer presents noise data as an overall truck noise level. Therefore, this noise data should be significantly higher than the exhaust noise level by itself.

Intake and exhaust system manufacturers that submitted test items were invited to Donaldson Company to witness the testing of their products.

The following subsections discuss in detail the procedures used in the test programs.

3.2.1 Engine Dynamometer Tests

An engine dynamometer in conjunction with the proper sound equipment can be used to evaluate the intake and exhaust noise of a diesel engine. The two engines used for these tests, a Cummins NTC 335 and a Detroit Diesel Allison Division 8V-71N, were chosen because they are two of the most widely used truck engines. The Cummins NTC 335 was equipped with a Jacobs "compression" braking system. A 500 hp Clayton water-brake dynamometer was used on the 8V-71N tests, and a 2000 hp Taylor water-brake was used with the NTC 335 engine. The moment of inertia of the Taylor dynamometer is large enough to extend engine deceleration time to allow acoustic evaluation of intake and exhaust components during engine compression braking. Dynamometer tests were conducted in the following manner:

The engine and dynamometer were located inside a test cell, figure 6. Outside, figure 7, the test item (muffler or air cleaner) was connected to the engine by a pipe through the nearby adjacent wall. A microphone was positioned at a distance of 75 in. from the end and at a right angle to the end of the test item as shown in figure 7. This close-in positioning of the microphone allowed test item noise emission to effectively mask the background noise by 20 dB, which is important if narrow-band analysis is to be conducted. A correction (the Inverse Square Law) was used to extrapolate the readings to the 50-ft distance value. The microphone was connected to a sound level meter, and the combination was calibrated

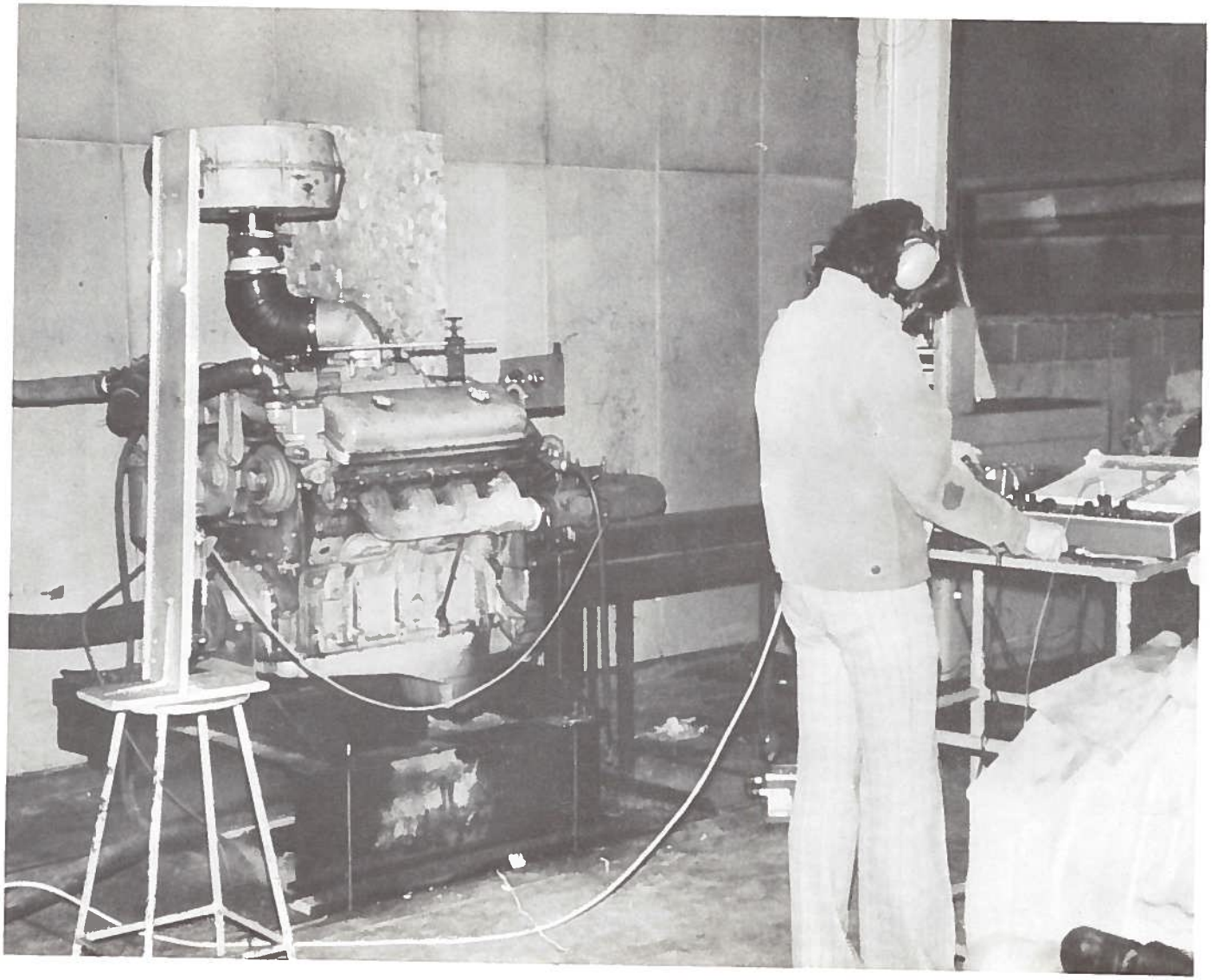


Figure 6. Engine and Dynamometer

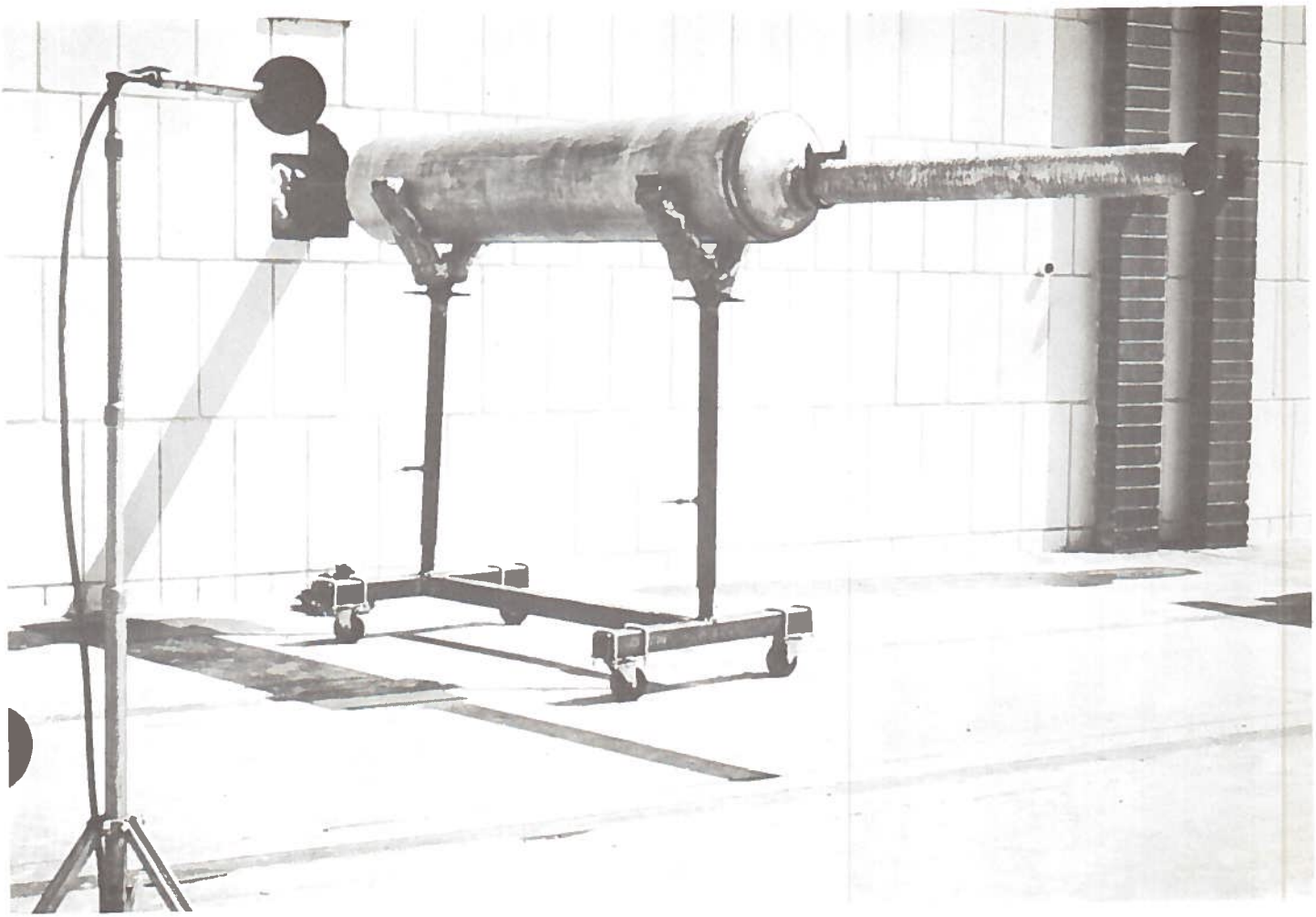


Figure 7. Microphone Location and Acoustic Wall

at 124 dB with a pistonphone. This calibration was also made to the X-Y recorder's Y-axis. The dc output of the sound level meter was used to drive the Y-axis. Special graph paper was used with the recorder since this dc output is not linear in dB. The X-axis was driven by voltage output from a tachometer generator on the dynamometer. Water manometers were used to measure air cleaner restriction and mercury manometers were used to measure exhaust system back pressure.

The B & K 2204 sound level meters used, have a fast response, an "A" weighing network, an ac voltage output which can be used for tapes recorded for further analysis, and a dc voltage output which was used in conjunction with an X-Y plotter for a permanent record of sound level vs. the engine speed. The engine speed (rpm) was measured with a dc tachometer generator which controls the plotter X-axis, while the sound level meter's dc output is recorded as dB(A) on the Y-axis. This procedure is repeatable and records all dB(A) levels of the intake or exhaust system as the engine is loaded down at wide-open-throttle and operated through its rpm range.

This technique was also used to record the instantaneous exhaust noise when the Jacobs brake was activated during deceleration tests from high idle.

The intake and exhaust systems were tested on the dynamometer test facility with the microphone located at right angles to the end of the test item at a distance of 75 in. (6-1/4 ft). From the Inverse Square Law, this results in an 18 dB reduction in sound level at the 50 ft location.

Corrected sound level at 50 ft in dB(A) equals the sound level at observed distance in dB(A) minus $20 \log \frac{x}{d}$.

Where: $20 \log \frac{x}{d} = 20 \log \frac{50}{6.25} = 18$ dB

and x = corrected distance

d = measured distance

We have also found from test experience that this relationship is valid. Figure 8 is a typical noise level obtained from the 75 in. distance during a dynamometer test. To extrapolate, for distance only to a 50 ft measurement, 18 dB would be subtracted. Figure 9 is a plot of the noise level, measured at 50 ft, of the same dynamometer test used to obtain figure 8. At rated rpm, 2100 rpm, the difference in noise level is 18.4 dB, while the peak noise level difference is 16.7 dB.

When extrapolating 75-in. measurement data, other factors must also be considered. In testing dual exhaust system mufflers, for example, tests are conducted with only one muffler connected to one bank of the engine cylinders. The combined increase in sound level at 50 ft would be 3 dB if the mufflers were placed side by side. However, on a truck, dual mufflers are approximately 8 ft apart, and therefore, one muffler would be at 46 ft and the other at 54 ft. Thus, a combined sound level increase of 2 dB is typical for dual systems at the 50 ft extrapolation. Orientation of the exhaust system must also be considered. Horizontally-exhausted mufflers are typically 3 dB louder than vertically-exhausted mufflers. This is attributed to the addition, at the observer location, of direct radiated sound and reflected sound from the pavement surface and the shorter length of tail pipe used with horizontal systems.

In summary, the following factors are used in this report for the dynamometer tests in extrapolating 75 in. data to 50 ft sound levels:

Type of Silencer System	Subtraction Factor
Intake system	18 dB
Vertical-single muffler	18 dB
Horizontal-single muffler	15 dB
Vertical-dual mufflers	16 dB
Horizontal-dual mufflers	13 dB

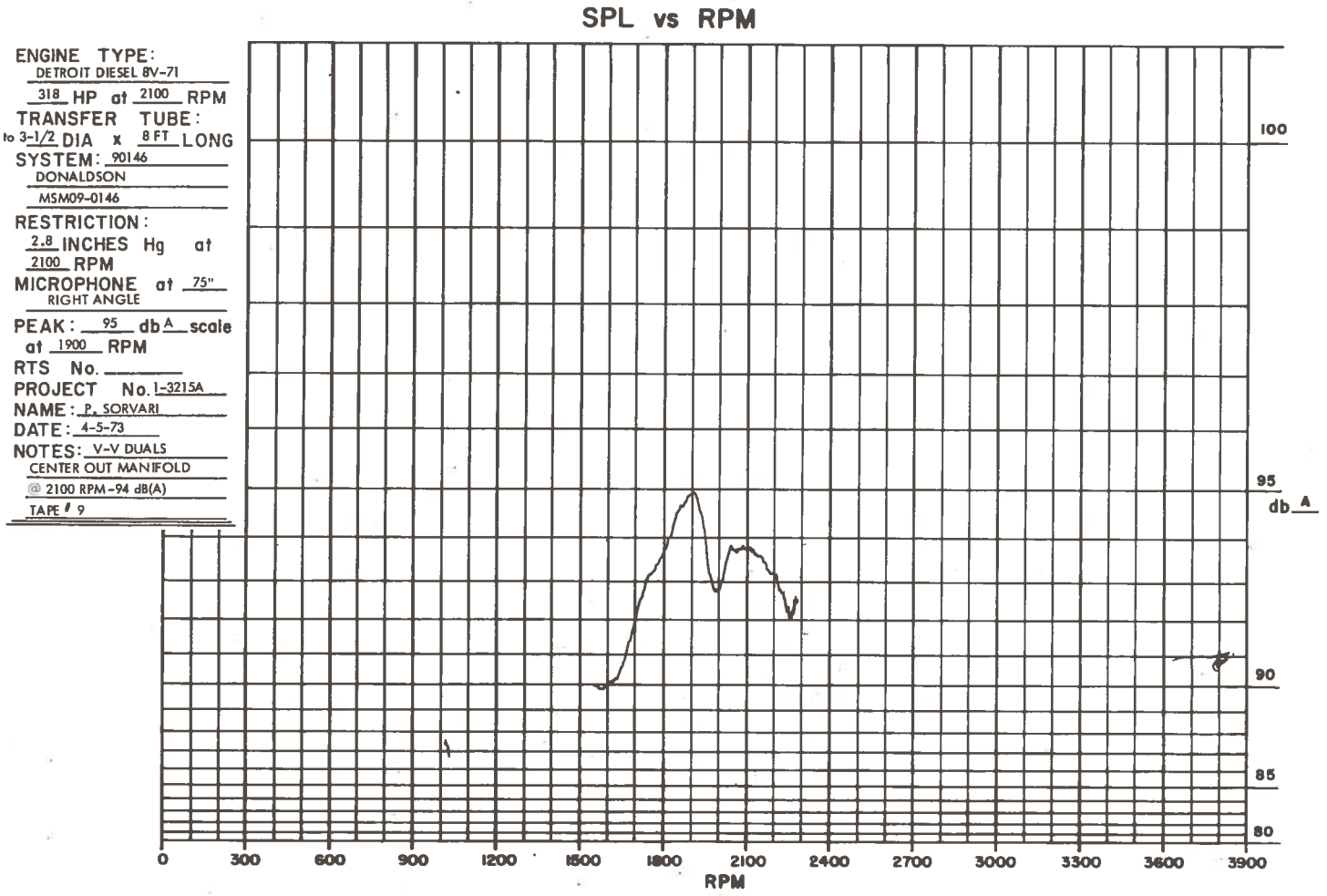


Figure 8. MSM09-0146 Exhaust System Noise Level at 75 Inches

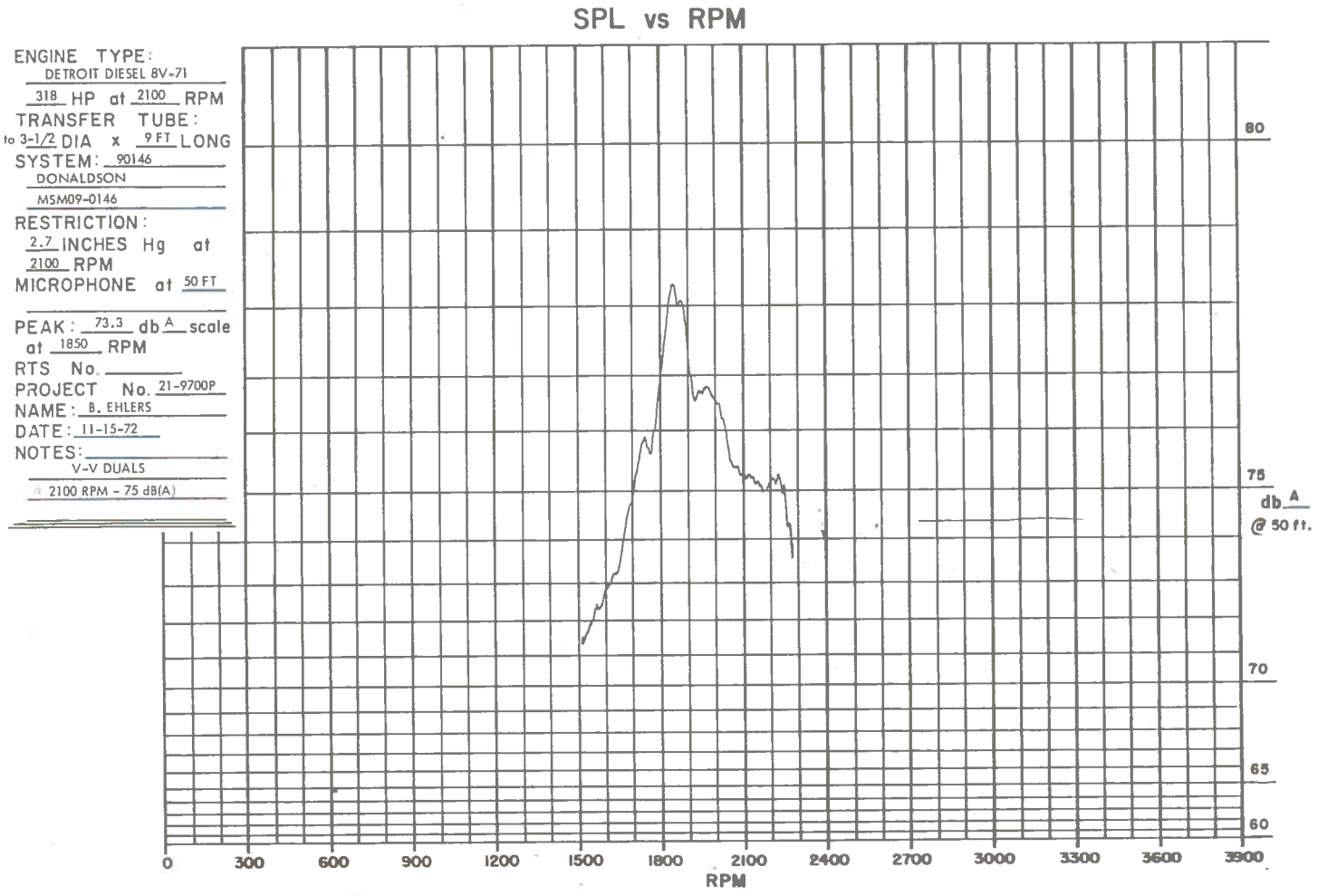


Figure 9. MSM09-0146 Exhaust System Noise Level at 50 Feet

3.2.1.1 Intake System Tests

Since the noise recording pick-up system and acoustic wall (figure 7) provide minimum engine noise transmission and minimum reflection from the outer wall surface of the test cell, test readings closely approximate free field conditions.

The engine intake system dynamometer tests were performed on engine running conditions ranging from high idle to full load. The data were plotted on graph paper showing noise level in dB(A) vs. rpm as shown in figure 10. A narrow-band analysis was made from the recording at full load for both engines.

The air cleaners were tested in a setup simulating a truck installation. This procedure was duplicated for all air cleaners tested except the FWD16-0011, which has an open face. This setup utilized the air cleaner plus a 2.5-ft inlet extension and air inlet cap. All air cleaners were placed approximately 4 ft from the acoustic wall and approximately 3 ft above ground level. The recording microphone was placed 75 in. from and perpendicular to the intake source. All 50-ft values were obtained through extrapolation of the data recorded at 75 in.

The intake system test data is summarized in tables 1 and 2.

With few exceptions, diesel engine intakes equipped with the air cleaners were not a significant noise source, compared with engine exhaust and cooling system noise. The majority fell below the 72 dB(A) level and a few were as low as 57 dB(A). From this data, we conclude that the majority of unevaluated air cleaners would also fall below the 72 dB(A) level, with the exception of the open face style air cleaners.

The attenuating qualities of air cleaners can be visualized if they are considered as silencers and catagorized into three acoustic classes, based on airflow. These three classes are shown in figure 11. The open face style air cleaner is the poorest noise attenuator. This type of air cleaner offers only minimal noise reduction because of its wide open inlet face. Most of the attenuation comes from the absorptive charac-

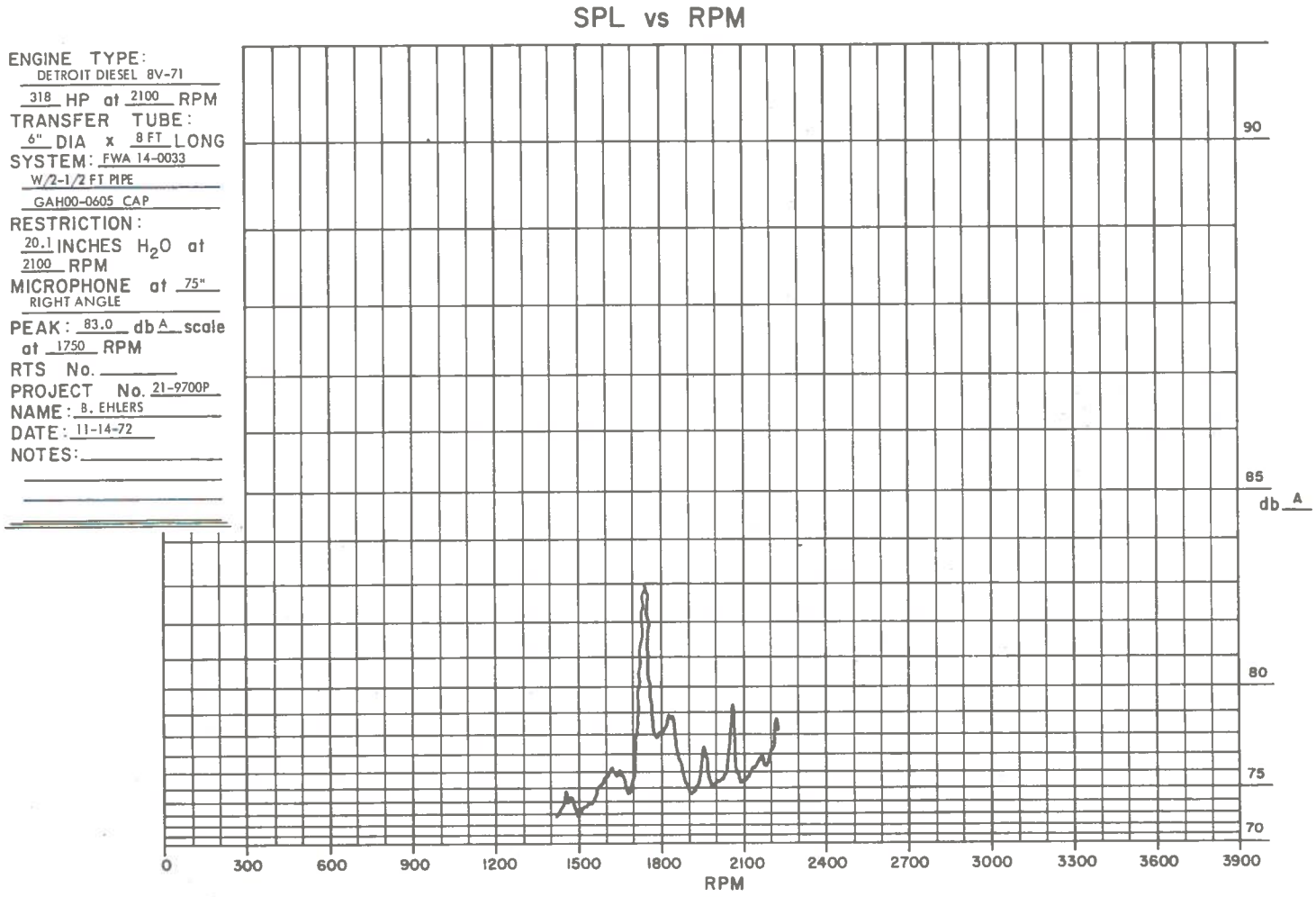


Figure 10. Plot of Noise Level vs. Engine RPM (Example)

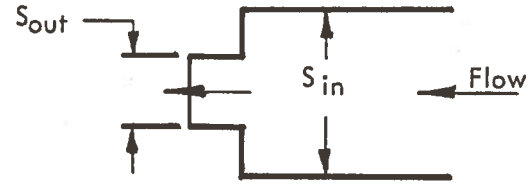
Table 1. Intake System Dynamometer Tests - Detroit Diesel 8V-71

Air Cleaner Model No.	75" Reading Peak (dB(A))	50' Reading (Extrapolated) (dB(A))	Air Cleaner Type
Open pipe (straight out)	105.7	87.7	--
Open pipe (mike at right angle)	102.2	84.2	--
Donaldson Air Cleaner			
EBA13-0018	89.9	71.9	Dry
EBA15-0003	84.8	66.8	Dry
EBA15-0005	89.4	71.4	Dry
FWA14-0033	83.0	65.0	Dry
FWA16-0001	83.3	65.3	Dry
EBB16-0007	84.5	66.5	Dry
EBB22-0003	85.2	67.2	Dry
FWD16-0011	88.9	70.9	Dry
FHG14-0121	81.2	63.2	Dry
FHG16-0151	80.2	62.2	Dry
FHG16-0116	82.5	64.5	Dry
FWG16-0199	96.7	78.7	Dry
Vortox Air Cleaner			
AB140A4	86.5	68.5	Dry
AB160A4	89.4	71.4	Dry
AE160A4	88.0	70.0	Dry
G160AC2	96.3	78.3	Oil Bath
G160BE2	96.3	78.3	Oil Bath

Table 2. Intake System Dynamometer Tests - Cummins NTC-335

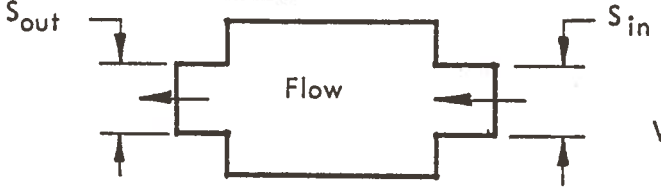
Air Cleaner Model No.	75" Reading Peak (dB(A))	50' Reading (Extrapolated) (dB(A))	Air Cleaner Type
Open pipe (straight out)	110.0	92.0	--
Open pipe (mike at right angle)	95.0	77.0	--
Donaldson Air Cleaner			
EBA13-0018	78.8	60.8	Dry
EBA15-0003	75.5	57.5	Dry
FWA14-0033	75.0	57.0	Dry
FWA16-0001	75.0	57.0	Dry
EBB16-0007	74.0	56.0	Dry
EBB22-0003	78.5	60.5	Dry
FWD16-0011	80.1	62.1	Dry
FHG14-0121	74.5	56.5	Dry
FHG16-0116	78.0	60.0	Dry
FHG16-0151	74.0	56.0	Dry
FWG16-0128	76.0	58.0	Dry
FWG16-0199	88.0	70.0	Dry
Vortox Air Cleaner			
AB140A4	74.5	56.6	Dry
AB160A4	75.5	57.5	Dry
AE160A4	74.5	56.5	Dry
G160AC2	81.7	63.7	Oil Bath
G160BE2	82.0	64.0	Oil Bath

1) Open Face



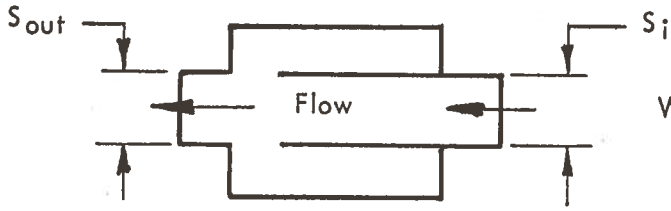
Where $S_{in} \gg S_{out}$

2) Expansion Chamber



Where $S_{in} \simeq S_{out}$

3) Center-Tube Expansion Chamber



Where $S_{in} \simeq S_{out}$

Figure 11. Three Classes of Intake Silencers

teristics of the components (usually paper elements) inside of the air cleaner. The Donaldson Company air cleaner, FWD16-0011, is an example of the class I or open-face style. The noise level of this air cleaner was at the high end of the measured range for both dynamometer tests.

The expansion chamber and center-tube expansion chamber types are better noise attenuators. These types of air cleaners are classed as reactive type elements and are frequency selective. That is, they could be tuned to a specific frequency for maximum attenuation. Filter elements in these air cleaners also contribute to noise absorption.

The effect of miscellaneous filtration accessories such as rain caps, precleaners, prescreeners, etc., for the most part will have little effect on the magnitude of intake pulsation or upon the sound pressure level. They do provide a slight increase in the acoustic length of the system, plus a different directivity pattern to the sound radiating from the air intake. It should be emphasized that directivity can change the noise level by $\pm$ 4 dB(A).

The general observation is that intake noise from a turbo-charged engine is easier to attenuate than the intake noise from a naturally-aspirated or blown engine. Figures 12 and 13 show the narrow-band analysis of a blower scavenged engine and a turbo-charged engine, respectively. Both are operating with an open pipe on the intake, no air cleaner. The blower scavenged engine exhibits narrow high-level spikes in the 200 Hz to 1500 Hz range. This is considered low frequency noise. The turbo-charged engine exhibits lower-level narrow spikes in the frequency range of 100 Hz to 7000 Hz. This is typical when comparing blower scavenged engines with turbo-charged engines. The higher frequency noise is more easily attenuated by the air cleaner.

Additional narrow-band analyses are included in Appendix B of this report.

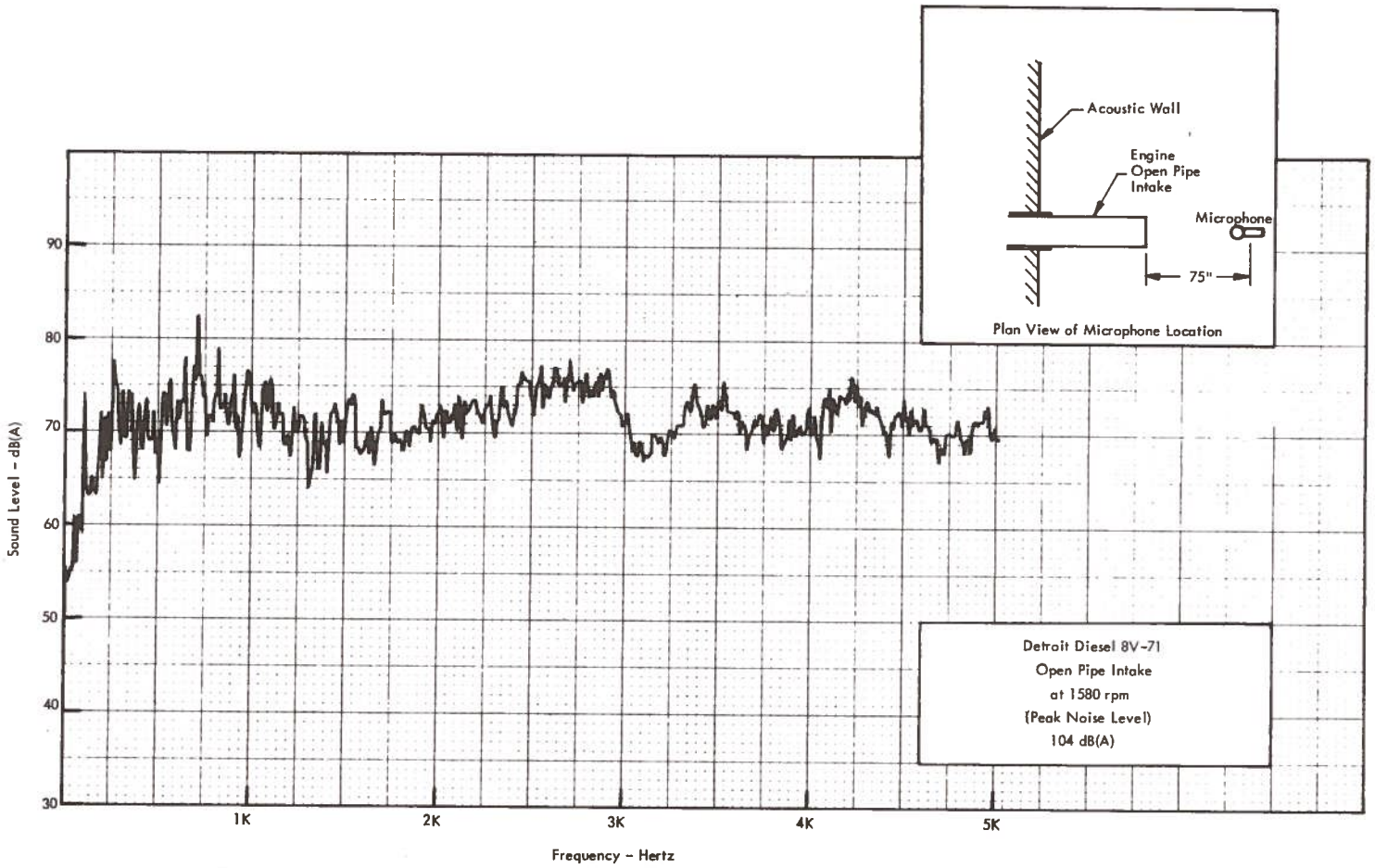


Figure 12. Narrow-Band Analysis of Blower Scavenged Engine (Open Pipe Intake)

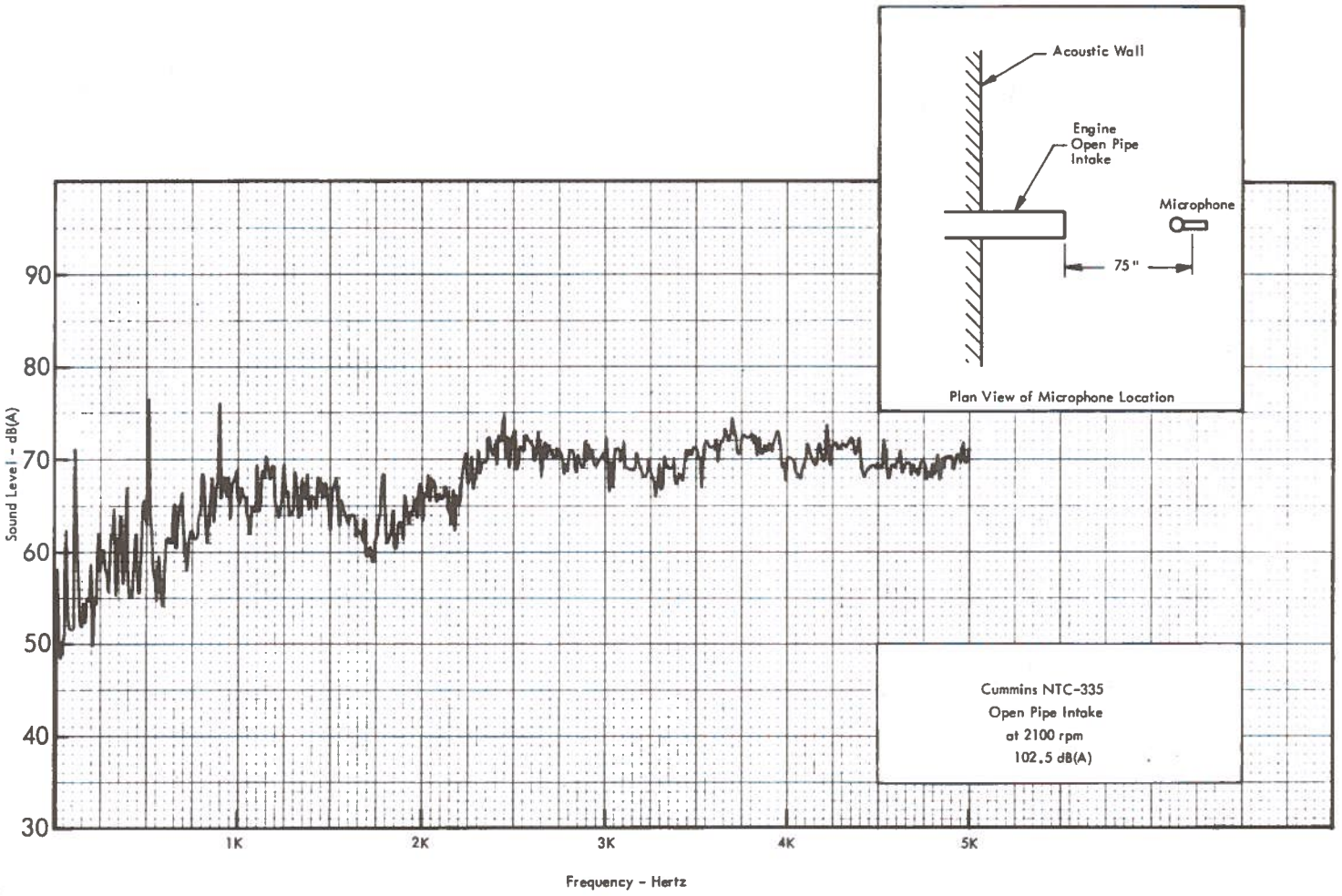


Figure 13. Narrow-Band Analysis of Turbo-Charged Engine (Open Pipe Intake)

3.2.1.2 Exhaust System Tests

Prior to testing the exhaust system, the test engine is operated a few minutes for warm-up and then loaded with the dynamometer at rated rpm. The X-Y plotter is then turned on and the dynamometer load increased to load the engine rpm down at wide-open-throttle. This simulates the normal maximum load and exhaust noise condition for an engine accelerating a truck. Measurements made by this method demonstrate exhaust noise resonances correlating with those measured during actual drive-by tests. Figures 14 and 15 covering identical exhaust systems show this resonance correlation at 1650 rpm (dynamometer test) and 0.75 seconds (drive-by test).

When the test engine is equipped with a Jacobs compression brake, these tests are repeated from high idle of the engine. The engine is operated at high idle rpm and the Jacobs brake actuated (which also cuts the fuel supply). The engine then rapidly decelerates (opposing the fly-wheel inertia of the dynamometer). Again, the exhaust noise is plotted vs. engine rpm. Generally, the exhaust noise is several dB(A) louder with the Jacobs brake operating than would be measured during normal operation (power output).

Since the time of the inertial load is very short (only a few seconds), the Jacobs brake noise levels are plotted twice continuously. If it were not for this continuous plot, only the peak level could be measured, and the engine rpm at which this occurs might not be accurately observed.

All tests were tape recorded from the ac output of the sound level meter. These were further analyzed for the spectral content by a digital Fast-Fourier Analyzer. Narrow-band analyses of several exhaust system tests are included in Appendix B.

Exhaust system back pressure is measured at the engine manifold and recorded only at maximum rated rpm and load. The technique used to measure back pressure is presented in Appendix C. This measurement represents the total exhaust system back pressure, including piping, elbows, and muffler. In truck exhaust systems, the back pressure of the piping is a considerable portion of the total. A few exhaust systems exhibited back pressures that were above the engine manufacturers' allowable limit.

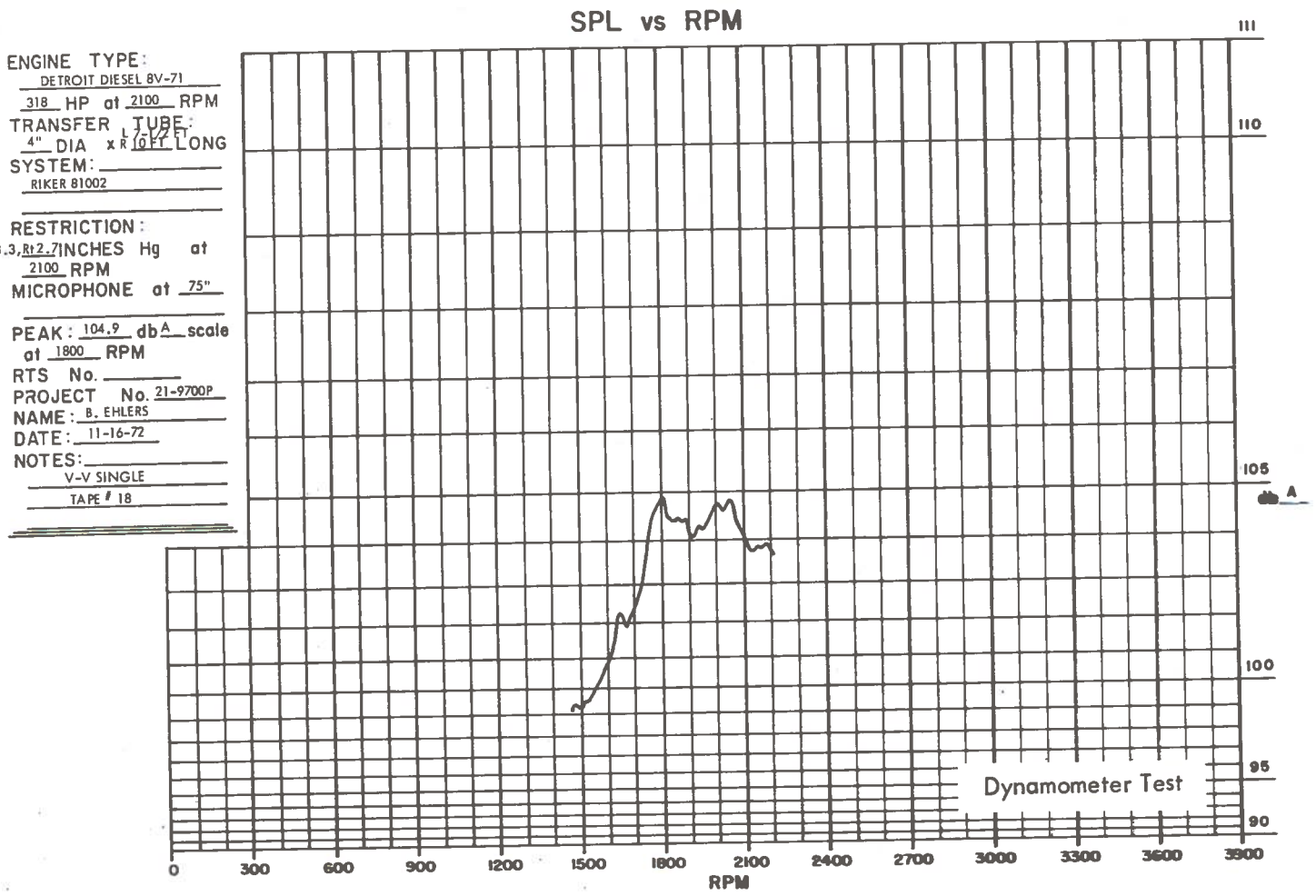


Figure 14. Sound Level Variation Produced by System Resonance, Dynamometer Test

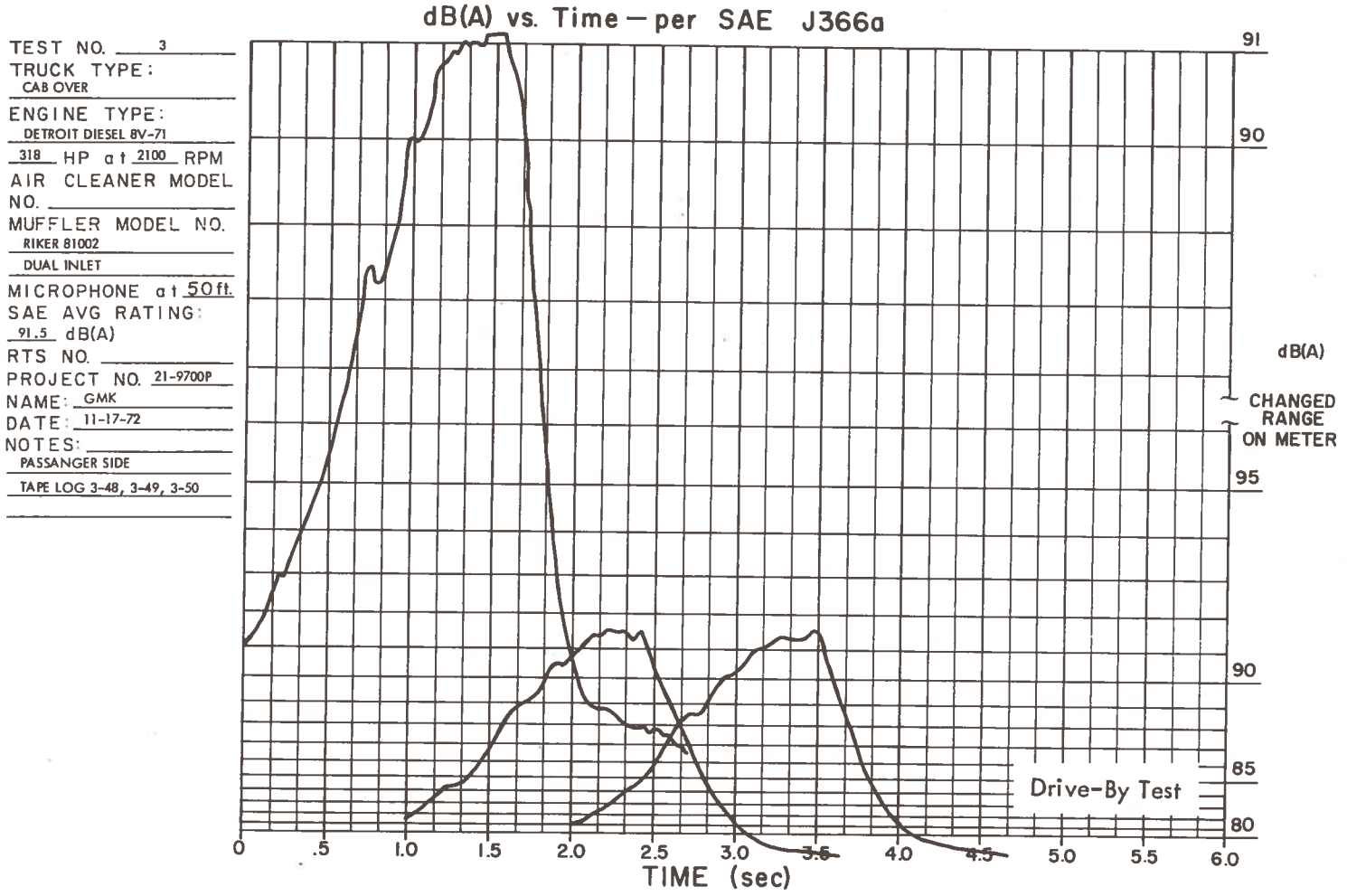


Figure 15. Sound Level Variation Produced by System Resonance, Drive-By Test

The exhaust system dynamometer test data is summarized in table 3, Single Exhaust Systems - Detroit Diesel 8V-71, table 4, Dual Exhaust Systems - Detroit Diesel 8V-71, and table 5, Single Exhaust Systems - Cummins NTC 335. These data indicate that available-for-order exhaust systems can reduce the exhaust noise below the 85 dB(A) level. If the engine is equipped with a Jacobs brake, the selection of suitable mufflers is diminished.

3.2.2 Vehicle Drive-By Tests

The drive-by test procedure is defined in SAE Recommended Practice J366a, and is designed to evaluate total truck noise, exclusive of tire noise. The measured noise levels using the SAE Practice J366a procedure then includes noise from the engine block, drive train, fan, intake, and exhaust.

Donaldson Company, as well as some truck manufacturers, have adopted techniques to measure isolated truck noise sources. The technique involves using acoustic treatments and mufflers to reduce all other noise sources 10 to 15 dB below the source to be measured.

The exhaust may be silenced to determine the "quiet" truck background level by using a series of mufflers (two or more per exhaust pipe) and directing the outlet of the exhaust pipe away from the microphone. Figure 16 shows how mufflers may be used in series. The intake air system can be silenced by using over-sized air cleaners and air silencers with the intake directed away from the microphone. Trucks can be run without fans for short periods of time or with additional cooling water carried in the back of the truck. Engine noise can be effectively shielded with sound barrier materials, such as leaded vinyl, hung from the vehicle hood and cab. This material extends down to cover the wheel and fender openings and radiator, etc., as shown in figures 17 and 18.

Table 3. Dynamometer Tests of Single Exhaust Systems - Detroit Diesel 8V-71

Muffler Model	System Configuration *	Back Pressure (in. Hg)		Measured Noise at 75"(dB(A))	Noise at 50'(dB(A)) (extrapolated)
		Rt.	Lt.		
Donaldson MTM10-0038	V-V	3.5	4.0	96.8	78.8
Riker 9 X D 505	V-V	3.4	4.1	99.3	81.3
Donaldson MOM12-0108	H-H	2.1	2.5	106.5	91.5
Riker 94506	H-V	3.1	3.9	95.9	77.9
Donaldson MOM12-0131	H-V	1.6	1.9	108.4	90.4
Riker 94306	H-V	6.1	6.5	95.0	77.0
Riker 94006	H-V	4.0	4.4	98.5	80.5
Donaldson MPM09-0063	V-V	3.3	3.6	100.2	82.2
Riker 9 X D 405	V-V	4.8	5.3	94.0	76.0
Stemco 9344	V-V	3.5	3.9	98.3	80.3
Stemco 9344	H-H	3.5	3.8	99.8	84.8
Stemco 9866	V-V	3.4	3.7	97.3	79.3
Stemco 9866	H-H	3.4	3.4	99.1	84.1
Donaldson MPM09-0141	V-V	3.5	3.8	99.8	81.8
Open Pipe		2.3	2.5	123.0	105.0

Note: These tests were run with the right bank of the engine using a center outlet manifold and the left bank with an end outlet manifold. With both banks using end outlet manifolds, slightly higher dB(A) levels may result.

*V-V (Vertical muffler - Vertical tail pipe)
H-V (Horizontal muffler - Vertical tail pipe)
H-H (Horizontal muffler - Horizontal tail pipe)

Table 4. Dynamometer Tests of Dual Exhaust Systems - Detroit Diesel 8V-71

Muffler Model	System Configuration	Back Pressure (in. Hg)		Measured Noise at 75"(dB(A)) (1 bank only)	Noise at 50'(dB(A)) (extrapolated)
		Rt.	Lt.		
Riker 81002	V-V	3.4	3.0	104.9	88.9
Riker 10005	V-V	3.3	2.7	101.9	85.9
Riker 9 X D 405	V-V	1.6		95.3	79.3
Stemco 9350	V-V	2.7		94.5	78.5
Stemco 9338	V-V	3.1		96.0	80.0
Donaldson MSM09-0135	V-V	2.5		95.5	79.5
Riker 9 X D 404	V-V	1.4		96.9	80.9
Donaldson MPM09-0115	V-V	2.2		98.0	82.0
Donaldson MSM09-0146	V-V	2.8		95.0	79.0
Donaldson WSM09-0211	V-V	2.9		90.5	74.5
Riker 9 X D 354	V-V	2.1		93.5	77.5
Riker 94306	H-V	1.5		97.1	81.1
Stemco 9416	H-V	1.0		95.4	79.4
Riker 94006	H-V	1.2		103.9	87.9
Riker 94506	H-V	1.0		97.8	81.8
Riker 94007	H-H	2.4		96.5	83.5
Donaldson MZM08-5008	H-H	2.6		98.7	85.7
Riker 94307	H-H	2.8		92.3	79.3
Open Pipe		.7		121.0	105.0

Table 5. Dynamometer Tests of Single Exhaust Systems - Cummins NTC 335 with Jacobs Brake

Muffler Model	System Configuration	Back Pressure (in. Hg)	Measured Noise Level at: 75"		Noise Level at: 50'(extrapolated)	
			EXH	Jacobs Brake	EXH	Jacobs Brake
Donaldson MUM09-0074	V-V	1.4	99.5	103.0	81.5	85.0
Riker 9 X D 505	V-V	3.4	95.0	96.5	77.0	78.5
Stemco 9327	V-V	.8	99.5	104.5	81.5	86.5
Donaldson MPM09-0197	V-V	1.6	94.0	100.5	76.0	82.5
Donaldson MPM09-0161	V-V	.9	95.5	99.2	77.5	81.2
Riker 9 X D 405	V-V	5.0	93.5	93.0	75.5	75.0
Riker 9 X D 404	V-V	5.3	97.0	93.0	79.0	75.0
Donaldson MUM09-0022	V-V	2.7	94.8	98.8	76.8	80.8
Donaldson MOM12-0108	H-H	2.1	95.0	100.0	80.0	85.0
Donaldson MOM12-0186	H-H	2.1	92.5	95.0	77.5	80.0
Riker 94506	H-V	3.7	89.0	93.5	71.0	75.5
Donaldson MOM12-0131	H-V	1.4	97.5	102.5	79.5	84.5
Donaldson MOM12-0176	H-V	2.8	93.5	96.0	75.5	78.0
Open Pipe		.5	111.5	117.5	93.5	99.5

Figure 16. Use of Mufflers in Series for "Quiet Truck" Tests

Figure 17. Use of Sound-Barrier Material for "Quiet Truck" Tests

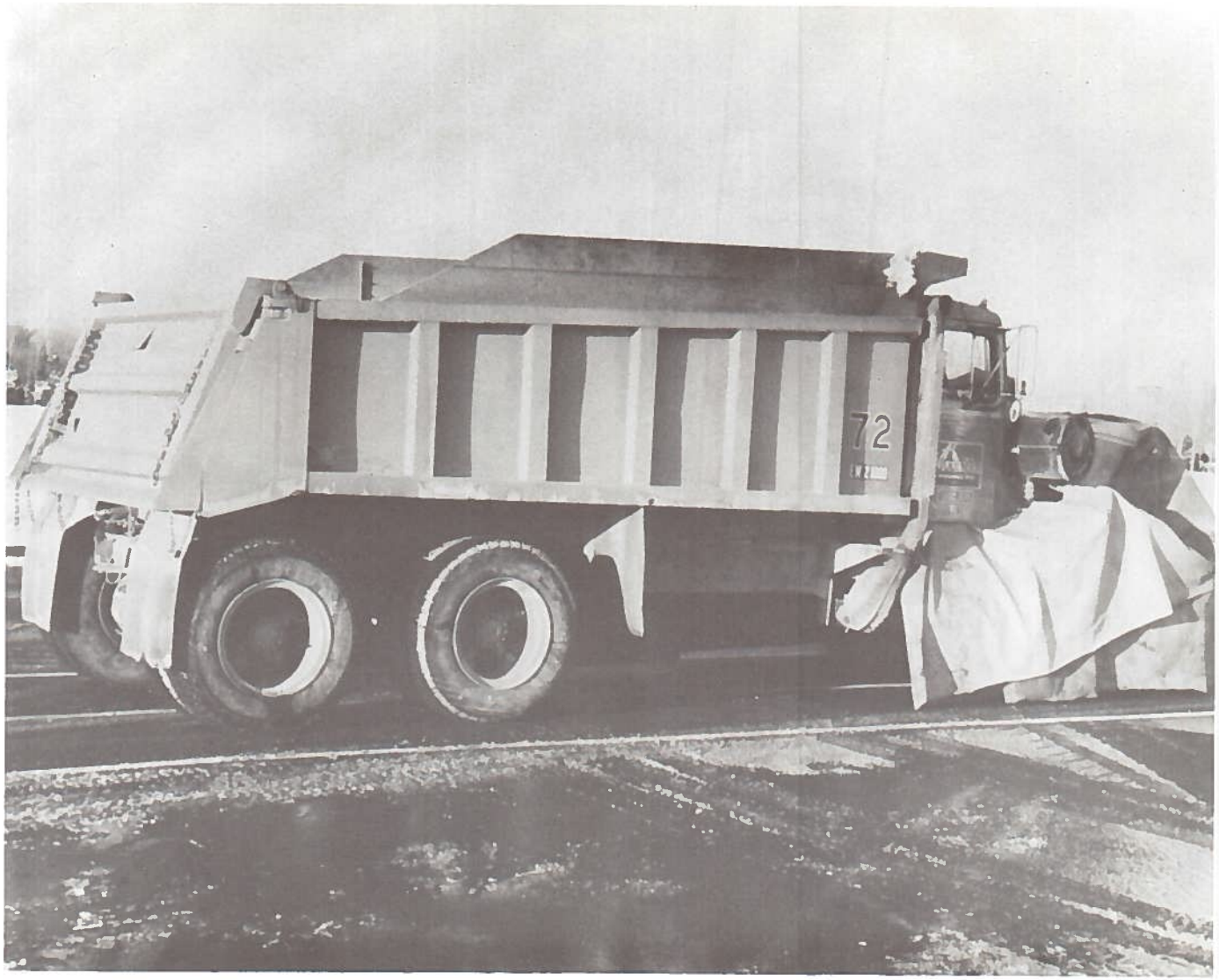


Figure 18. Use of Sound-Barrier Material for "Quiet Truck" Tests

Donaldson Company's test track consists of a black top surface with a driving lane marked for an acceleration zone and a deceleration zone as shown in figure 19. The microphone is located 50 ft perpendicular to the middle of the 100-ft driving zone (arrow, figure 19), and is connected to a B & K sound level analyzer by a 100-ft extension cable. The sound level analyzer is located in an instrumentation trailer.

The dc output of the sound level meter was connected to the Y-axis input of an X-Y recorder (figure 20). The ac output of the sound analyzer is fed into a tape recorder (figure 21). Pneumatic switches (figure 22) were positioned at the start and finish point of the 100-ft test zone to start and stop the X-Y recorder. A similar switch was used 15 ft ahead of the test zone to start the tape recorder. A fourth switch was positioned 15 ft down from the end of the test zone to turn off the recorder. This 15 ft distance insures that the recorder is up to speed before the truck enters the test zone.

All measurements were taken with a 4-in. polyfoam sound windscreen on the 1-in. diameter microphone to minimize wind noise (see figure 23). The microphone is calibrated with a pistonphone. The X-Y recorder is set for a 20 dB(A) dynamic range on the Y-axis and the X-axis is set for a time interval range of 6 seconds. This time base is adequate for drive-by since the test zone is usually traveled in 3 to 5 seconds. Each test was repeated three times. Since the tests are highly repeatable, the starting point is shifted 1 second on the X-axis of the X-Y recorder for each test to prevent the three traces from coinsiding with one another (see figure 24).

Two-way radios were used for communication between the truck driver and the personnel in the instrumentation trailer.

Truck cab noise was measured with a hand-held sound level meter positioned at ear level to the right side of the driver.

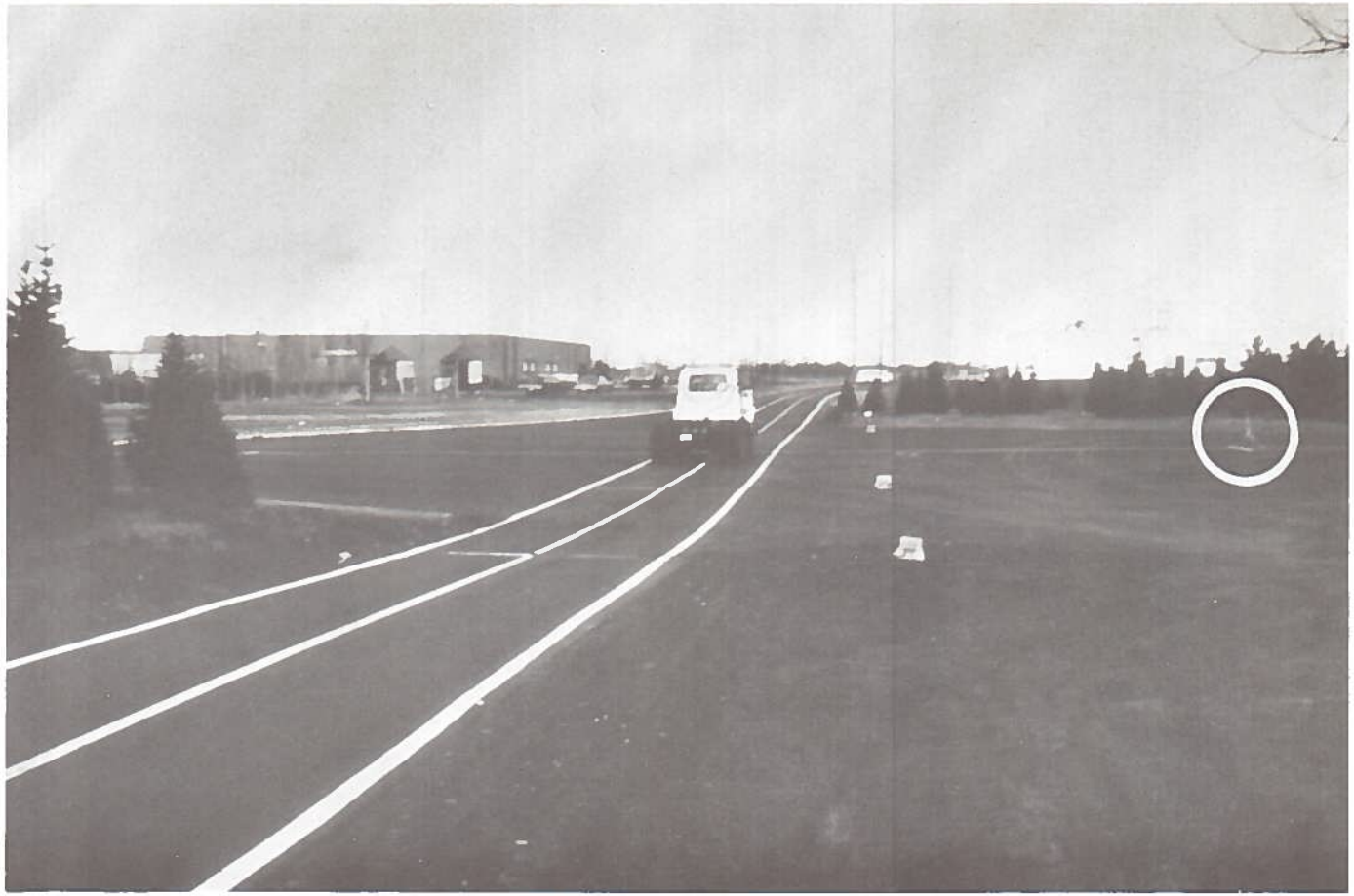


Figure 19. Donaldson Test Site Showing Microphone Location

Figure 20. X-Y Recorder for dB(A) Plotting

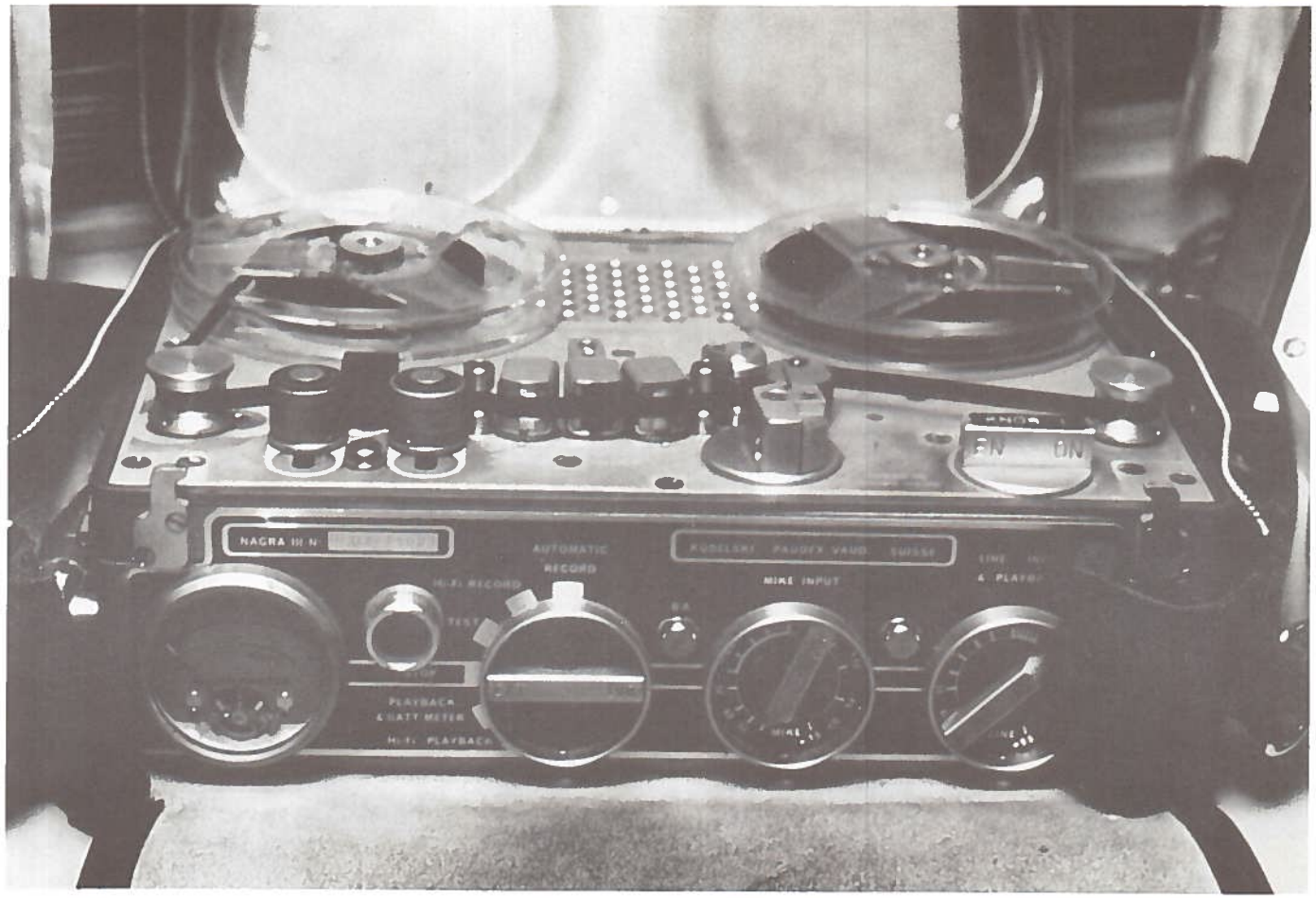


Figure 21. Tape Recorder Used for Data Storage

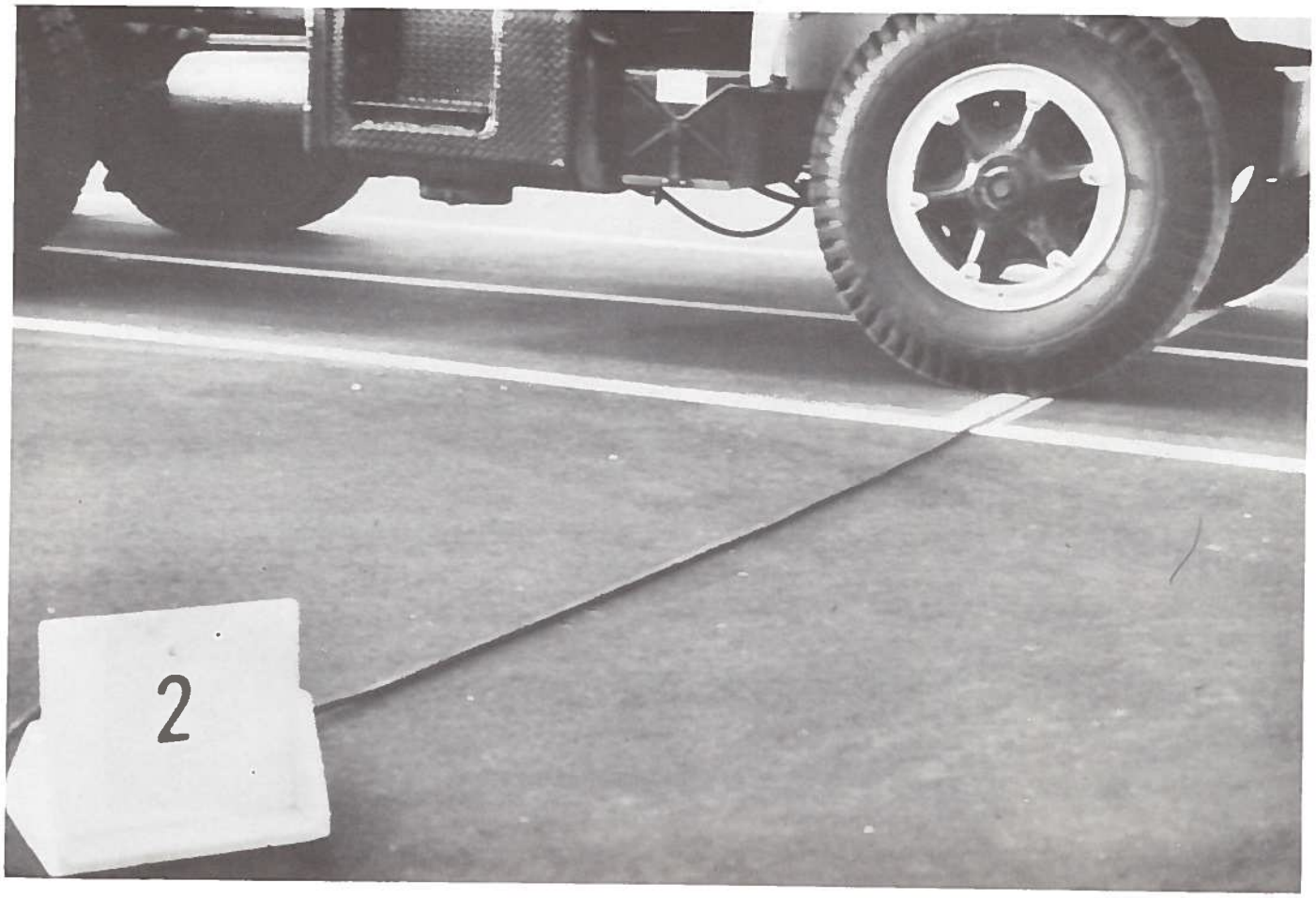


Figure 22. Pneumatic Switch on Test Track

Figure 23. Polyfoam Windscreen on Microphone

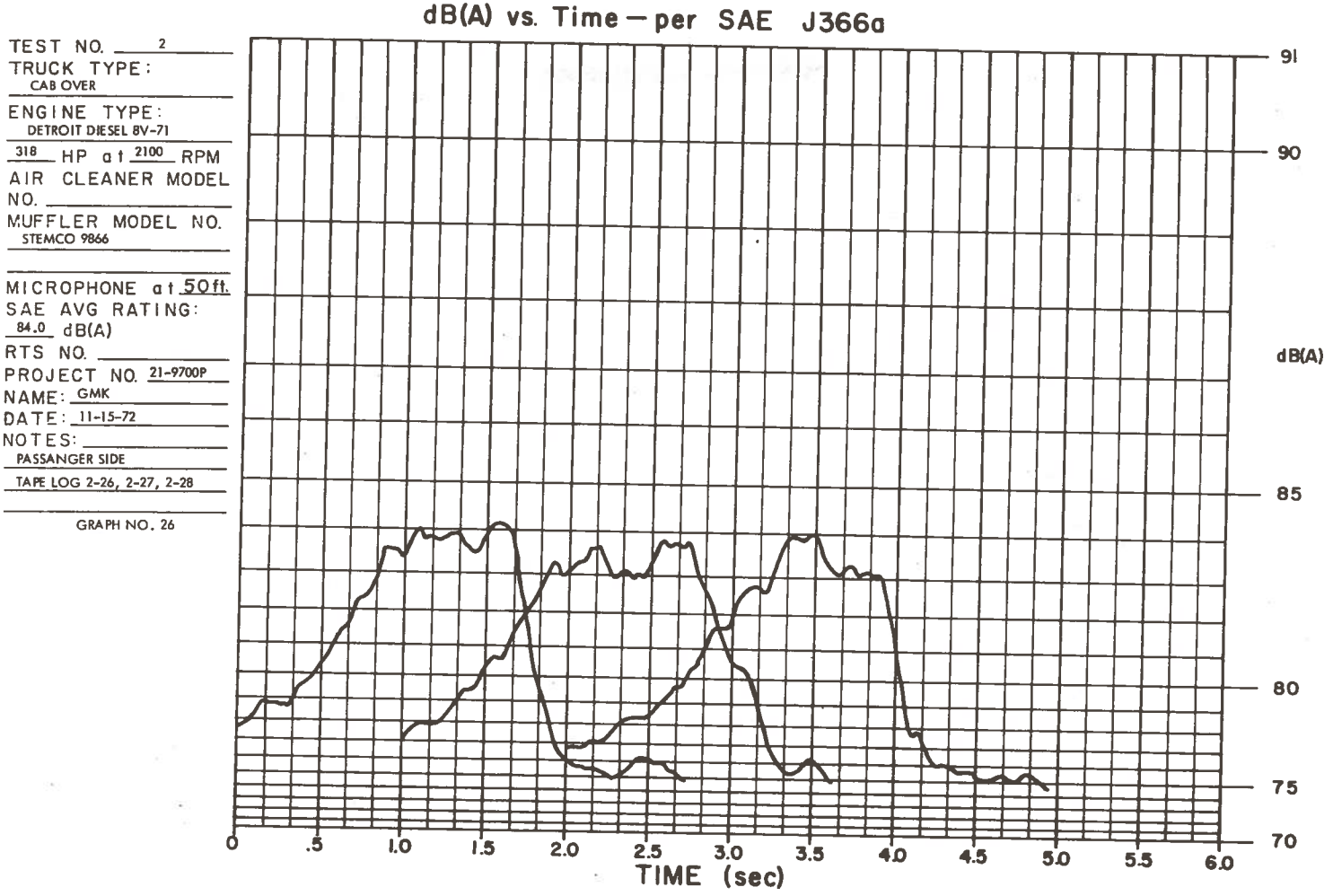


Figure 24. Plotter Trace Shift Technique

3.2.2.1 Acceleration Tests

For the drive-by acceleration tests, the truck was first tested to select the proper transmission gear which provided maximum truck speed of 35 mph at full engine rpm. The truck must approach the test zone at 2/3 of rated rpm and accelerate at wide-open-throttle through the zone. Maximum rpm is achieved approximately 10 to 15 ft past the microphone, at which time the truck is decelerated. This procedure was used for all acceleration tests carried out for this program.

Generally, the highest exhaust sound levels are obtained near maximum rpm. Some tests indicate additional peaks earlier in the test zone ar at lower engine rpm and diagonal distances larger than 50 ft. These peaks are engine-exhaust system resonances that can be observed on dynamometer tests on the same muffler-exhaust system at comparable low rpms. Three drive-by passes per test were made, and the reported noise level is the average of the peak levels of the two loudest passes, provided the peaks agree within 2 dB. Table 6 lists the vehicles used in the drive-by testing. Tables 7 through 16 list the drive-by test data by vehicle. Test runs labeled "standard truck" are tests conducted on the truck as it was received by Donaldson Company. Tests labeled "quiet truck" are tests on the truck with exhaust noise attenuated as low as possible using series mufflers, no engine radiator fan, and with leaded vinyl covering the engine compartment.

Intake noise was measured on runs 8, 9, and 10 of vehicle number 1. Intake noise for even the "quiet trucks" was generally substantially below exhaust and other truck noise levels. This noise was, therefore, very difficult to isolate during the drive-by tests.

> Note: It might be worthwhile at this point to discuss further SAE J366a. In order to control truck noise, state legislation usually defines an allowable dB(A) sound level figure, and then a technical agency is authorized to establish test and evaluation procedures. In the case of California, the method established was done in conjunction with truck and engine manufacturers and the SAE. The adopted method, SAE J366a, has become the accepted industry standard.

Table 6. Index of Vehicles Used in SAE Drive-By Tests

Test Number	Truck Make	Truck Style	Engine	Remarks
1	Kenworth	Cab Over	Cummins NTC 350	
2	Kenworth	Cab Over	Detroit Diesel 8V-71	Single Exhaust
3	Kenworth	Cab Over	Detroit Diesel 8V-71	Dual Exhaust
4	Mack	Conv.	Detroit Diesel 6-71	
5	Mack	Conv.	Mack ENDT 675	
6	Kenworth	Cab Over	Cummins NTA 420	
7	Mack	Cab Over	Mack ENDT 865	
8	White	Conv.	Cummins NTC-270CT	Jacobs Brake Equipped
9	Kenworth	Cab Over	Detroit Diesel 8V-71T	(Turbo-Charged)
10	M C I	Bus	Detroit Diesel 8V-71	

Vehicle: Kenworth
Engine: Cummins NTC 350
Exhaust System: Single

Table 7. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Pass. Side		50 ft Drivers Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Std Truck			89.0				90.0	89.0
2	Std Truck					87.5			
3	Std Rerun					87.2			
4	Quiet Truck			81.0					
5	Quiet Truck					81.1			
6	Quiet Truck			81.5					
7	Quiet Truck					80.4			
	Quiet Truck with:								
8	EBA 15-0003					77.5			
9	FHG 16-0116					84.1			
10	St. Intake Pipe					83.1			
11	Donaldson MUM09-0074(V-V)	1.0	1.8	84.6	84.0			90.0	90.0
12	Donaldson MPM09-0161(V-V)	.75	1.3	83.2	82.0			90.0	90.0
13	Stemco 9327 (V-V)	.75	1.0	84.4	79.0*			88.0	88.0
14	Donaldson MPM09-0197(V-V)	2.0		80.8				-	-
15	Riker 9 X D 505 (V-V)	2.6	1.9	80.4	72.3			87.0	86.0
16	5" Open Pipe	.3		93.9				90.0	88.0

* Noise level reported for NTC 335

Vehicle: Kenworth
Engine: Detroit Diesel 8V-71
Exhaust System: Single

Table 8. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Pass. Side		50 ft Drivers Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Std Truck			89.0				90.0	90.0
2	Std Truck	1.8				85.7			
3	Quiet Truck	4.75		80.5				88.0	89.0
4	Quiet Truck	4.75				81.0			
	Quiet Truck with:								
5	Riker 9 X D 505 (V-V)	2.6		86.4				88.0	89.0
6	Donaldson MTM10-0038 (H-H)	2.85		84.8				88.5	88.0
7	Riker 9 X D 405 (V-V)	3.85	3.6	83.4	86.6			88.5	88.0
8	Donaldson MPM09-0063 (V-V)	2.80	3.9	86.7	87.0			89.0	88.5
9	Donaldson MPM09-0141(V-V)	1.80	3.4	86.2	84.0			88.5	88.0
10	Stemco 9866 (V-V)	3.0	3.8	84.0	78.0			88.0	89.0
11	Stemco 9344 (H-H)	2.85	3.8	86.8	80.0			90.0	89.5
12	5" St. Stack	1.6		104.8				98.5	98.0

Vehicle: Kenworth
Engine: Detroit Diesel 8V-71
Exhaust System: Dual

Table 9. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Pass. Side		50 ft Drivers Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Std Truck	.75		90.4				94.0	90.0
2	Std Truck	.75				90.6			
3	Quiet Truck	4.75		80.5				88.0	89.0
4	Quiet Truck	4.75				81.0			
	Quiet Truck with:								
5	Donaldson MSM09-0146 (V-V)	2.3				82.5		90.0	89.5
6	Donaldson MSM09-0146 (V-V)	2.3		83.0					
7	Donaldson MPM09-0115 (V-V)	1.6	2.1			87.2	85.0	90.0	88.5
8	Donaldson MPM09-0115 (V-V)	1.6	2.1	85.7	85.0				
9	Riker 9 X D 354 (V-V)	2.0	2.7			83.5	85.7	90.5	90.0
10	Riker 9 X D 354 (V-V)	2.0	2.7	83.6	85.7				
11	Riker 9 X D 404 (V-V)	1.5	1.2			85.3	86.3	90.5	89.5
12	Riker 9 X D 404 (V-V)	1.5	1.2	85.5	86.3				
13	Donaldson MSM09-0135 (V-V)	2.0	2.7			84.4	81.0	89.5	89.5
14	Donaldson MSM09-0135 (V-V)	2.0	2.7	83.8	81.0				
15	4" St. Stacks	2.0		108.4				-	-
16	Riker 10005 (V-V)	2.75	1.7	90.0	82.0			90.0	90.0
17	Riker 81002 (V-V)	2.75	1.4	91.5	83.0			92.0	92.0
18	Stemco 9350 (V-V)	2.5	3.1			84.1	78.0	90.0	89.0
19	Stemco 9350 (V-V)	2.5	3.1	84.0	78.0			90.0	90.0

Vehicle: Mack
Engine: Detroit Diesel 6-71
Exhaust System: Single

Table 10. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Pass. Side		50 ft Drivers Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Quiet Truck	6.0		79.3				-	-
	Quiet Truck with:								
2	Stemco 9336 (V-V)	1.75	1.8	81.5	78.0			93.0	92.0
3	Stemco 9344 (V-V)	1.5		81.6				93.5	92.0
4	Riker 9 X D 405 (V-V)	2.5	2.0	80.4	87.0			92.0	90.0
5	Donaldson MTM10-0038 (V-V)	2.0		81.5				92.0	93.0
6	Donaldson MSM09-0142 (V-V)	2.6	3.0	81.5	82.0			92.5	88.0
7	Donaldson MUM07-0054+142 (V-V)	2.25		79.6				89.0	88.5
8	Stemco 9344 (V-V)	1.6		86.4				93.0	90.0
9	Donaldson MTM10-0048 (H-H)	2.25		82.3				90.5	90.0
10	Riker 94007 (H-H)	4.5		81.4				-	-
11	Donaldson MTM10-0006 (H-H)	2.5	2.6	92.9	86.0				
12	Donaldson MTM10-0043 (H-H)	1.75		83.5					
13	Donaldson MOM12-0154 (H-V)	2.5	3.3	78.9	83.0				
14	St. Stack 4"	.75		104.9					
15	Stemco 9416 (H-V)	1.75		80.7					
16	Donaldson MSM09-0142 (V-V)	2.25		79.8 *	82.0				

* Test 16 was a rerun of test 6

Vehicle: Mack
Engine: Mack ENDT 675
Exhaust System: Single

Table 11. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Pass. Side		50 ft Drivers Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Std Truck *	.0		85.8				94.5	94.0
2	Std *	.0				85.0			
3	Quiet Truck	.6		74.5				-	-
4	Quiet Truck	.6				74.3			
	Quiet Truck with:								
5	Donaldson MTM10-0043 (V-V)	1.0		74.6				90.5	89.0
6	Donaldson MTM10-0048 (H-H)	.6		75.0				91.0	90.0
7	Donaldson MPM09-0063 (V-V)	.7		75.2				93.0	93.0
8	Donaldson MPM09-0141 (V-V)	.5		74.8				92.0	92.0
9	Donaldson MUM09-0022 (V-V)	.4		77.8				93.0	93.0
10	Donaldson MOM12-1000 (H-V)	.7		73.3				90.0	90.0
11	Donaldson MOM12-0100 (H-H)	.8		73.4				93.0	94.0
12	4" St. Stack	.0		83.9				93.0	91.5

* The standard truck, as received by Donaldson Company for test, was equipped with a 4" diameter vertical stack (no muffler)

Vehicle: Kenworth
Engine: Cummins NTA 420
Exhaust System: *

Table 12. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Pass. Side		50 ft Drivers Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Std Truck	1.25		89.5				91.0	91.5
2	Std Truck	1.25				88.4			
3	Quiet Truck	-		83.9					
4	Quiet Truck	-				87.1			
5	Quiet Rerun			82.9					
6	Quiet Rerun					83.5			
	Quiet Truck with:								
7	Donaldson MUM09-0074 (V-V)	1.25	2.3	86.9	84.0			89.0	89.0
8	Donaldson MPM09-0161 (V-V)	1.25	2.1	85.2	83.0			88.0	87.5
9	Donaldson MPM09-0197 (V-V)	2.5		84.0				89.0	89.0
10	Stemco 9327 (V-V)	.8		86.6				89.0	87.0
11	Donaldson MOM12-0131 (H-V)	1.6		85.9				89.0	89.0
12	Donaldson MOM17-0101 (H-H)	.6		83.5				90.0	90.0
13*	MPM09-0161 + 197 (V-V)	.5		84.6				90.0	88.0
14*	(2) MSM09-0135 (V-V)	4.0		83.1				88.0	87.0

* Run 1 - 12: Single exhaust; run 13 and 14: Dual exhaust

Vehicle: Mack
Engine: Mack ENDT 866
Exhaust System: Single

Table 13. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Pass. Side		50 ft Drivers Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Std Truck	-		83.0				84.5	83.5
2	Std Truck					80.8			
3	Quiet Truck	1.0		77.4				84.0	83.0
4	Quiet Truck	1.0				78.3			
	Quiet Truck with:								
5	Donaldson MOM12-0109 (H-H)	1.5		78.0				84.0	82.0
6	Donaldson MOM12-0131 (H-V)	1.25		77.8				88.0	87.0
7	Riker 94506 (H-V)	3.0		77.2				85.0	82.0
8	Donaldson MOM12-0176 (H-V)	3.0		79.1				83.5	82.0
9	Stemco 9854 (H-V)	3.0		77.3				85.5	84.0
10	Stemco 9327 (V-V)	.5		78.8				85.0	84.0
11	Donaldson MPM09-0161 (V-V)	.75		78.8				85.0	83.0
12	Donaldson MPM09-0197 (V-V)	1.25		78.0				83.5	83.0
13	Riker 9 X D 505 (V-V)	2.85		77.5				86.0	85.0
14	Donaldson MUM09-0022 (V-V)	1.75		82.8				83.5	83.0
15	Riker 9 X D 405 (V-V)	4.5		80.6				84.0	84.0
16	Riker 9 X D 404 (V-V)	4.5		84.0				85.0	82.0
17	5" St. Stack	.25		85.8				86.0	82.0
18	Donaldson MUM09-0074 (V-V)	1.0		80.5				-	83.0

Vehicle: White
Engine: Cummins NTC-270CT
Exhaust System: Single

Table 14. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Exhaust Pass. Side		50 ft Jacobs Brake Pass. Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Std Truck	-		90.8				94.0	92.0
2	Std Truck	-				95.5		102.0	94.0
3	Quiet Truck			80.0				86.5	85.0
4	Quiet Truck					75.8		87.0	86.0
	Quiet Truck with:								
5	Donaldson MPM09-0161 (V-V)	.6	1.3	80.3				88.5	86.0
6	Donaldson MPM09-0161 (V-V)					82.2		-	-
7	Donaldson MUM09-0074 (V-V)	.75	1.7	80.5	82.0			87.0	86.0
8	Donaldson MUM09-0074 (V-V)					82.7		93.0	90.0
9	Stemco 9327 (V-V)	.75	1.0	80.3	79.0			87.5	86.0
10	Stemco 9327 (V-V)					86.2		95.0	92.0
11	Donaldson MPM09-0197 (V-V)	.75		79.8				88.0	86.5
12	Donaldson MPM09-0197 (V-V)					83.7		92.0	89.0
13	Riker 9 X D 505 (V-V)	1.75	1.8	80.1	72.1			88.0	86.5
14	Riker 9 X D 505 (V-V)					82.0		91.0	89.0
15	Donaldson MOM12-0108 (H-H)	.5	2.4	81.6	84.0			88.0	86.0
16	Donaldson MOM12-0108 (H-H)					90.6		90.0	88.0
17	Hopkins Dynavac (H-V)	1.5		86.4				92.0	-
18	Hopkins Dynavac (H-V)					95.0		94.0	95.0
19	5" St. Stack	.5		91.8		100.0		108.0	98.0

Vehicle: Kenworth
Engine: Detroit Diesel 8V-71T
Exhaust System: *

Table 15. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Pass. Side		50 ft Drivers Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Std Truck	.75		90.7				91.0	93.0
2	Std Truck	.75			92.6				
3	Quiet Truck	1.0		80.9				87.0	87.0
4	Quiet Truck	1.0			81.8				
	Quiet Truck with:								
5	Donaldson MPM09-0197 (V-V)	1.0		80.7				85.5	85.0
6	Donaldson MPM09-0161 (V-V)	.6		80.5				86.0	85.0
7	Stemco 9327 (V-V)	.5		82.3				86.5	86.0
8	5" St. Stack	.5		94.4				88.5	88.5
9	Donaldson MOM12-0131 (H-V)	.8		81.2				88.0	86.5
10	Donaldson MOM12-0108 (H-H)	1.4		82.3				86.0	86.0
11	Donaldson MUM09-0074 (V-V)	.75		82.9				87.0	86.0
12*	Donaldson MPM09-0161 (V-V)	.2		80.9				86.5	86.0
13*	Donaldson MPM09-0161 (V-V)	.2			81.0				
14*	4" St. Stack + MAM10-0059	.6		84.9				89.0	88.0
15*	4" St. Stack (Wye)	.3		91.6				93.0	89.0

*Run 1-11: Single exhaust, Run 12 - 15: Dual exhaust

Vehicle: MCI Bus
Engine: Detroit Diesel 8V-71
Exhaust System: Single

Table 16. Drive-By Tests

Run No.	Device Tested	Back Pressure (in. Hg)		Noise Level (dB(A))					
				50 ft Pass. Side		50 ft Drivers Side		In Cab with windows:	
		Test	Mfgr Data	Test	Mfgr Data	Test	Mfgr Data	Open	Closed
1	Std Muffler (Nelson)	-		81.2					
2	Std Muffler (Nelson)					85.2			

J366a is considered as the best method to consistantly provide maximum, or close to maximum, truck noise levels that may be comparable between many different qualified testing groups. Its only shortcoming is that it does not always cause the truck to create maximum noise.

Other modes of truck operation may cause higher readings; such as sudden acceleration from dead stop ("dig out"), and steady rpm, full load, "drive-bys" (searching for loudest engine speed).

In order to fully define a truck's noise characteristics, the type of runs discussed above might be included (see DCI test sheets, figure 25). However, the test results would not be completely comparable between testing groups and much of the consistency, as well as test simplicity, would suffer.

Vehicle number 10 was a bus. Two tests were run on this vehicle. Both of these tests were exhaust noise tests using the standard (original equipment) oval muffler. Exhaust systems from other manufacturers were not readily available for this vehicle, therefore, we were limited to evaluating the standard muffler only.

Table 17 summarizes straight pipe noise level, standard vehicle noise level, quiet vehicle noise level, and cab noise level for both standard and quiet vehicles. It is pertinent to note that even though the external noise levels at 50 ft are substantially reduced on the quiet truck, the noise inside the cab remains high, indicating that mechanical engine noise is a predominant source of cab noise. (Fans are inoperative on "quiet" truck tests.)

3.2.2.2 Jacobs Brake Tests

The Jacobs brake drive-by test is a deceleration test. The truck is operated at maximum rpm and 35 mph going into the test zone. Ten to 15 ft before the center line of the microphone, the Jacobs brake is actuated; the truck decelerates and the exhaust system sound level is recorded and plotted. The deceleration is continued until 1/2 maximum engine rpm is reached, and the truck is then driven

DONALDSON COMPANY, INC.

TRUCK NOISE QUALIFICATION TEST

File No. _____
Date _____
Location _____
Sheet No. _____
Reel No. _____

Customer: _____

Chassis Model _____ Serial No. _____

Engine Model _____ Serial No. _____

Exhaust System: Muffler(s) No. _____ Single ___ Dual ___

Frame or Cab Mount. Exhaust Pipe: Rt. Bank (Length & Dia) _____
Left Bank (Length & Dia) _____ Wye _____
Common (Length & Dia) _____ Tailpipe (Length & Dia) _____
Vertical or Horizontal.
Description of Outlet _____
Description of Manifold _____

Fan: Dia. _____, Blades _____ Symmetrical, Non-Symmetrical
Ratio _____ Pitch _____ Shroud _____ Shutters _____

Induction System: Inlet Position & Description: _____

Stack (Length & Dia) _____ Transfer Pipe (Length & Dia) _____

Air Cleaner _____ Silencer _____

Load: _____ lbs. _____ brakes only

Weather: Temp. _____ Wind _____ Bar. _____ Hum. _____ Ceiling _____

Test Conditions: Road Surface _____ Surface to Microphone _____

Backpressure: _____ in. Hg. Tap Location _____

NOISE LEVEL: Steady Full Load @ Rated _____ rpm _____ dB "A"
@ Max. Noise _____ rpm _____ dB "A" Max. Sones _____

		Rating
SAE J366 : Rt. Side	___ ___ ___	_____ dB"A"
Left Side	___ ___ ___	_____ dB"A"
Accel. from Stop: Rt. Side	___ ___ ___	_____ dB"A"
Left Side	___ ___ ___	_____ dB"A"

Remarks: _____

Cab Noise Level: Window Open _____ dB"A"
Window Shut _____ dB"A"

Tested By: _____
(Observer)

_____
(Driver)

DWR/mr
4-3-70

Certified By: _____

Figure 25. Drive-By Test Data Sheet

Table 17. Drive-By Test Summary

Engine Type	St. Pipe (dB(A))	*Std. Truck (dB(A))	*Quiet Truck (dB(A))	Std. Trk in Cab Cab Levels (dB(A))		Quiet Trk Best Muffler/No Fan Cab Levels (dB(A))	
				Windows Open	Closed	Windows Open	Closed
Cummins NTA 350	93.9	89.0	81.0	90.0	89.0	87.0	86.0
Detroit Diesel 8V-71**	104.8	89.0	-	90.0	90.0	88.5	88.0
Detroit Diesel 8V-71***	108.4	90.6	80.5	94.0	90.0	89.5	89.5
Detroit Diesel 6-71	104.9	-	79.3	93.0	92.0	92.5	88.0
Mack ENDT 675	83.9	85.8	74.5	94.5	94.0	90.5	89.0
Cummins NTA 420	-	89.5	83.9	91.0	91.5	88.0	87.0
Mack ENDT 865	85.8	83.0	77.4	84.5	83.5	83.5	83.0
Cummins NTC 270 CT	91.8	90.8	80.0	94.0	92.0	88.0	86.5
Jacobs Brake	100.0	95.5	75.8	102.0	94.0	91.0	89.0
Detroit Diesel 8V-71T	94.4	90.7	80.9	91.0	93.0	85.5	85.0
Detroit Diesel 8V-71	-	85.2	-	-	-	-	-

* "Standard Truck" and "Quiet Truck" are defined in section 3.2.2.1.

** Single Exhaust System

*** Dual Exhaust System

through the remainder of the test zone. Generally, the exhaust noise levels are higher under the Jacobs brake deceleration than under normal acceleration. Increases of 3 to 9 dB appear to be normal.

Vehicle number 8 was equipped with a Jacobs brake. The noise level measurement of the vehicle with the Jacobs brake are summarized in table 14. This particular vehicle was a gravel truck. During the drive-by test, the vehicle was loaded with 15 tons of gravel to insure proper loading of the engine during decelerating testing.

3.2.2.3 Back Pressure Tests

Exhaust system back pressure was measured with a mercury manometer located in the vehicle cab. It was connected with rubber tubing to a copper pressure fitting in the exhaust system. A 1/8-in. hole was drilled in the exhaust pipe near the engine manifold flange in a location where the exhaust tube is free of elbows.

The truck was operated in an intermediate gear at maximum rpm and load. This was achieved by partially holding the brakes under full vehicle acceleration. Several hundred feet are driven at this condition, allowing the exhaust gas temperature to increase to a maximum and, in the case of the turbo-charged engine, the turbine speed to reach a maximum. Under these test conditions, the back pressure increases to a maximum stabilized value. This value in inches of mercury is the reported back pressure.

The back pressure readings are summarized for the exhaust systems during drive-by tests in tables 7 through 16. A few of the exhaust systems exhibited high back pressure readings. Since it is easier to maintain steady-state test conditions during dynamometer testing, back pressure measurements made during dynamometer tests (tables 3, 4, and 5) are frequently higher than those recorded during drive-by tests.

3.3 Data Reduction and Presentation

The end item of this contract is development of a comparative catalog system to allow selection of existing or available-for-order intake and exhaust systems for a particular engine. The comparative system should provide noise level information, system geometry, and cost.

The basis for this comparative catalog system is the data obtained from the manufacturers survey. The survey replies received from the manufacturers, in most cases, were not complete. Therefore, the presentation of the comparative data had to be adjusted to fit that which was obtained.

The presentation of comparative data on intake and exhaust systems by engine model is included as Appendix A of this report. The data received from engine manufacturers was presented on the form shown in figure 26. A total of 36 engines have been so cataloged (see Appendix A).

Following the engine specification sheet, specification sheets on the intake system and exhaust system are presented for each engine.

3.3.1 Intake Systems

Information received from intake system manufacturers was of the application type. However, information on performance as an intake silencer was lacking. It would be improper for Donaldson Company to try to predict performance of another manufacturer's product. Therefore, this information is missing in the comparison sheets. However, referring back to section 3.2.1.1 of this report, the dynamometer tests show that intake systems are generally good intake silencers because of the large expansion ratio. Most present-day air cleaners attenuate noise to a

ENGINE DATA

MANUFACTURER MODEL NO.

TYPE .....
NUMBER OF CYLINDERS .....
FORM .....
CYCLES .....

BORE .....
STROKE .....
DISPLACEMENT .....
COMPRESSION RATIO .....

MAX RATED HP .....
MAX RATED TORQUE .....

INTAKE FLOW RATE AT RATED LOAD .....
MAX INTAKE RESTRICTION.....
EXHAUST TEMPERATURE AT RATED FLOW ...
MAX EXHAUST SYSTEM BACK PRESSURE ....

EXHAUST GAS COMPOSITION

N_2 .....
O_2 .....
CO .....
CO_2 .....

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

Figure 26. Engine Data Form

level of 72 dB(A) or lower, at rated rpm, when observed at 50 ft. As a result truck intake noise is uaually found to be substantially below the level of other noise sources.

Data obtained from testing was intended to confirm manufacturer supplied data. The noise data was collected in two ways. First, a 75-in. measurement of the dB(A) noise level was plotted against engine rpm from high idle to full load as shown in figure 27. This example indicates a peak noise level of 75.5 dB(A) at 1650 rpm. Donaldson Company normally uses 1400 rpm as the lower speed limit for peak noise level. Second, a tape recording was made with the engine operating at the condition where the peak noise level was observed and also at rated rpm. This technique allowed a narrow-band analysis to be made at a later time.

A sample data sheet for comparison of intake system is shown in figure 28.

Caution is recommended against placing too much confidence in the prices listed on these data sheets. Each manufacturer has several recommended price schedules. Contact local jobbers for firm prices on these products.

3.3.2 Exhaust Systems

The exhaust system data received in the manufacturers survey was, for the most part, completed or partially completed questionnaires that were submitted with the letter of inquiry. However, examining the exhaust noise level information reveals that at least one manufacturer is presenting combined overall vehicle noise, including exhaust system noise. This should result in a slightly higher noise level. Donaldson Company has not altered such noise data but has indicated those noise readings that include overall vehicle noise.

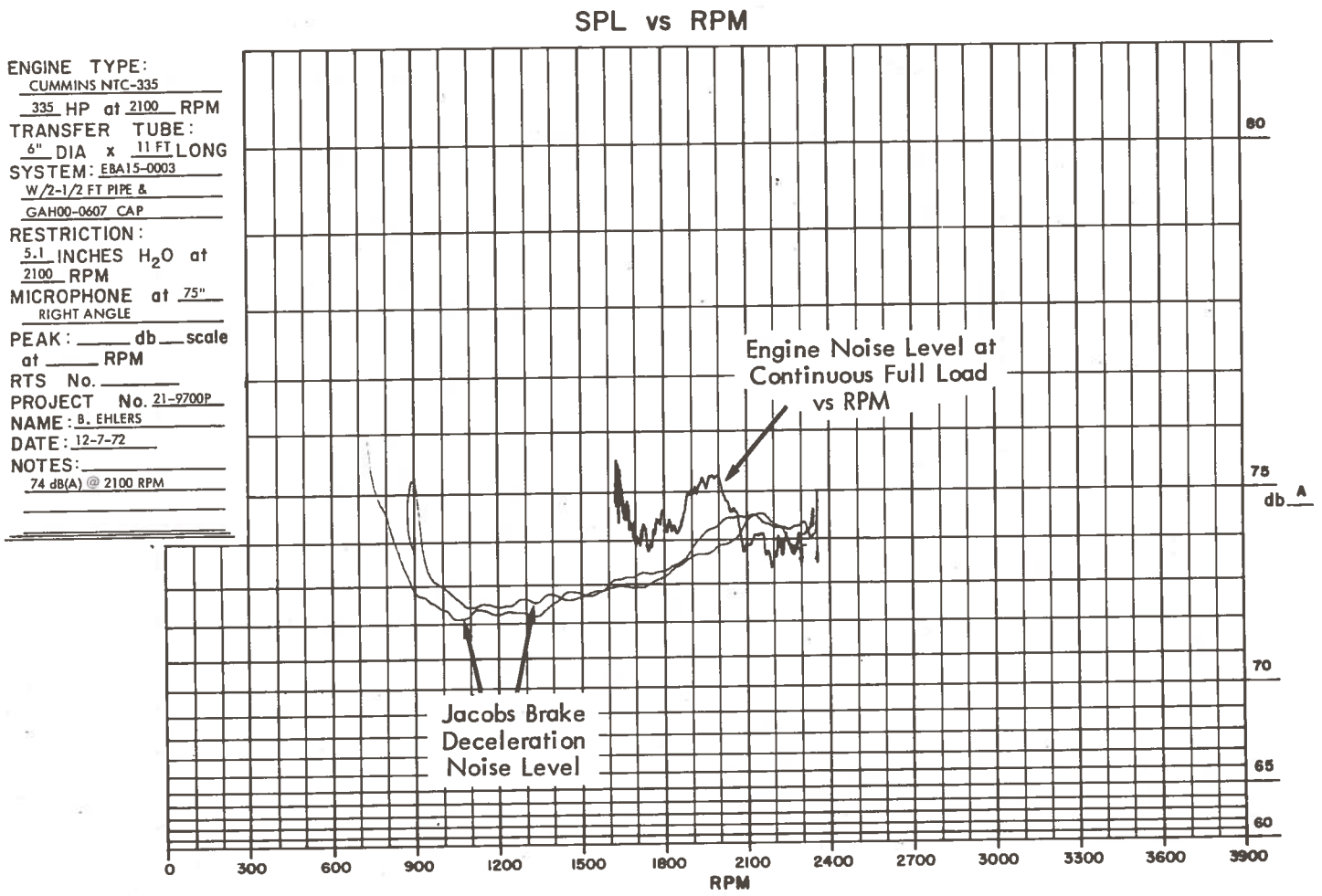


Figure 27. Intake Noise Level vs. Engine RPM

INTAKE SYSTEMS

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100

Figure 28. Intake System Data Form

Exhaust system noise was measured during dynamometer tests and during drive-by tests on quiet vehicles. Figure 14 is the plot of A-scale exhaust noise vs. rpm taken during dynamometer tests. The 75-in. measurement is 104.9 dB(A) and must be extrapolated to 50 ft giving a peak noise level of 88.9 dB(A). Figure 15 is a plot of the exhaust system noise level during drive-by tests, the peak level being 91.5 dB(A). These two tests show agreement within 2.6 dB. Comparing the two plots, the peaks below 1800 rpm are discernible in the drive-by acceleration test as the engine increases in speed. Because of the change in the noise level measurement scale, these peaks are somewhat masked in the second and third drive-by tests.

Figure 29 is a plot of A-scale exhaust noise vs. engine rpm measured during dynamometer testing. The plot shows both full-load exhaust noise and Jacobs brake deceleration noise. Figure 30 is a composite plot of both acceleration exhaust noise and Jacobs brake deceleration noise as measured during vehicle drive-by tests.

Tape recordings of the noise level are also made during the dynamometer test and drive-by tests. These allow further analysis of the test data at a later time. Figure 31 shows narrow-band analysis of a dual exhaust system on the dynamometer. The A-scale 75-in. noise level measurement was 95.5 dB(A). This extrapolates to a 50 ft measurement of 79.5 dB(A). Figure 32 is a narrow-band analysis of the same dual exhaust system and engine during drive-by tests. The noise level measurement was 83.8 dB(A). The two narrow-band analyses, allowing for distance and differences in the number of samples used in averaging, are similar indicating a good correlation between the dynamometer test and drive-by tests.

Figures 33 and 34 are two narrow-band analyses taken on engines during drive-by tests. These engines are the same, except the first is blown and the second is turbo-charged. The straight-pipe noise level of the blown engine is 108.4 dB(A). The straight-pipe noise level of the turbo-charged engine is 94.4 dB(A). The narrow-band analysis shows this significant reduction in exhaust noise level due to turbo-charging.

Additional narrow-band analyses are included in Appendix B of this report. Figure 35 shows the data sheet form used for cataloging exhaust system data.

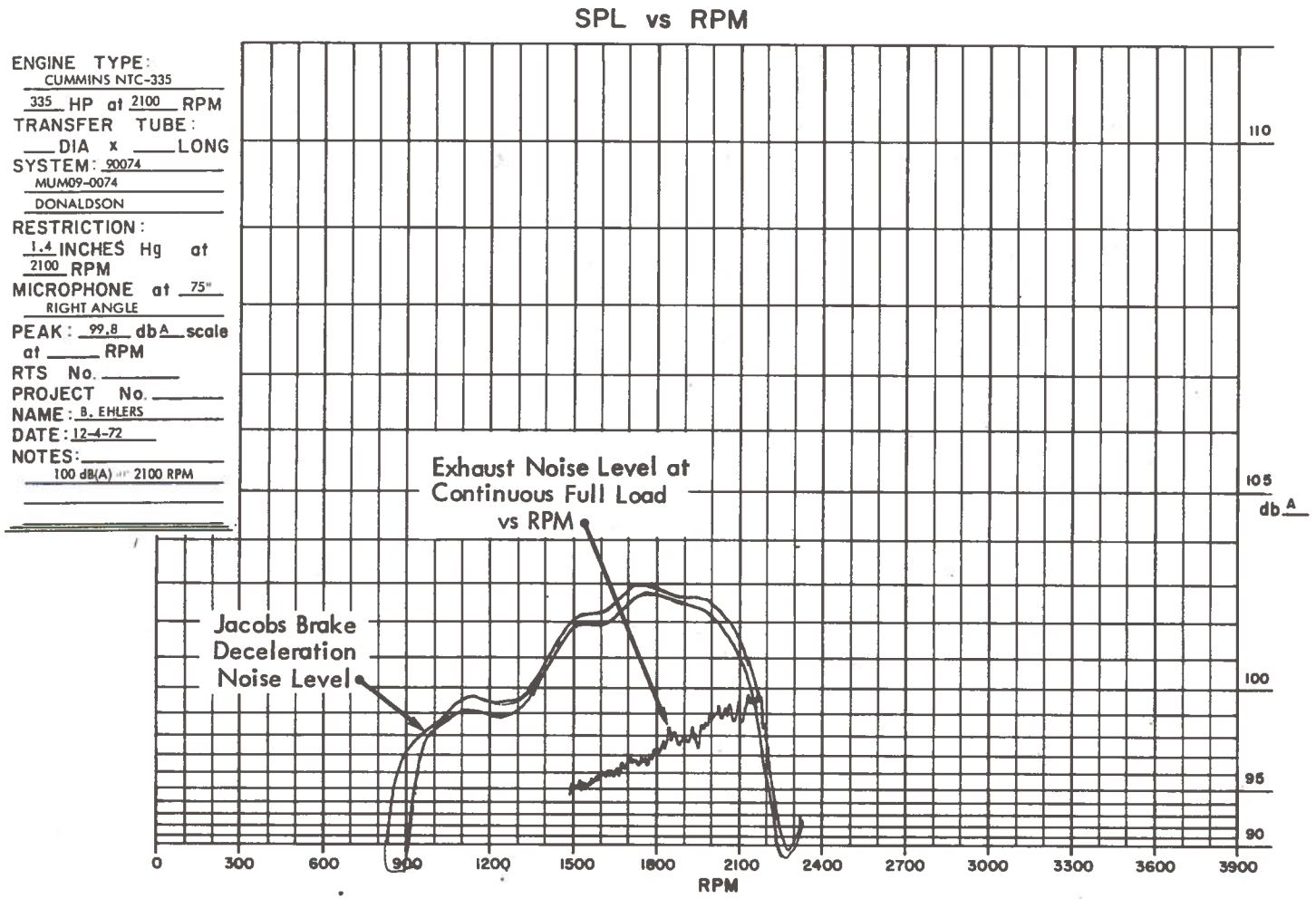


Figure 29. A-Scale Exhaust Noise vs. Engine RPM – Dynamometer Test

TEST NO. 8
TRUCK TYPE:
CONVENTIONAL CAB
ENGINE TYPE:
CUMMINS 270 CT
____ HP at ____ RPM
AIR CLEANER MODEL NO. ____
MUFFLER MODEL NO.
HOPKINS DYNAVAC
MICROPHONE at 50ft.
SAE AVG RATING:
____ dB(A)
RTS NO. ____
PROJECT NO. 21-9700P
NAME: CMK
DATE: 12-13-73
NOTES: PASSENGER SIDE

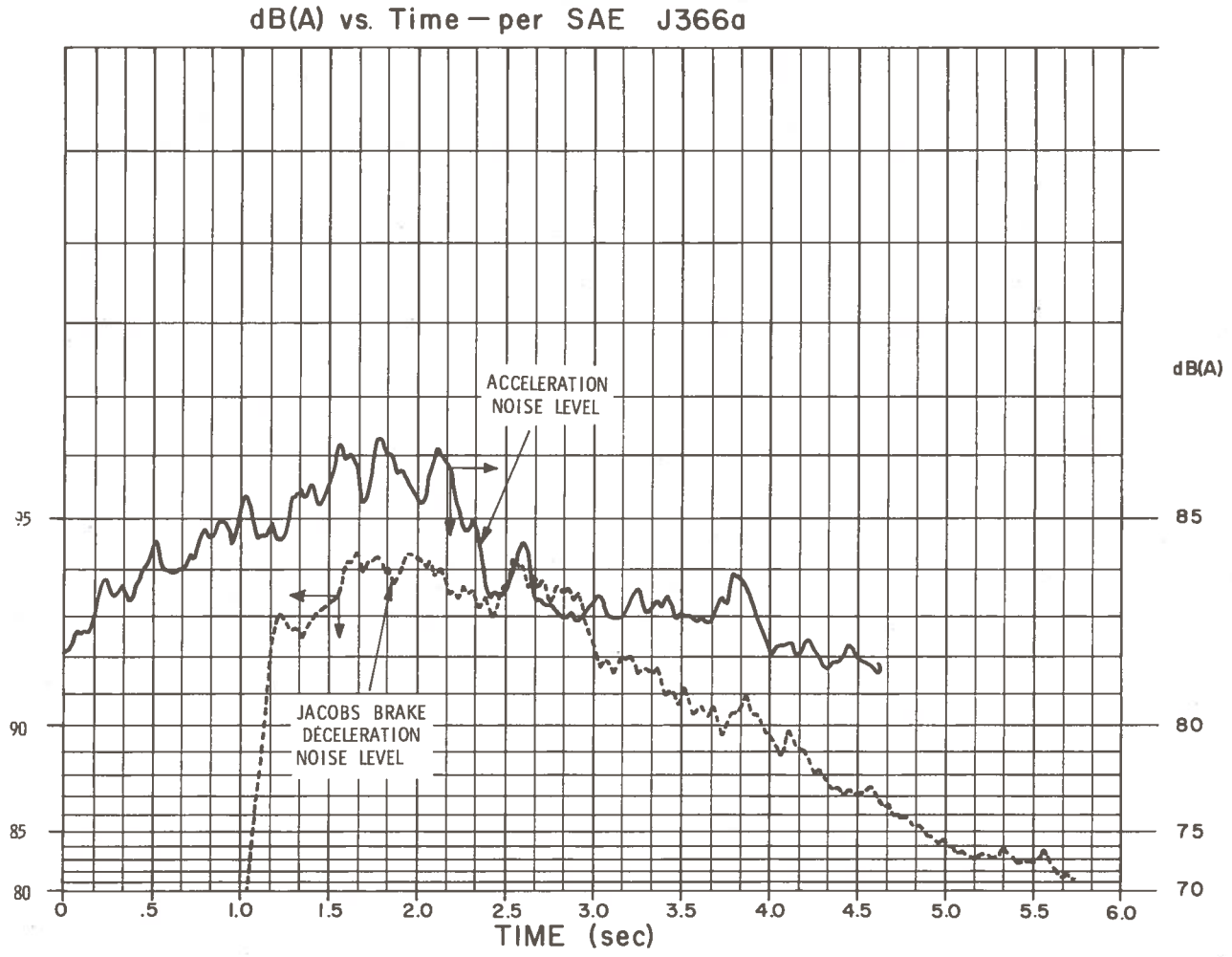


Figure 30. A-Scale Exhaust Noise Level - Drive-By Test and Deceleration Test

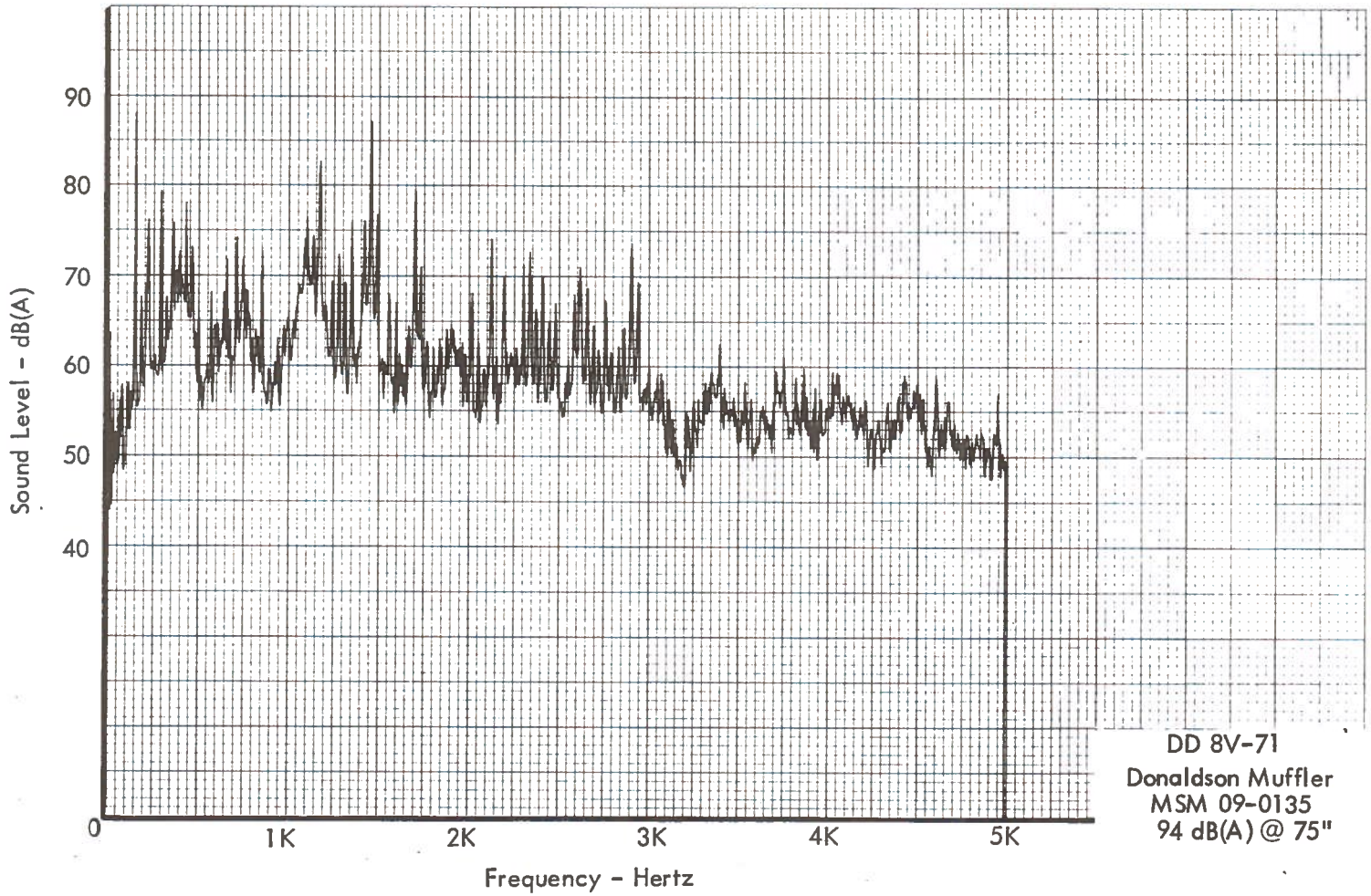


Figure 31. Narrow-Band Analysis of Dual Exhaust System Muffler - Dynamometer Test

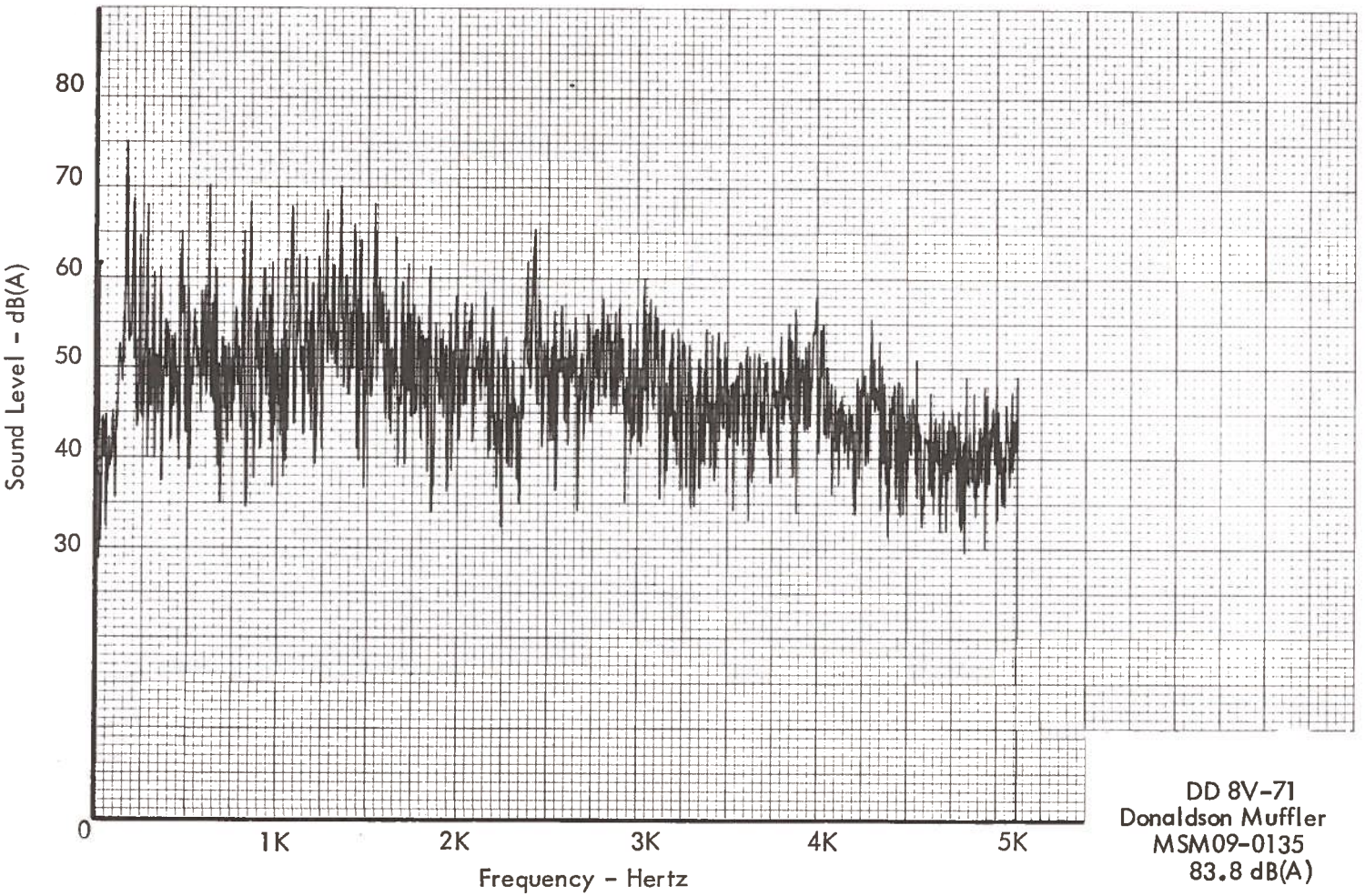


Figure 32. Narrow-Band Analysis of Dual Exhaust System Muffler - Drive-By Test

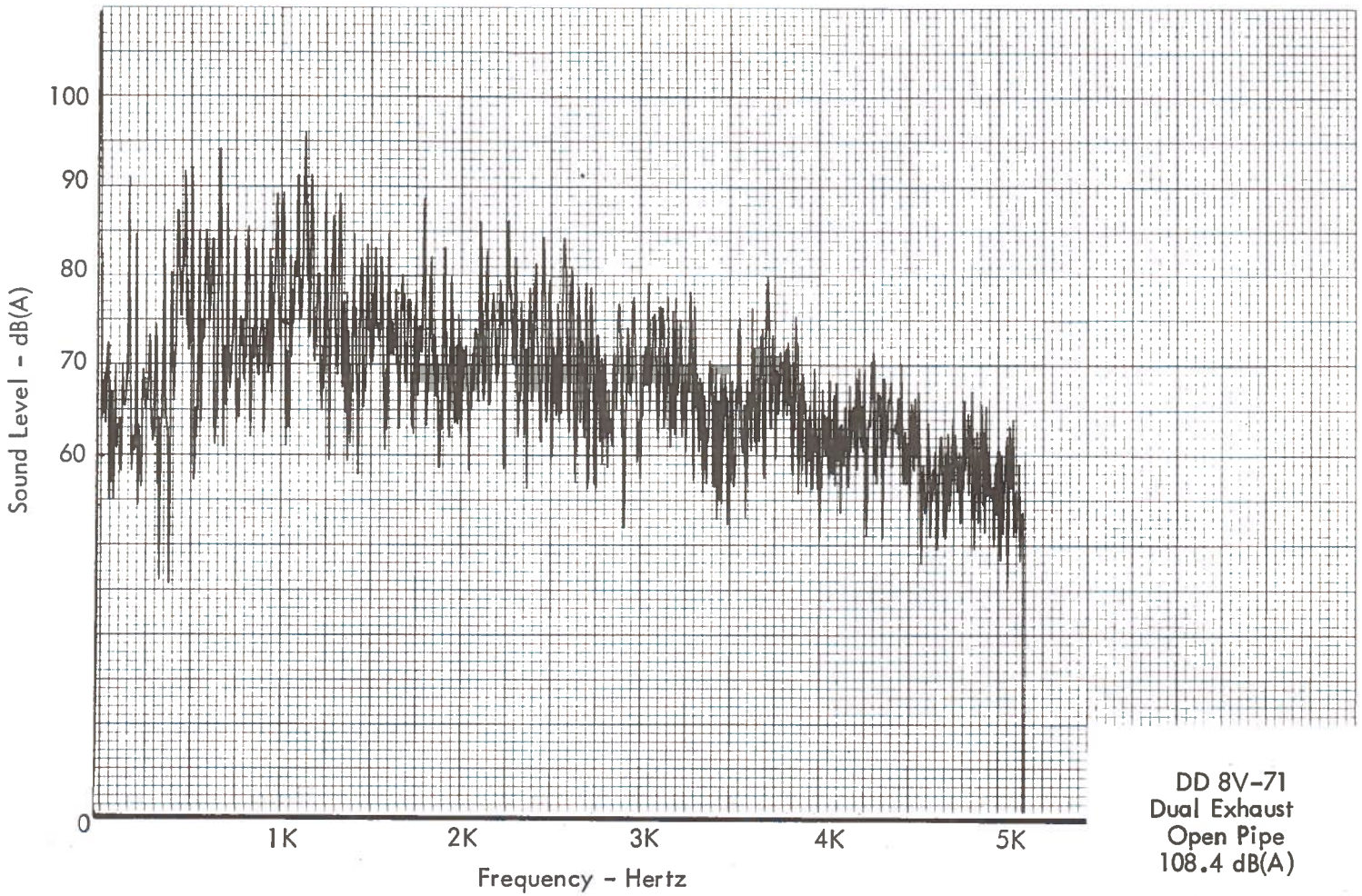


Figure 33. Narrow-Band Analysis of Blower Scavenged Engine (Open Pipe Exhaust) - Drive-By Test

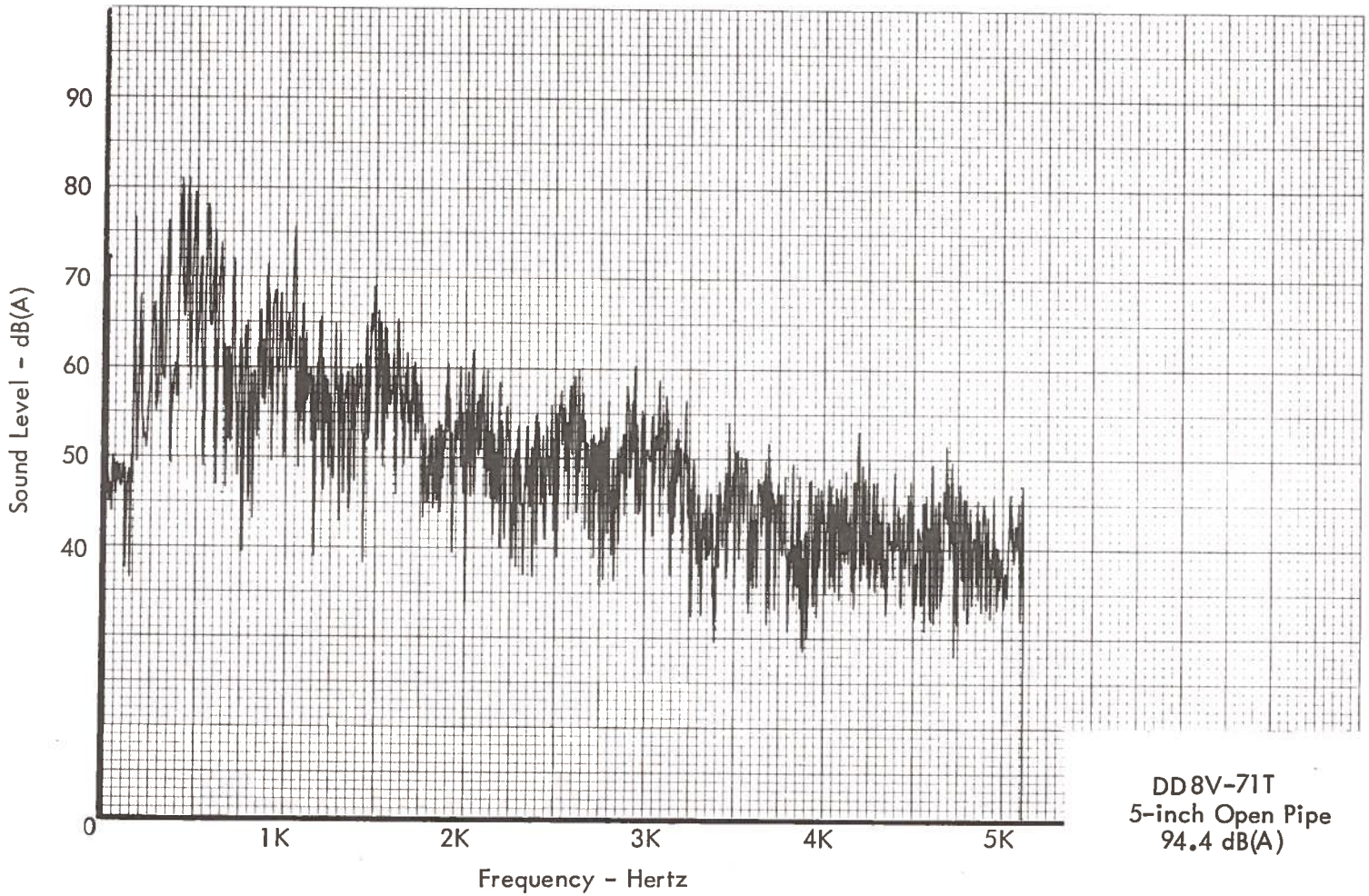


Figure 34. Narrow-Band Analysis of Turbo-Charged Engine (Open Pipe Exhaust) - Drive-By Test

EXHAUST SYSTEMS

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100

Figure 35. Exhaust System Data Presentation Form

APPENDIX A

ENGINE, INTAKE, AND EXHAUST SYSTEM DATA SUMMARY *

* Intake and exhaust system data are cataloged by engine.

APPENDIX A

ENGINE, INTAKE, AND EXHAUST SYSTEM DATA SUMMARY

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Model	END 707 & ENDL 707	183
Model	ENDT 865	186
Model	ENDT 866	189

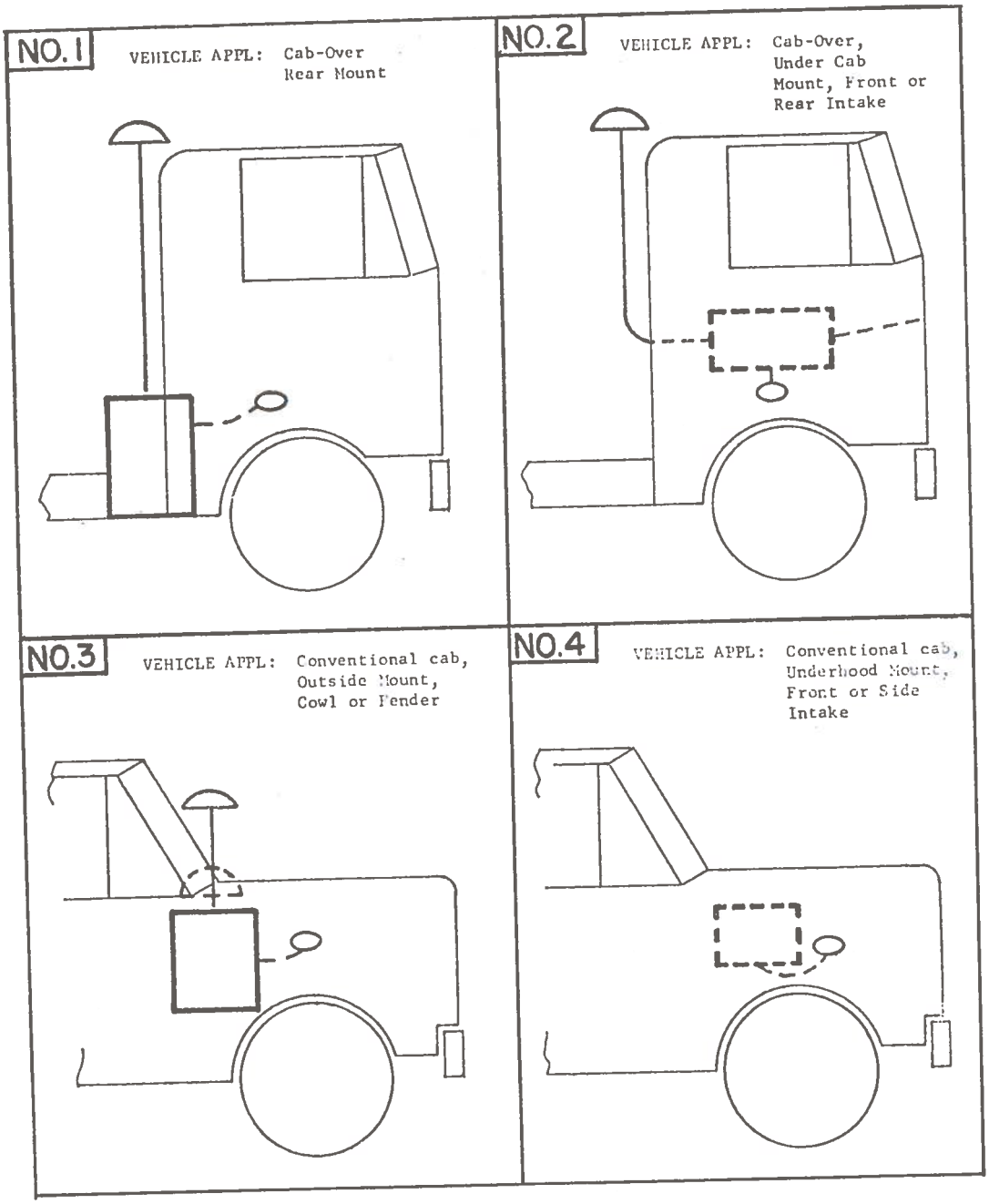


Figure A1. Intake System Configurations

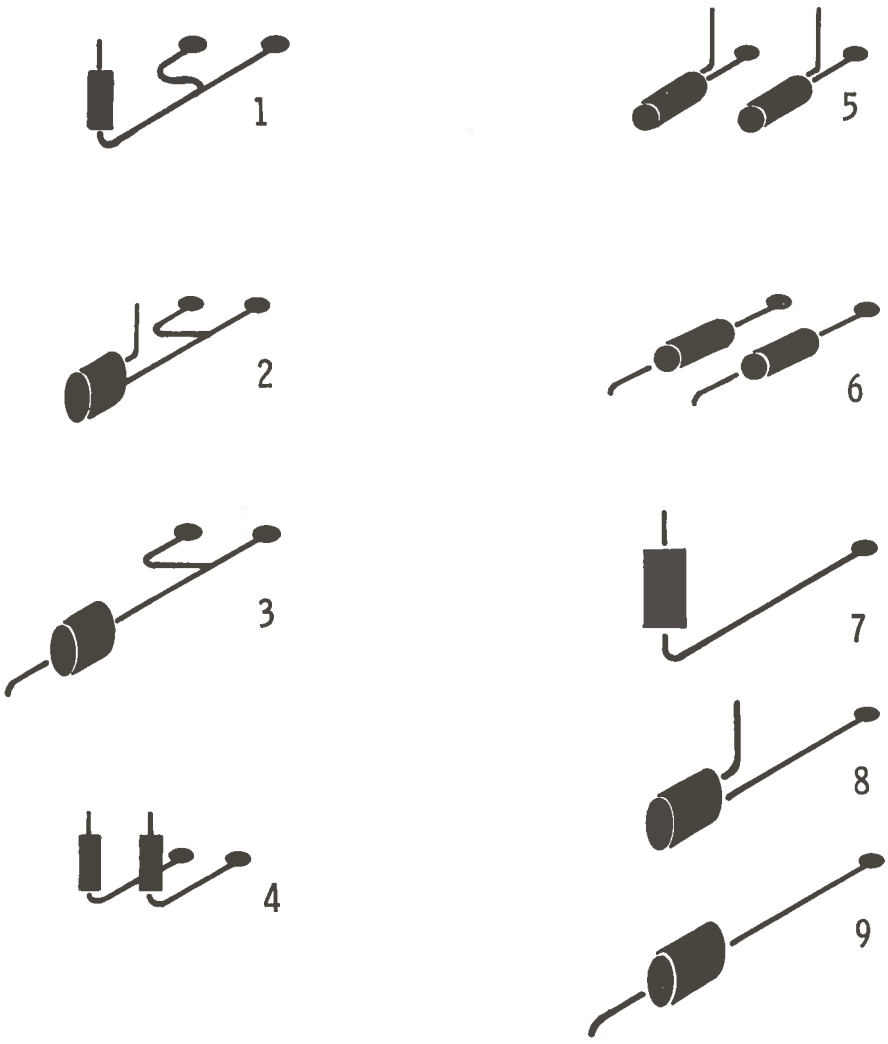


Figure A2. Exhaust System Configurations

ENGINE DATA

CATERPILLAR 1140

MANUFACTURER MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	4.5 in.
STROKE	4.1 in.
DISPLACEMENT	522 in.^{3}
COMPRESSION RATIO	
MAX RATED HP	135 @ 3200 rpm
MAX RATED TORQUE	277 @ 1800 rpm
INTAKE FLOW RATE AT RATED LOAD	390 cfm
MAX INTAKE RESTRICTION	25 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	960°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.5 in. Hg

EXHAUST GAS COMPOSITION

N_2	76.5 %
O_2	10.7 %
CO	0.057 %
CO_2	6.8 %

EXHAUST NOISE AT 50 FT

OPEN PIPE ..... 87 dBA

INTAKE NOISE AT 50 FT

OPEN PIPE .....

ENGINE DATA

CATERPILLAR 1145

MANUFACTURER MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	4.5 in.
STROKE	4.1 in.
DISPLACEMENT	522 in.^{3}
COMPRESSION RATIO	
MAX RATED HP	160 @ 3200 rpm
MAX RATED TORQUE	326 @ 1700 rpm
INTAKE FLOW RATE AT RATED LOAD	390 cfm
MAX INTAKE RESTRICTION	25 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1080°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.5 in. Hg

EXHAUST GAS COMPOSITION

N_2	76 %
O_2	9.0 %
CO	.1153 %
CO_2	7.8 %

EXHAUST NOISE AT 50 FT

OPEN PIPE ..... 88 dBA

INTAKE NOISE AT 50 FT

OPEN PIPE .....

ENGINE DATA

CATERPILLAR — MANUFACTURER

1150 — MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	4.5 in.
STROKE	4.5 in.
DISPLACEMENT	573 in.^{3}
COMPRESSION RATIO	
MAX RATED HP	185 @ 3000 rpm
MAX RATED TORQUE	403 @ 1600 rpm
INTAKE FLOW RATE AT RATED LOAD	390 cfm
MAX INTAKE RESTRICTION	25 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1080°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.5 in. Hg

EXHAUST GAS COMPOSITION

N_2	75.7 %
O_2	7.7 %
CO	.0945 %
CO_2	7.63 %

EXHAUST NOISE AT 50 FT

OPEN PIPE ..... 90 dBA

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

CATERPILLAR - MODEL NO. 1140, 1145, 1150

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
4	Canadian Fram	FA562IH		2.9				
1	Donaldson Co.	FWA14-0033	Dry	4.5		131.00	106.00	93.00
1,3	Donaldson Co.	EBA13-0018	Dry	2.0		112.00	91.00	80.00
1,3	Vortox	AB120A4	Dry	6.0		77.00	77.00	57.00
1,3	Vortox	G135AC2	Oil	6.0		78.00	78.00	57.00
2	Vortox	AE120A4	Dry	6.0		77.00	77.00	57.00

CATERPILLAR - MODEL NO. 1140, 1145

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
4	Donaldson Co	MTM08-5078	78	-	1.2	24.00	22.00	20.00
1	Donaldson Co	MPM09-0063	80	-	1.0	34.00	27.00	24.00
1	Donaldson Co	MPM09-0141	79	-	.8	48.00	38.00	34.00
1	Donaldson Co	MSM09-0142	77	-	1.5	42.00	34.00	30.00
5	Donaldson Co	MBM08-5083	75	-	1.3	18.00	15.00	11.00
6	Donaldson Co	MZM08-5023	79	-	1.1	22.00	18.00	16.00
6	Donaldson Co	MOM09-0170	76	-	1.5	25.00	22.00	16.00
6	Donaldson Co	MTM08-5078	78	-	1.2	28.00	22.00	20.00
2	DonaldsonCo.	MBM10-0002	78	-	1.5	32.00	25.00	22.00
2	Donaldson Co	MAM10-0004	-	-	-	42.00	34.00	30.00
2	Donaldson Co	MBM10-0049	74	-	1.7	22.00	18.00	14.00
2	Donaldson Co	MOM12-0154	71.5	-	1.8	44.00	35.00	31.00
3	Donaldson Co	MOM09-0124	78	-	1.3	39.00	31.00	28.00
3	Donaldson Co	MOM09-0168	76	-	1.7	23.00	19.00	14.00
3	Donaldson Co	MTM10-0043	76	-	1.2	27.00	23.00	17.00
3	Donaldson Co	MTM10-0048	77	-	1.2	29.00	24.00	18.00
3	Donaldson Co	MOM12-0100	87	-	2.4	39.00	31.00	28.00
1	Walker	22809	-	-	-	-	-	-
2	Walker	21465	78	-	1.5	-	-	-
6	Walker	21476	79	-	1.1	-	-	-

EXHAUST SYSTEMS

CATERPILLAR - MODEL NO. 1150

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
4	Donaldson Co.	MTM08-5078	78	-	1.2	28.00	22.00	20.00
1	Donaldson Co.	MPM09-0063	80	-	1.0	34.00	27.00	24.00
1	Donaldson Co.	MPM09-0141	79	-	.8	48.00	38.00	34.00
1	Donaldson Co.	MSM09-0142	77	-	1.5	42.00	34.00	30.00
5	Donaldson Co.	MBM08-5083	75	-	1.3	18.00	15.00	11.00
6	Donaldson Co.	MZM08-5023	79	-	1.1	22.00	18.00	16.00
6	Donaldson Co.	MOM09-0170	76	-	1.5	25.00	21.00	16.00
6	Donaldson Co.	MTM08-5078	78	-	1.2	28.00	22.00	20.00
2	Donaldson Co.	MBM10-0002	78	-	1.5	32.00	25.00	22.00
2	Donaldson Co.	MAM10-0004	-	-	-	42.00	34.00	30.00
2	Donaldson Co.	MBM10-0049	74	-	1.7	22.00	18.00	14.00
2	Donaldson Co.	MOM12-0154	71.5	-	1.8	44.00	35.00	31.00
3	Donaldson Co.	MOM09-0124	78	-	1.3	39.00	31.00	28.00
3	Donaldson Co.	MOM09-0168	76	-	1.7	23.00	20.00	14.00
3	Donaldson Co.	MTM10-0043	76	-	1.2	27.00	23.00	17.00
3	Donaldson Co.	MTM10-0048	77	-	1.2	29.00	24.00	18.00
3	Donaldson Co.	MOM12-0100	-	-	-	39.00	31.00	28.00
1	Stemco Mfg.	9300	-	-	-	36.00	36.00	36.00
1	Stemco Mfg.	9349	-	-	-	50.00	50.00	50.00
2	Stemco Mfg.	9855	-	-	-	41.00	41.00	41.00
3	Stemco Mfg.	9864	-	-	-	51.00	51.00	51.00
1	Walker	22809	-	-	-	-	-	-
2	Walker	21465	78	-	1.5	-	-	-
3	Walker	21476	79	-	1.1	-	-	-

ENGINE DATA

CATERPILLAR 1160

MANUFACTURER MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	4.5 in.
STROKE	5.0 in.
DISPLACEMENT	636 in.^{3}
COMPRESSION RATIO	
MAX RATED HP	210 @ 2800 rpm
MAX RATED TORQUE	474 @ 1400 rpm
INTAKE FLOW RATE AT RATED LOAD	410 cfm
MAX INTAKE RESTRICTION	25 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1160°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.5 in. Hg

EXHAUST GAS COMPOSITION

N_2	75.4 %
O_2	6.5 %
CO	.1328 %
CO_2	8.80 %

EXHAUST NOISE AT 50 FT

OPEN PIPE ..... 94 dBA

INTAKE NOISE AT 50 FT

OPEN PIPE ..... 84 dBA

INTAKE SYSTEMS

CATERPILLAR - MODEL NO. 1160

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,3	Donaldson Co.	EBA13-0018	Dry	2.0		112.00	91.00	80.00
1	Donaldson Co.	FWA14-0033	Dry	4.5		131.00	105.00	93.00
1,3	Vortox	AB120A4	Dry	6.7		77.00	77.00	57.00
1,3	Vortox	G135AC2	Oil	6.7		78.00	78.00	57.00
2	Vortox	AE120A4		6.7		77.00	77.00	57.00

EXHAUST SYSTEMS

CATERPILLAR - MODEL NO. 1160

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
4	Donaldson Co.	MTM08-5078	78	-	1.5	28.00	22.00	20.00
1	DonaldsonCo.	MPM09-0063	80	-	1.3	34.00	27.00	24.00
1	Donaldson Co.	MPM09-0141	79	-	1.1	48.00	38.00	34.00
1	Donaldson Co.	MSM09-0142	77	-	1.8	42.00	34.00	30.00
5	Donaldson Co.	MBM08-5083	75	-	1.6	18.00	15.00	11.00
6	Donaldson Co.	MZM08-5023	79	-	1.4	22.00	18.00	16.00
6	Donaldson Co.	MOM09-0170	76	-	1.8	25.00	21.00	16.00
6	Donaldson Co.	MTM08-5078	78	-	1.5	28.00	22.00	20.00
2	Donaldson Co.	MBM10-0002	78	-	1.8	32.00	25.00	22.00
2	Donaldson Co.	MAM10-0004	-	-	-	42.00	34.00	30.00
2	Donaldson Co.	MBM10-0049	74	-	2.0	22.00	18.00	14.00
2	Donaldson Co.	MOM12-0154	71.5	-	2.1	44.00	35.00	31.00
3	Donaldson Co.	MOM09-0124	-	-	1.5	39.00	31.00	28.00
3	Donaldson Co.	MOM09-0168	-	-	2.0	23.00	20.00	14.00
3	Donaldson Co.	MTM10-0043	-	-	1.5	27.00	23.00	17.00
3	Donaldson Co.	MTM10-0048	-	-	1.5	29.00	24.00	18.00
3	Donaldson Co.	MOM12-0100	-	-	-	39.00	31.00	28.00
1	Stemco	9300	-	-	-	36.00	36.00	36.00
1	Stemco	9349	-	-	-	50.00	50.00	50.00
2	Stemco	9855	-	-	-	41.00	41.00	41.00
1	Stemco	9864	-	-	-	51.00	51.00	51.00
1	Walker	22809	-	-	-	-	-	-
2	Walker	21465	78	-	1.8	-	-	-
6	Walker	21476	79	-	1.4	-	-	-

ENGINE DATA

CATERPILLAR	1673 T
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	4.75 in.
STROKE	6.0 in.
DISPLACEMENT	638 in.^{3}
COMPRESSION RATIO	
MAX RATED HP	250 @ 2200 rpm
MAX RATED TORQUE	690 @ 1600 rpm
INTAKE FLOW RATE AT RATED LOAD	600 cfm
MAX INTAKE RESTRICTION	30 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1000°F
MAX EXHAUST SYSTEM BACK PRESSURE	1.47 in. Hg

EXHAUST GAS COMPOSITION

N_2	76 %
O_2	9.0 %
CO	.0153 %
CO_2	7.9 %

EXHAUST NOISE AT 50 FT

OPEN PIPE ..... 85 dBA

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

CATERPILLAR - MODEL NO. 1673 T

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Donaldson Co.	FHG14-0121	Dry	8.0		183.00	148.00	130.00
1,3	Donaldson Co.	EBA13-0018	Dry			112.00	91.00	80.00
1,3	Vortox	AB160A4	Dry	6.0		123.00	123.00	90.00
1,3	Vortox	G160BE2	Oil	6.5		102.00	102.00	75.00
2	Vortox	AE160A4	Dry	6.0		123.00	123.00	90.00

EXHAUST SYSTEMS

CATERPILLAR - MODEL NO. 1673 T

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MPM09-0161	73	-	0.3	31.00	26.00	19.00
8	Donaldson Co.	MOM12-0131	74	-	0.5	49.00	39.00	35.00
9	Donaldson Co.	MOM12-0108	77	-	1.1	47.00	38.00	34.00
7	Stemco	9300	-	-	-	36.00	36.00	36.00
7	Walker	22823	-	-	-	-	-	-
7	Walker	22829	73	-	0.3	-	-	-

ENGINE DATA

CATERPILLAR — MANUFACTURER

1674 TA — MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	4.75 in.
STROKE	6.0 in.
DISPLACEMENT	638 in.^{3}
COMPRESSION RATIO	
MAX RATED HP	270 @ 2200 rpm
MAX RATED TORQUE	805 @ 1400 rpm
INTAKE FLOW RATE AT RATED LOAD	660 cfm
MAX INTAKE RESTRICTION	30 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	900°F
MAX EXHAUST SYSTEM BACK PRESSURE	1.47 in. Hg

EXHAUST GAS COMPOSITION

N_2	76.2 %
O_2	9.6 %
CO	.0118 %
CO_2	7.5 %

EXHAUST NOISE AT 50 FT

OPEN PIPE ..... 88 dBA

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

CATERPILLAR - MODEL NO. 1674 TA

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Donaldson Co.	FHG14-0121	Dry	8.0		183.00	148.00	131.00
1,3	Donaldson Co.	EBA13-0018	Dry	5.0		112.00	91.00	80.00
1,3	Vortox	AB160A4	Dry	8.3		123.00	123.00	90.00
1,3	Vortox	G160AC2	Oil	9.5		103.00	103.00	76.00
2	Vortox	SE160A4	Dry	8.3		123.00	123.00	90.00

CATERPILLAR - MODEL NO. 1674 TA

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Alexander-T.	2418	84*	-	.5*	62.00	-	56.00
7	Donaldson Co.	MPM09-0161	74	-	0.3	31.00	26.00	19.00
8	Donaldson Co.	MOM12-0131	75	-	0.5	49.00	39.00	35.00
9	Donaldson Co.	MOM12-0108	79	-	1.2	47.00	38.00	34.00
7	Walker	22823	-	-	-	-	-	-
7	Walker	22829	74	-	0.3	-	-	-

*Vehicle Test Data

ENGINE DATA

CATERPILLAR	1693 T
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	5.4 in.
STROKE	6.5 in.
DISPLACEMENT	893 in. ^{3}
COMPRESSION RATIO	
MAX RATED HP	325 @ 2100 rpm
MAX RATED TORQUE	1000 @ 1450 rpm
INTAKE FLOW RATE AT RATED LOAD	860 cfm
MAX INTAKE RESTRICTION	30 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	900°F
MAX EXHAUST SYSTEM BACK PRESSURE	1.47 in. Hg

EXHAUST GAS COMPOSITION

N_2	76.4 %
O_2	10.5 %
CO	.0128 %
CO_2	7.1 %

EXHAUST NOISE AT 50 FT

OPEN PIPE ..... 90 dBA

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

CATERPILLAR - MODEL NO. 1693 T

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,3	Donaldson Co.	EBA15-0005	Dry	4.5		145.00	116.00	103.00
1	Donaldson Co.	FHG16-0116	Dry	8.0		133.00	108.00	95.00
1,3	Vortox	AB160A4	Dry	6.3		123.00	123.00	90.00
1,3	Vortox	G160BE2	Oil	6.7		102.00	102.00	75.00
2	Vortox	AE160A4	Dry	6.3		123.00	123.00	90.00

EXHAUST SYSTEMS

CATERPILLAR - MODEL NO. 1693 T

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Alexander-T.	2418	84.5*	-	.7	62.00	-	56.00
7	Donaldson Co.	MPM09-0161	75	-	0.5	31.00	26.00	19.00
8	Donaldson Co.	MOM12-0131	76	-	0.7	49.00	39.00	35.00
9	Donaldson Co.	MOM12-0108	81	-	1.5	47.00	38.00	34.00
7	Stemco	9327	-	-	-	41.00	41.00	41.00
7	Walker	22823	-	-	-	-	-	-
7	Walker	22829	75	-	0.5	-	-	-

* Vehicle Test Data

ENGINE DATA

CATERPILLAR	1693 TA
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	5.4 in.
STROKE	6.5 in.
DISPLACEMENT	893 in.^{3}
COMPRESSION RATIO	
MAX RATED HP	425 @ 2100 rpm
MAX RATED TORQUE	1275 @ 1400 rpm
INTAKE FLOW RATE AT RATED LOAD	1080 cfm
MAX INTAKE RESTRICTION	30 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	950°F
MAX EXHAUST SYSTEM BACK PRESSURE	1.47 in. Hg

EXHAUST GAS COMPOSITION

N_2	76.4 %
O_2	10.4 %
CO	.0164 %
CO_2	7.4 %

EXHAUST NOISE AT 50 FT

OPEN PIPE ..... 91 dBA

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

CATERPILLAR - MODEL NO. 1693 TA

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Donaldson Co.	FHG16-0116	Dry	10.0		134.00	108.00	96.00
1,3	Donaldson Co.	EBA15-0005	Dry	6.0		145.00	117.00	103.00
1,3	Vortox	AB120A4 (2 ea)	Dry	7.0		77.00	77.00	57.00
1,3	Vortox	G135AC2 (2 ea)	Oil	7.0		78.00	78.00	57.00
2	Vortox	AE120A4 (2 ea)	Dry	7.0		77.00	77.00	57.00

EXHAUST SYSTEMS

CATERPILLAR - MODEL NO. 1693 TA

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MPM09-0161	76	-	1.0	31.00	26.00	19.00
8	Donaldson Co.	MOM12-0131	77	-	1.5	49.00	39.00	35.00
9	Donaldson Co.	MOM12-2300	87	-	1.4	63.00	50.00	45.00
7	Stemco	9327	-	-	-	41.00	41.00	41.00
7	Walker	22829	76	-	1.0	-	-	-

ENGINE DATA

CUMMINS	V8-210
MANUFACTURER	MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	4-5/8 in.
STROKE	3-3/4 in.
DISPLACEMENT	504 in.^{3}
COMPRESSION RATIO	17.0 : 1
MAX RATED HP	202 @ 3300 rpm
MAX RATED TORQUE	387 @ 1900 rpm
INTAKE FLOW RATE AT RATED LOAD	425 cfm
MAX INTAKE RESTRICTION	15.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1150°F
MAX EXHAUST SYSTEM BACK PRESSURE	3.0 in. Hg

EXHAUST GAS COMPOSITION

N_2	82%
O_2	6.8 %
CO	.27 %
CO_2	9.3%

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. V8-185 & 210

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Canadian Fram	FA562WHI	Dry	2.3				
4	Canadian Fram	FA562IH	Dry	2.4				
1	Donaldson Co.	FWA14-0033	Dry	4.8		131.00	106.00	93.00
1,3	Donaldson Co.	EBA13-0018	Dry	2.0		112.00	91.00	80.00
1,3	Vortox	AB120A4	Dry	4.6		77.00	77.00	57.00
1,3	Vortox	G120CG2	Oil	5.5		63.00	63.00	46.00
2	Vortox	AE120A4		4.6		97.00	77.00	57.00

EXHAUST SYSTEMS

CUMMINS - MODEL NO. V8-210

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
3	Alexander-T.	2532	83*	-	3.1*	52.00	-	47.00
3	Alexander-T.	2503	84*	-	3.3*	49.00	-	44.00
4	Donaldson Co.	MTM08-5078	75	-	2.2	28.00	22.00	20.00
1	Donaldson Co.	MPM09-0063	83	-	1.5	34.00	27.00	24.00
1	Donaldson Co.	MPM09-0141	80	-	1.5	48.00	38.00	34.00
1	Donaldson Co.	MSM09-0142	78	-	2.4	42.00	34.00	30.00
5	Donaldson Co.	MBM08-5083	78	-	2.2	18.00	15.00	11.00
6	Donaldson Co.	MOM09-0170	72	-	2.6	25.00	21.00	16.00
3	Donaldson Co.	MOM09-0168	74	-	2.9	23.00	19.00	14.00
3	Donaldson Co.	MTM10-0043	77	-	1.6	22.00	23.00	17.00
1	Stemco	9336	-	-	-	40.00	40.00	40.00
-	Stemco	9344	-	-	-	45.00	45.00	45.00
1or6	Stemco	9345	-	-	-	35.00	35.00	35.00
1	Walker	22828	80	-	1.5	-	-	-
3	Walker	21465	-	-	-	-	-	-
3	Walker	22808	-	-	-	-	-	-
1	Walker	22827	83	-	1.5	-	-	-

* Vehicle Test Data

ENGINE DATA

CUMMINS	V-555
MANUFACTURER	MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	4-5/8 in.
STROKE	4-1/8 in.
DISPLACEMENT	555 in.^{3}
COMPRESSION RATIO	17.0 : 1
MAX RATED HP	216 @ 3300 rpm
MAX RATED TORQUE	425 @ 1800 rpm
INTAKE FLOW RATE AT RATED LOAD	470 cfm
MAX INTAKE RESTRICTION	15 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1150°F
MAX EXHAUST SYSTEM BACK PRESSURE	3.0 in. Hg

EXHAUST GAS COMPOSITION

N_2	84%
O_2	4.3 %
CO	.20 %
CO_2	10%

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. V-555

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
4	Canadian Fram	FA562IH	Dry	2.8				
1	Donaldson Co.	FWA14-0033	Dry	6.0	72	131.00	106.00	93.00
1,3	Donaldson Co.	EBA13-0018	Dry	2.4	75	113.00	91.00	80.00
1,3	Vortox	AB120A4	Dry	5.6		77.00	77.00	57.00
1,3	Vortox	G135AC2	Oil	5.7		78.00	78.00	57.00
2	Vortox	AE120A4		5.6		77.0	77.00	57.00

CUMMINS - MODEL NO. V-555

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
3	Alexander-T.	2532	83*	-	3.2*	52.00	-	47.00
3	Alexander-T.	2503	84*	-	3.4*	49.00	-	44.00
4	Donaldson Co.	MTM08-5078	75	-	2.2	28.00	22.00	20.00
1	Donaldson Co.	MPM09-0063	83	-	1.5	34.00	27.00	24.00
1	Donaldson Co.	MPM09-0141	80	-	1.5	48.00	38.00	34.00
1	Donaldson Co.	MSM09-0142	78	-	2.4	42.00	34.00	30.00
5	Donaldson Co.	MBM08-5083	78	-	2.2	18.00	15.00	11.00
6	Donaldson Co.	MOM09-0170	72	-	2.6	25.00	21.00	16.00
3	Donaldson Co.	MOM09-0168	74	-	2.9	23.00	19.00	14.00
3	Donaldson Co.	MTM10-0043	77	-	1.6	22.00	23.00	17.00
1	Stemco	9336	-	-	-	40.00	40.00	40.00
1or3	Stemco	9344	-	-	-	45.00	45.00	45.00
-	Walker	22828	80	-	1.5	-	-	-
1	Walker	22827	83	-	1.5	-	-	-

* Vehicle test data

ENGINE DATA

CUMMINS	V-903
MANUFACTURER	MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	5-1/2 in.
STROKE	4-3/4 in.
DISPLACEMENT	903 in.^{3}
COMPRESSION RATIO	16.5 : 1
MAX RATED HP	307 @ 2600 rpm
MAX RATED TORQUE	707 @ 1800 rpm
INTAKE FLOW RATE AT RATED LOAD	610 cfm
MAX INTAKE RESTRICTION	15 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1150°F
MAX EXHAUST SYSTEM BACK PRESSURE	2 in. Hg

EXHAUST GAS COMPOSITION

N_2	81%
O_2	7.1%
CO	.17 %
CO_2	10.6 %

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. V-903

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
4	Canadian Fram	FA362IH	Dry	3.7				
1	Donaldson Co.	FHG14-0121	Dry	6.5	72	183.00	148.00	131.00
1,3	Donaldson Co.	EBA13-0018	Dry	3.6	72	113.00	91.00	80.00
2	Donaldson Co.	EBB22-0022	Dry	5.5	71	163.00	131.00	116.00
1,3	Vortox	AB140A4	Dry	6.8		95.00	95.00	70.00
1,3	Vortox	G150C2	Oil	8.0		99.00	99.00	73.00
2	Vortox	AE140A4	Dry	6.8		95.00	95.00	70.00

CUMMINS - MODEL NO. V-903

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
4	Donaldson Co.	MUM09-0022	85	-	.9	32.00	26.00	23.00
1	Donaldson Co.	MUM09-0022	85	-	1.8	32.00	26.00	23.00
4	Donaldson Co.	MPM09-0063	84	-	1.0	33.00	27.00	24.00
1	Donaldson Co.	MUM09-0074	88	-	1.2	39.00	31.00	28.00
4	Donaldson Co.	MPM09-0115	82	-	1.5	39.00	31.00	28.00
4	Donaldson Co.	MSM09-0135	78	-	2.0	41.00	33.00	30.00
4	Donaldson Co.	MPM09-0141	80	-	.9	48.00	38.00	34.00
1	Donaldson Co.	MPM09-0141	82	-	2.0	48.00	38.00	34.00
4	Donaldson Co.	MSM09-0142	82	-	1.4	42.00	34.00	30.00
6	Donaldson Co.	MTM10-0006	86	-	1.1	33.00	27.00	23.00
6	Donaldson Co.	MOM12-0100	86	-	1.0	39.00	31.00	28.00
3	Donaldson Co.	MOM12-0108	84	-	1.4	47.00	38.00	34.00
2	Donaldson Co.	MOM12-0131	85	-	1.5	49.00	39.00	35.00
6	Riker Mfg.	94007	84*	-	1.4*	50.00	-	-
3	Riker Mfg.	94507	86*	-	1.4*	52.00	-	-
4	Riker Mfg.	9XD-354	83*	-	1.6*	57.00	-	-
4	Riker Mfg	9XD-404	86.5*	-	1.6*	59.00	-	-
1	Riker Mfg.	9XD505	86.5*	-	2.0*	69.00	-	-
4	Riker Mfg.	9XD505	87.3*	-	1.4*	69.00	-	-
2	Riker Mfg.	94006	85.7*	-	2.0*	52.00	-	-
2	Riker Mfg.	94506	83.4*	-	1.7*	54.00	-	-
4	Stemco Mfg.	9338	71	-	2.1	42.00	42.00	42.00
4	Stemco Mfg.	9350	-	-	-	51.00	51.00	51.00
2	Stemco Mfg.	9854	-	-	-	47.00	47.00	47.00
2	Stemco Mfg.	9855	-	-	-	41.00	41.00	41.00
1,3	Stemco Mfg.	9866	-	-	-	55.00	55.00	55.00
1	Walker	22829	-	-	-	-	-	-
4	Walker	22809	85	-	0.9	-	-	-
4	Walker	22827	84	-	1.0	-	-	-

* Vehicle test data

CUMMINS - MODEL NO. V-903 (continued)

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
1	Walker	22823	88	-	1.2	-	-	-
4	Walker	22828	80	-	0.9	-	-	-
6	Walker	21174	86	-	1.0	-	-	-

ENGINE DATA

CUMMINS	VT-903
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	5-1/2 in.
STROKE	4-3/4 in.
DISPLACEMENT	903 in.^{3}
COMPRESSION RATIO	15.5 : 1
MAX RATED HP	320 @ 2600 rpm
MAX RATED TORQUE	775 @ 1800 rpm
INTAKE FLOW RATE AT RATED LOAD	930 cfm
MAX INTAKE RESTRICTION	15 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	900°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.5 in. Hg

EXHAUST GAS COMPOSITION

N_2	83%
O_2	10.1 %
CO	.01 %
CO_2	7.0 %

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

EXHAUST SYSTEMS

CUMMINS - MODEL NO. VT-903

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MUM09-0074	82	-	1.7	39.00	31.00	28.00
7	Donaldson Co.	MPM09-0161	81	-	1.3	31.00	26.00	19.00
9	Donaldson Co.	MOM12-0108	83	-	2.3	47.00	38.00	34.00
8	Donaldson Co.	MOM12-0131	83	-	2.2	49.00	39.00	35.00
7	Walker	22829	81	-	1.3	-	-	-
7	Walker	22823	82	-	1.7	-	-	-

ENGINE DATA

CUMMINS	NH-230
MANUFACTURER	MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	5-1/2 in.
STROKE	6 in.
DISPLACEMENT	855 in.^{3}
COMPRESSION RATIO	15.8 : 1
MAX RATED HP	220 @ 2100 rpm
MAX RATED TORQUE	644 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	460 cfm
MAX INTAKE RESTRICTION	15.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1160°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. NH 230

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Canadian Fram	FA562WH3	Dry	2.6				
4	Canadian Fram	FA562IH	Dry	2.8				
1	Donaldson Co.	FWA14-0033	Dry	5.5		131.00	106.00	93.00
1,3	Donaldson Co.	EBA13-0018	Dry	2.2		113.00	91.00	80.00
1,3	Vortox	AB120A4	Dry	5.2		77.00	77.00	57.00
1,3	Vortox	G135AC2	Oil	5.6		78.00	78.00	57.00
2	Vortox	AE120A4	Dry	5.2		77.00	77.00	57.00

EXHAUST SYSTEMS

CUMMINS - MODEL NO. NH-230

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Alexander-T.	2435A	83.5*	-	1.5*	66.00	-	59.00
9	Alexander-T.	24	84*	-	1.4*	38.00	-	34.00
9	Alexander-T.	2470	84*	-	1.4*	38.00	-	34.00
8	Alexander-T.	2437	83*	-	1.3*	38.00	-	34.00
7	Donaldson Co.	MPM09-0063	84	-	1.2	36.00	27.00	24.00
7	Donaldson Co.	MPM09-0141	82	-	1.0	48.00	38.00	34.00
7	Donaldson Co.	MPM09-0161	85	-	0.4	31.00	26.00	19.00
7or9	Donaldson Co.	MTM10-0038	81	-	1.4	63.00	51.00	45.00
8	Donaldson Co.	MOM12-0154	81	-	1.8	44.00	35.00	31.00
9	Donaldson Co.	MTM10-0043	80	-	1.2	27.00	23.00	17.00
7	Stemco	9300	-	-	-	36.00	36.00	36.00
7or9	Stemco	9344	-	-	-	45.00	45.00	45.00
7	Stemco	9349	-	-	-	50.00	50.00	50.00
9	Stemco	9400	-	-	-	38.00	38.00	38.00
8	Stemco	9416	-	-	-	60.00	60.00	60.00
8	Stemco	9854	-	-	-	47.00	47.00	47.00
8	Stemco	9855	-	-	-	41.00	41.00	41.00
9	Stemco	9864	-	-	-	51.00	51.00	51.00
7	Walker	22828	82	-	1.0	-	-	-
7	Walker	22827	84	-	1.2	-	-	-
7	Walker	22829	85	-	0.4	-	-	-

* Vehicle Test Data

ENGINE DATA

CUMMINS — MANUFACTURER

NH-250 — MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	5-1/2 in.
STROKE	6 in.
DISPLACEMENT	855 in.^{3}
COMPRESSION RATIO	15.8 : 1
MAX RATED HP	240 @ 2100 rpm
MAX RATED TORQUE	658 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	460 cfm
MAX INTAKE RESTRICTION	15 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1200°F
MAX EXHAUST SYSTEM BACK PRESSURE	2 in. Hg

EXHAUST GAS COMPOSITION

N_2	85 %
O_2	4.0 %
CO	.24 %
CO_2	10.5 %

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. NH 250

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Canadian Fram	FA562WH3	Dry	2.8				
4	Canadian Fram	FA562IH	Dry	3.0				
1	Donaldson Co.	FWA14-0033	Dry	5.5		131.00	106.00	93.00
1,3	Donaldson Co.	EBA13-0018	Dry	2.2		113.00	91.00	80.00
1,3	Vortox	AB120A4	Dry	5.2		77.00	77.00	57.00
1,3	Vortox	G135AC2	Oil	5.6		77.00	77.00	57.00

CUMMINS - MODEL NO. NH-250

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Alexander-Tagg	2435A	84*	-	1.5*	66.00	-	59.00
9	Alexander-Tagg	24	84*	-	1.4*	38.00	-	34.00
9	Alexander-Tagg	2470	84*	-	1.4*	38.00	-	34.00
8	Alexander-Tagg	2437	83*	-	1.3*	38.00	-	34.00
7	Donaldson Co.	MPM09-0063	84	-	1.3	34.00	27.00	24.00
7	Donaldson Co.	MPM09-0141	82	-	1.1	48.00	38.00	34.00
7	Donaldson Co.	MPM09-0161	85	-	0.5	31.00	26.00	19.00
7	Donaldson Co.	MTM10-0038	80	-	1.5	63.00	51.00	45.00
8	Donaldson Co.	MOM12-0154	81	-	1.9	44.00	35.00	31.00
9	Donaldson Co.	MTM10-0043	80	-	1.3	27.00	23.00	17.00
7	Riker Mfg.	9XD405	86.2*	-	2.2*	59.00	-	-
7	Walker	22827	84	-	1.3	-	-	-
7	Walker	22828	82	-	1.1	-	-	-
7	Walker	22829	85	-	0.5	-	-	-

* Vehicle test data

ENGINE DATA

CUMMINS — MANUFACTURER

NTC-270 CT — MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	5-1/2 in.
STROKE	6 in.
DISPLACEMENT	855 in.^{3}
COMPRESSION RATIO	14.3 : 1
MAX RATED HP	270 @ 2100 rpm
MAX RATED TORQUE	930 @ 1300 rpm
INTAKE FLOW RATE AT RATED LOAD	825 cfm
MAX INTAKE RESTRICTION	15.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1025°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.50 in. Hg

EXHAUST GAS COMPOSITION

N_2	82 %
O_2	9.3 %
CO	.02 %
CO_2	7.6 %

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. NTC-270-CT

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Canadian Fram	FA562WH3	Dry	4.8				
4	Canadian Fram	FA-575-IH	Dry	4.2				
1	Donaldson Co.	FWA14-0033	Dry	11.0		131.00	106.00	93.00
1,3	Donaldson Co.	EBA13-0018	Dry	4.0		113.00	91.00	80.00
1,3	Vortox	AB140A4	Dry	8.5		95.00	95.00	70.00
1,3	Vortox	G150C2	Oil	9.0		99.00	99.00	73.00
2	Vortox	AE140A4	Dry	8.5		95.00	95.00	70.00

EXHAUST SYSTEMS

CUMMINS - MODEL NO. NTC-270-CT

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MPM09-0063	84	-	1.4	34.00	27.00	24.00
7	Donaldson Co.	MPM09-0141	82	-	1.2	48.00	38.00	34.00
7	Donaldson Co.	MPM09-0161	85	-	0.5	31.00	26.00	19.00
7	Donaldson Co.	MTM10-0038	80	-	1.6	63.00	51.00	45.00
8	Donaldson Co.	MOM12-0154	81	-	2.0	44.00	35.00	31.00
9	Donaldson Co.	MTM10-0043	82	-	1.4	27.00	23.00	17.00
7	Walker	22827	84	-	1.4	-	-	-
7	Walker	22828	82	-	1.2	-	-	-
7	Walker	22829	85	-	0.5	-	-	-

ENGINE DATA

CUMMINS	NTC-290
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	5-1/2 in.
STROKE	6 in.
DISPLACEMENT	855 in.^{3}
COMPRESSION RATIO	14.3 : 1
MAX RATED HP	290 @ 2100 rpm
MAX RATED TORQUE	837 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	685 cfm
MAX INTAKE RESTRICTION	15.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1100°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.50 in. Hg

EXHAUST GAS COMPOSITION

N_2	81 %
O_2	9.7 %
CO	.03 %
CO_2	8.4 %

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. NTC-290

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
4	Canadian Fram	FA-575-IH	Dry	4.8				
1	Donaldson Co.	FHG14-0121	Dry	8.7		183.00	148.00	131.00
1,3	Donaldson Co.	EBA13-0018	Dry	4.7		113.00	91.00	80.00
1,3	Vortox	AB160B4	Dry	5.0		123.00	123.00	90.00
1,3	Vortox	G150C2	Oil	9.5		99.00	99.00	73.00
2	Vortox	AE160B4	Dry	5.0		123.00	123.00	90.00

CUMMINS - MODEL NO. NTC-290

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MUM09-0022	80	-	1.5	32.00	26.00	23.00
7	Donaldson Co.	MUM09-0074	81	-	1.1	39.00	31.00	28.00
7	Donaldson Co.	MPM09-0141	78	-	2.3	48.00	38.00	34.00
7	Donaldson Co.	MPM09-0161	80	-	0.9	31.00	26.00	19.00
7	Donaldson Co.	MPM09-0197	77	-	1.3	33.00	28.00	21.00
9	Donaldson Co.	MOM12-0100	83	-	2.3	39.00	31.00	28.00
9	Donaldson Co.	MOM12-0108	85	-	1.8	47.00	38.00	34.00
8	Donaldson Co.	MOM12-0131	83	-	1.4	49.00	39.00	34.00
8	Donaldson Co.	MOM12-1000	82	-	2.1	68.00	55.00	48.00
7	Riker	9XD-404	82.7*	-	2.2*	59.00	-	-
8	Riker	94006	83.7*	-	2*	52.00	-	-
7	Stemco	9327	-	-	-	41.00	41.00	41.00
7	Walker	22809	80	-	1.5	-	-	-
7	Walker	22823	81	-	1.1	-	-	-
7	Walker	22828	78	-	2.3	-	-	-
7	Walker	22829	80	-	0.9	-	-	-
9	Walker	21174	83	-	2.3	-	-	-

* Vehicle test data

ENGINE DATA

CUMMINS	NTC-335
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	5-1/2 in.
STROKE	6 in.
DISPLACEMENT	855 in.^{3}
COMPRESSION RATIO	14.1 : 1
MAX RATED HP	335 @ 2100 rpm
MAX RATED TORQUE	930 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	850 cfm
MAX INTAKE RESTRICTION	15.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1150°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.50 in. Hg

EXHAUST GAS COMPOSITION

N_2	81 %
O_2	9.1 %
CO	.05 %
CO_2	8.0 %

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. NTC-335

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Canadian Fram	FA575WH	Dry	5.1				
4	Canadian Fram	FA575IH	Dry	7.2				
1,3	Donaldson Co.	EBA15-0005	Dry	4.8	56	145.00	117.00	103.00
1	Donaldson Co.	FHG16-0116	Dry	8.5	56	134.00	107.00	95.00
4	Donaldson Co.	EBB16-0007	Dry	5.5	56	122.00	99.00	87.00
1,3	Vortox	AB160B4	Dry	7.0	57	123.00	123.00	90.00
1,3	Vortox	G160BE2	Oil	7.3	59	102.00	102.00	75.00
2	Vortox	AE160B4	Dry	7.0	56	123.00	123.00	90.00

EXHAUST SYSTEMS

CUMMINS - MODEL NO. NTC-335

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
9	Alexander-T.	2397	85*	-	1.6*	62.00	-	56.00
7	Alexander-T.	2418	84*	-	1.8*	62.00	-	56.00
7	Donaldson Co.	MUM09-0022	81	76.8	2.3(2.7)	32.00	26.00	23.00
7	Donaldson Co.	MUM09-0074	83	81.5	1.6(1.4)	39.00	31.00	28.00
7	Donaldson Co.	MPM09-0161	81	77.5	1.2(.9)	31.00	26.00	19.00
7	Donaldson Co.	MPM09-0197	-	76.0	1.8(1.6)	33.00	28.00	21.00
9	Donaldson Co.	MOM12-0108	86	80.0	2.4(2.1)	47.00	38.00	34.00
8	Donaldson Co.	MOM12-0131	84	79.5	2.1(1.4)	49.00	39.00	35.00
8	Donaldson Co.	MOM12-0176	-	75.5	-(2.8)	32.00	27.00	20.00
7	Riker Mfg.	9XD-404	82.4*	79.0	2.4*(5.3)	59.00	-	-
7	Riker Mfg.	9XD-405	81.9*	75.5	2.5*(5.0)	59.00	-	-
7	Riker Mfg.	9XD-505	72.3	77.0	1.9(3.4)	69.00	-	-
8	Riker Mfg.	94506	84*	71.0	2.4*(3.7)	54.00	-	-
9	Stemco Mfg.	9327	79	81.5	1.0(0.8)	41.00	41.00	41.00
7	Walker	22829	81	-	1.2	-	-	-
7	Walker	22809	81	-	2.3	-	-	-
7	Walker	22823	83	-	1.6	-	-	-

* Vehicle test data

( ) Back pressure measurements from dynamometer tests

ENGINE DATA

CUMMINS	NTC-350
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	5-1/2 in.
STROKE	6 in.
DISPLACEMENT	855 in.^{3}
COMPRESSION RATIO	14.1 : 1
MAX RATED HP	350 @ 2100 rpm
MAX RATED TORQUE	1006 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	895 cfm
MAX INTAKE RESTRICTION	15.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1130°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.50 in. Hg

EXHAUST GAS COMPOSITION

N_2	82%
O_2	9.8 %
CO	.04 %
CO_2	7.3 %

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. NTC-350

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
4	Canadian Fram	FA370IH	Dry	6.4				
1	Donaldson Co.	FHG16-0116	Dry	9.0		134.00	108.00	95.00
1,3	Donaldson Co.	EBA15-0005	Dry	5.2		145.00	117.00	103.00
4	Donaldson Co.	EBB16-0007	Dry	6.0		122.00	99.00	87.00
1,3	Vortox	AB160B4	Dry	7.0		123.00	123.00	90.00
1,3	Vortox	G160BE2	Oil	7.4		102.00	102.00	75.00
2	Vortox	AE160B4	Dry	7.0		123.00	123.00	90.00

EXHAUST SYSTEMS

CUMMINS - MODEL NO. NTC-350

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MUM09-0074	84	-	1.8	39.00	31.00	28.00
7	Donaldson Co.	MPM09-0161	82	-	1.3	31.00	26.00	19.00
7	Donaldson Co.	MPM09-0197	79	-	2.0	33.00	28.00	21.00
8	Donaldson Co.	MOM12-0131	84	-	2.3	49.00	39.00	35.00
7	Stemco	9327	-	-	-	41.00	41.00	41.00
7	Walker	22829	82	-	1.3	-	-	-
7	Walker	22823	84	-	1.8	-	-	-

ENGINE DATA

CUMMINS — MANUFACTURER

NTA-370 — MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	5-1/2 in.
STROKE	6 in.
DISPLACEMENT	855 $in.^3$
COMPRESSION RATIO	13.5 : 1
MAX RATED HP	370 @ 2100 rpm
MAX RATED TORQUE	1015 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	950 cfm
MAX INTAKE RESTRICTION	15.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1130°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.50 in. Hg

EXHAUST GAS COMPOSITION

N_2	82 %
O_2	9.8 %
CO	.04 %
CO_2	7.1 %

EXHAUST NOISE AT 50 FT
OPEN PIPE .....

INTAKE NOISE AT 50 FT
OPEN PIPE .....

INTAKE SYSTEMS

CUMMINS - MODEL NO. NTA-370

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
4	Canadian Fram	FA3701H	Dry	7.4				
1	Donaldson Co.	FHG16-0151	Dry	8.5		134.00	108.00	95.00
1,3	Donaldson Co.	EBA15-0005	Dry	6.0		145.00	117.00	103.00
4	Donaldson Co.	EBB16-0007	Dry	6.8		122.00	99.00	87.00
1,3	Vortox	AB160B4	Dry	8.7		123.00	123.00	90.00
1,3	Vortox	G160BE2	Oil	9.0		102.00	102.00	75.00
2	Vortox	AE160B4	Dry	8.7		123.00	123.00	90.00

CUMMINS - MODEL NO. NTA-370

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MUM09-0074	84	-	2.1	39.00	32.00	28.00
7	Donaldson Co.	MPM09-0161	82	-	1.6	31.00	26.00	19.00
7	Stemco	9327	-	-	-	41.00	41.00	41.00
7	Walker	22823	84	-	2.1	-	-	-
7	Walker	22829	82	-	1.6	-	-	-

ENGINE DATA

DETROIT DIESEL 3-53N

MANUFACTURER MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	3
FORM	In-line
CYCLES	2
BORE	3-7/8 in.
STROKE	4-1/2 in.
DISPLACEMENT	159 $in.^3$
COMPRESSION RATIO	21.00 : 1
MAX RATED HP	94 @ 2800 rpm
MAX RATED TORQUE	198 @ 1800 rpm
INTAKE FLOW RATE AT RATED LOAD	319 cfm
MAX INTAKE RESTRICTION	16.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	920°F
MAX EXHAUST SYSTEM BACK PRESSURE	4.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

EXHAUST SYSTEMS

DETROIT DIESEL - MODEL NO. 3-53N

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MTM08-5078	81	-	2.2	28.00	22.00	20.00
8	Donaldson Co.	MBM08-5083	81	-	2.9	18.00	15.00	11.00
9	Donaldson Co.	MOM09-0170	77	-	2.4	25.00	21.00	16.00
7	Walker	22808	-	-	-	-	-	-

ENGINE DATA

DETROIT DIESEL — 4-53N

MANUFACTURER — MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	4
FORM	In-line
CYCLES	2
BORE	3-7/8 in.
STROKE	4-1/2 in.
DISPLACEMENT	212 in.^{3}
COMPRESSION RATIO	21.00 : 1
MAX RATED HP	130 @ 2800 rpm
MAX RATED TORQUE	270 @ 1800 rpm
INTAKE FLOW RATE AT RATED LOAD	450 cfm
MAX INTAKE RESTRICTION	16.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	920°F
MAX EXHAUST SYSTEM BACK PRESSURE	4.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

EXHAUST SYSTEMS

DETROIT DIESEL - MODEL NO. 4-53N

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MSM09-0146	76	-	1.8	26.00	22.00	16.00
8	Donaldson Co.	MOM09-0158	75	-	1.6	23.00	20.00	14.00
9	Donaldson Co.	MOM09-0158	78	-	1.5	23.00	20.00	14.00
7	Walker	22808	-	-	-	-	-	-

ENGINE DATA

DETROIT DIESEL — MANUFACTURER

6V-53N — MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	6
FORM	Vee
CYCLES	2
BORE	3-7/8 in.
STROKE	4-1/2 in.
DISPLACEMENT	318 in.^{3}
COMPRESSION RATIO	21.00 : 1
MAX RATED HP	197 @ 2800 rpm
MAX RATED TORQUE	421 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	675 cfm
MAX INTAKE RESTRICTION	16,0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	920°F
MAX EXHAUST SYSTEM BACK PRESSURE	4.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

DETROIT DIESEL - MODEL NO. 6V-53N

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Canadian Fram	FA562WHI	Dry	3.5 @535 cfm				
4	Canadian Fram	FA462IH	Dry	3.9 @627 cfm				
1,3	Donaldson Co.	EBA13-0018	Dry	4.5	72	112.00	91.00	80.00
1	Donaldson Co.	FHG14-0121	Dry	8.0	69	183.00	148.00	131.00
2	Donaldson Co.	EBB22-0004	Dry	6.0	70	157.00	127.00	112.00
1,3	Vortox	AB140A4	Dry	8.2		95.00	95.00	70.00
1,3	Vortox	G150C2	Oil	9.5		95.00	95.00	70.00
2	Vortox	AE140A4	Dry	8.2		95.00	95.00	70.00

EXHAUST SYSTEMS

DETROIT DIESEL - MODEL NO. 6V-53N

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
1	Donaldson Co.	MPM09-0063	85	-	2.5	34.00	27.00	24.00
1	Donaldson Co.	MPM09-0141	83	-	2.1	48.00	38.00	34.00
1	Donaldson Co.	MSM09-0142	81	-	3.5	48.00	38.00	34.00
3	Donaldson Co.	MTM10-0043	82	-	2.7	27.00	23.00	17.00
3	Donaldson Co.	MTM10-0048	85	-	3.0	29.00	24.00	18.00
3	Donaldson Co.	MOM12-0100	87	-	2.4	39.00	31.00	28.00
2	Donaldson Co.	MOM12-0154	79	-	3.7	44.00	35.00	31.00
5	Donaldson Co.	MBM08-5083	82	-	2.9	18.00	15.00	11.00
1	Donaldson Co.	MSM09-0142	81	-	3.5	42.00	34.00	30.00
4	Donaldson Co.	MTM08-5078	82	-	2.2	28.00	22.00	20.00
3	Riker	94007	88*	-	2.1*	50.00	-	-
1	Walker	22827	85	-	2.5	-	-	-
1	Walker	22828	83	-	2.1	-	-	-
3	Walker	21174	87	-	2.4	-	-	-

* Vehicle test data

ENGINE DATA

DETROIT DIESEL — MANUFACTURER

8V-53N — MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	2
BORE	3-7/8 in.
STROKE	4-1/2 in.
DISPLACEMENT	424 in.^{3}
COMPRESSION RATIO	21.00 : 1
MAX RATED HP	240 @ 2500 rpm
MAX RATED TORQUE	562 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	790 cfm
MAX INTAKE RESTRICTION	14,0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	920°F
MAX EXHAUST SYSTEM BACK PRESSURE	4.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

EXHAUST SYSTEMS

DETROIT DIESEL - MODEL NO. 8V-53N

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
1	Donaldson Co.	MPM09-0141	84	-	3.7	48.00	38.00	34.00
2	Donaldson Co.	MBM10-0002	86	-	3.8	32.00	25.00	22.00
3	Donaldson Co.	MTM10-0043	83	-	3.6	27.00	23.00	17.00
4	Donaldson Co.	MSM09-0146	78	-	1.8	26.00	22.00	16.00
5	Donaldson Co.	MOM09-0140	77	-	1.6	30.00	24.00	21.00
6	Donaldson Co.	MOM09-0140	80	-	1.5	30.00	24.00	21.00
1	Stemco	9336	-	-	-	40.00	40.00	40.00
1	Walker	22809	-	-	-	-	-	-
3	Walker	21465	86	-	3.8	-	-	-
4or6	Walker	22808	-	-	-	-	-	-

ENGINE DATA

DETROIT DIESEL — MANUFACTURER

4-71N — MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	4
FORM	In-line
CYCLES	2
BORE	4-1/4 in.
STROKE	5 in.
DISPLACEMENT	284 in.^{3}
COMPRESSION RATIO	18.7 : 1
MAX RATED HP	140 @ 2100 rpm
MAX RATED TORQUE	385 @ 1200 rpm
INTAKE FLOW RATE AT RATED LOAD	437 cfm
MAX INTAKE RESTRICTION	15.9 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	4.0 in. Hg
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

EXHAUST SYSTEMS

DETROIT DIESEL - MODEL NO. 4-71N

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MPM09-0115	84	-	2.1	39.00	31.00	28.00
7	Donaldson Co.	MSM09-0135	80	-	2.7	41.00	33.00	30.00
8	Donaldson Co.	MBM10-0002	82	-	1.2	32.00	25.00	22.00
9	Donaldson Co.	MZM08-5008	85	-	2.3	27.00	22.00	19.00
7	Walker	02809	-	-	-	-	-	-
8	Walker	21465	82	-	1.2	-	-	-
9	Walker	22808	85	-	2.3	-	-	-

ENGINE DATA

DETROIT DIESEL — MANUFACTURER

6-71N — MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	6
FORM	In- line
CYCLES	2
BORE	4-1/4 in.
STROKE	5 in.
DISPLACEMENT	426 in.^{3}
COMPRESSION RATIO	18.7 : 1
MAX RATED HP	210 @ 2100 rpm
MAX RATED TORQUE	577 @ 1200 rpm
INTAKE FLOW RATE AT RATED LOAD	655 cfm
MAX INTAKE RESTRICTION	15.9 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	855°F
MAX EXHAUST SYSTEM BACK PRESSURE	4.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

DETROIT DIESEL - MODEL NO. 6-71N

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Canadian Fram	FA562WH3	Dry	5.1 @675 cfm				
4	Canadian Fram	FA562IH		6.1 @637 cfm				
1,3	Donaldson Co.	EBA13-0018	Dry	5.2		112.00	91.00	80.00
1	Donaldson Co.	FHG14-0121		9.0		183.00	148.00	131.00
4	Donaldson Co.	EBB16-0007	Dry	4.0		122.00	99.00	87.00
1,3	Vortox	AB160B4	Dry	5.2		123.00	123.00	90.00
1,3	Vortox	G160BE2	Oil	6.0		102.00	102.00	75.00
2	Vortox	AE160E4	Dry	5.2		123.00	123.00	90.00

EXHAUST SYSTEMS

DETROIT DIESEL - MODEL NO. 6-71N

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
9	Donaldson Co.	MOM12-0100	88	-	1.8	39.00	31.00	28.00
7	Donaldson Co.	MPM09-0063	88	-	2.0	34.00	27.00	24.00
7	Donaldson Co.	MPM09-0141	85	-	1.6	48.00	38.00	34.00
7	Donaldson Co.	MSM09-0142	82	-	3.0	42.00	34.00	30.00
9	Donaldson Co.	MTM10-0006	86	-	2.6	33.00	27.00	23.00
8	Donaldson Co.	MOM12-0131	89	-	1.0	49.00	39.00	35.00
8	Donaldson Co.	MOM12-0154	83	-	3.3	44.00	35.00	31.00
9	Riker	94007	87.2*	-	2.2*	50.00	-	-
7	Walker	22829	-	-	-	-	-	-
9	Walker	21465	-	-	-	-	-	-
7	Walker	22827	88	-	2.0	-	-	-
7	Walker	22828	85	-	1.6	-	-	-

* Vehicle test data

ENGINE DATA

DETROIT DIESEL 6V-71N

MANUFACTURER MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	6
FORM	Vee
CYCLES	2
BORE	4-1/4 in.
STROKE	5 in.
DISPLACEMENT	426 in. ^{3}
COMPRESSION RATIO	18.7 : 1
MAX RATED HP	210 @ 2100 rpm
MAX RATED TORQUE	577 @ 1200 rpm
INTAKE FLOW RATE AT RATED LOAD	655 cfm
MAX INTAKE RESTRICTION	15.9 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	4.0 in. Hg
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

ENGINE DATA

DETROIT DIESEL 6V-71T

MANUFACTURER MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	Vee
CYCLES	2
BORE	4-1/4 in.
STROKE	5 in.
DISPLACEMENT	426 in.^{3}
COMPRESSION RATIO	
MAX RATED HP	262 @ 2100 rpm
MAX RATED TORQUE	723 @ 1600 rpm
INTAKE FLOW RATE AT RATED LOAD	875 cfm
MAX INTAKE RESTRICTION	12.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	730°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.50 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

DETROIT DIESEL - MODEL NO. 6V-71N

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,3	Donaldson Co.	EBA13-0018	Dry	5.2		112.00	91.00	80.00
1	Donaldson Co.	FHG14-0121	Dry	9.0		183.00	148.00	131.00
1,3	Vortox	AB160B4	Dry	5.2		123.00	123.00	90.00
1,3	Vortox	G160BE2	Oil	6.0		102.00	102.00	75.00
2	Vortox	AE160B4	Dry	5.2		123.00	123.00	90.00

DETROIT DIESEL - MODEL NO. 6V-71N

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
1	Alexander-Tagg	2517C	84.5*	-	3.0*	54.00	-	49.00
3	Alexander-Tagg	2458	85*	-	.9*	59.00	-	53.00
4	Donaldson Co.	MTM08-5078	81	-	3.2	28.00	22.00	20.00
4	Donaldson Co.	MSM09-0135	82	-	1.6	41.00	33.00	30.00
1	Donaldson Co.	MPM09-0063	88	-	2.1	34.00	27.00	23.00
4	Donaldson Co.	MPM09-0115	87	-	0.9	39.00	31.00	28.00
1	Donaldson Co.	MPM09-0141	86	-	1.7	48.00	38.00	34.00
1	Donaldson Co.	MSM09-0142	83	-	3.1	42.00	34.00	30.00
2	Donaldson Co.	MTM10-0006	86	-	2.7	33.00	27.00	23.00
3	Donaldson Co.	MOM12-0100	88	-	1.9	39.00	31.00	28.00
2	Donaldson Co.	MOM12-0154	84	-	3.4	44.00	35.00	31.00
4	Riker Mfg.	9XD304	85*		2.7*	55.00	-	-
4	Riker Mfg.	9XD354	86*	-	1.5*	57.00	-	-
2	Riker Mfg.	94306	84*	-	3.1*	48.00	-	-
3	Riker Mfg.	94307	86*	-	2.9*	48.00	-	-
3	Riker Mfg.	94007	85.6*	-	2.1*	50.00	-	-
1	Stemco Mfg.	9336	-	-	-	40.00	40.00	40.00
4	Stemco Mfg.	9338	-	-	-	42.00	42.00	42.00
4	Stemco Mfg.	9350	-	-	-	51.00	51.00	51.00
1	Walker	22809	-	-	-	-	-	-
1	Walker	22829	-	-	-	-	-	-
3	Walker	21465	-	-	-	-	-	-
4	Walker	21476	-	-	-	-	-	-
1	Walker	22828	86	-	1.7	-	-	-
3	Walker	21174	88	-	1.9	-	-	-

* Vehicle test data

ENGINE DATA

DETROIT DIESEL 8V-71N

MANUFACTURER MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	2
BORE	4-1/4 in.
STROKE	5 in.
DISPLACEMENT	568 in. ^{3}
COMPRESSION RATIO	18.7 : 1
MAX RATED HP	280 @ 2100 rpm
MAX RATED TORQUE	770 @ 1200 rpm
INTAKE FLOW RATE AT RATED LOAD	874 cfm
MAX INTAKE RESTRICTION	15.9 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	855°F
MAX EXHAUST SYSTEM BACK PRESSURE	4.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

DETROIT DIESEL - MODEL NO. 8V-71N

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
4	Canadian Fram	FA362IH	Dry	7.6				
1,3	Donaldson Co.	EBA15-0005	Dry	6.0	69	145.00	117.00	103.00
1	Donaldson Co.	FHG16-0116	Dry	12.0	58	134.00	108.00	95.00
2	Donaldson Co.	EBB22-0003	Dry	8.5	67	164.00	133.00	117.00
4	Donaldson Co.	EBB16-0007	Dry	7.0	66	122.00	99.00	87.00
1,3	Vortox	AB160A4	Dry	9.0	69	123.00	123.00	90.00
1,3	Vortox	G160AC2	Oil	10.0	78	103.00	103.00	90.00
2	Vortox	AE160A4	Dry	9.0	67	123.00	123.00	90.00

EXHAUST SYSTEMS

DETROIT DIESEL - MODEL NO. 8V-71N

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
1	Alexander-Tagg	2533	83.2*	-	3.2*	73.00	-	66.00
4	Alexander-Tagg	2531	84*	-	3.0*	67.00	-	60.00
1,3	Alexander-Tagg	2478	85*	-	3.0*	70.00	-	63.00
4	Alexander-Tagg	2435A	84*	-	1.1*	66.00	-	59.00
1	Alexander-Tagg	2435A5	85*	-	3.2*	70.00	-	63.00
1	Donaldson Co.	MPM09-0063	87	82.2	3.9(3.5)	34.00	27.00	24.00
4	Donaldson Co.	MPM09-0115	85	82.0	2.1(2.2)	39.00	31.00	28.00
4	Donaldson Co.	MSM09-0135	81	79.5	2.7(2.5)	41.00	33.00	30.00
1	Donaldson Co.	MPM09-0141	84	81.8	3.4(3.7)	48.00	38.00	34.00
2	Donaldson Co.	MOM12-0131	86	90.4	2.8(1.8)	49.00	39.00	35.00
1	Donaldson Co.	MTM10-0038	83	78.8	-(3.8)	-	-	-
3	Donaldson Co.	MOM12-0108	-	91.5	-(2.3)	47.00	38.00	34.00
4	Donaldson Co.	MSM09-0146	77	79.0	2.3(2.8)	26.00	22.00	16.00
6	Donaldson Co.	MZM09-5008	-	85.7	-(2.6)	-	-	-
5	Donaldson Co.	MBM10-0002	83	-	1.2	32.00	25.00	22.00
4	Donaldson Co.	MSM09-0146	78	79.0	3.2	26.00	22.00	16.00
4	Donaldson Co.	MSM09-0146 with AYMOO-1137 silencing kit	77	-	3.0	-	-	-
4	Donaldson Co.	WSM09-0211	76	74.5	3.6	-	-	-
1	Donaldson Co.	WSM09-0212	77	-	3.5	-	-	-
1	Donaldson Co.	MKM10-0064	81	-	3.4	-	-	-
4	Riker Mfg.	9XD354	85.7*	77.5	2.7*(2.1)	57.00	-	-
4	Riker Mfg.	9XD404	86.3*	80.9	1.2*(1.4)	59.00	-	-
1	Riker Mfg.	9XD505	85.7*	81.3	3.2*(5.0)	69.00	-	-
5	Riker Mfg.	94306	83.9*	77.0	1.9*(1.5)	48.00	-	-

* Vehicle test data

( ) Back pressure measurements from dynamometer tests

DETROIT DIESEL - MODEL NO. 8V-71N (continued)

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
2	Riker Mfg.	94306	83.2*	81.1	3.3*(6.3)	48.00	-	-
2	Riker Mfg.	94006	83.0*	80.5	2.2*(4.2)	52.00	-	-
5	Riker Mfg.	94006	83.9*	87.9	1.9*(1.2)	52.00	-	-
5	Riker Mfg.	94506	86*	81.8	1.7*(1.0)	54.00		
2	Riker Mfg.	94506	83.7*	77.9	2.4*(3.5)	54.00	-	-
6	Riker Mfg.	94307	86.2*	79.3	2.5*(2.8)	48.00	-	-
6	Riker Mfg.	94007	85.4*	83.5	1.5*(2.4)	50.00	-	-
6	Riker Mfg.	94507	87*	-	2.7*	52.00	-	-
1	Riker Mfg.	81002	83*	88.9	1.4*(3.2)	-	-	-
1	Riker Mfg.	10005	82*	85.9	1.7*(3.0)	-	-	-
1	Riker Mfg.	9XD405	-	79.3	-(1.6)	59.00	-	-
1 or 3	Stemco Mfg.	9344	80	80.3	3.8 (3.7)	45.00	45.00	45.00
1	Stemco Mfg.	9866	78	79.3	3.8 (3.5)	55.00	55.00	55.00
4	Stemco Mfg.	9350	78	78.5	*3.1(2.7)	51.00	51.00	51.00
4	Stemco Mfg.	9338	80	80.0	*2.9(2.1)	42.00	42.00	42.00
2	Stemco Mfg.	9416	77	79.4	*3.8(1.0)	60.00	60.00	60.00
1	Walker	22809	-	-	-	-	-	-
6	Walker	22808	85	-	2.6	-	-	-
1	Walker	22827	87	-	3.9	-	-	-
1	Walker	22828	84	-	3.4	-	-	-
2	Walker	21465	83	-	1.2	-	-	-

* Vehicle test data

( ) Back pressure measurements from dynamometer tests

ENGINE DATA

DETROIT DIESEL — 12V-71N

MANUFACTURER — MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	12
FORM	Vee
CYCLES	2
BORE	4-1/4 in.
STROKE	5 in.
DISPLACEMENT	852 in.^{3}
COMPRESSION RATIO	18.7 : 1
MAX RATED HP	420 @ 2100 rpm
MAX RATED TORQUE	1154 @ 1200 rpm
INTAKE FLOW RATE AT RATED LOAD	1309 cfm
MAX INTAKE RESTRICTION	15.9 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	855°F
MAX EXHAUST SYSTEM BACK PRESSURE	4.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

DETROIT DIESEL - MODEL NO. 12V-71

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,3,4	Donaldson Co.	EBA15-0003	Dry	8.5		162.00	131.00	115.00
4	Donaldson Co.	EBB16-0008	Dry	8.5		246.00	198.00	175.00
1,3	Vortox	AB140A4(2)	Dry	6.5 @1160cfm		95.00	95.00	70.00
1,3	Vortox	G135AC2	Oil	7.5 @1160cfm		78.00	78.00	57.00
2	Vortox	AE140A4(2)	Dry	6.5 @1160cfm		95.00	95.00	70.00

EXHAUST SYSTEMS

DETROIT DIESEL - MODEL NO. 12V-71N

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
4	Donaldson Co.	MPM09-0063	89	-	2.0	34.00	27.00	24.00
4	Donaldson Co.	MPM09-0141	86	-	1.6	48.00	38.00	34.00
4	Donaldson Co.	MSM09-0142	83	-	3.0	42.00	34.00	30.00
4	Donaldson Co.	MTM10-0038	85	-	1.6	63.00	51.00	45.00
5	Donaldson Co.	MOM12-0154	84	-	3.3	44.00	35.00	31.00
6	Donaldson Co.	MTM10-0006	86	-	2.6	33.00	27.00	23.00
4	Riker	9XD-404	87	-	1.4	59.00	-	-
6	Riker	94007	87.7	-	2.6	50.00	-	-
4	Walker	22828	86	-	1.6	-	-	-
6	Walker	21465	-	-	-	-	-	-
4	Walker	22827	89	-	2.0	-	-	-
4	Walker	22828	86	-	1.6	-	-	-

ENGINE DATA

DETROIT DIESEL — 6-71T

MANUFACTURER — MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	2
BORE	4-1/4 in.
STROKE	5 in.
DISPLACEMENT	426 in.^{3}
COMPRESSION RATIO	
MAX RATED HP	262 @ 2100 rpm
MAX RATED TORQUE	723 @ 1600 rpm
INTAKE FLOW RATE AT RATED LOAD	875 cfm
MAX INTAKE RESTRICTION	12.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	730°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.50 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

DETROIT DIESEL - MODEL NO. 6-71T

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,3	Donaldson Co.	EBA15-0005	Dry	8.5		145.00	117.00	103.00
1	Donaldson Co.	FHG16-0151	Dry	11.5		134.00	108.00	95.00
4	Donaldson Co.	EBB16-0008	Dry	5.0		246.00	198.00	175.00
1,3	Vortox	AB140A4(2)	Dry	6.0		95.00	95.00	70.00
1,3	Vortox	G135AC2(2)	Oil	7.5		78.00	78.00	57.00
2	Vortox	AE140B4(2)	Dry	6.0		95.00	95.00	70.00

DETROIT DIESEL - MODEL NO. 6-71T

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MUM09-0022	77	-	2.4	32.00	26.00	23.00
7	Donaldson Co.	MUM09-0074	81	-	1.5	39.00	31.00	28.00
7	Donaldson Co.	MPM09-0161	78	-	1.2	31.00	26.00	19.00
9	Donaldson Co.	MOM12-0108	81	-	2.3	47.00	38.00	34.00
8	Donaldson Co.	MOM12-0131	80	-	1.7	49.00	39.00	35.00
7	Walker	22809	77	-	2.4	-	-	-
7	Walker	22829	78	-	1.2	-	-	-
9	Walker	21465	-	-	-	-	-	-
7	Walker	22823	81	-	1.5	-	-	-

ENGINE DATA

DETROIT DIESEL — 8V-71T

MANUFACTURER — MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	2
BORE	4-1/4 in.
STROKE	5 in.
DISPLACEMENT	568 in.^{3}
COMPRESSION RATIO	17.00 : 1
MAX RATED HP	350 @ 2100 rpm
MAX RATED TORQUE	965 @ 1600 rpm
INTAKE FLOW RATE AT RATED LOAD	1180 cfm
MAX INTAKE RESTRICTION	12.0 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	730°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.50 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

DETROIT DIESEL - MODEL NO. 8V-71T

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
4	Canadian Fram	FA3701H	Dry	12.0				
1,3,4	Donaldson Co.	EBA15-0003	Dry	6.0		162.00	131.00	115.00
1,3	Votrox	AB160A4(2)	Dry	5.0 @1390cfm		123.00	123.00	90.00
1,3	Vortox	G150C2(2)	Oil	10.0 @1390cfm		99.00	99.00	73.00
2	Vortox	AE160A4(2)				123.00	123.00	90.00

EXHAUST SYSTEMS

DETROIT DIESEL - MODEL NO. 8V-71T

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Alexander-T.	2418	84.5*	-	2.2*	62.00	-	56.00
7	Alexander-T.	2435A5	86*	-	3.6*	70.00	-	63.00
7	Donaldson Co.	MUM09-0074	81	-	2.5	39.00	31.00	28.00
7	Donaldson Co.	MPM09-0161	78	-	2.0	31.00	26.00	19.00
9	Donaldson Co.	MPM09-0161	82	-	1.9	31.00	26.00	19.00
9	Donaldson Co.	MOM12-2300	85	-	2.0	63.00	50.00	45.00
7	Walker	22828	-	-	-	-	-	-
7	Walker	22829	78	-	2.0	-	-	-
7	Walker	22823	81	-	2.5	-	-	-

* Vehicle test data

ENGINE DATA

INTERNATIONAL HARVESTER DV 462-B

MANUFACTURER MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	4-1/8 in.
STROKE	4-5/16 in.
DISPLACEMENT	461.064 in. ^{3}
COMPRESSION RATIO	
MAX RATED HP	160 @ 3000 rpm
MAX RATED TORQUE	307 @ 2000 rpm
INTAKE FLOW RATE AT RATED LOAD	372 cfm
MAX INTAKE RESTRICTION	20 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1200°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

EXHAUST SYSTEMS

INTERNATIONAL HARVESTER - MODEL NO. DV 462-B

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Dyno Test	DCI Dyno Test		1	10	100
1	Donaldson Co.	MPM09-0141	77	-	0.9	48.00	38.00	34.00
2	Donaldson Co.	MBM10-0049	80	-	1.3	22.00	18.00	14.00
3	Donaldson Co.	MTM10-0043	75	-	1.1	27.00	23.00	17.00
4&6	Donaldson Co.	MTM08-5078	75	-	1.0	28.00	22.00	20.00
5	Donaldson Co.	MBM08-5083	74	-	1.3	18.00	15.00	11.00
1	Walker	22828	-	-	-	-	-	-
3	Walker	21152	-	-	-	-	-	-
1	Walker	21174	-	-	-	-	-	-
1	Walker	22828	77	-	0.9	-	-	-

ENGINE DATA

INTERNATIONAL HARVESTER D 301

MANUFACTURER MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	
STROKE	
DISPLACEMENT	301.7
COMPRESSION RATIO	
MAX RATED HP	112.5 @ 3000 rpm
MAX RATED TORQUE	228 @ 1600 rpm
INTAKE FLOW RATE AT RATED LOAD	
MAX INTAKE RESTRICTION	
EXHAUST TEMPERATURE AT RATED FLOW	
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

EXHAUST SYSTEMS

INTERNATIONAL HARVESTER - MODEL NO. D 301

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7,9	Donaldson Co.	MTM08-5078	75	-	1.8	28.00	22.00	20.00
8	Donaldson Co.	MBM08-5083	75	-	2.0	18.00	15.00	11.00
7	Walker	21475	-	-	-	-	-	-
7	Walker	21476	-	-	-	-	-	-

ENGINE DATA

INTERNATIONAL HARVESTER — DV 550-B

MANUFACTURER — MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	4
BORE	4-1/2 in.
STROKE	4-5/16 in.
DISPLACEMENT	548.704 in. ^{3}
COMPRESSION RATIO	
MAX RATED HP	200 @ 3000 rpm
MAX RATED TORQUE	389 @ 2000 rpm
INTAKE FLOW RATE AT RATED LOAD	372 cfm
MAX INTAKE RESTRICTION	20 in. H_2O
EXHAUST TEMPERATURE AT RATED FLOW	1200°F
MAX EXHAUST SYSTEM BACK PRESSURE	2.0 in. Hg

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

INTERNATIONAL HARVESTER - MODEL NO. DV-550

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,4	Donaldson Co.	FWA14-0033	Dry	5.0		131.00	106.00	93.00
1,3	Donaldson Co.	EBA13-0018	Dry	2.0		112.00	91.00	80.00
1,3	Vortox	AB120A4	Dry	6.0		77.00	77.00	57.00
1,3	Vortox	G135AC2	Oil	6.0		78.00	78.00	57.00
2	Vortox	AE120A4	Dry	6.0		77.00	77.00	57.00

EXHAUST SYSTEMS

INTERNATIONAL HARVESTER - MODEL NO. DV 550-B

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
1	Donaldson Co.	MPM09-0141	78	-	1.1	48.00	38.00	34.00
2	Donaldson Co.	MBM10-0049	81	-	1.5	22.00	18.00	14.00
3	Donaldson Co.	MTM10-0043	76	-	1.3	27.00	23.00	17.00
4	Donaldson Co.	MSM09-0146	74	-	0.9	26.00	22.00	16.00
5	Donaldson Co.	MBM08-5083	75	-	1.5	18.00	15.00	11.00
6	Donaldson Co.	MTM08-5078	78	-	1.1	28.00	22.00	20.00
1	Walker	22808	-	-	-	-	-	-
3	Walker	21152	-	-	-	-	-	-
1	Walker	21174	-	-	-	-	-	-
1	Walker	22828	78	-	1.1	-	-	-

ENGINE DATA

MACK	ENDT 475
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	4
BORE	4.53 in.
STROKE	4.92 in.
DISPLACEMENT	475 in. ^{3}
COMPRESSION RATIO	15.5 : 1
MAX RATED HP	190 @ 2400 rpm
MAX RATED TORQUE	470 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	
MAX INTAKE RESTRICTION	
EXHAUST TEMPERATURE AT RATED FLOW	
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

MACK - MODEL NO. ENDT 475

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Donaldson Co.	FWA14-0033	Dry	5.0		131.00	106.00	93.00
1,3	Donaldson Co.	EBA13-0018	Dry	2.5		112.00	91.00	80.00
1,3	Vortox	AB120B4	Dry	6.5		77.00	77.00	57.00
1,3	Vortox	G120T2	Oil	9.0		63.00	63.00	46.00
2	Vortox	AE120C4	Dry	6.5		77.00	77.00	57.00

EXHAUST SYSTEMS

MACK - MODEL NO. ENDT 475

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
9	Alexander	2188	84*	-	0.9*	41.00	-	37.00
7	Donaldson Co.	MUM09-0022	77	-	0.8	32.00	26.00	23.00
7	Donaldson Co.	MPM09-0063	76	-	1.4	34.00	27.00	24.00
7	Donaldson Co.	MPM09-0141	75	-	1.2	48.00	38.00	34.00
8	Donaldson Co.	MOM12-1000	78	-	1.0	68.00	55.00	48.00
9	Donaldson Co.	MOM12-0100	74	-	1.4	39.00	31.00	28.00
7	Stemco	9300	-	-	-	36.00	36.00	36.00
7	Stemco	9349	-	-	-	50.00	50.00	50.00
8	Stemco	9855	-	-	-	41.00	41.00	41.00
9	Stemco	9864	-	-	-	51.00	51.00	51.00
9	Walker	21174	74	-	1.4	-	-	-
7	Walker	22825	79	-	1.6	-	-	-
7	Walker	22809	77	-	0.8	-	-	-
7	Walker	22828	75	-	1.2	-	-	-

* Vehicle test data

ENGINE DATA

MACK	ENDT 673 & ENDLT 673
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	
BORE	4-7/8 in.
STROKE	6 in.
DISPLACEMENT	672 in.^{3}
COMPRESSION RATIO	16.59 : 1
MAX RATED HP	225 @ 2100 rpm
MAX RATED TORQUE	653 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	
MAX INTAKE RESTRICTION	
EXHAUST TEMPERATURE AT RATED FLOW	
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2	
O_2	
CO	
CO_2	

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

MACK - MODEL NO. END 673

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,3	Donaldson Co.	EBA13-0018	Dry	2.5		112.00	91.00	80.00
1	Donaldson Co.	FWA14-0033	Dry	7.5		131.00	106.00	93.00
1,3	Vortox	AB100A4	Dry	6.5		69.00	69.00	50.00
1,3	Vortox	G110Q2	Oil	7.5		60.00	60.00	44.00
2	Vortox	AE100A4	Dry	6.5		69.00	69.00	50.00

EXHAUST SYSTEMS

MACK - MODEL NO. ENDT 673

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Stemco	9300	-	-	-	36.00	36.00	36.00
7	Stemco	9349	-	-	-	50.00	50.00	50.00
8	Stemco	9855	-	-	-	41.00	41.00	41.00
7	Walker	22827	-	-	-	-	-	-
9	Walker	21465	-	-	-	-	-	-

ENGINE DATA

MACK — MANUFACTURER

ENDT 673C & ENDLT 673 C — MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	
BORE	4-7/8 in.
STROKE	6 in.
DISPLACEMENT	672 in.^{3}
COMPRESSION RATIO	15.12 : 1
MAX RATED HP	250 @ 2100 rpm
MAX RATED TORQUE	700 @ 1600 rpm
INTAKE FLOW RATE AT RATED LOAD	
MAX INTAKE RESTRICTION	
EXHAUST TEMPERATURE AT RATED FLOW	
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2	
O_2	
CO	
CO_2	

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

EXHAUST SYSTEMS

MACK - MODEL NO. ENDT-673C

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
9	Stemco	9864	-	-	-	51.00	51.00	51.00
7	Walker	22827	-	-	-	-	-	-
9	Walker	21465	-	-	-	-	-	-
9	Walker	22808	-	-	-	-	-	-

ENGINE DATA

MACK	END 673E & ENDL 673E
MANUFACTURER	MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	
BORE	4-7/8 in.
STROKE	6 in.
DISPLACEMENT	672 in. ^{3}
COMPRESSION RATIO	16.11 : 1
MAX RATED HP	180 @ 2100 rpm
MAX RATED TORQUE	540 @ 1400 rpm
INTAKE FLOW RATE AT RATED LOAD	
MAX INTAKE RESTRICTION.....	
EXHAUST TEMPERATURE AT RATED FLOW ...	
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2	
O_2	
CO	
CO_2	

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

EXHAUST SYSTEMS

MACK - MODEL NO. END 673E

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Donaldson Co.	MPM09-0063	80	-	1.1	34.00	27.00	24.00
7	Donaldson Co.	MPM09-0141	78	-	0.8	48.00	38.00	34.00
7	Donaldson Co.	MSM09-0142	76	-	1.5	42.00	34.00	30.00
9	Donaldson Co.	MOM09-0124	81	-	1.3	39.00	31.00	28.00
9	Donaldson Co.	MTM10-0043	78	-	1.2	27.00	23.00	17.00
9	Donaldson Co.	MOM12-0100	79	-	0.9	39.00	31.00	28.00
8	Donaldson Co.	MBM10-0049	77	-	1.6	22.00	18.00	14.00
8	Donaldson Co.	MOM12-0154	75	-	1.5	44.00	35.00	31.00
7	Walker	22827	80	-	1.1	-	-	-
9	Walker	21465	-	-	-	-	-	-
9	Walker	22808	-	-	-	-	-	-
7	Walker	22828	78	-	0.8	-	-	-
9	Walker	21174	79	-	0.9	-	-	-

ENGINE DATA

MACK	ENDT 675
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	
BORE	4-7/8 in.
STROKE	6 in.
DISPLACEMENT	672 in. ^{3}
COMPRESSION RATIO	14.9 : 1
MAX RATED HP	237 @ 1700 rpm
MAX RATED TORQUE	906 @ 1200 rpm
INTAKE FLOW RATE AT RATED LOAD	
MAX INTAKE RESTRICTION	
EXHAUST TEMPERATURE AT RATED FLOW	
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

MACK - MODEL NO. ENDT 675

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1	Donaldson Co.	FWA14-0033	Dry	8.0		131.00	106.00	93.00
1,3	Donaldson Co.	EBA13-0018	Dry	4.0		112.00	91.00	80.00
1,3	Vortox	AB140A4	Dry	7.2		95.00	95.00	70.00
1,3	Vortox	G140G2	Oil	9.0		84.00	84.00	62.00
2	Vortox	AE140A2		7.2		95.00	95.00	70.00

EXHAUST SYSTEMS

MACK - MODEL NO. ENDT 675

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
9	Alexander-T.	1393	85*	-	0.6*	46.00	-	42.00
7	Alexander-T.	1393	84*	-	0.8*	46.00	-	42.00
7	Donaldson Co.	MUM09-0022	75	-	0.8	32.00	26.00	23.00
8	Donaldson Co.	MOM12-1000	76	-	1.2	68.00	55.00	48.00
7	Stemco	9300	71	-	.55	36.00	36.00	36.00
7	Stemco	9349	-	-	-	50.00	50.00	50.00
8	Stemco	9855	-	-	-	41.00	41.00	41.00
9	Stemco	9864	-	-	-	51.00	51.00	51.00
9	Walker	22808	-	-	-	-	-	-
7	Walker	22409	75	-	0.8	-	-	-

* Vehicle test data

ENGINE DATA

MACK	END 707 & ENDL 707
MANUFACTURER	MODEL NO.

TYPE	Naturally aspirated
NUMBER OF CYLINDERS	6
FORM	In-line
CYCLES	
BORE	5 in.
STROKE	6 in.
DISPLACEMENT	707 in. ^{3}
COMPRESSION RATIO	15.67 : 1
MAX RATED HP	200 @ 2100 rpm
MAX RATED TORQUE	557 @ 1500 rpm
INTAKE FLOW RATE AT RATED LOAD	
MAX INTAKE RESTRICTION.....	
EXHAUST TEMPERATURE AT RATED FLOW ...	
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

MACK - MODEL NO. END 707

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,3	Donaldson Co.	EBA13-0018	Dry	2.0		112.00	91.00	80.00
1	Donaldson Co.	FWA14-0033	Dry	4.2		131.00	106.00	93.00
1,3	Vortox	AB120B4	Dry	6.0		77.00	77.00	57.00
1,3	Vortox	G120T2	Oil	7.6		63.00	63.00	46.00
2	Vortox	AE120C4	Dry	6.0		77.00	77.00	57.00

EXHAUST SYSTEMS

MACK - MODEL NO. END-707

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
9	Alexander-T.	1436	83*	-	1.0*	49.00	-	44.00
7	Alexander-T.	2359A	83*	-	1.2*	49.00	-	45.00
8	Alexander-T.	2393	83*	-	1.4*	49.00	-	45.00
7	Donaldson Co.	MPM09-0063	81	-	1.1	34.00	22.00	24.00
7	Donaldson Co.	MPM09-0141	79	-	1.3	48.00	38.00	34.00
7	Donaldson Co.	MSM09-0142	77	-	1.7	42.00	34.00	30.00
9	Donaldson Co.	MTM10-0043	78	-	1.5	27.00	23.00	17.00
9	Donaldson Co.	MOM12-0100	80	-	1.2	39.00	31.00	28.00
8	Donaldson Co.	MBM10-0049	79	-	1.7	22.00	18.00	14.00
8	Donaldson Co.	MOM12-0154	76	-	1.8	44.00	35.00	31.00
9	Walker	22808	-	-	-	-	-	-
7	Walker	22827	81	-	1.3	-	-	-
9	Walker	21465	-	-	-	-	-	-
7	Walker	22828	79	-	1.1	-	-	-
9	Walker	21174	80	-	1.2	-	-	-

* Vehicle test data

ENGINE DATA

MACK	ENDT 865
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	
BORE	5-1/4 in.
STROKE	5 in.
DISPLACEMENT	866 in.^{3}
COMPRESSION RATIO	15.0 : 1
MAX RATED HP	325 @ 2100 rpm
MAX RATED TORQUE	1100 @ 1350 rpm
INTAKE FLOW RATE AT RATED LOAD	
MAX INTAKE RESTRICTION.....	
EXHAUST TEMPERATURE AT RATED FLOW ...	
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

MACK - MODEL NO. ENDT 865

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,3	Donaldson Co.	EBA15-0005	Dry	5.5		145.00	117.00	103.00
1	Donaldson Co.	FHG16-0116	Dry	11.0		134.00	108.00	95.00
1,3	Vortox	AB120A4(2)	Dry	6.0		77.00	77.00	57.00
1,3	Vortox	G160BE2	Oil	9.0		102.00	102.00	75.00
2	Vortox	AE120A4(2)	Dry	6.0		77.00	77.00	57.00

EXHAUST SYSTEMS

MACK - MODEL NO. ENDT 865

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Alexander-T.	2418	84*	-	0.6*	62.00	-	56.00
7	Alexander-T.	1899	84*	-	0 .6*	30.00	-	27.00'
7	Donaldson Co.	MUM09-0074	80	-	0.7	39.00	32.00	28.00
7	Donaldson Co.	MPM09-0197	76	-	1.1	33.00	28.00	21.00
7	Donaldson Co.	MPM09-0161	78	-	0.6	31.00	26.00	19.00
8	Donaldson Co.	MOM12-0131	80	-	1.2	49.00	39.00	35.00
7	Walker	22823	80	-	0.7	-	-	-
7	Walker	22829	78	-	0.6	-	-	-

* Vehicle test data

ENGINE DATA

MACK	ENDT 866
MANUFACTURER	MODEL NO.

TYPE	Turbocharged
NUMBER OF CYLINDERS	8
FORM	Vee
CYCLES	
BORE	5-1/4 in.
STROKE	5 in.
DISPLACEMENT	866 in.^{3}
COMPRESSION RATIO	15.0 : 1
MAX RATED HP	375 @ 2200 rpm
MAX RATED TORQUE	1040 @ 1600 rpm
INTAKE FLOW RATE AT RATED LOAD	
MAX INTAKE RESTRICTION	
EXHAUST TEMPERATURE AT RATED FLOW	
MAX EXHAUST SYSTEM BACK PRESSURE	

EXHAUST GAS COMPOSITION

N_2 .....

O_2 .....

CO .....

CO_2 .....

EXHAUST NOISE AT 50 FT

OPEN PIPE .....

INTAKE NOISE AT 50 FT

OPEN PIPE .....

INTAKE SYSTEMS

MACK - MODEL NO. ENDT 866

Configuration (See Fig A-1)	Air Cleaner Manufacturer	Model No.	Type	Initial Airflow Resistance (in. H_2O)	Intake Noise Level at 50 ft (dBA)	Cost Each in Lots of		
						1	10	100
1,3	Donaldson Co.	EBA15-0005	Dry	6.0		145.00	117.00	103.00
1	Donaldson Co.	FHG16-0116	Dry	13.0		134.00	106.00	95.00

EXHAUST SYSTEMS

MACK - MODEL NO. ENDT 866

Configuration (See Fig A-2)	Muffler Manufacturer	Model No.	Exhaust Noise Level at 50 ft (dBA)		Back Pressure (in. Hg)	Cost Each in Lots of		
			Mfgr Data	DCI Dyno Test		1	10	100
7	Alexander-T.	2418	84*	-	0.8*	62.00	-	56.00
7	Alexander-T.	1899	84*	-	0.8*	30.00	-	27.00

* Vehicle Test Data

APPENDIX B

"A"-WEIGHTED NARROW-BAND FREQUENCY ANALYSIS OF EXHAUST AND INTAKE NOISE AS MEASURED DURING DRIVE-BY AND DYNAMOMETER TESTS

APPENDIX B

"A"-WEIGHTED NARROW-BAND FREQUENCY ANALYSIS OF EXHAUST AND INTAKE NOISE AS MEASURED DURING DRIVE-BY AND DYNAMOMETER TESTS

Figure	Description	Page
	Drive-By Tests - 50 ft location	
B1	Cummins NTC-350, Open Pipe Exhaust	195
B2	Detroit Diesel 8V-71, Single Open Pipe Exhaust	196
B3	Detroit Diesel 8V-71, Dual Open Pipe Exhaust	197
B4	Detroit Diesel 8V-71, Dual Donaldson MSM09-0135 Mufflers	198
B5	Detroit Diesel 8V-71, Dual Stemco 9350 Mufflers	199
B6	Detroit Diesel 6-71, Open Pipe Exhaust	200
B7	Mack ENDT 675, Open Pipe Exhaust	201
B8	Mack ENDT 865, Open Pipe Exhaust	202
B9	Cummins NTC-270 CT, Open Pipe Exhaust	203
B10	Cummins NTC-270 CT, Open Pipe Jacobs Brake Noise	204
B11	Detroit Diesel 8V-71T, 5-In. Open Pipe Exhaust	205
B12	Detroit Diesel 8V-71T, Dual, Open Pipes with Donaldson MAM10-0059 "Wye" Muffler	206
B13	Detroit Diesel 8V-71T, Dual, Open Pipes with Tubular "Wye" Connection	207
B14	Detroit Diesel 8V-71, Bus with Oval Muffler	208
	Dyno Tests - 75-In. Location	
B15	Cummins NTC-335, Open Pipe Intake	209
B16	Cummins NTC-335, Open Pipe Intake	210
B17	Cummins NTC-335, Open Pipe Exhaust	211
B18	Cummins NTC-335, Open Pipe and Jacobs Brake	212
B19	Detroit Diesel 8V-71, Open Pipe Intake	213
B20	Detroit Diesel 8V-71, Intake with Donaldson FWA16-0001 Air Cleaner	214
B21	Detroit Diesel 8V-71, Dual Stemco 9530 Mufflers	215
B22	Detroit Diesel 8V-71, Dual Donaldson MSM09-0135 Mufflers	216

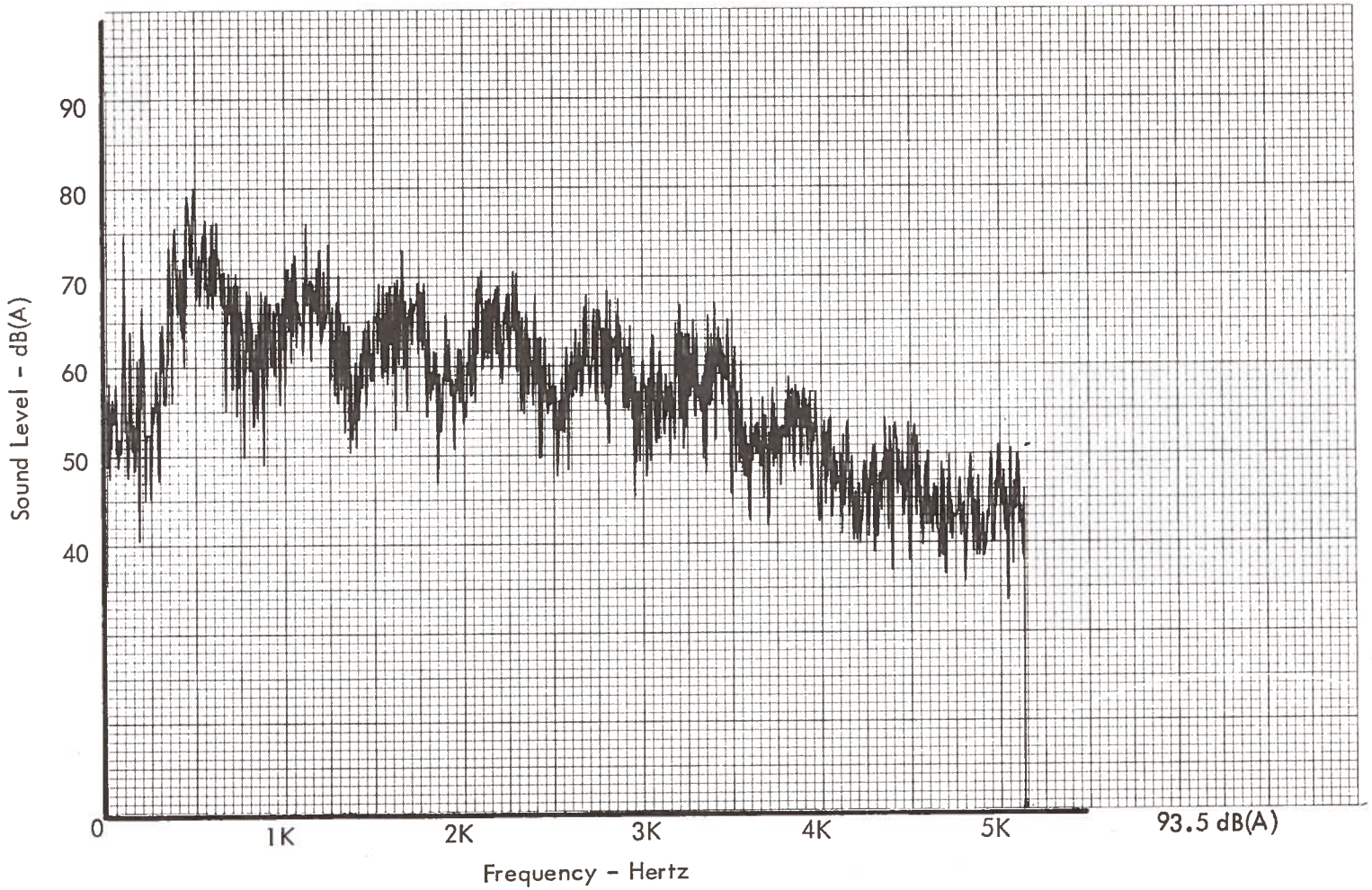


Figure B1. Cummins NTC-350, Open Pipe Exhaust

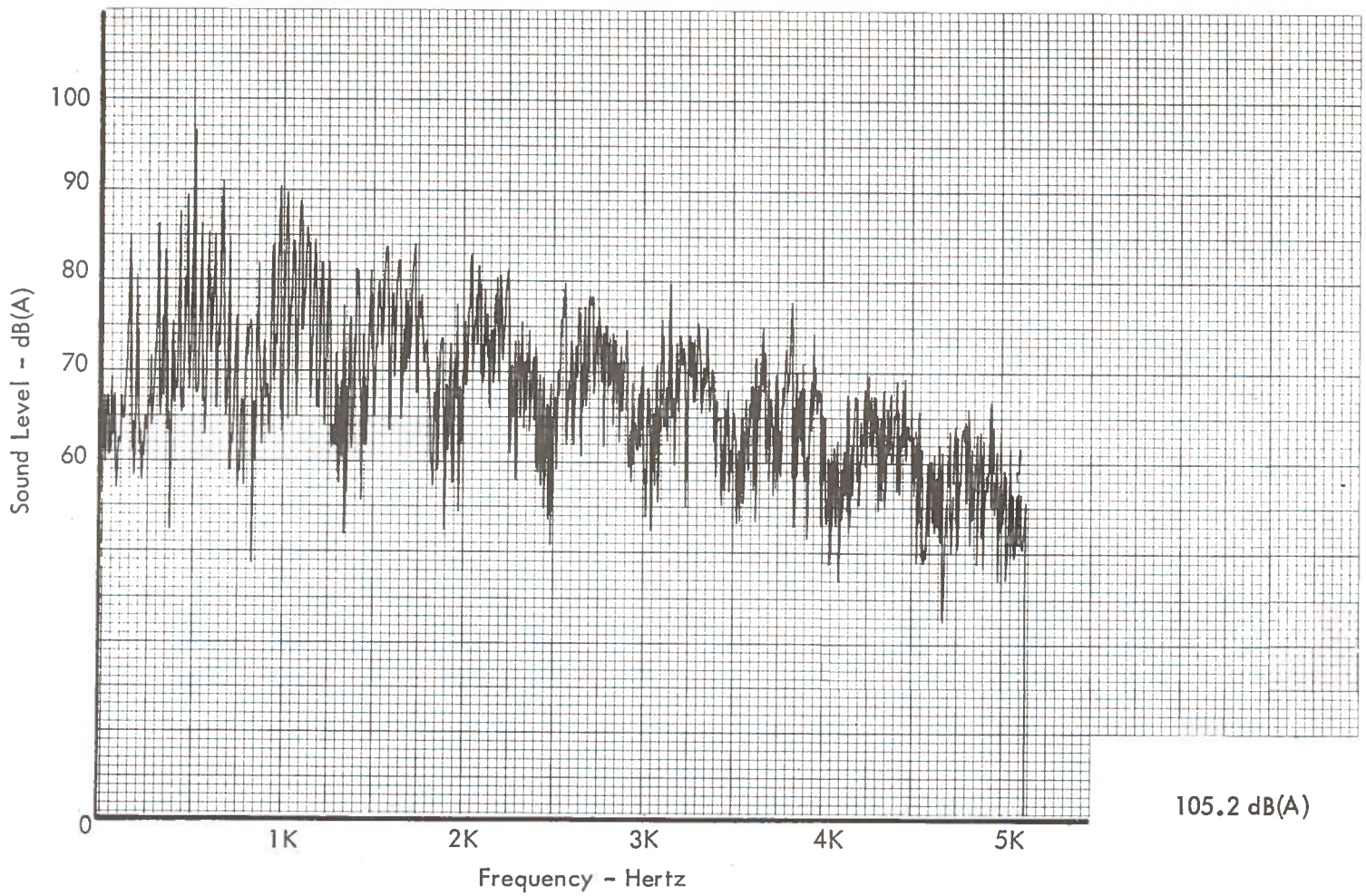


Figure B2. Detroit Diesel 8V-71, Single Open Pipe Exhaust

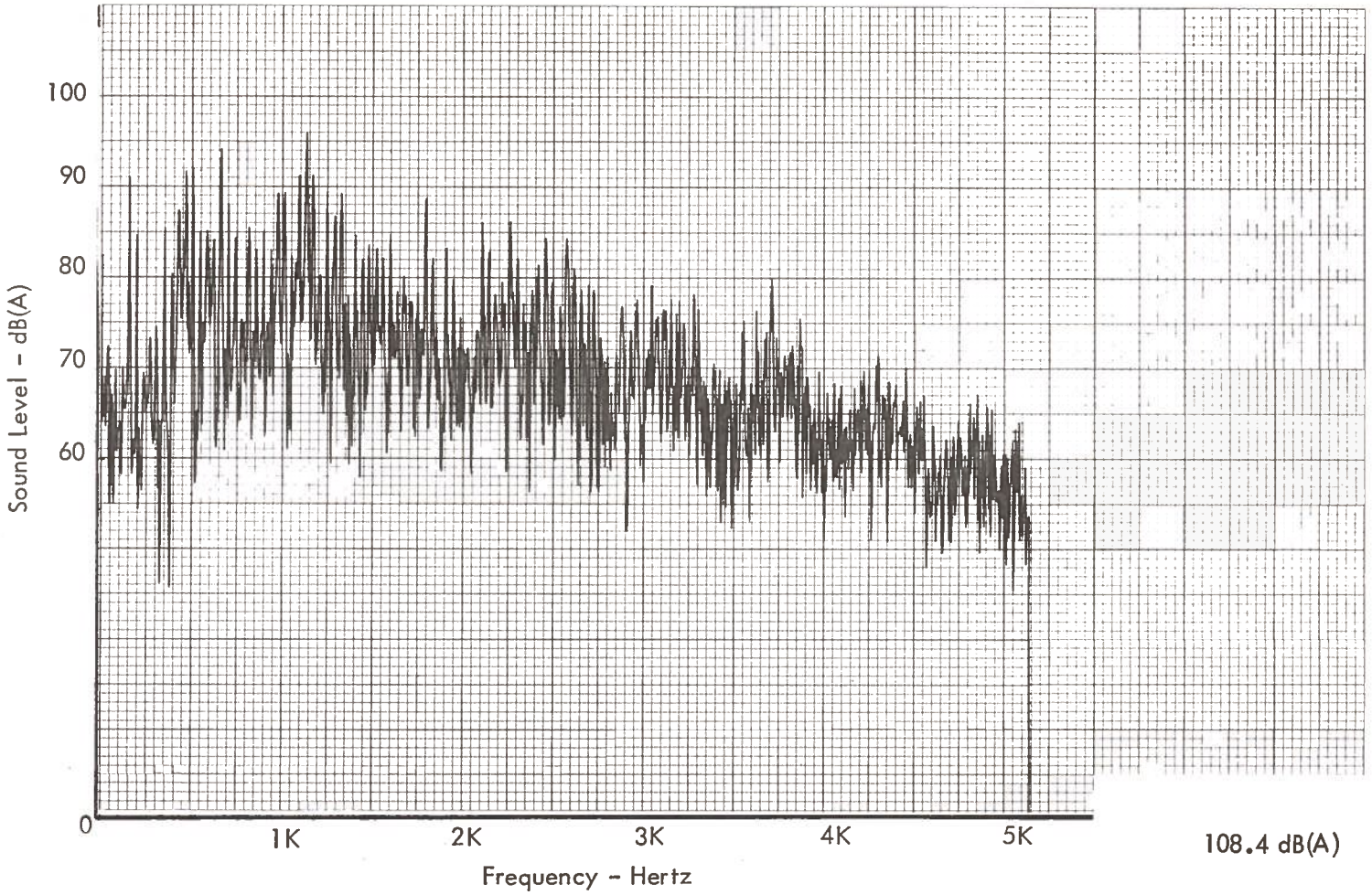


Figure B3. Detroit Diesel 8V-71, Dual Open Pipe Exhaust

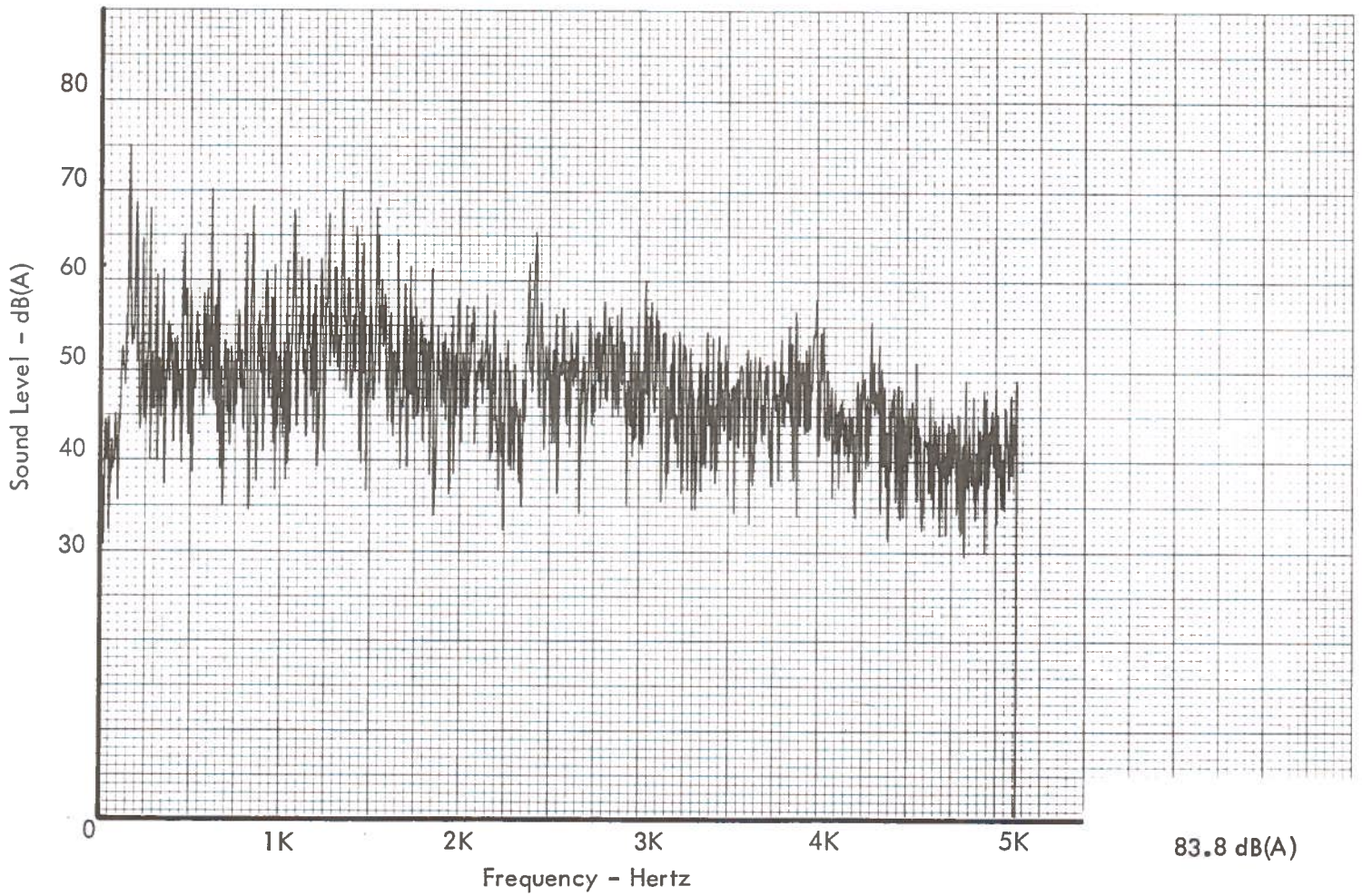


Figure B4. Detroit Diesel 8V-71, Dual Donaldson MSM09-0135 Mufflers

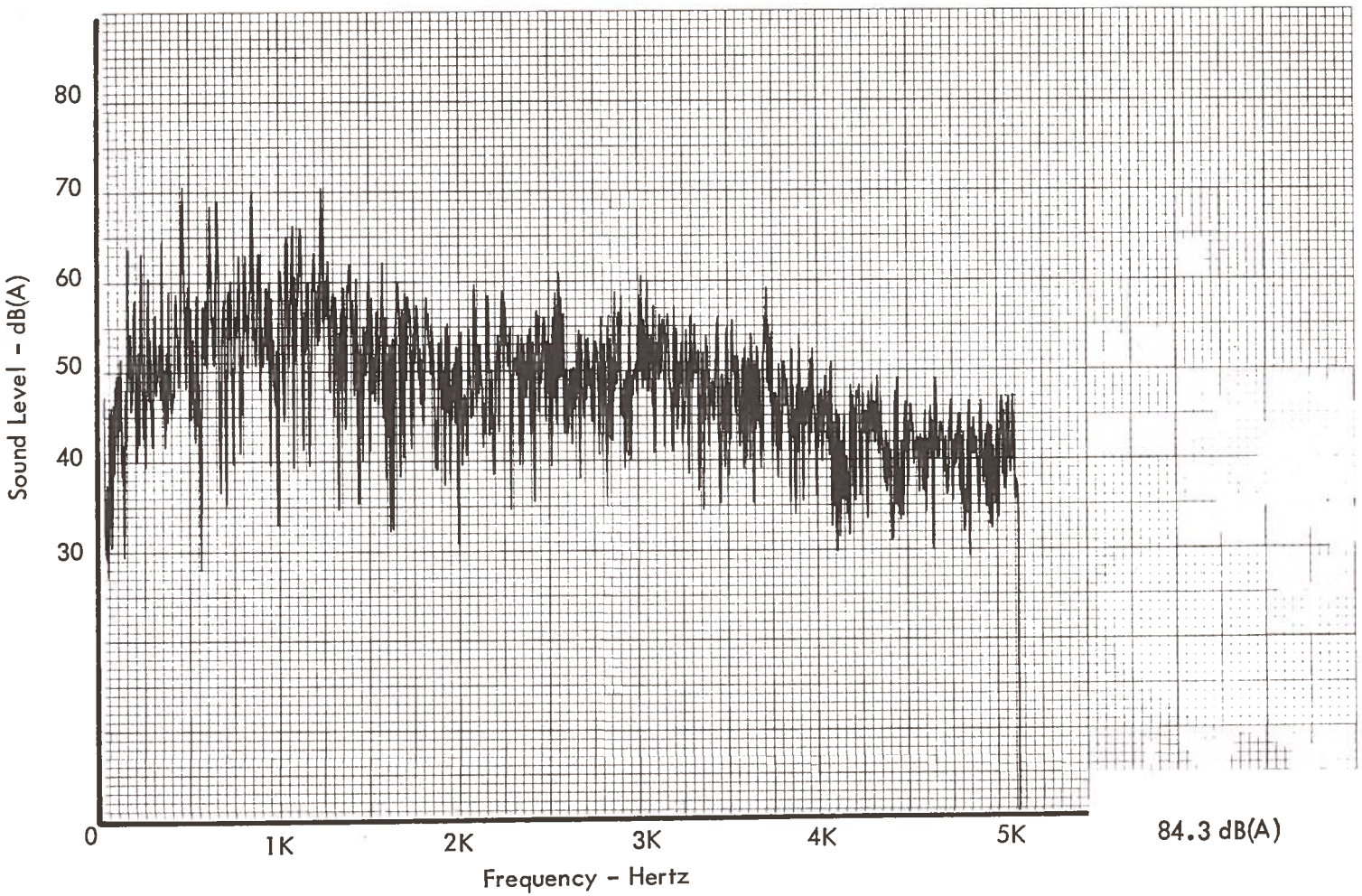


Figure B5. Detroit Diesel 8V-71, Dual Stemco 9350 Mufflers

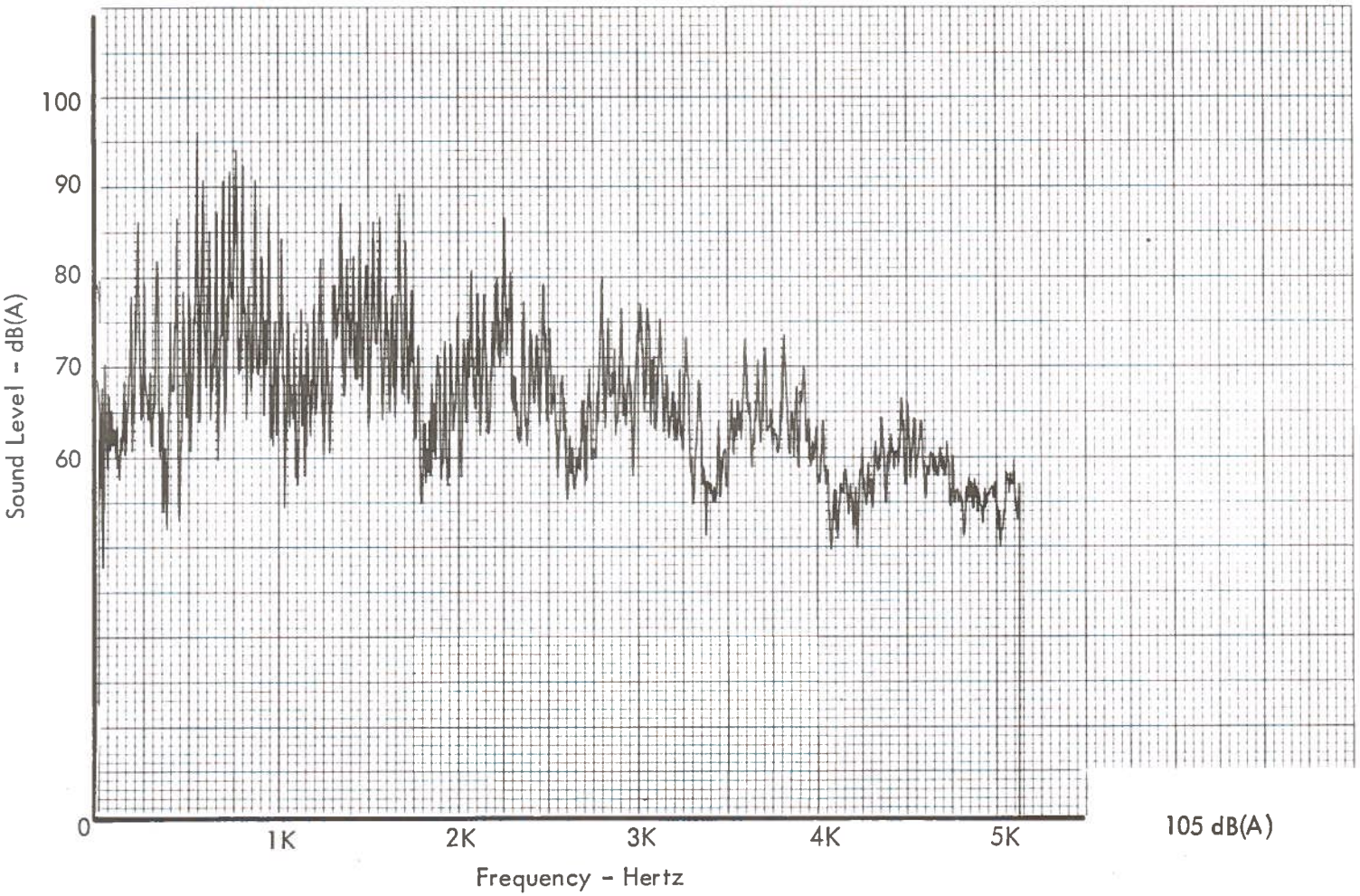


Figure B6. Detroit Diesel 6-71, Open Pipe Exhaust

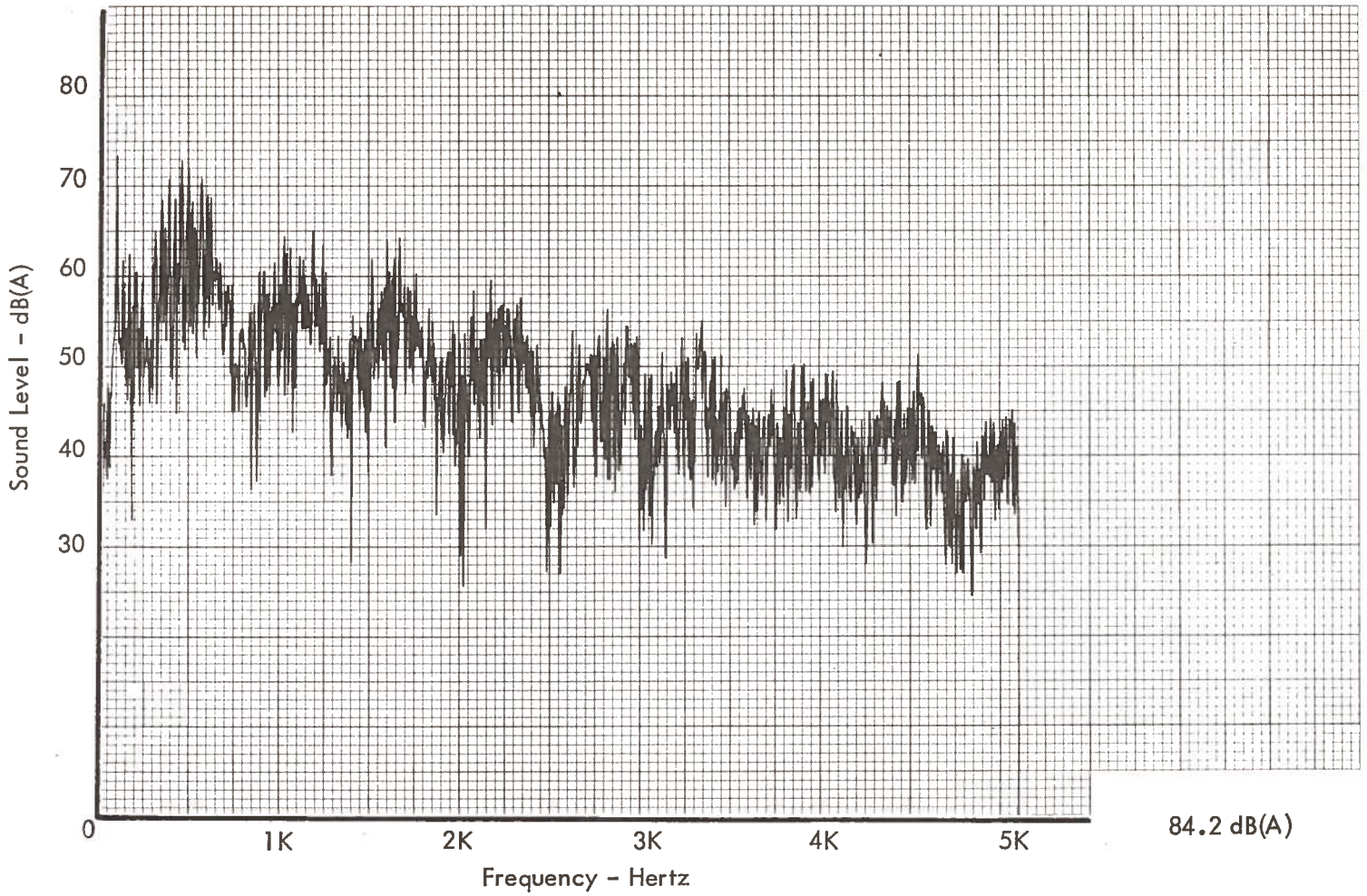


Figure B7. Mack ENDT 675, Open Pipe Exhaust

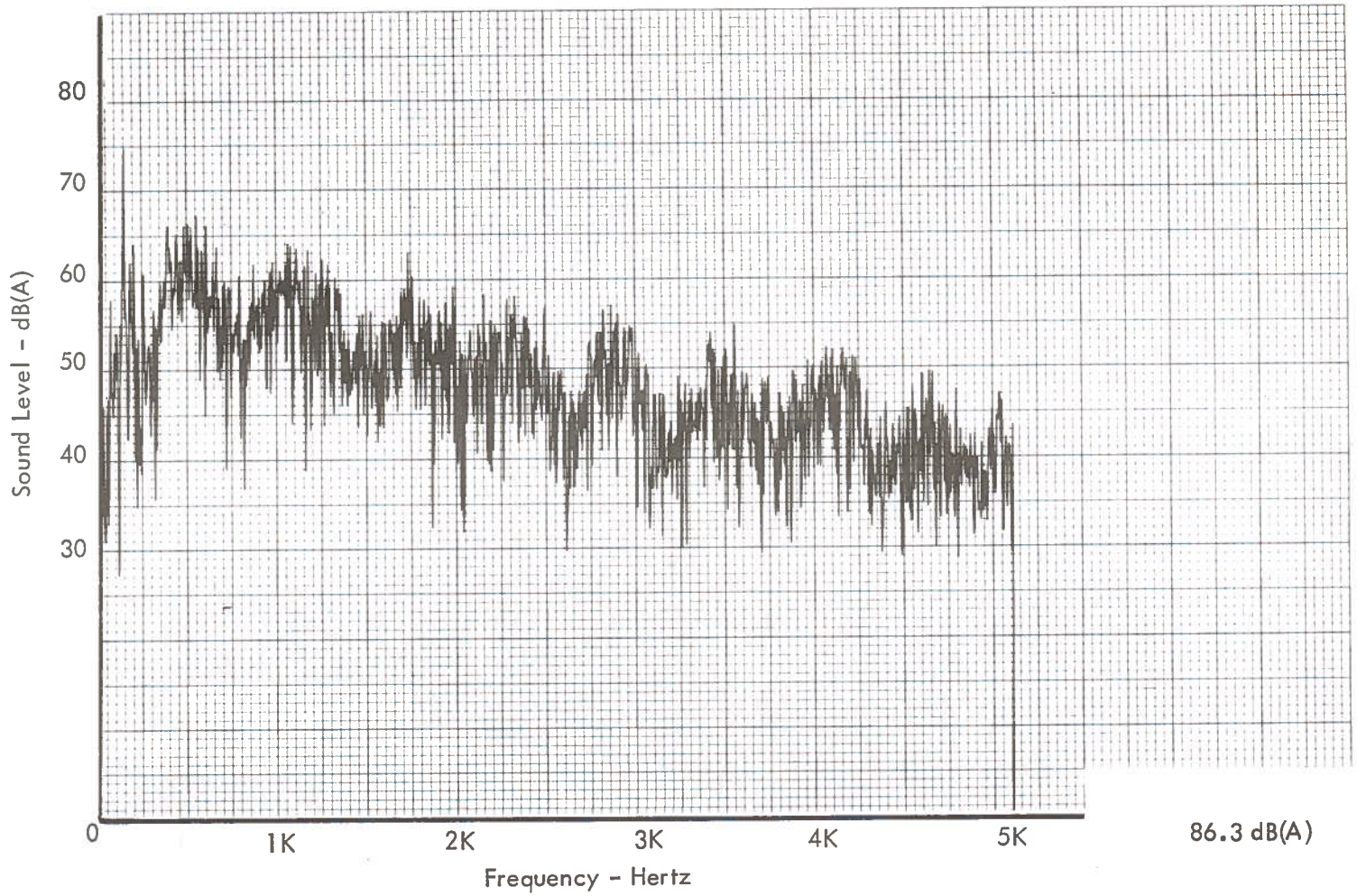


Figure 88. Mack ENDT 865, Open Pipe Exhaust

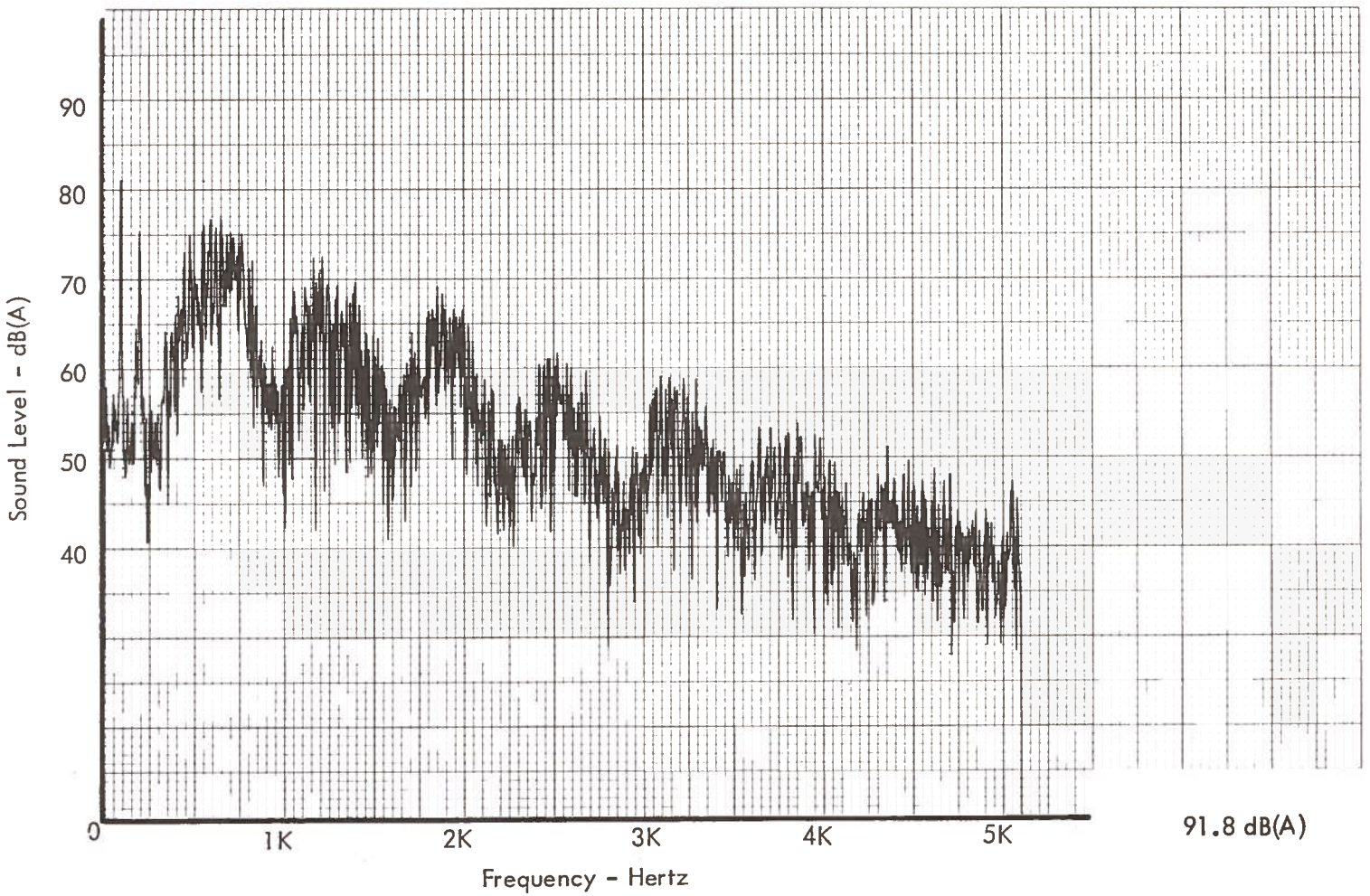


Figure B9. Cummins NTC-270 CT, Open Pipe Exhaust

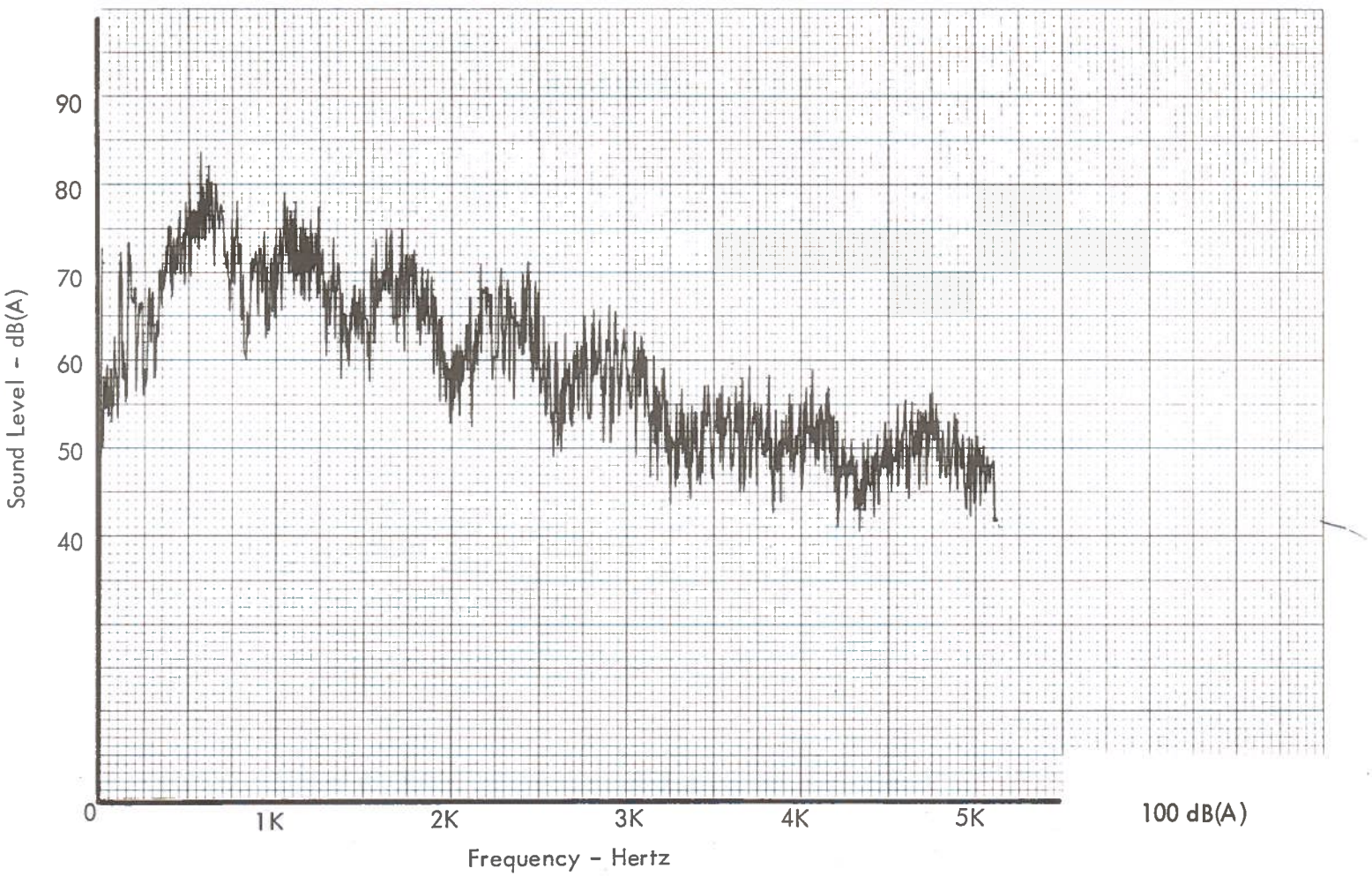


Figure B10. Cummins NTC-270 CT, Open Pipe and Jacobs Brake Noise

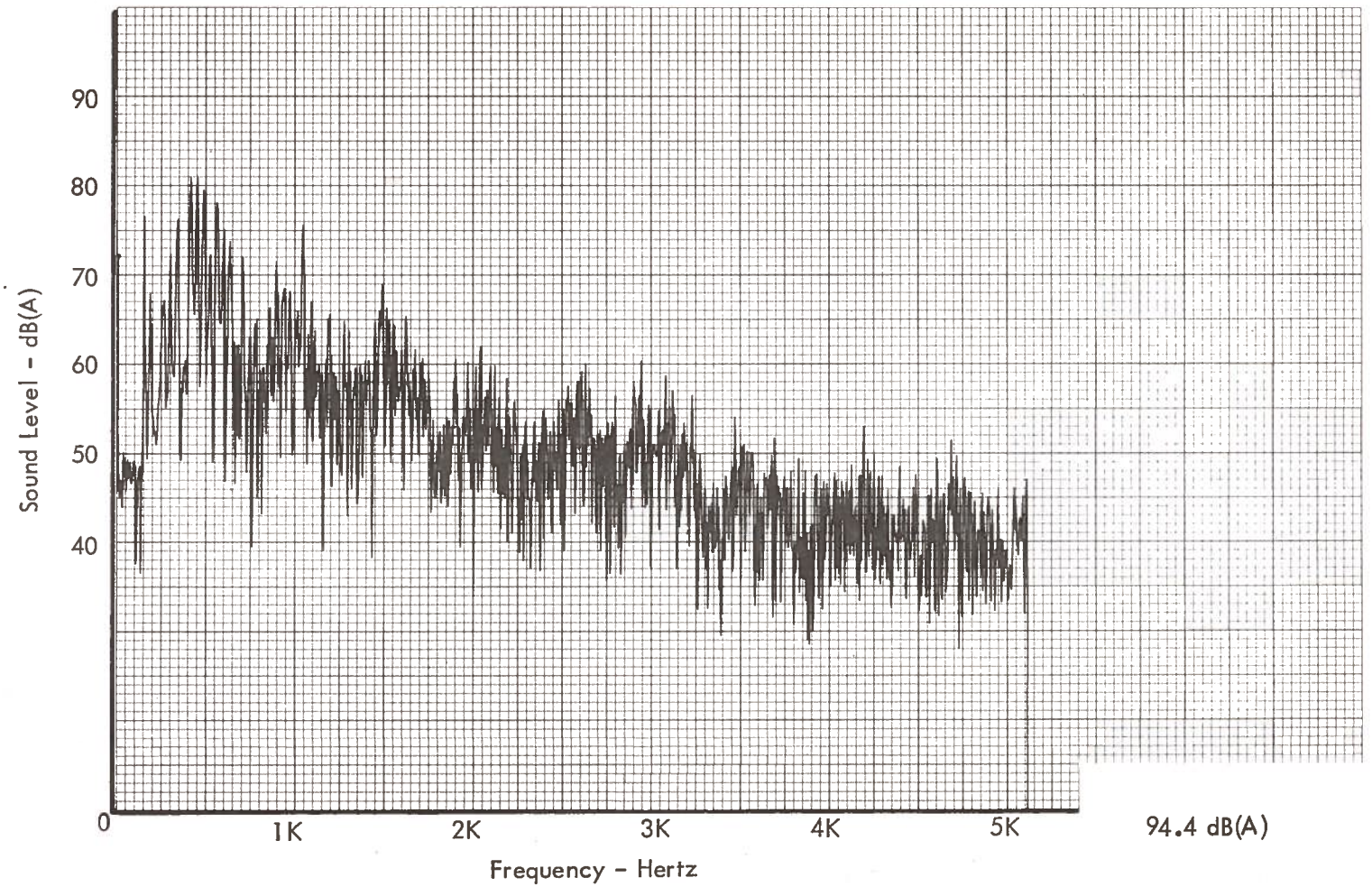


Figure B11. Detroit Diesel 8V-71T, 5-In. Open Pipe Exhaust

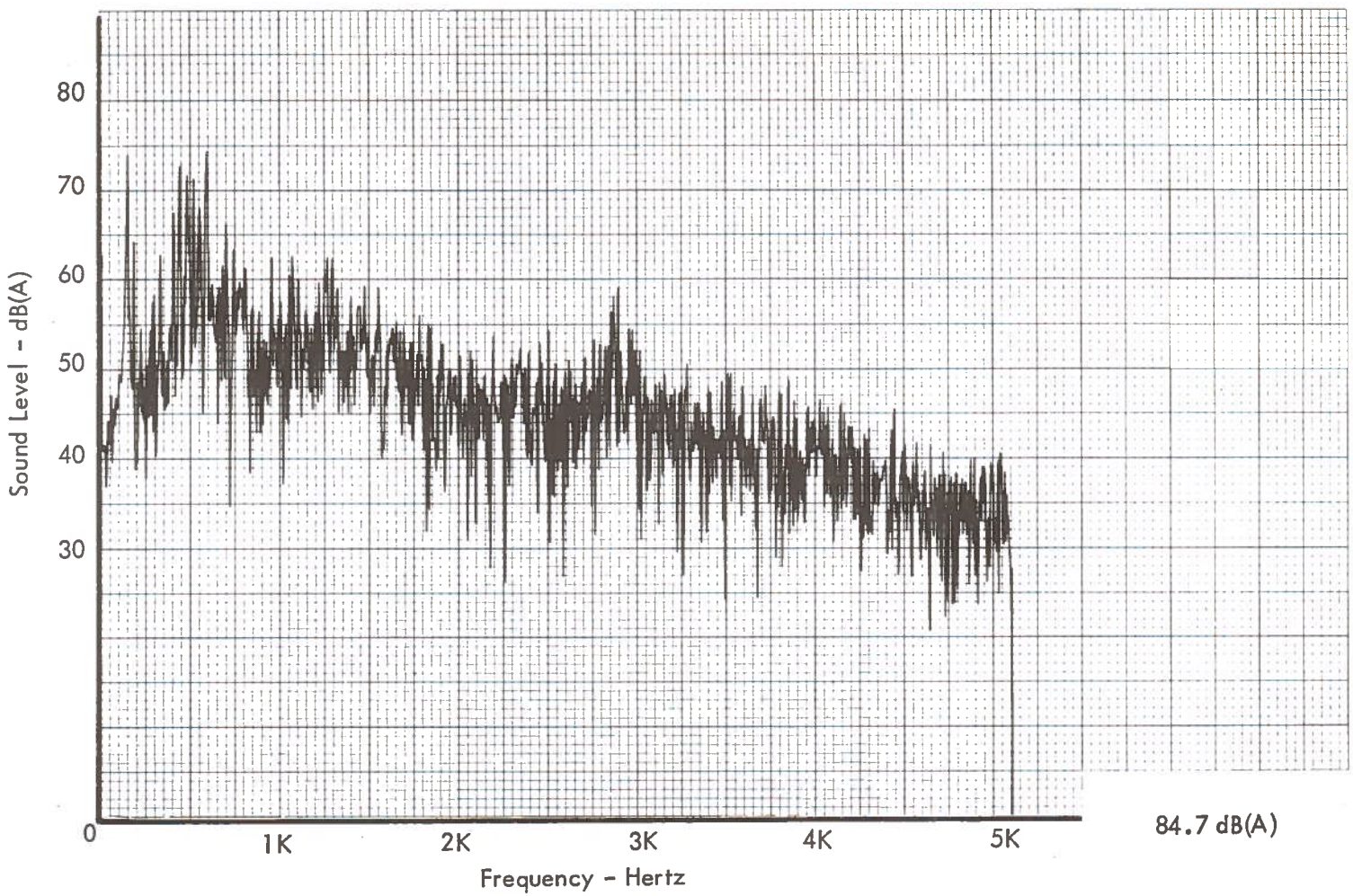


Figure B12. Detroit Diesel 8V-71T, Dual Open Pipes with Donaldson MAM10-0059 "Wye" Muffler

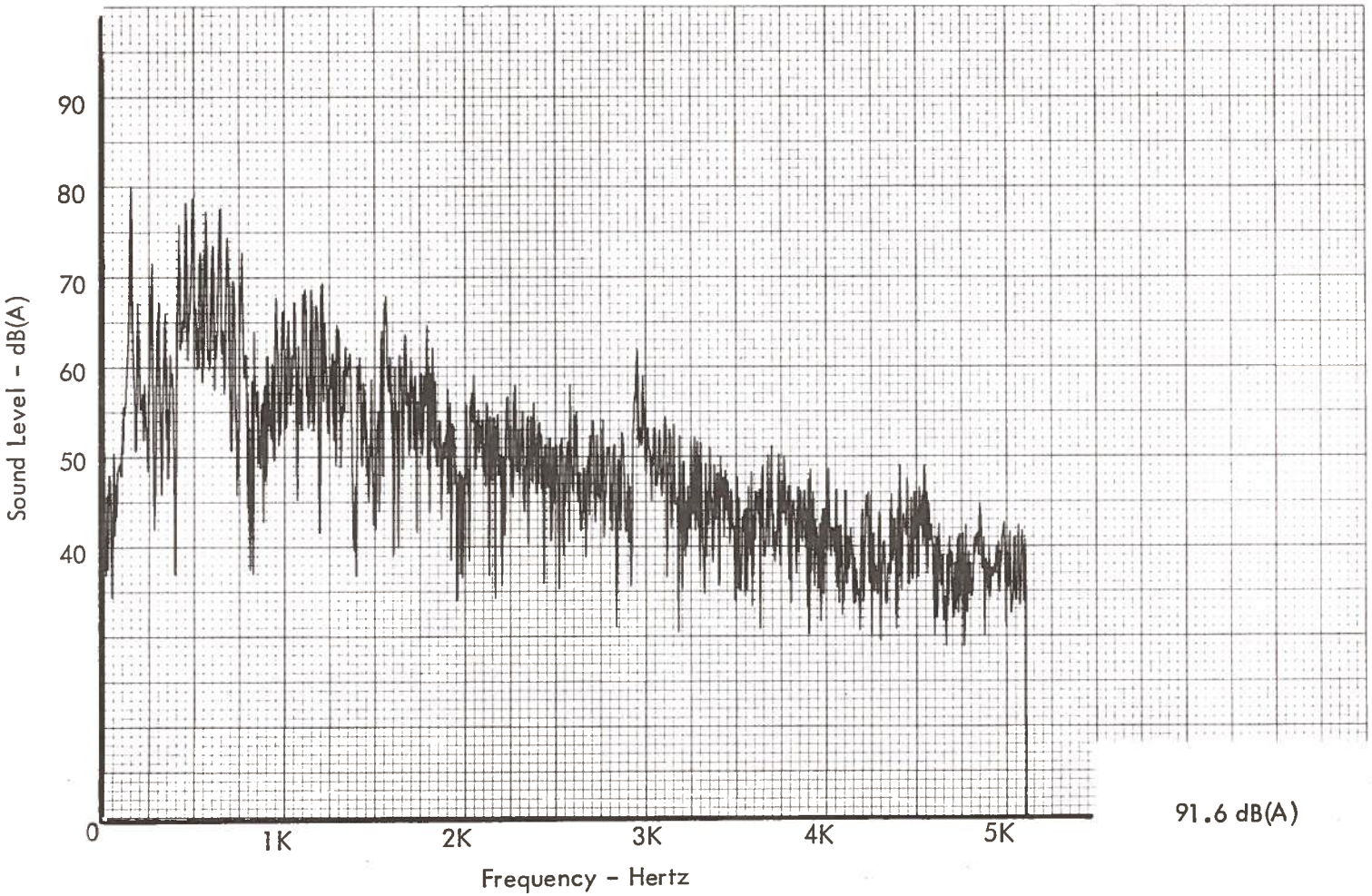


Figure B13. Detroit Diesel 8V-71T, Dual Open Pipes with Tubular "Wye" Connection

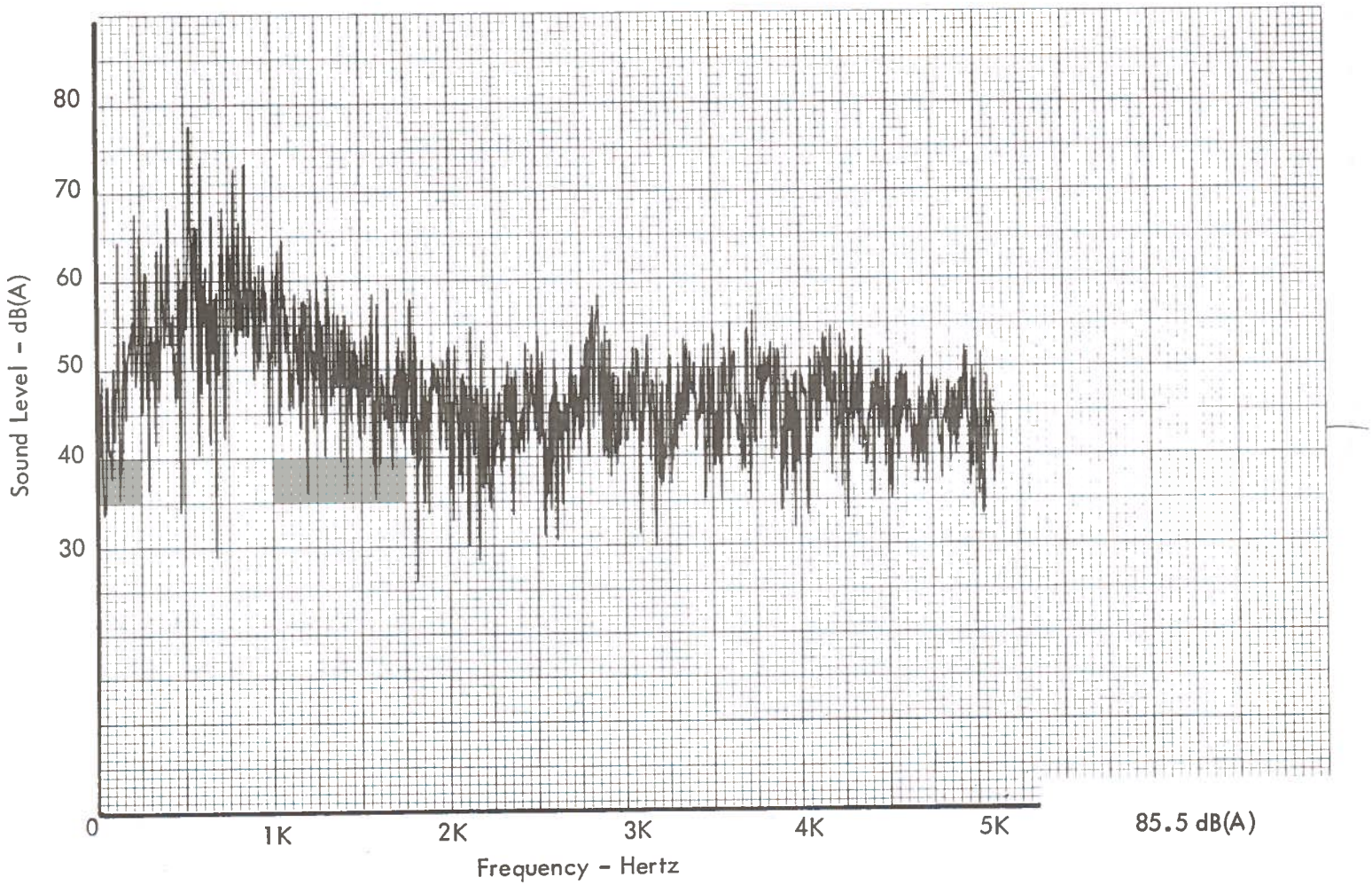


Figure B14. Detroit Diesel 8V-71, Bus with Oval Muffler

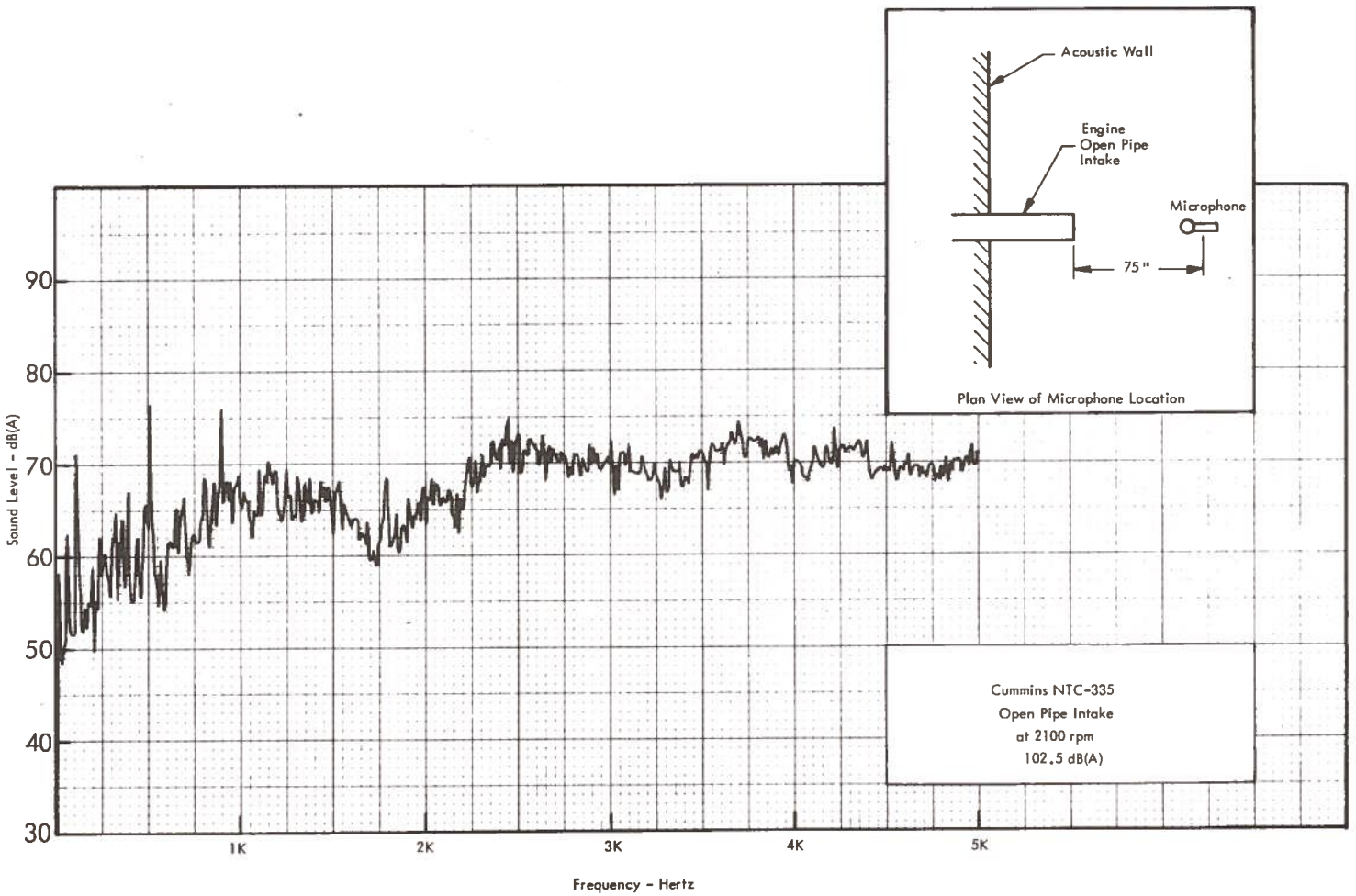


Figure B15. Cummins NTC-335, Open Pipe Intake

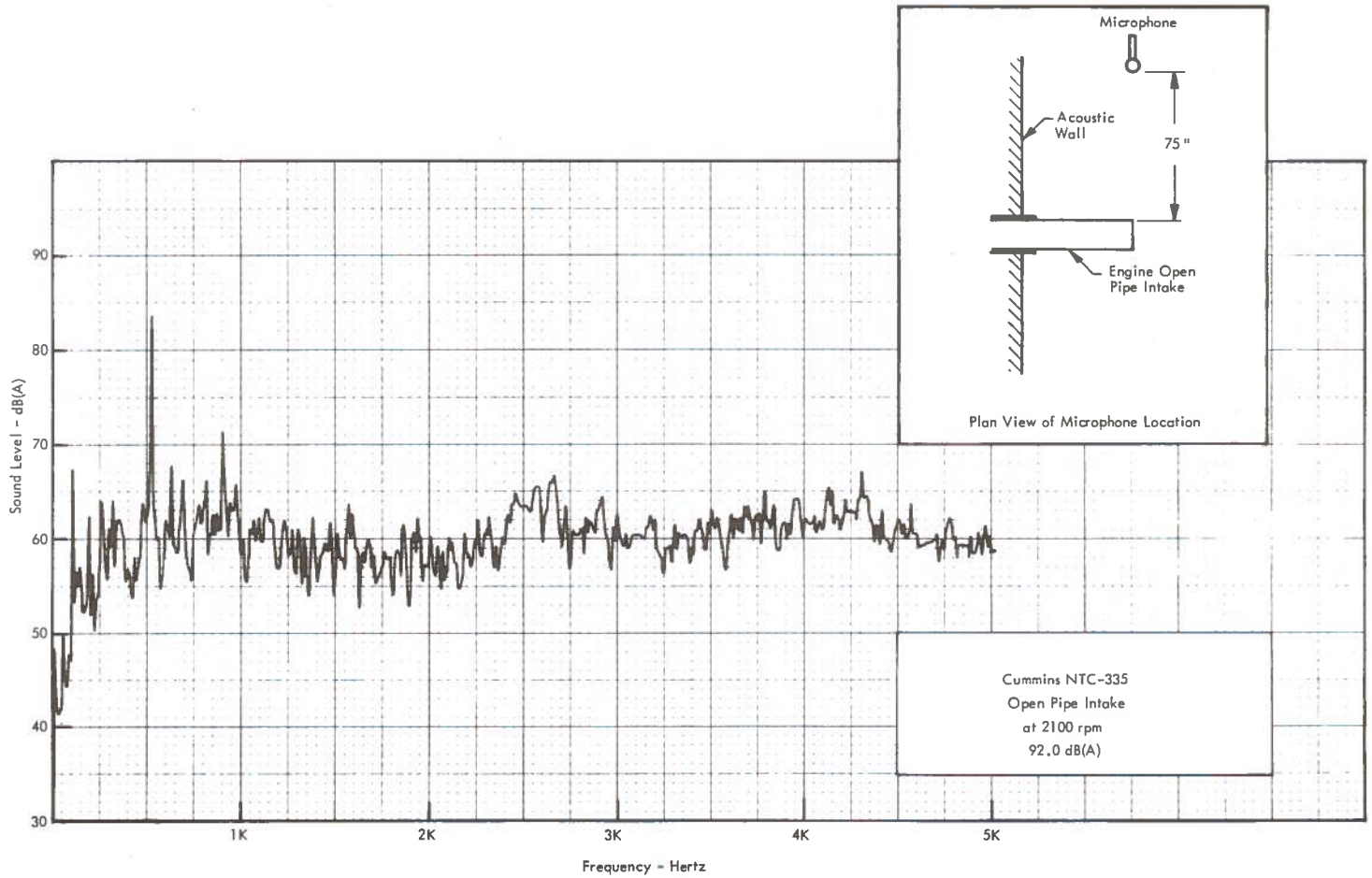


Figure B16. Cummins NTC-335, Open Pipe Intake

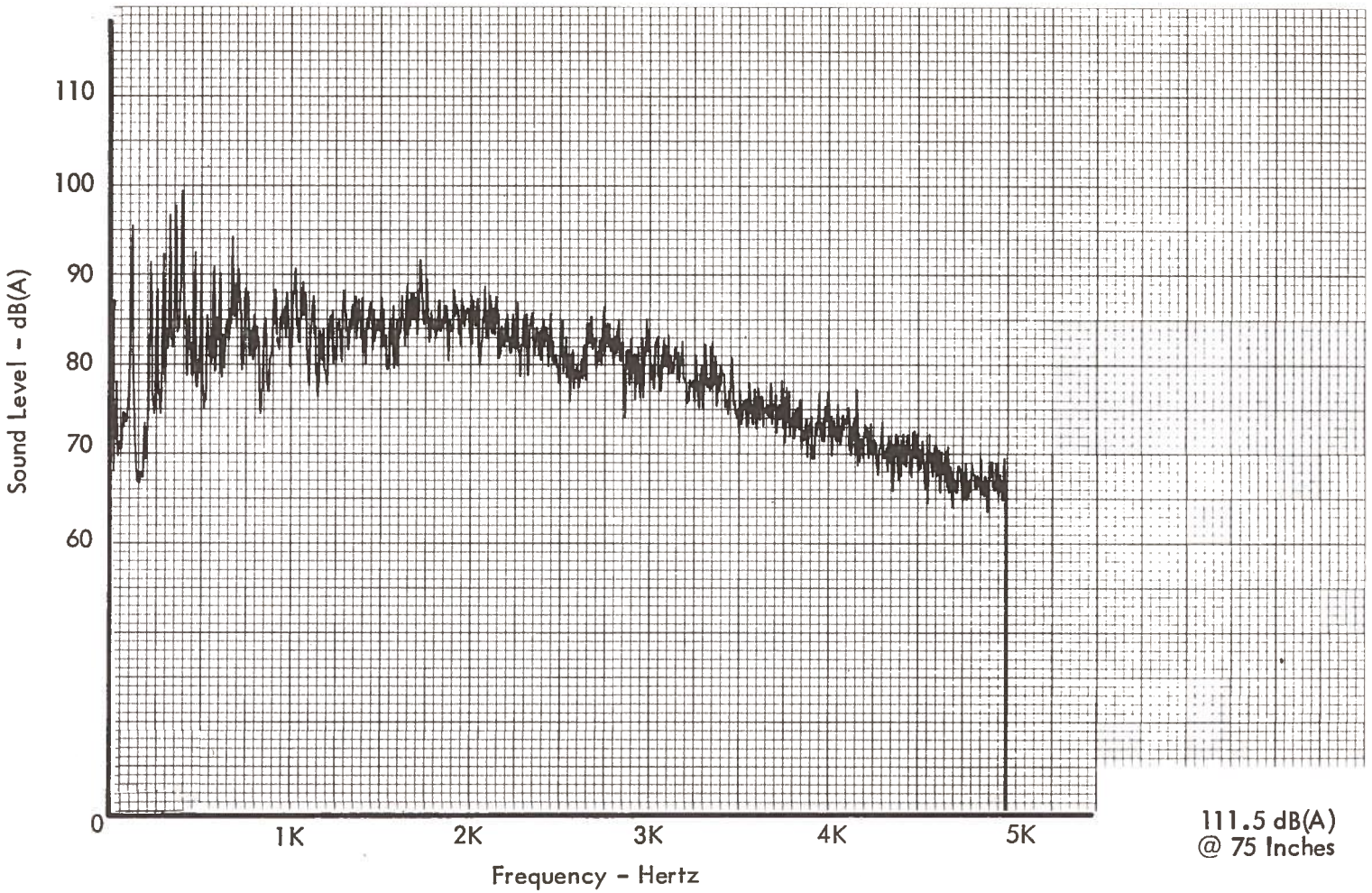


Figure B17. Cummins NTC-335, Open Pipe Exhaust

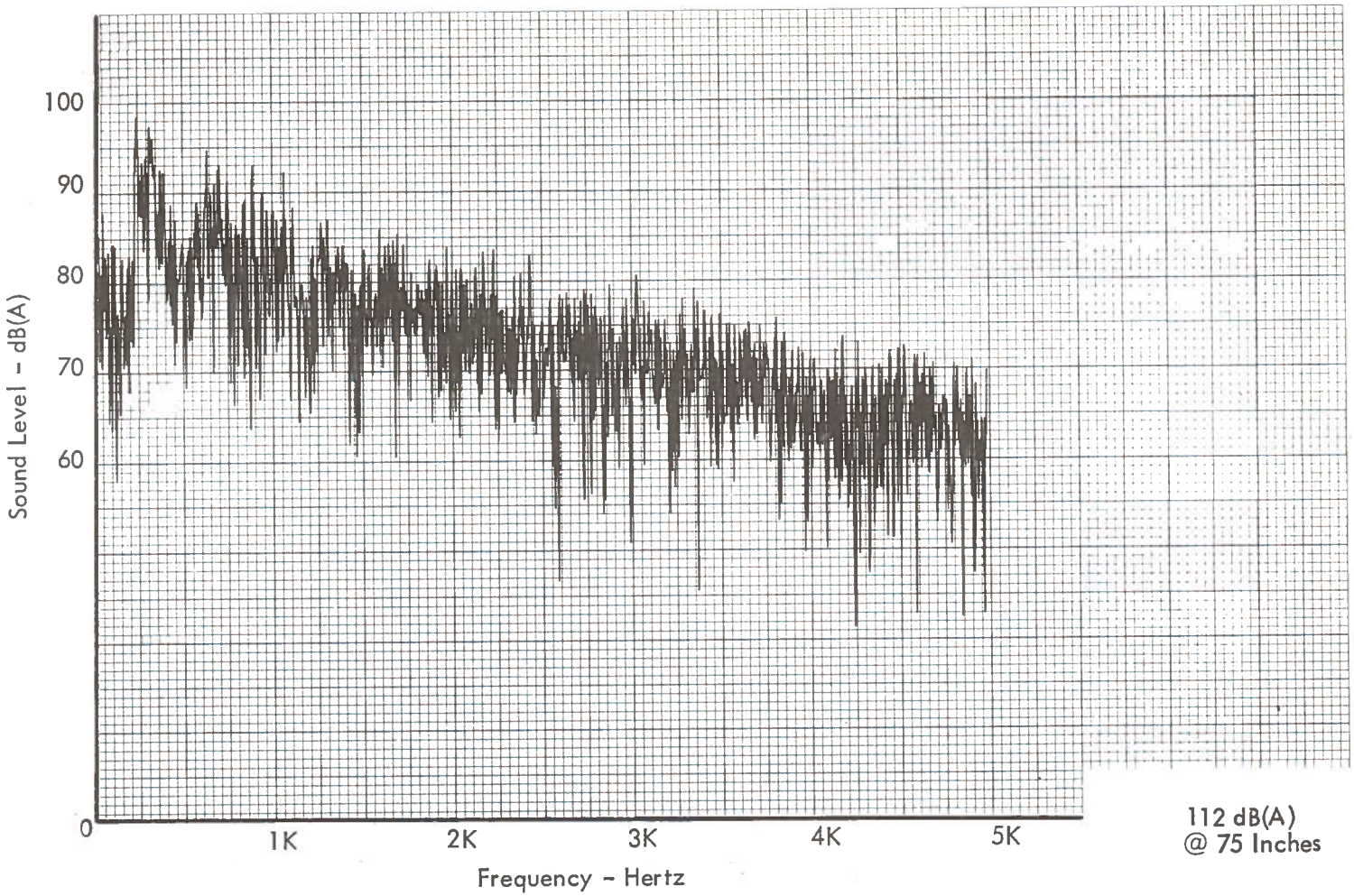


Figure B18. Cummins NTC-335, Open Pipe and Jacobs Brake

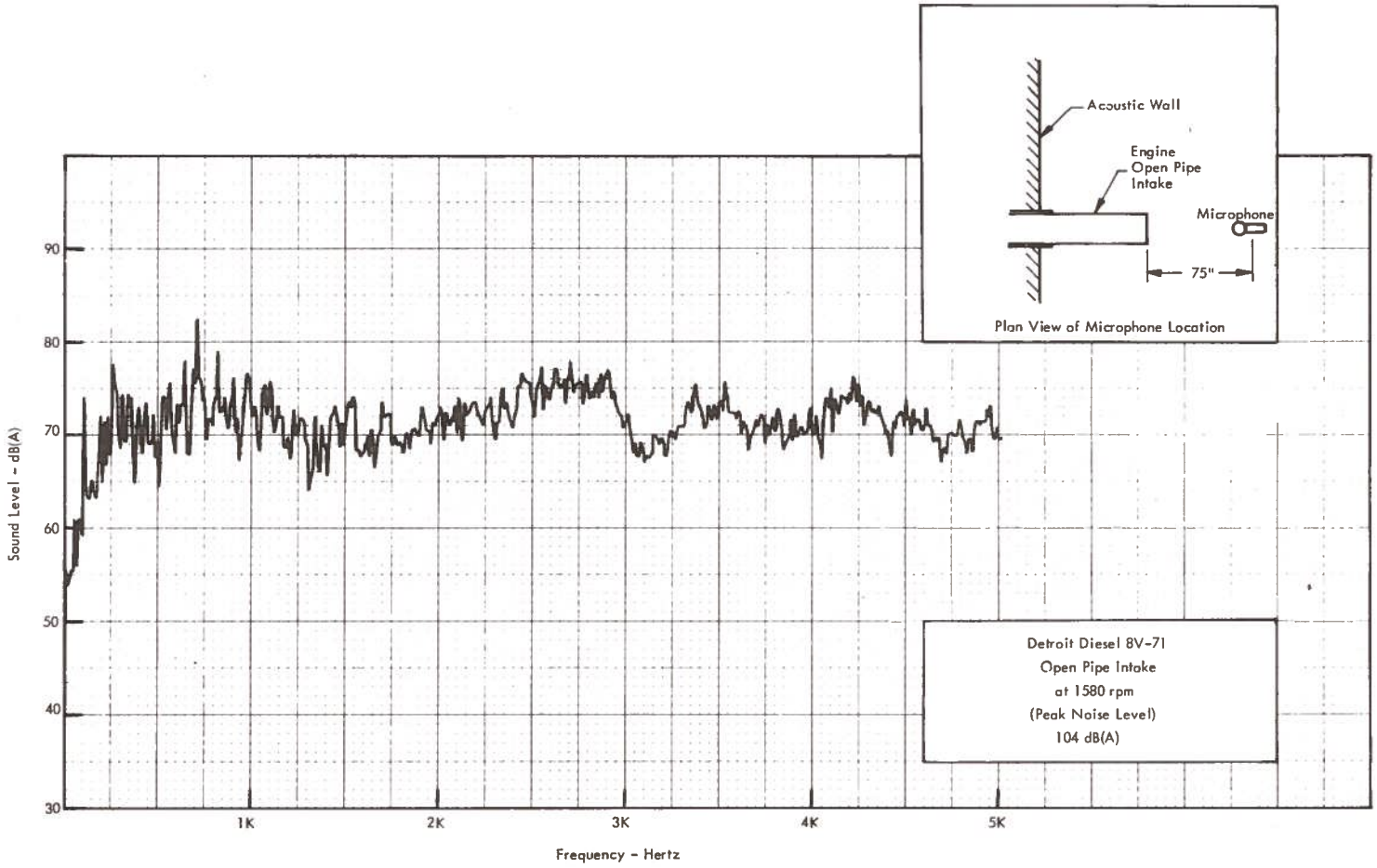


Figure B19. Detroit Diesel 8V-71, Open Pipe Intake

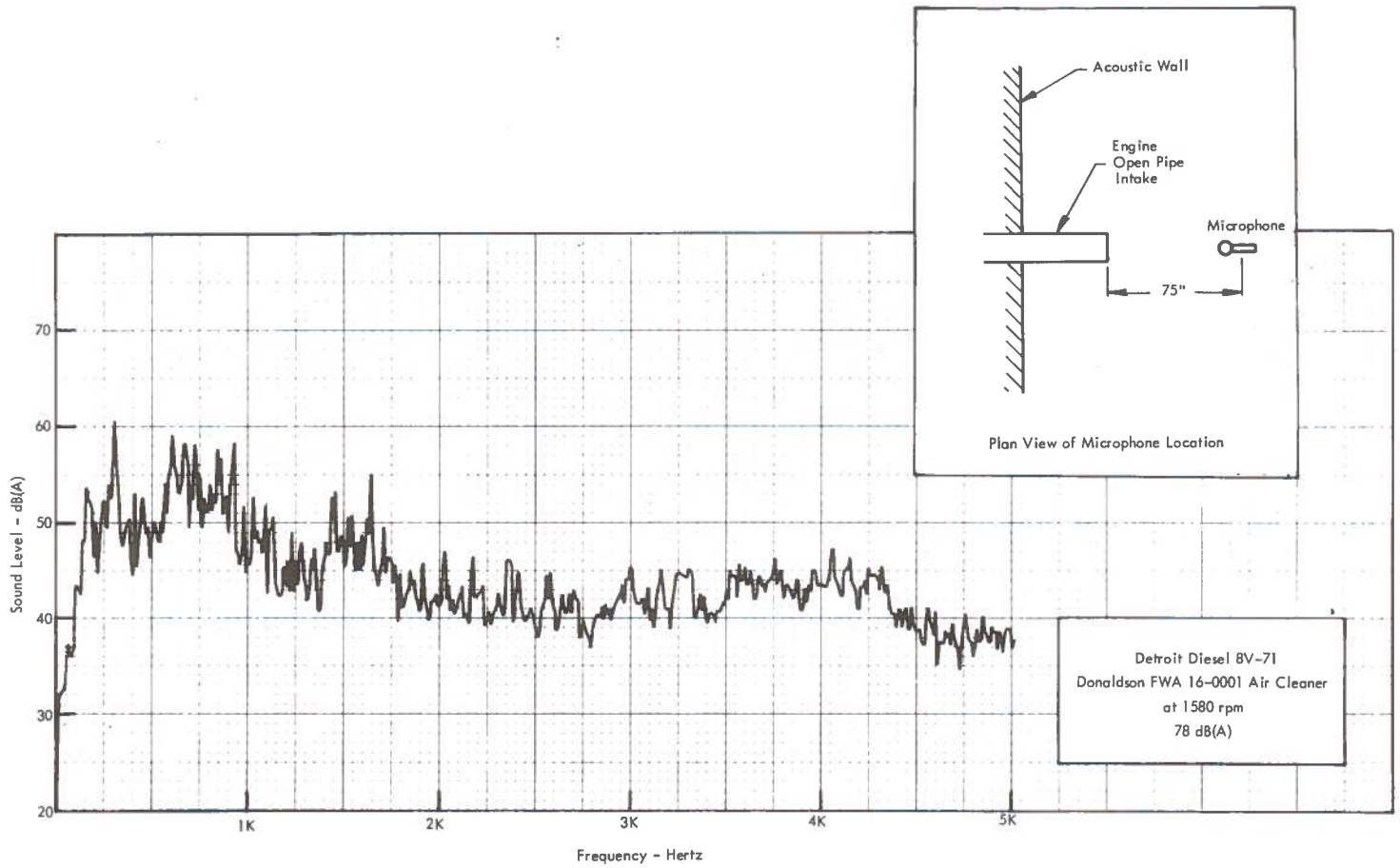


Figure B20. Detroit Diesel 8V-71 with Donaldson FWA16-0001 Air Cleaner

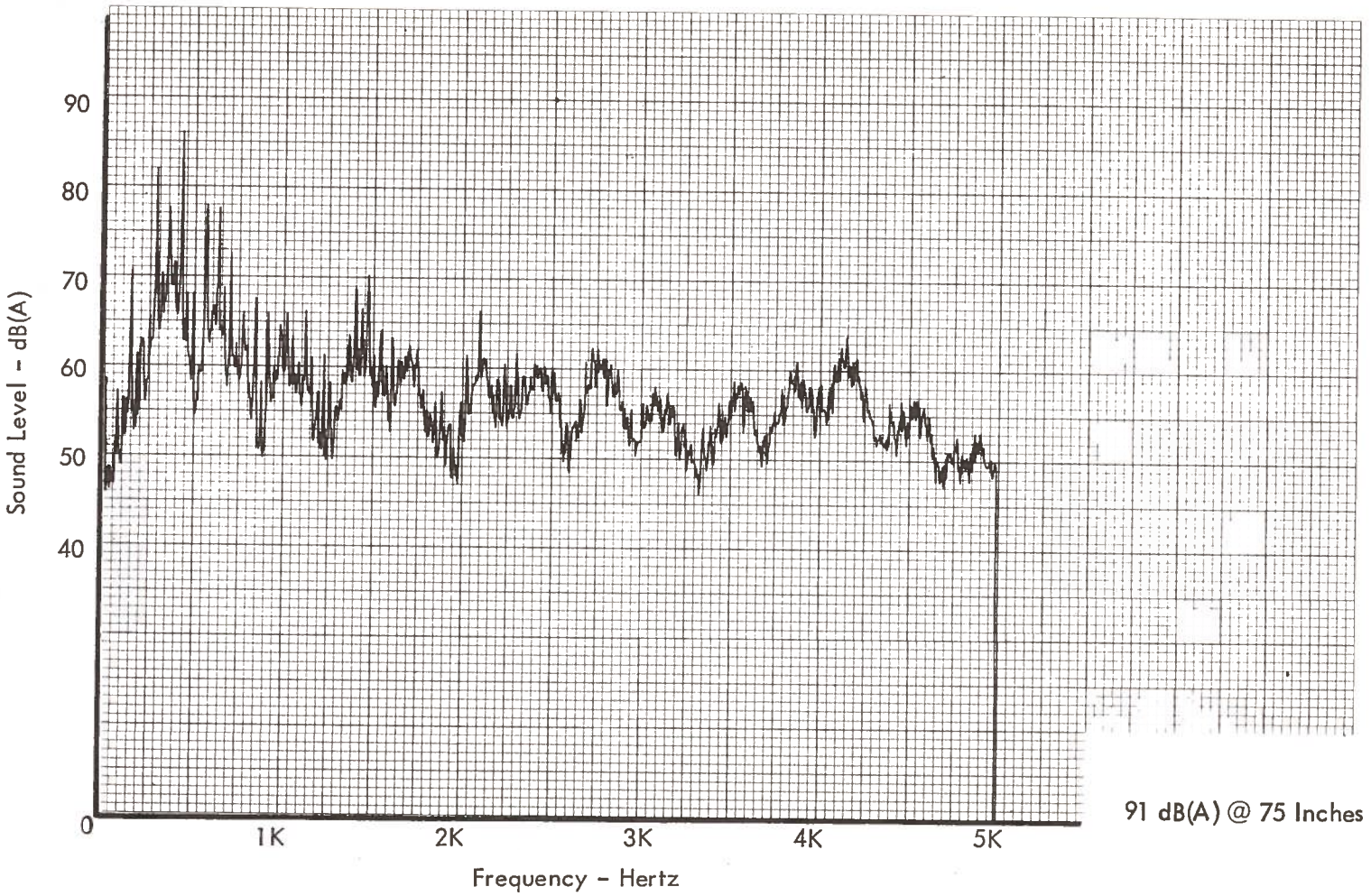


Figure B21. Detroit Diesel 8V-71, Dual Stemco 9350 Mufflers

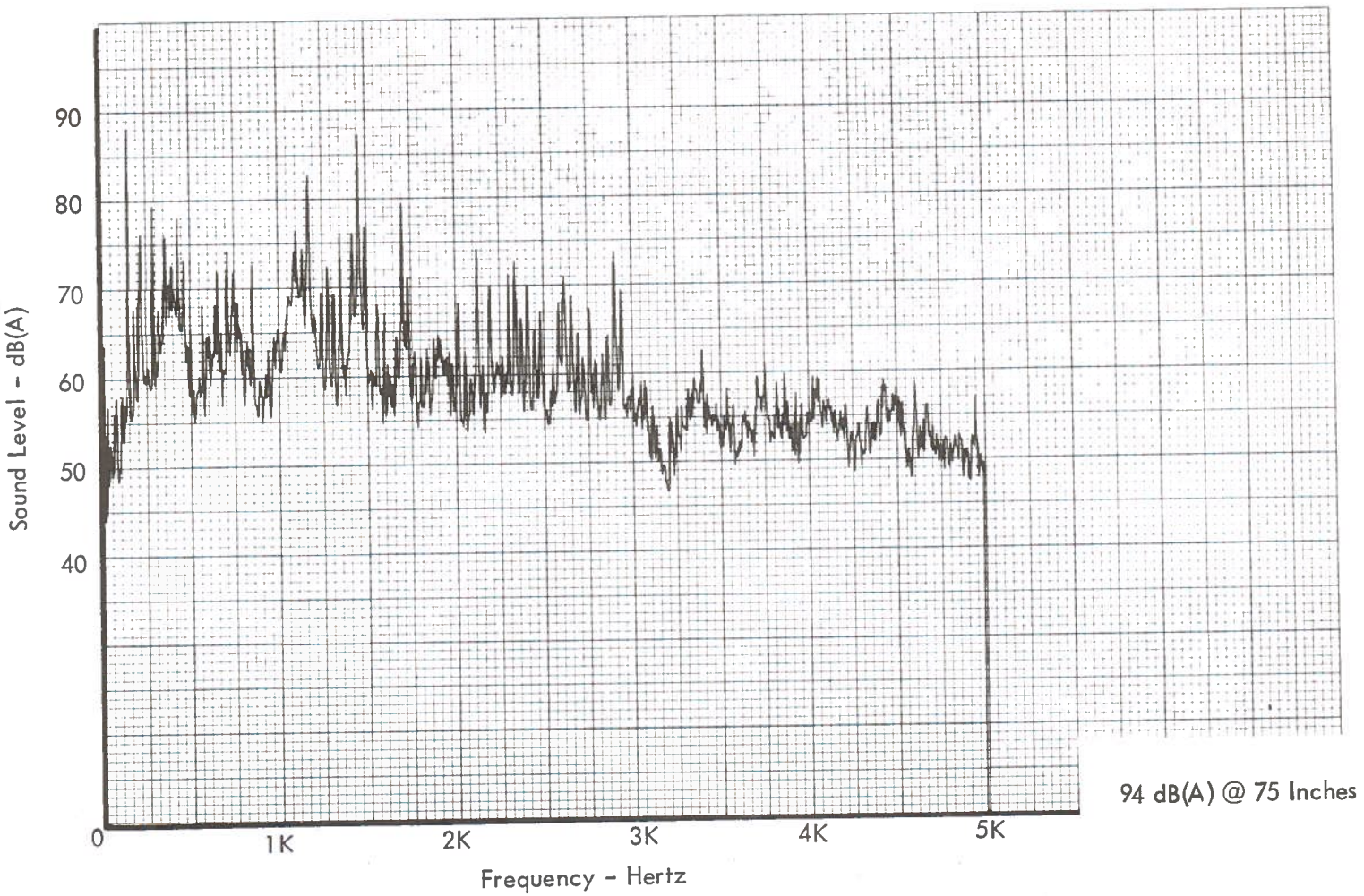


Figure B22. Detroit Diesel 8V-71, Dual Donaldson MSM09-0135 Mufflers

APPENDIX C

BACK PRESSURE MEASUREMENT
(USE AND LIMITATIONS OF THE MANOMETER)

APPENDIX C

BACK PRESSURE MEASUREMENT
(USE AND LIMITATIONS OF THE MANOMETER)

The U-Tube Manometer is commonly used to grade one of the most important aspects of an exhaust system - the effect on the flow of gases out of the engine. The reading is referred to as backpressure and is measured in inches of Hg. If the reading meets the engine manufacturer's backpressure limits, that aspect of the exhaust system is considered acceptable. A current list of these limits for a number of different engines is included at the end of the Bulletin.

Because of its common use, it is well to know just what the Manometer measures and what its limitations are. Technically, backpressure is the force required to push a volume of gas through a restriction. As the amount of restriction is increased, more force is required, hence higher backpressure.

Because of the unevenness of the engine discharge system, the exhaust flow has severe pulsations. It is the intended job of the Manometer to integrate these pulsations and give an average pressure reading. In most cases it does not, thus resulting in inaccurate backpressure readings.

The Manometer will give fairly accurate readings when the backpressure is very high (above 3 in. Hg). However, as the restriction decreases, the amount of error increases. The error can be large and can result in confusing data. For example, a long system may have a lower backpressure than a short system, or an exhaust system may have a higher backpressure with the engine at a lower hp output than at a higher one; and occasionally, even negative readings are observed.

When the flow losses through a muffler are low, measured system backpressure can decrease as silencing increases. It is not uncommon for a good straight-through muffler to decrease the backpressure below that of a straight-pipe system. This is because of the muffler's role in decreasing the standing pressure waves.

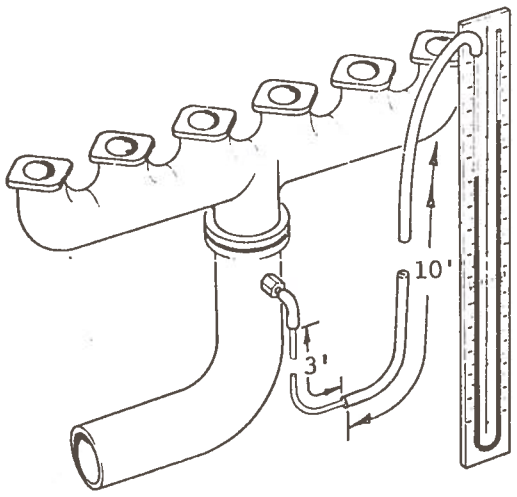
The pressure pulsations and resulting standing waves referred to have instantaneous amplitudes in the vicinity of 2 in. Hg. Because of the standing waves, the pulsations can be greater at one point than at another. As a result, backpressure can change with any change in Manometer line position. Also, because of standing waves in the lines themselves, any change in line length will also cause different readings. Hence, the amount of error in reading backpressure could be decreased if the pressure waves in the Manometer lines could be eliminated. This can be accomplished by the following method.

METHOD OF MEASUREMENT

Extreme care should be exercised in making backpressure measurements. In order to make the most accurate, and thereby the most meaningful readings, the following method is recommended:

> The point of measurement should be as close as possible to the manifold flange, but on a neutral flow plane at least one pipe diameter away from

any changes in flow area or flow direction. At the point selected, weld a 1/8 in. pipe coupling to the exhaust tubing. Drill through tubing with a 1/8 in. drill. Remove all burrs. The above precautions will minimize errors caused by gas velocities. Then mount 90° Weatherhead fitting to coupling. Use 3 ft of 1/8 in. copper tubing (to resist heat) plus 10 ft of 3/16 in. rubber hose to Hg Manometer. The long, small diameter tubing will eliminate the standing waves in the lines. Fairly reliable readings can be made in this manner.



SUMMARY

To sum up, the common Manometer is a somewhat undependable instrument when measuring backpressure, and is only a fair substitute for a laboratory test when predicting engine performance (fuel economy, horsepower output, and exhaust system temperatures). However, reasonably dependable readings can be obtained if precautions are taken to eliminate velocity effects and to keep pressure waves in the Manometer lines to a minimum.

APPENDIX D

REPORT OF INVENTIONS APPENDIX

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After a diligent review of the work performed under this contract, no new innovation, discovery, improvement, or invention was made.