Jacobs Vehicle Systems™

Vehicle Noise Levels and Compression Release Engine Braking

INTRODUCTION

This document is intended to provide the reader with information about commercial vehicle noise and its relationship with compression release engine brakes. This relationship is a subject of community concern and often results in the posting of "No Engine Brake" signs along roads and highways. Data is presented illustrating the relationship between vehicle noise and the condition of the vehicle's exhaust system. This data identifies improperly muffled vehicles as the principal cause of the vehicle noise that concerns communities. This document examines existing regulations that govern vehicle noise levels and presents suggestions for effectively addressing noise concerns at the community level. References are provided for further reading on the subjects of engine braking and vehicle noise.

COMPRESSION RELEASE ENGINE BRAKES

Compression release engine brakes (referred to hereafter as engine brakes) are the most popular type of supplemental vehicle retarder used in North America. Their function is to turn a power producing diesel engine into a power absorbing air compressor. It does this by quickly opening the exhaust valve near top dead center of the compression stroke. This causes a sudden release of compressed air from an engine cylinder into the exhaust system. This is what causes the characteristic staccato sound of an engine brake in operation. The engine brake is activated only when the driver's foot is off of the accelerator pedal and no fuel is being injected into the cylinder.

It is well known that the stopping power available from a vehicle's service (or wheel) brakes decreases significantly as the brake lining temperature increases. One of the uses of engine brakes on commercial vehicles is to help control vehicle speed on long downgrades. Minimizing the use of the vehicle's service brakes virtually eliminates the likelihood of overheating the brakes and thus helps to avoid dangerous brake fade. Reduced usage of the service brakes on engine brake equipped vehicles also leads to lower maintenance costs through reduced brake lining wear. Vehicles equipped with engine brakes are more efficient and productive to operate. Enhanced driver control and a reduced risk of brake fade also means safer interaction between all of the vehicles operating on public roadways. The overall result of engine brake usage is of significant value to the trucking industry and to the general public as well.

The need for equipping commercial vehicles with engine brakes is greater today than ever before. Vehicle weight and speed limits have been increasing. At the same time the vehicle's natural retarding power has decreased due to reductions in aerodynamic drag and rolling resistance. These improvements are beneficial in terms of vehicle fuel consumption and operating cost. However, they require that more work be done by the service brakes to maintain speeds on long down grades or slow the vehicle. The increased load being placed on vehicle service brakes led to the issuance of an industry practice recommending the use of supplemental retarders [7]. In addition to supplementing the vehicle's service brakes, engine brakes are also being integrated into other vehicle functions such as cruise control, automatically shifted manual transmissions, and the newly introduced collision avoidance systems. These factors are why the majority of heavy-duty vehicles produced in North America today are equipped with engine brakes when delivered from the vehicle manufacturer.

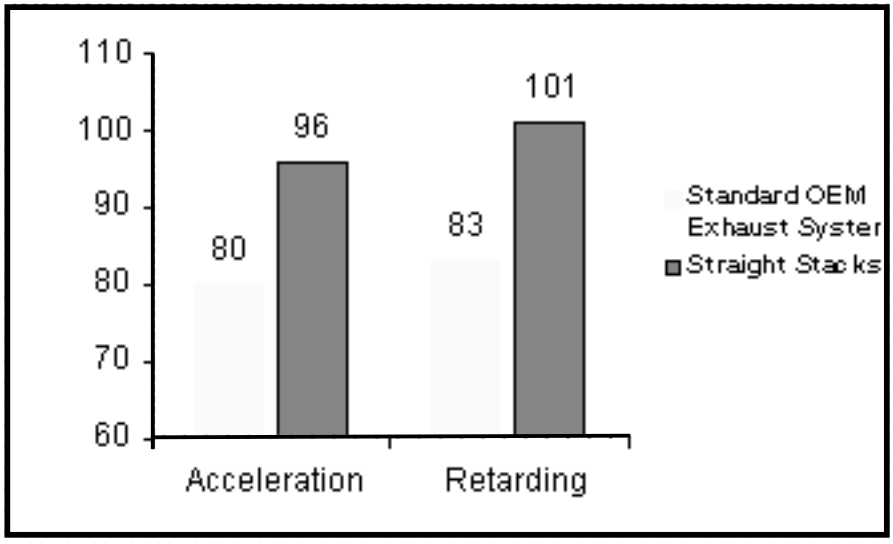
ABOUT NOISE

Residents near steep downgrades, highway exits and curves in some communities in North America have expressed concerns about commercial vehicle noise. These concerns frequently identify engine brakes, due to their characteristic sound, as the cause of the objectionable noise. Signs prohibiting engine brake usage have been posted in some communities. The trucking industry is sensitive to these concerns and has studied the issue with regard to both new and in use trucks.

Truck, engine and equipment manufacturer studies have consistently found that improperly muffled vehicles are the root cause of this noise issue. Vehicle operating sound levels have been shown repeatedly to be much higher for vehicles with improper, defective or deteriorated mufflers. The problem is most pronounced on vehicles equipped with "straight stack" exhaust systems (i.e., no muffler). Studies have found that the sound level from "straight stacks" is 16 to 22 dB(A) higher than from original equipment mufflers [1]. Studies have also shown that the operation of an engine brake produces sound levels that are similar to those produced during acceleration on properly muffled vehicles [2].

Figure 1 shows total vehicle sound level data for a typical heavy-duty diesel powered vehicle. Sound levels are measured in 'A' weighted decibels or dB(A). This is a logarithmic scale weighted to the sensitivity of human hearing. Each doubling of a sound source will increase the sound level by 3 dB(A). An 18 dB(A) increase corresponds to a 64 fold increase in the sound source. Additional information on other vehicle/engine combinations is presented in Society of Automotive Engineers (SAE) papers [1] and [2].

Figure1. Typical Heavy-Duty Vehicle Results



Improper, defective or deteriorated mufflers will increase vehicle sound levels over those of properly maintained exhaust systems. The magnitude of the increase though is not as large as that for "straight stacks". A question that can be asked is how prevalent are improperly muffled exhaust systems on commercial vehicles? One survey observed a moderate traffic volume consisting of about 300 trucks per hour traveling on a stretch of Indiana highway. It found 5.3 percent of the trucks did not have a functioning muffler; in fact, 2.4 percent of the vehicles inspected were operating with "straight stacks" installed [1].

From this data one can conclude that residents living near that stretch of highway were on average exposed to 16 vehicles per hour with improperly muffled exhaust systems. These vehicles would be operating beyond acceptable noise levels during acceleration as well as retarding. Overall, this information supports the position that the root cause of objectionable vehicle noise is improperly muffled vehicles.

ABOUT THE LAW

All new vehicles must comply with EPA noise regulations. The maximum permitted noise level was set to 83 dB(A) in 1979 and later reduced to 80 dB(A) in 1988. The overall design and manufacture of heavy-duty trucks, including their exhaust systems, results in all new vehicles meeting the applicable regulations when they leave their manufacturer's factory.

The EPA regulations prohibit "The removal or rendering inoperative by any person, other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any new vehicle for the purpose of noise control prior to its sale or delivery to the ultimate purchaser or while it is in use". The EPA regulations also prohibit the use of a vehicle that has had the noise control system rendered inoperative. This is stated clearly on a label required on all vehicles sold in the U.S. and is fully explained in the operator's manual for every new truck [3]. The improperly muffled vehicles, especially those with straight stacks, are not operating in compliance with current federal regulations.

Most states have adopted motor vehicle regulations that address the configuration and condition of vehicles operated on their roads and highways. These regulations typically require that a vehicle be equipped with a proper exhaust system and a muffler. "Straight stacks" are not in compliance with either the federal or the state regulations.

WHAT CAN BE DONE

The current federal and state regulations addressing exhaust system configuration and maintenance are not always aggressively enforced. This has led communities to adopt ordinances of their own and post signs prohibiting engine brake usage. Prohibiting engine brake use attempts to solve the problem without addressing the real cause. Any action taken should address the small percentage of vehicles with improperly muffled exhaust systems that are at the root of the problem.

The most direct solution is to visually inspect vehicles for the presence of a muffler. This type of inspection is relatively simple to implement once some basic definitions of what constitutes a muffler are established. The inspection could be done as part of current roadside inspections with minimal additional training and effort. This action would address the root cause of the community problem and would eliminate the most severe noise offenders. This type of inspection would be the simplest way to start addressing the noise problem.

The drawback to a simple inspection is that it may not catch all offenders. Improper, defective or deteriorated mufflers that appear intact from the outside may be missed. Detecting these cases requires a roadside noise test. The EPA sets forth procedures in its regulations based on the SAE J366 Recommended Practice [4]. The International Standards Organization (ISO) also has procedures for driveby testing, described in ISO 362 [5]. A stationary test could be used to detect vehicles that are noise offenders [6]. However, active noise tests for inspection purposes are complicated by various vehicle and muffler configurations, and require calibrated noise-testing equipment and trained operators. Therefore visual inspection for the presence of mufflers is the simplest and most immediate way to address commercial vehicle noise.

If a community determines that a sign is still required, wording similar to the following examples is suggested. Signs under Oregon State Vehicle Code Section 811.492 read: Unmuffled Engine Brake Use Prohibited Except In Emergencies. Signs under Minnesota Traffic Regulations Section 169.69 read: Vehicle Noise Laws Enforced. Both address the root cause of the problem, do not adversely effect properly maintained vehicles and acknowledge the positive impact of engine brakes on operating safety.

CONCLUSIONS

Enforcement of current muffler regulations is the most direct way to address the noise issue. It will have benefits to the trucking industry as well as to the public. Installing the mufflers required by federal and most state motor vehicle regulations on vehicles that are operated without a muffler will reduce noise levels by 16 to 22 dB(A). This does not necessitate anything more than proper maintenance using original equipment mufflers or replacement systems that are equivalent to those provided by the vehicle manufacturer. Signs prohibiting engine brake usage should be eliminated. This is especially true since most heavy-duty vehicles are properly muffled and do not cause offensive noise when operating their engine brakes.

The benefits to the public are two-fold. First, proper mufflers effectively control objectionable noise during all modes of vehicle operation, not just retarding. This means that objectionable noise is controlled in congested city streets, stop and go traffic, climbing hills, as well as in retarding situations. The second public benefit comes indirectly in the goods we all use that are moved by truck. The improved effectiveness of trucks in terms of operating economy, reduced trip times and improved operating safety will be reflected in the cost of the goods they transport. Truckers will be free to utilize their engine brakes and realize the economic and operating benefits they were purchased to provide. The result will be more efficient transportation, safer vehicles and safer highways.

The benefits to properly muffling trucks and allowing engine brake usage to the trucking industry are also compelling. Drivers will benefit by being exposed to less on-the-job noise. Vehicle operating safety and productivity will be improved. Controlling the noise level of vehicles by installing proper mufflers will also serve to improve the overall image of the trucking industry.

REFERENCES:

1. Reinhart, Thomas E., “U.S. Vehicle Noise Regulations and the Effects of Vehicle Condition”, SAE Paper 912709, Society of Automotive Engineers, Inc., 1991.

2. Reinhart, Thomas E. and Wahl, Thomas J., “Reducing Compression Brake Noise”, SAE Paper 971870, Society of Automotive Engineers, Inc., 1997.

3. Environmental Protection Agency, “Noise Emission Standards for Transportation Equipment”, Title 40, Code of Federal Regulations, Chapter 1, Part 205, Subpart B - Medium and Heavy Trucks.

4. Society of Automotive Engineers Recommended Practice J366, Sound Level for Heavy Trucks and Buses.

5. ISO 362 – Acoustics – Measurement of Noise Emitted by Accelerating Road Vehicles – Engineering Method.

6. Wahl, Thomas J. and Reinhart, Thomas E., “Developing a Test Procedure for Compression Brake Noise”, SAE Paper 972038, Society of Automotive Engineers, Inc., 1997.

7. “ RP 636 - Specifying Auxiliary Retarders ”, 1998-1999 Recommended Engineering Practices Manual, The Maintenance Council - American Trucking Associations, Inc., 1998.

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