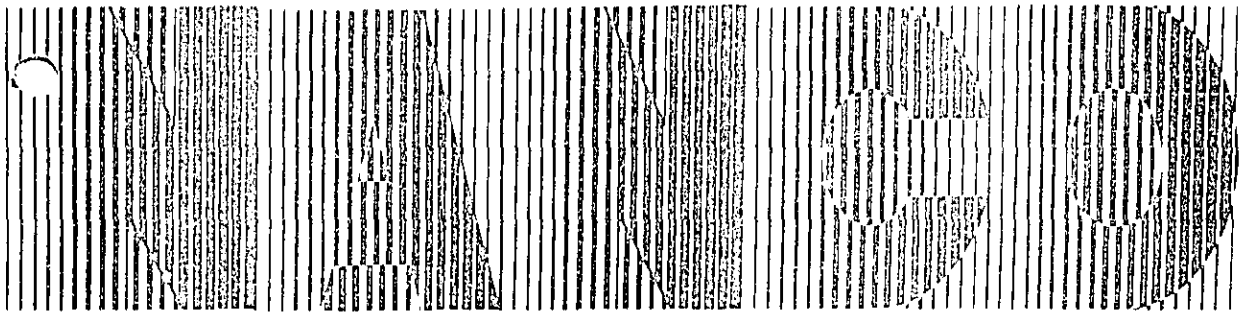

MODEL ON-ROAD LIGHT VEHICLE NOISE ENFORCEMENT PROCEDURES MANUAL

NATIONAL ASSOCIATION
of
NOISE CONTROL OFFICIALS

N A N C O

MODEL ON-ROAD LIGHT VEHICLE NOISE ENFORCEMENT PROCEDURES MANUAL

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NOTICE

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N A N C O

Model On-Road Light Vehicle
Noise Enforcement Procedures Manual

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I. INTRODUCTION

Noise from vehicular traffic has long been recognized as a potential health problem and has now reached such a point that in the recent Annual Housing Survey conducted by the U.S. Bureau of the Census,* noise was identified as the most undesirable neighborhood condition (rated over such things as inadequate street lighting and street crime). The most disturbing feature of traffic noise has been identified as excessive noise emission from individual vehicles, caused either by a faulty exhaust system or improper vehicle operation. Hence, it is well understood that noisy individual vehicles constitute a major source of community annoyance and should be the focal point of a community's noise control program. It is in this regard that the NANCO Vehicle Noise Task Force was formed, to develop a variety of means through which local authorities may effectively deal with the problem of vehicular noise. Fortunately, though the problem is pervasive, there are a number of proven, effective and simple means for dealing with it.

An effective vehicle noise enforcement program consists of three elements:

A. Noisy Vehicle Identification;

B. Citation; and

C. Compliance (i.e., correction of defective equipment).

The approach taken in the NANCO enforcement manual is to present various proven techniques and methodologies for each of these elements, so that an enforcement program may be formulated, using a "Building Block" approach.

This allows the level of sophistication and detail in each element to be commensurate with the needs, resources and nature and extent of specific local vehicle noise problems. These program "Building Blocks" are shown in Figure I-1. Scenarios of a number of actual state and local programs which utilize these "Building Blocks" are included in Appendix A.

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*"Annual Housing Survey: 1975, United States and Regions. Part B: Indicators of Housing and Neighborhood Quality". U.S. Department of Commerce, Bureau of the Census, Washington, D.C., February 1977. (Series H-150-75B.)

The enforcement concepts presented in this manual include the citation of moving or stationary noisy vehicles, with and without the use of a sound level meter. Thus, enforcement ranges from simple subjective screening through curbside stationary tests to roadside monitoring with a sound level meter. Procedures for ensuring compliance with local noise regulations are also included, as well as options concerning the use of available personnel in such a vehicle noise control program. These procedures have been structured to allow enforcement to proceed with a minimal amount of noise enforcement training (16+ hours). Guidelines for suitable training and personnel qualifications are also included.

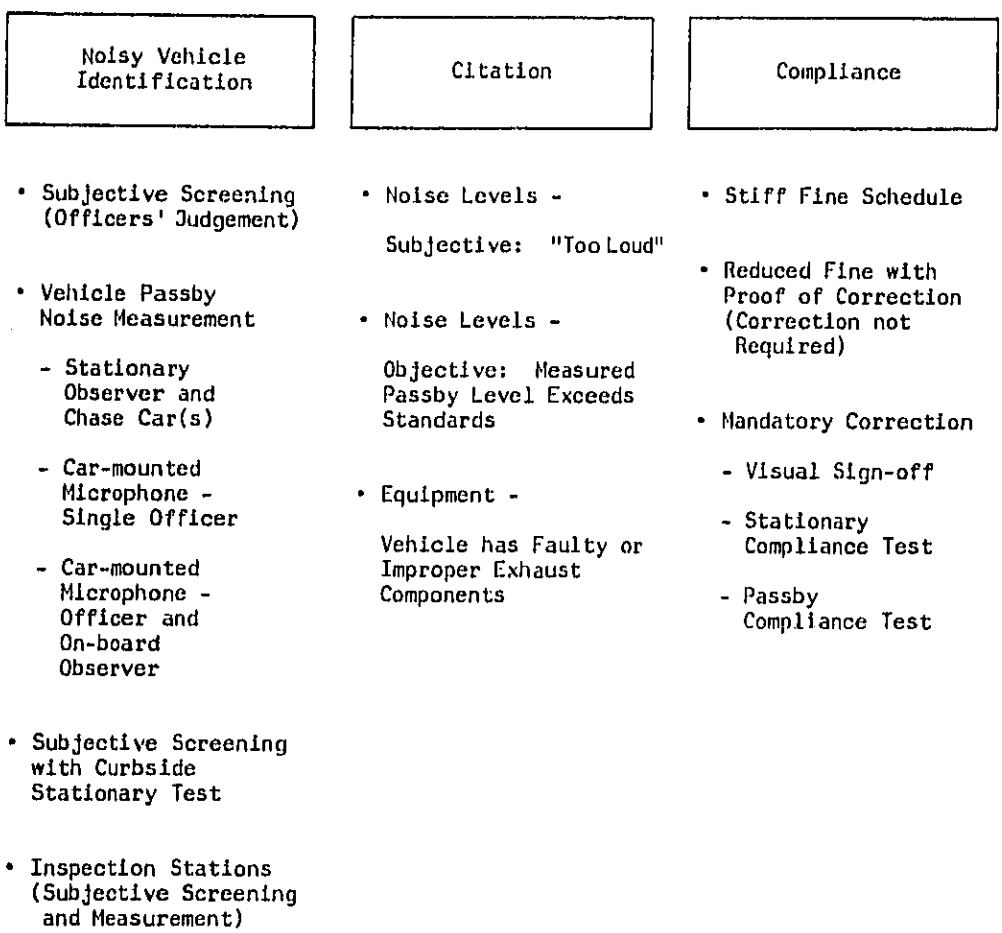
The basic philosophy incorporated in the NANCO vehicle noise program is to cite those vehicles whose noise emission stands out above others in the traffic stream. Thus, initial efforts are directed towards removing the "cream off the top". Because initial citations are oriented towards such clear-cut violators, it allows the program to begin smoothly, with little risk of improper citations. As the program progresses and the worst-case offenders are apprehended, and the officers gain experience, the noise limits may then be tightened down in order to eliminate the marginal cases.

The methods and techniques presented in this manual deal with the control of noise emission from light vehicles (automobiles and light trucks under 10,000 lbs. GVWR) and motorcycles operating on public roadways. Noise standards for heavy trucks (when operated as interstate motor carriers) have been promulgated by the U.S. Environmental Protection Agency (40 CFR 202) and are included in Appendix E, along with the enforcement procedures adopted by the Bureau of Motor Carrier safety. However, there are a number of techniques by which state and local officials may deal with the noise associated with these varieties of vehicles when not operated in interstate commerce, and NANCO plans to issue a report on this topic in the future.

Note: Throughout this manual, all noise measurements are in terms of A-weighted sound levels and are expressed in decibels (dB). (The term dBA, often used to describe such noise levels, is not used in this report.)

Figure I-1

VEHICLE NOISE ENFORCEMENT PROGRAM "BUILDING BLOCKS"



II. RECOMMENDED VEHICLE NOISE EMISSION LIMITS

A. Background

NANCO-recommended noise limits are based on the fact that motor vehicles emit different levels of noise, depending upon mode of operation and type of vehicle. Therefore, in order to establish noise limits, it was necessary to consolidate the various modes of vehicle operation into general categories for which specific limits have been recommended. For purposes of the NANCO vehicle noise enforcement manual, two classes of motor vehicles have been identified as having distinctly different noise emission characteristics: Light vehicles (automobiles and light trucks - GVWR under 10,000 lbs.) and on-highway motorcycles. (As discussed in Section I, emission standards for trucks over 10,000 lbs. GVWR operated by motor carriers engaged in interstate commerce have been established by the U.S. EPA and preempt non-identical state and local regulations.)

1. Passby Noise Limits:

The modes of operation for which passby noise limits have been recommended have been generally broken into on-highway or freeway operation, and in-city operation (speed zones of 45 mph or less). The rationale for establishing low and high speed noise limits is that the former should reflect all modes of in-city driving and the latter, basically freeway operation. Thus, if we are to use non-freeway limits in-town, the speed break must reflect the highest normal in-town speed; hence, 45 mph.

The use of in-town limits applicable to speed zones up to and including 45 mph <u>does not</u> compromise noise control efforts in those communities whose maximum posted speeds are less than 45 mph. The 45 mph break actually places more restrictive controls on vehicle operations and requires some driver control to prevent these limits from being exceeded. In-town limits have been based on the highest noise producing <u>normal</u> mode of vehicle operation (urban acceleration) which still requires the driver to operate the vehicle some 10-20 dB below its maximum noise output potential. Clearly, however, such operational restrictions should not be applied in the case of emergency safety maneuvers nor on freeway on-ramps where higher rates of acceleration may be warranted.

Noise limits have also been recommended for an additional in-city mode of operation; that of a level roadway cruise condition where it is assumed that vehicles are operating at basically a steady-state (non-accelerating) speed. Such limits are appropriate for speed zones of 35 mph or less and should only be applied at a distance of at least 200 feet from an intersection or when vehicles are observed to be operating under essentially constant speed conditions. Also note that the presence of snow tires may cause a vehicle to emit higher noise levels, in which case, if tire noise appears to be the dominant factor, the limits in the above categories should not be enforced.

The recommended passby limits presented in II.B. are specified at a reference distance of 50 feet (15 m) from the microphone to the centerline of the vehicle path of travel. While 50 feet is the standard reference distance for vehicle noise measurements, it is often difficult to locate relatively clear sites in the community on which the microphone can be set up the full 50 feet from the path of travel without ending up too close to buildings, walls and parked cars, causing sound reflections leading to inaccurate measurements. To overcome such difficulties, measurement at a distance of 25 feet (7.5 m) is generally recommended, with a +7 dB adjustment applied to the enforcement limits to account for this shorter distance (see Appendix F for measurement distance correction factors). A relatively simple nomograph procedure is also presented in Appendix F to account for the presence of walls or buildings near either or both the microphone or the vehicle being measured. In all cases, however, it is necessary to maintain an approximate 10-foot or greater radius clear area around the microphone and the measured vehicle.

2. Stationary Test Noise Limits:

In addition to recommending passby noise limits for light vehicles and motorcycles, NANCO has also recommended stationary test sound levels. Such stationary sound level tests provide a useful objective screening device for correctly detecting obviously noisy vehicles. While it is arguable that such stationary tests measure only exhaust noise and passby tests measure total vehicle noise, and that correlations between the two measurements may indeed be poor, they are useful for identifying the noisier vehicles whose noise output is generally exhaust dominated.

Stationary noise tests are conducted with the vehicle stationary, the transmission in neutral and the engine revved and held briefly at a specified RPM while the sound level is measured at a distance of 20 inches (.5 m) from the exhaust outlet. Further details on the recommended stationary test procedures are found in Appendix G.

The NANCO-recommended noise limits represent averages of the sound levels of broad vehicle populations, with most emphasis placed on more recent data. In some cases, however, these limits may not be fully representative of special local conditions which may cause the traffic to generally emit more or less than the recommended levels.

The detailed basis for selection of the current NANCO-recommended noise limits by generalized mode of operation for each vehicle category is summarized in Appendix C, along with considerations for reduction of these limits in the future as a result of the influx of quieter vehicles (reflective of current production) into the total vehicle population. Appendix D contains summaries of vehicle noise emission surveys by type of vehicle and mode of operation. The suggested course of action is to begin enforcement with the NANCO recommendations and to revise the limits downward in the future (1-2 years) if analysis shows that lower limits are warranted.

As mentioned earlier, the NANCO limits have been selected so as to allow operation of legally equipped vehicles in a reasonable manner. At this time, the enforcement of limits lower than the NANCO recommendations could necessitate additional constraints on the operation of a vehicle rather than further improvements in exhaust system equipment.

B. Passby Vehicle Sound Limits

Recommended A-Weighted Sound Level Limits for Operation on Public Roadways. (Specified at 50 feet (15 m) From the Centerline of the Vehicle Travel Lane.)

Posted Speed Zone	Automobiles, Vans, Light Trucks (GVWR < 10,000 lbs.)	On-Highway Motorcycles
Greater than 45 mph [a]	78 dB	82 dB
45 mph or Less[a]	72 dB	78 dB
35 mph or Less Level Roadways, Constant Speed Cruise, 200 Feet or More from Intersection	70 dB	74 dB

a. At any time under any condition of grade, load, acceleration, or deceleration.

Note: *Vehicles should not be cited if their passby noise levels are dominated by noise emitted by mud and snow tires installed on the vehicle or by operation over wet pavement.*

C. Stationary Test Sound Limits

Recommended A-Weighted Sound Level Limits for Stationary Vehicle Exhaust Noise Tests. (Measurement at 20" (.5 m) from Exhaust Outlet.)

Automobiles, Vans Light Trucks (GVWR < 10,000 lbs.)	95 dB[a.b.]
On-Highway Motorcycles	99 dB[c.]

a. Add +2 dB for rear- and mid-engined vehicles.

b. Test shall be conducted at 3/4 the maximum rated horsepower engine speed. For simplified, in-the-field enforcement, an engine test speed of 3,000 RPM may be used. *

c. Test specified at 1/2 the maximum rated horsepower engine speed. For simplified enforcement, may test at 1/2 indicated engine red line.

*Trade-offs between correctly identifying a higher percent of illegal vehicles versus simplified enforcement must be made. The more accurate procedure of testing at 3/4 rated RPM requires the incorporation of a sizeable catalog of test RPMs by make and model of vehicle, while testing at a fixed 3,000 RPM greatly simplifies in-the-field enforcement. It has been suggested that 3/4 rated RPM testing is most appropriate for vehicle inspection stations which would have ready access to specifications of vehicle-specific test parameters.

D. Additional Recommended Vehicle Noise Ordinance Provisions

Equipment Required: Every motor vehicle subject to registration shall at all times be equipped with an adequate muffler in constant operation and properly maintained to prevent any excessive or unusual noise, and no muffler or exhaust system shall be equipped with a cutout, bypass, or similar device.

Improperly Equipped Vehicle Prohibited: No person shall operate a motor vehicle with the exhaust system modified in such a manner which will amplify or increase the noise emitted by such vehicle, *above the limit applicable to that specific vehicle at time of manufacture.*[1] (Alternate Proposal: .... *noticeable above that by the exhaust system originally installed on the vehicle.*)[2]

Excessive Noise Prohibited: Notwithstanding any other provision of this section, no person may operate any vehicle so as to create excessive or unusual noise.

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1. This language is appropriate only in those jurisdictions which require manufacturers to comply with new vehicle certification noise limits. Compliance with such provisions has historically been demonstrated by conduct of an SAE J986 test for automobiles, or an SAE J331 test for motorcycles; however, the U.S. Environmental Protection Agency has proposed noise test procedures for automobiles and motorcycles that are designed to be more representative of actual on-road maximum noise emission levels.

2. This language requires the enforcement officer to exercise his subjective judgement that the vehicle in question is not noticeably (3-5 dB) louder than other comparable vehicles of similar age and design. Such wording is appropriate for jurisdictions without new vehicle certification noise limits.

III. VEHICLE NOISE ENFORCEMENT PROCEDURES

An effective vehicle noise enforcement program consists of three elements:

A. Noisy Vehicle Determination;

B. Citation; and

C. Compliance (i.e., Resolution of Complaints).

The concept embodied in the NANCO enforcement manual is to present various proven techniques and methodologies for each of these program elements, so that an enforcement program may be formulated, using a "Building Block" approach. This allows the level of sophistication and detail in each element to be commensurate with the needs, resources and the nature and extent of specific local vehicle noise problems. The various program "Building Blocks" are shown in Figure III-1.

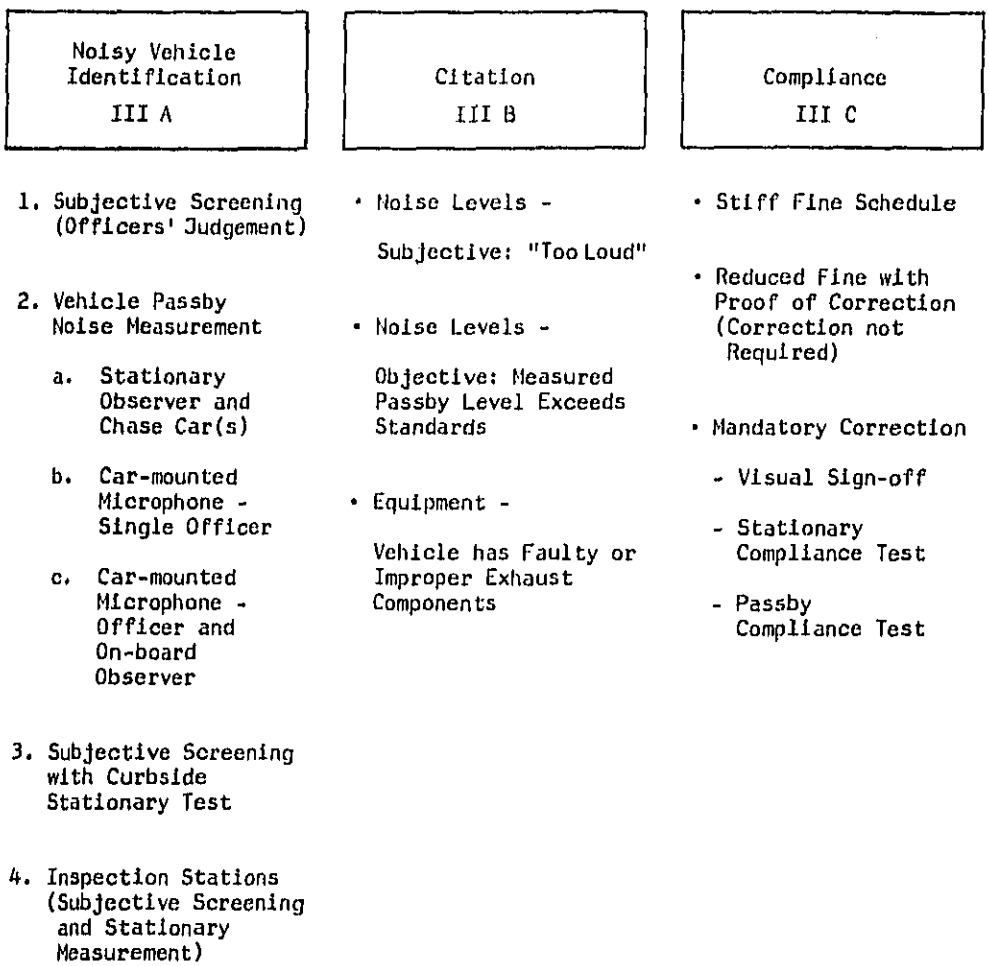
In the following sections, each element of the noise control program is examined and the various options within each element are detailed. Rather than present hypothetical scenarios involving various combinations of these "Building Blocks", summaries of actual current enforcement programs incorporating varying combinations of these techniques are presented in Appendix A.

A. Noisy Vehicle Determination

The first step in controlling excessive noise from motor vehicles is the determination and identification of those vehicles which emit higher noise levels than are acceptable to the community. Both subjective and objective means may legally be used in these determinations.

Figure III-1

VEHICLE NOISE ENFORCEMENT PROGRAM "BUILDING BLOCKS"



1. Subjective Screening:

A subjective determination (one made in the officer's judgement) that a vehicle emits excessive or unusual noise levels, either through the existence of a faulty or improperly modified exhaust system or improper vehicle operation, is legally supportable (Appendix B). In order to make such objective judgements "stick", the officer must be a trained observer.

The officer may also cite a vehicle for modifications to the exhaust system which, in his opinion, will allow it to create excessive noise, without ever actually observing the vehicle in operation, although this latter approach is subject to potential challenge.

Pros.:

- *Least expensive program to initiate - no sound level meter required;*
- *Any on-duty officer who has been trained can issue a vehicle noise citation - not limited by the availability of meters;*
- *No initial capital expenditures that would delay program start-up.*

Cons.:

- *An officer's training as an expert and his physical health (hearing acuity)* are more critical and may be subject to challenge;*
- *Will catch only the worst-case offenders - will miss the marginal cases;*
- *Harder to prosecute than objective, metered enforcement - District Attorneys are not as convinced of strength of charge;*
- *Courts may be more wary of harrassment potential of subjective judgement of police officers.*

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* However, hearing acuity is not a critical factor because the ear still is a good comparative device.

2. Objective Determination -

Vehicle Passby Sound Level Measurement:

The objective determination of motor vehicle noise emission is made using a sound level meter (see Section IV). The maximum observed A-weighted sound level (fast meter response) as the vehicle passes by is reported, provided that this maximum value exceeds that of the background noise and other traffic by at least 6 dB.

A +2 dB measurement tolerance is recommended to account for instrument accuracy, site-to-site variations, and variations in the vehicle population.

There are basically three variations on the theme of noisy vehicle measurement and citation involving curbing the offending vehicle with a well-marked chase vehicle manned by a uniformed police officer.

a. Stationary Observer and Chase Car(s):

Utilize a stationary observer equipped with either a standard sound level meter or a meter with a remote microphone. The observer corresponds via 2-way radio to one or more chase vehicles. (California Highway Patrol uses uniformed officers for all functions, while Salt Lake City uses a technician to read the meter.)

Pros.:

- *Two officers per car improve officer safety;*
- *Using a technician to take noise readings minimizes training requirements for peace officers;*
- *Widely-used, proven techniques;*
- *Pride in the program and higher performance levels are encouraged when specific officers or noise teams conduct vehicle noise enforcement.*

Cons.:

- *Not the most efficient use of available manpower;*
- *Requires more complex equipment set-up.*

b. Car-mounted Microphone - Single Officer:

Utilize a single peace officer in a chase vehicle that is equipped with a car-mounted microphone attached to a boom and connected to a remote sound level meter which is mounted inside the vehicle. (Used by Boulder and Colorado Springs, Colorado.)

Pros.:
- *Efficient use of manpower;*
- *No equipment set-up time other than standard calibration;*
- *Enforcement officer is a trained noise specialist and is encouraged to take an active role in the program.*

Cons.:
- *Officer safety may be impaired;*
- *Potential errors resulting from mounting the microphone 18" above the roof of the chase vehicle have been studied.* It is recommended that a +3 dB measurement tolerance be used with such microphone mountings pending further studies.*

c. Car-mounted Microphone - Officer and Observer:

Instrumentation as in b. above, but have a noise technician accompany the peace officer and conduct the meter readings. (Utilized by Bloomington, Minnesota.)

Pros.:
- *No peace officer training required;*
- *Program maintains consistency by having noise control personnel continually involved;*
- *Improved officer safety.*

Cons.:
- *Requires two men for essentially a one-man job.*

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* Carlson, M.B. and Foch, J.D., Jr.: "Motor Vehicle Noise Monitoring From a Patrol Car". Minnesota Pollution Control Agency, 1979.

3. Subjective Screening with Stationary Test:

There is a third variation which combines subjective and objective determination, and involves the officer curbing a vehicle he subjectively judges to be unusually loud or improperly modified. (Sometimes this is necessary in pass-by monitoring situations when a noisy vehicle's passby sound level is masked by other traffic.) He then requests that the vehicle operator participate in a stationary sound level test. This test may be conducted either at the curbside or at an approved vehicle inspection station within a specified time period. For such a test, it may be necessary for the officer to connect a tachometer to the engine (if the vehicle is not so equipped) and, with the vehicle in neutral, have the operator rev the engine to a predetermined engine speed. Readings are taken at a distance of 20" (.5 m) from the vehicle exhaust outlet on a line 45^0 off the exhaust outlet axis while the proper engine speed is maintained. If the noise standard for such a test is exceeded, the officer may cite the vehicle operator for excessive noise emission (see Section III.B.); however, it can be argued that to subject oneself to such a test is self-incriminating and such a procedure may be challenged. Therefore, it is recommended that the test noise level be used to indicate a faulty or improper exhaust system and to base the citation on equipment only, as opposed to illegal operation.

A +2 dB measurement tolerance is recommended to account for instrument accuracy, site-to-site variations, and variations in the vehicle population. When conducting stationary tests on motorcycles at 1/2 indicated red line rather than at 1/2 the maximum rated horsepower engine speed, a total measurement tolerance of +3 dB is recommended.

4. Inspection Stations:

Vehicle inspection stations may be used to provide the most cost-effective manner in which to remove excessively noisy vehicles from public roadways (assuming that the "noise portion" of a vehicle inspection can be piggy-backed to other existing required inspections; i.e., air pollution and safety). It is conceived that vehicle inspection stations may play a significant role in a vehicle noise control program through the following applications:

- Mandatory inspections upon transfer of vehicle ownership;
- Mandatory annual (bi-annual) inspection of all vehicles;
- Mandatory annual (bi-annual) inspection of all vehicles over, say, five years of age;
- Referral by traffic officer, based on his observation that the vehicle appears to emit excessive noise (compliance testing). (Re.: Section III.A.3.)

The exhaust system portion of a "vehicle check" as performed at a vehicle inspection station may take any or all of the following forms:

- A visual inspection of exhaust system to detect faulty or improperly modified components.
- Rev up the engine with the vehicle in neutral, to aid the inspection officer in subjectively screening quiet vehicles. Those he suspects may be too noisy should then undergo the more rigorous stationary test that follows.
- A stationary test of the vehicle exhaust system's noise emission conducted with a hand-held sound level meter positioned at a distance of 20" (.5 m) from the exhaust exit. If the vehicle is not so equipped, it is necessary to attach an engine tachometer. The sound measurement is taken with the transmission in neutral, while the engine speed is held at a specified RPM. (The State of Oregon, in their vehicle inspection program, provides a detailed manual from which the engine test speed for each particular model vehicle is selected.) See Appendix C for detailed stationary test procedures for automobiles and motorcycles.

The particular benefits of the inspection station approach to vehicular noise control as experienced by the State of Oregon (see Appendix A) are outlined below:

- Test may be performed indoors, thereby avoiding inclement weather;
- Cost is low if the program is piggy-backed with other vehicle inspection programs; e.g., safety and emission inspections;
- Subjective screening may be used to eliminate necessity to test "quiet" vehicles.

Oregon has found that although the correlations between drive-by noise levels and a stationary test are poor (the stationary test measures only exhaust noise, while the drive-by measures total vehicle noise), the correlation between their subjective evaluations and measured stationary test results are good. Oregon found it necessary, however, to establish a 2 dB higher test limit for rear-engined vehicles due to additional noise sources near the measurement point.

These measurement options, along with the variations on personnel and sound measurement instrumentation, are summarized in the following illustration (Figure III-2).

Figure III-2

PERSONNEL AND INSTRUMENTATION OPTIONS
FOR VARIOUS MEASUREMENT PROCEDURES

Sound Measurement System Configurations	Personnel Options					
	Subjective Screening	Passby Measurement in Traffic			Curbside Stationary Test	Vehicle Inspection Stations
	Traffic Officer **	1 Officer ** in Chase Vehicle	1 Technician ** (Meter Observer) and 1 or More Chase Vehicles (with Radio Communications)	Officer ** in Chase Vehicle Accompanied By Noise Technician ***	1 Officer ** in Chase Vehicle	Technician or Inspection Officer*
Sound Level Meter			X		X	X
Sound Level Meter With Remote Microphone (Optional)			X		X	X
Car Mounted System		X		X		

* Uniformed or Non-Uniformed

** Uniformed Only (Commissioned Peace Officer)

*** Non-Uniformed

B. Citations

When a noise violation is determined, two types of citations may be given:

- Noise Emission: Citation based upon observed exceedance of the noise regulations; and
- Equipment: Citation based upon a faulty or improperly modified vehicle exhaust system.

Citations based solely upon violation of the noise standards may be viewed in the same context as speeding tickets; they provide a penalty for the violation but do not ensure that the offense will not be repeated. Citations based upon faulty or improperly modified exhaust system equipment, issued by themselves or in addition to noise limit violations, provide some essential benefits:

- Equipment citations generally require proof of correction before the vehicle can be operated legally on public roadways. Thus, they require the noisy vehicle to be repaired.
- The courts and the violators have tended to understand the concept of faulty vehicle hardware better than the somewhat abstract concept of decibel emission levels. Equipment citations have rarely been challenged. (The experiences of NANCO members suggest that on any noise or equipment citation, a thorough description of the vehicle's exhaust system be included, and the presence of any non-stock appearing, performance, or faulty components should be noted on the citation.)

Any uncertainty factors encountered at the beginning of the program are best handled by the issuance of warnings in lieu of citations for some period of time. Such a policy serves multiple purposes: It gives the officers on-the-job training and experience in dealing with noise control; and it provides a clear indication as to the appropriateness of the noise standards in a particular community.

C. Compliance

Compliance with vehicle noise laws can be achieved through either of the following approaches:

- A well-publicized, (rapidly) escalating, fine schedule for repeat violators; or
- Compliance certification, either through visual inspection and sign-off, and/or stationary or moving tests to determine that vehicle noise emission values are within an acceptable range.

The considerations of visual exhaust system inspection are discussed in Section III.B. and Appendix B. Since the basic philosophy embodied in the NANCO approach is quieting those vehicles whose noise emissions clearly stand out above the rest, faulty systems and those which have been improperly modified can be rather easily identified in most cases by visual inspection.

Compliance testing, as utilized by various NANCO members, takes two forms: Moving procedures and stationary tests. Of the two alternatives, the stationary test imposes the fewest potential problems to new programs. A stationary compliance test procedure, though its correlation to moving maximum noise emission test procedures (SAE J986 and J331) is not high, is suitable as a pass/fail screening device. Also, such stationary tests should be conducted at the standard measurement distance of 20" (.5 m), as the majority of available data on stationary test vehicle emissions is based on testing at this distance. Some NANCO members incorporate a stationary compliance test with the measurement distance specified at 25 feet (7.5 m). The stated reason is that tests at such a distance are consistent with the distance under which the noisy vehicles were originally cited. Such arguments have been viewed favorably in the local courts. The main problem with such large distances, however, is that the site requirements are much more restrictive. Recommended stationary test procedures are presented in Appendix G.

Upon satisfactory completion of a stationary noise emission compliance test or visual inspection, it is standard practice to sign off on the citation, or present the violator with a certificate of compliance (in some cases, a window decal so stating compliance) that may be presented along with the citation during a specified time period with the result that the fine is suspended or significantly reduced. Local communities establishing a vehicle noise control program must balance their priorities between maintaining a self-supporting program based on incoming revenues vs. the ultimate goal of only achieving compliance and eliminating noisy vehicles; i.e., dropping fines if vehicle is corrected.

IV. NOISE MEASUREMENT INSTRUMENTATION

With the exception of subjective screening, the procedures outlined in this manual require, at a minimum, the following acoustic instrumentation:

A. Sound Level Meter (SLM)

B. Calibrator

C. Windscreen

A. Sound Level Meter

The sound level meter is the basic instrument for measuring noise. It basically consists of a microphone, amplifier circuits, frequency weighting networks, and an indicating meter. The microphone transforms the noise signal to an equivalent electrical signal that is shown on the meter. Filtering circuits are incorporated into the device (A-weighting network) so that it essentially responds to the sound in the same fashion as the human ear.

Specifications for sound level meters have been established by the American National Standards Institute and are included in ANSI S1.4-1971, "Specifications for Sound Level Meters". This ANSI standard provides the maximum allowable tolerances for the Type 1 and Type 2 sound level meters, which NANCO considers acceptable for use in motor vehicle noise enforcement.

Type 1 "Precision" sound level meters typically are used in acoustic laboratories and in new product noise certification, where measurements require extreme accuracy. The Type 2 "General Purpose" sound level meters typically are used for community/motor vehicle noise enforcement. While the Type 1 meters do offer a slight increase in accuracy, they are considerably more expensive than Type 2 meters. Any loss of accuracy by using Type 2 meters is more than covered by the 2 and 3 dB measurement tolerances recommended (Chapter III, Enforcement Procedures). NANCO, therefore, endorses the use of Type 2 "General Purpose" sound level meters for motor vehicle noise enforcement.

Note: ANSI is purely an advisory standard. An instrument manufacturer may claim that his product complies with ANSI Type 1 or Type 2 specifications, but then state numerous exceptions.

Several manufacturers are currently in the process of developing special-purpose sound level meters with automatic operation features, specifically for use in motor vehicle noise enforcement. Regardless of the type of meter purchased, manufacturers' instructions for microphone orientation, meter operation, and calibration should be studied carefully and followed.

B. Calibrator

Sound level meters should never be used unless properly calibrated. An acoustic calibrator provides a means for conducting an overall system check, as well as calibration of the sound level meter. The meter reading is adjusted to match the specified calibrator sound pressure level. Calibrators are specifically matched to individual microphone systems; therefore, it is important that only the proper calibrator be used. Otherwise, errors may result and/or the microphone permanently damaged.

Calibrator output is affected by changes in atmospheric (barometric) pressure. Care must be taken when using the calibrator at atmospheric pressures other than standard. Calibrator manufacturers provide correction curves for calibrator use at nonstandard atmospheric conditions (i.e., for use at higher altitudes).

Field calibration should be accomplished with the system as it will be in actual use (for example, with microphone and cables installed). Calibrate in accordance with the manufacturer's recommendations. At a minimum, you should calibrate before and after each period of use and at intervals not exceeding two hours.

A laboratory calibration on both the sound level meter and calibrator should be performed at regular intervals of not more than one year. These calibrations should be performed by the instrument manufacturer or by qualified personnel at an acoustical laboratory.

C. Windscreen

Rapid air movement over a microphone causes turbulence, which in turn generates extraneous noise. This noise can effectively mask the sound being measured and cause erroneous high level readings. The use of earphones connected to the sound level meter output jack (consult manufacturers' recommendations) often will enable the operator to detect wind-generated noise; however, low-level masking may occur that will be inaudible. Therefore, whenever outdoor measurements are made, it is good practice to always use a microphone windscreen. The screen also protects the sensitive microphone diaphragm from dust or serious damage if it is dropped.

The effectiveness of the microphone windscreen is limited. Therefore, measurements should never be made under high wind conditions (wind over 15 mph) or when the wind effects can be detected either visually or aurally.

D. Guide to Purchasing Instrumentation

Figure IV-1 has been developed to assist in purchasing the appropriate instrumentation for motor vehicle noise enforcement. Depending on the enforcement methodology to be used, the Figure identifies various instrument features as being Mandatory (***), Highly Desirable (**), Nice Feature (*), Not Applicable (NA), or Undesirable/Unnecessary (U).

A list of sound level meter manufacturers and suppliers is provided in Figure IV-2. This listing does not necessarily contain the names and addresses of all sound level meter suppliers, nor does it represent an official NANCO endorsement of those manufacturers listed.

Figure IV-1

NOISE MEASUREMENT INSTRUMENTATION

Vehicle Measurement System Features	Enforcement Methodology					
	Passby Measurements				Compliance Testing	
	Chase Car-Mounted Microphone		Hand-Held SLM or Remote Microphone			
	Fixed Distance To Center Line	Variable Distance To Center Line	Fixed Distance To Center Line	Variable Distance To Center Line	Fixed Distance To Center Line	Stationary [Fixed Distance .5m (20")]
Scales:						
A	***	***	***	***	***	***
C	U	U	U	U	U	U
Linear	U	U	U	U	U	U
Response:						
Fast (c)	***	***	***	***	***	U
Slow (c)	U	U	U	U	U	***
Readout:						
Digital or Analog	***	***	***	***	***	***
Both	*	*	*	*	*	U
Instant Capture	*	*	*	*	*	*
Max Hold	**	**	**	**	**	U
Hard Copy Printout	*	*	*	*	*	*
ANSI Specifications:						
Type 1	*	*	*	*	*	*
Type 2 or Better	***	***	***	***	***	***
Dynamic Range:						
60-100	***	***	***	***	***	NA
80-120	NA	NA	NA	NA	NA	***
60-120 (Auto Ranging)	*	*	*	*	*	U
Power:						
Low Voltage Alarm	*	*	*	*	*	*
Battery Check	***	***	***	***	***	***
Auxiliary Power Input - 12 volt	***	***	*	*	*	U

Vehicle Measurement System Features	Enforcement Methodology					
	Passby Measurements				Compliance Testing	
	Chase Car-Mounted Microphone		Hand-Held SLM or Remote Microphone			
	Fixed Distance To Center Line	Variable Distance To Center Line	Fixed Distance To Center Line	Variable Distance To Center Line	Fixed Distance To Center Line	Stationary [Fixed Distance .5m (20")]
Microphone:						
• Weather Resistant	**	**	**	**	**	U
• Remote Mounting	***	***	*	*	*	*
Automatic Operation:						
• Preset Levels (At Fixed Distance)						
H/S & L/S Autos	***	NA	***	NA	***	***
H/S & L/S Trucks	*	NA	*	NA	***	***
H/S & L/S M/Cs	***	NA	***	NA	***	***
• Preset Levels Variable Distance (Say, 15' to 100')	NA	***	NA	***	NA	NA
• Exceedance Alarm	**	**	**	**	U	U
• -6 dB Down (b) Peak Rejection	*** (a)	*** (a)	*** (a)	*** (a)	U	U
• Internal Calibration	*	*	U	U	U	U
• Simple On-Off Operation (All Functions Pre-set)	*	NA	*	NA	*	*
• Integrated Tachometry SLM	NA	NA	NA	NA	NA	*

*** Mandatory
** Highly Desirable
* Nice Feature
NA Not Applicable
U Undesirable/Unnecessary

(a) Mandatory Only with Digital Only Readout
(b) Required in BMCS Truck Standards
(c) Equivalent Digital Sampling Rates:
Fast: 16/Second
Slow: 2/Second

Figure IV-2

MANUFACTURERS AND SUPPLIERS OF
SOUND LEVEL METERS

ACOUSTIC INSTRUMENTS, INTERNATIONAL
650 Vaqueros Avenue
Sunnyvale, California 94086
(408) 733-0233

ADCO HEARING CONSERVATION, INC.
1558 California Street
Denver, Colorado 80202
(303) 893-0624

B & K INSTRUMENTS, INC.
5111 West 164th Street
Cleveland, Ohio 44142
(216) 267-4800

CASTLE ASSOCIATES
650 Vaqueros Avenue
Sunnyvale, California 94086
(408) 732-4590

COLUMBIA RESEARCH LABORATORIES, INC.
1925 McDade Boulevard
Woodlyn, Pennsylvania 19094
(215) 532-9464

DALLAS INSTRUMENTS, INC.
10205 Plano Road
Dallas, Texas 75238
(214) 349-1180

DATACRAFT, INC.
13714 South Normandie
Gardena, California 90249
(213) 321-2320

DIGITAL ACOUSTICS, INC.
1415 McFadden, Suite F
Santa Ana, California 92705
(714) 835-4884

G E QUICK-RENTAL INSTRUMENTS
1 River Road, Building 6,
Room 328
Schenectady, New York 12345
(518) 372-9900

GEN RAD
300 Baker Avenue
Concord, Massachusetts 01742
(617) 369-4400

GUINTA ASSOCIATES, INC.
67 Leuning Street
South Hackensack, N. J. 07606
(201) 488-4425

I R D MECHANALYSIS, INC.
6150 Huntley Road
Columbus, Ohio 43229
(614) 885-5376

IVIE ELECTRONICS, INC.
500 West 1200 Street
Orem, Utah 94057
(801) 224-1800

KORFUND DYNAMICS CORPORATION
Post Office Box 235
Westbury, New York 11590
(516) 333-7580

LEASAMETRIC
1164 Triton Drive
Foster City, California 94044
(415) 574-4441

LEE LAB SUPPLY
13714 South Normandie
Gardena, California 90249
(213) 323-9120

LING ELECTRONICS, INC.
1515 South Manchester Avenue
Anaheim, California 92803
(714) 774-2000

METROSONICS, INC.
Post Office Box 23075
Rochester, New York 14692
(716) 334-7300

MINE SAFETY APPLIANCES COMPANY
600 Penn Center Boulevard
Pittsburgh, Pennsylvania 15235
(412) 273-5175

MONARCH INTERNATIONAL, INC.
Columbia Drive
Amherst, New Hampshire 03031
(613) 883-3390

NAGRA MAGNETIC RECORDERS, INC.
26050 Richmond Road
Cleveland, Ohio 44146
(216) 831-4038

QUEST ELECTRONICS DIVISION
LA BELLE INDUSTRIES
510 South Worthington Street
Oconomowoc, Wisconsin 53066
(414) 567-9157

RENTAL ELECTRONICS, INC.
2445 Faber Place
Palo Alto, California 94303
(415) 856-7600

RION COMPANY, LTD.
Ikeda Building
7-7, 2-Chrome Yoyogi
Shibuya-Ku
Tokyo 151, Japan

SCOTT INSTRUMENT LABORATORIES
533 Main Street
Acton, Massachusetts 01720
(617) 263-3263

SIMPSON ELECTRIC COMPANY
853 Dundee Avenue
Elgin, Illinois 60120
(312) 697-2260

ANATOLE J. SIPIN COMPANY, INC.
425 Park Avenue South
New York, New York 10016
(212) 689-2550

THERMOTRON INDUSTRIES, INC.
DYNAMIC SYSTEMS DIVISION
Kollen Park Drive
Holland, Michigan 49423
(616) 396-1727

3 M COMPANY
Occupational Health and
Safety Products Division
230-B 3 M Center
St. Paul, Minnesota 55101
(800) 328-1300

TRACOR, INC.
6500 Tracor Lane
Austin, Texas 78721
(512) 926-2800

T S I INCORPORATED
500 Cardigan Road
St. Paul, Minnesota 55165
(612) 483-0900

U. S. INSTRUMENT RENTALS
2121 South El Camino Real
San Mateo, California 94403
(415) 574-6006

V. NOISE ENFORCEMENT PERSONNEL QUALIFICATIONS AND TRAINING

A. General Considerations

Motor vehicle noise enforcement requires that enforcement personnel receive adequate training and experience in areas of noise, its measurement, and enforcement. A training program is necessary to achieve competent operator status so that program credibility will be established. While the training should not be designed to make the officer an expert witness, certain minimum requirements are needed to show that the officer is competent and has received training in the use of a sound level meter to measure vehicle noise.

The training should be conducted by qualified personnel. Typically, the technical aspects of sound should be handled by an acoustical scientist, while the enforcement interests should be conducted by police officers or other enforcement personnel.

Satisfactory completion of a training course, including a written examination, should result in the issuance of a "Certificate of Training" to each attendee. This certificate has proven to be extremely useful in matters such as court appearances. Periodic competency checks or re-certification are recommended.

In addition to the training, on-the-job experience in noise enforcement is desirable. A minimum of 8 hours in-field enforcement is recommended (after the training course) before actual citations are issued. Also, a 30 to 90 day "warning only" period is recommended as a public awareness feature.

The training should include a discussion of the laws, regulations, and court appearances. Some physics of sound should also be included, as well as noise source identification. Finally, a minimum of 4 hours field measurement practices should be set aside. The following is a suggested course outline, along with recommended minimum discussion times for training vehicle noise enforcement personnel.

B. Motor Vehicle Noise Enforcement Training Outline (20 Hours)

1. Introduction (2 Hours)

   a. Course purpose, content and schedule
   b. History of legislation
   c. Specific laws, rules and regulations

2. Basic Theory of Sound (3 Hours)

   a. Definition
   b. Characteristics

      (1) Intensity

         (a) Loudness
         (b) Decibel

      (2) Frequency

         (a) Spectra
         (b) Hertz

      (3) Time Variation

         (a) Instantaneous level
         (b) Cumulative exposure

   c. Sound Propagation

      (1) Inverse-square law (distance)
      (2) Ground Absorption
      (3) Shielding
      (4) Meteorological effects
      (5) Effects of other noise sources

         (a) Combining decibels
         (b) Subtracting decibels

   d. Human Response to Noise

      (1) Range of hearing
      (2) Frequency of weighting

         (a) Equal loudness contours
         (b) A-weighting

(3) Impacts of noise

(a) Physiological

- Stress
- Hearing loss

(b) Psychological

- Annoyance
- Sleep loss
- Speech interference

3. Sound Measurement Instrumentation (2 Hours)

a. Sound Level Meter

(1) Components

(a) Weighting networks
(b) Slow/fast response
(c) Scale
(d) Attenuator
(e) Microphone
(f) Windscreen
(g) Other (cables, tripod, etc.)

(2) Types of sound level meters
(3) Service and repair

b. Other Equipment
d. Costs

4. Motor Vehicle Noise Sources (1 Hour)

a. Exhaust System

(1) Defective
(2) Inadequate
(3) Modified

b. Fan
c. Engine (Mechanical)
d. Air Intake
e. Drive Train
f. Tires
g. Operational
h. Aerodynamic
i. Other (Refrigeration Units, Radios, etc.)

5. Sound Measurement Procedures (2 Hours)

a. Moving Vehicle

(1) Personnel
(2) Site selection

(a) Distance
(b) Reflecting surfaces
(c) Weather
(d) Ambient level
(e) Traffic
(f) Corrections

(3) Equipment set-up

(a) Microphone location and orientation
(b) Calibration
(c) Windscreen
(d) Meter settings

(4) Vehicle measurement

(a) Engine operation
(b) Recording (maximum level)
(c) Noise limits
(d) Tolerances

b. Stationary Test

(1) Test site
(2) Ambient conditions

(a) Sound level
(b) Wind
(c) Precipitation
(d) Observer/bystander

(3) Equipment set-up

(a) Microphone location and orientation
(b) Calibration
(c) Meter settings

(4) Measurement

(a) Engine operation
(b) Recording (maximum level)

(c) Noise limits
(d) Tolerances

6. Policies and Procedures (2 Hours)

a. Public Awareness
b. Completion of Noise Forms
c. Administration

(1) Federal
(2) State
(3) Local

d. Enforcement

(1) Tolerances
(2) Citations
(3) Compliance/correction test

e. Violator Comments and Reactions
f. Fines/Penalties

7. Field Exercises (4 Hours)

a. Site Selection
b. Noise Measurement
c. Vehicle Pull-over

(1) Violator discussion
(2) Noise source identification

8. Court Appearances (1 Hour)

a. Pre-enforcement Conference
b. Officer Qualification/Certification
c. Expert Witnesses
d. Equipment Reliability
e. Sample Testimony

9. Review (1 Hour)

10. Examination (1 Hour)

11. Certification (1/2 Hour)

12. Course Evaluation (1/2 Hour)

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Hornet, H. and Williamson, I.M., "Evaluation of Stationary and Moving Motorcycle Noise Test Methods for Use in Proposed Regulations", Prepared by McDonnell-Douglas for the Motorcycle Industry Council, Inc., Newport Beach, California 92660, December 1975.

Appendix A

SELECTED SUMMARIES OF CURRENT VEHICLE NOISE ENFORCEMENT PROGRAMS

		STATE OR LOCAL VEHICLE NOISE CONTROL PROGRAMS												
	PROGRAM ELEMENT	Bloomington, Minnesota	Boulder, Colorado	California Highway Patrol	Colorado Springs, Colorado	Eugene, Oregon	Florida Highway Patrol	Maryland State Police	Oregon	Salt Lake City, Utah	San Francisco, California			
A. NOISY VEHICLE IDENTIFICATION	1. Subjective Screening	X	X		X	X			X		X			
	2. Passby Measurements													
	a. Observer and Chase Car(s)			X			X	X		X				
	b. Car-mounted Microphone Single Officer		X		X						X			
	c. Car-mounted Microphone Officer and Observer	X												
	3. Subjective Screening with Curbside Stationary Test					X			X					
	4. Inspection Stations								X					
B. CITATION	1. Noise Level													
	a. Subjective										X			
	b. Measured	X	X	X	X	X	X	X	X	X	X			
	2. Improper Exhaust Equipment			X			X		X		X			
C. COMPLIANCE	1. Stiff Fine Schedule	*	X	*	X	*	X	*			*			
	2. Reduced Fine with Correction		X	*	X*				X	X	X			
	3. Mandatory Correction													
	a. Visual Sign-off			X							X			
	b. Stationary Compliance Test	X	X						X	X				
	c. Passby Compliance Test		X		X									
	COMMENTS	* $10 each cite		* left to local jounsolicitions	* 14 days for correction	* $40		* $50			* $25.50 each cite			

BLOOMINGTON, MINNESOTA

Population: 79,000

Year Program Began:	1977	Department:	Community Development
Budget:	$26,000	Noise Staff:	1-1/4
Citations:	600	Fines:	$6,000

Ordinance: 1. Limits: Sound Level Limit @ 50 Feet, dB.

	Speed Zones 35 mph or Less	Speed Zones Greater than 35 mph
Automobile	75	75
Motorcycle	80	83
Truck	86	90

(A +2 dB Tolerance is Applied)

2. Excessively Loud in Officer's Subjective Opinion.

Measurement Procedure: Police officer drives a chase car equipped with mast-mounted microphone. Environmental protection officer accompanies police officer.

Compliance Procedure: Compliance test required on all vehicles cited.

Compliance Test: Stationary test for automobiles and motorcycles. Automobiles are operated at 3,000 RPM and must not exceed 92 dB (+3 dB) @ 20". Motorcycles are operated at 3,500 RPM and must not exceed 100 dB (+5 dB) @ 20".

Fines: A fine of $10 is imposed on all noise citations. The fine is not accepted unless accompanied by a compliance slip.

Contact: LON C. LOKEN
City of Bloomington
2215 West Old Shakapee Road
Bloomington, Minnesota 55431
(612) 881-5811

BOULDER, COLORADO

Population: 85,000

Year Program Began:	1970	Department:	Environmental Protection Office
Budget:	$39,500 (Average for 2 Years)	Noise Staff:	3
Citations:	Approximately 800/Year	Fines:	Approximately $1,400/Year

Ordinance: 1. Excessively Loud in Officer's Subjective Judgement.

2. Limits: Automobiles and Motorcycles - 80 dB @ 25 Feet, Speed Zones of Less Than 45 mph (+3 dB tolerance allowed).

Measurement Procedure: One-man team with externally mounted microphone attached to noise control vehicle.

Compliance Procedure: Violator must take corrective action and pass compliance test for dismissal of case. No corrective action results in court appearance.

Compliance Test: 1. Stationary Test: Autos - Operated @ Idle, 2,000, 3,000 and 4,000 RPM. Motorcycles - Operated @ 60% red line. Motorcycles and autos must produce no more than 80 dB @ 25 Feet (0 dB tolerance).

2. Moving Vehicle: Vehicle approaches measurement area at 20 mph and accelerates at full throttle, without downshifting. Motorcycles and autos must meet 80 dB @ 25 Feet (0 dB tolerance).

Fines:

Noise Level, dB	1st Offense	2nd Offense	3rd Offense
81-83	$10	$15	$20
84-86	20	25	40
87-88	30	50	50
89 +	50	50	100

Fine is Dismissed if Correction is Made.

Comments: Enforcement is conducted by commissioned police officer in Environmental Protection Office.

Contact: JAMES V. ADAMS
City of Boulder
1739 North Broadway, Suite 406
Boulder, Colorado 80302
(303) 441-3239

State of California
DEPARTMENT OF CALIFORNIA HIGHWAY PATROL
Population: Approximately 22 Million

Year Program Began: 1969

Department: California Highway Patrol

Noise Staff: 16 Officers Statewide (8 Two-man Noise Teams)

Fines: No record of fines. They are collected by local jurisdictions, and do not revert back to the State.

Budget: Approximately $610,000

Citations: 23,000/Year

Ordinance: California Vehicle Code: Noise Limits at 50 Feet, dB.

Lower Speed Zones*			Higher Speed Zones*			Level Streets (35 mph or Less)		
Heavy Truck	M/C	Car	Heavy Truck	M/C	Car	Heavy Truck	M/C	Car
86	82	76	90	86	82	82	77	74

*Autos and Motorcycles: 45 mph. Heavy Trucks: 35 mph. Also: Section 27150: Defective Muffler Prohibited. Section 27151: No modification to increase noise above original factory system.

Measurement Procedure: Enforcement is conducted by two-man uniformed officer teams. One officer reads meter connected to remote microphone placed 50 feet from lane of travel. When violation is observed, officer radios chase vehicle and citation is given - usually based on faulty or modified exhaust equipment with sound levels noted on citation.

Compliance Procedure: Visual inspection and proof of correction of improperly modified or defective exhaust system generally required. Requires officer to sign off on citation.

Compliance Test: None conducted.

Comments: Officer may also cite when a particular vehicle produces higher noise levels than other similar model vehicles - whether or not standards are actually exceeded. (CHP has developed a considerable data base to support this practice.)

Contact: ROSS A. LITTLE
California Office of Noise Control
Department of Health Services
2151 Berkeley Way, Room 514
Berkeley, California 94704
(415) 540-2657

COLORADO SPRINGS, COLORADO

Population: 300,000 +

Year Program Began:	1971	Department:	Safety Office
Budget:	1978: $55,182 1979: $81,067	Noise Staff:	5
		Fines:	Approximately $14,000/Year
Citations:	650/Year		

Ordinance:

1. The officer must be able to ascertain that the vehicle is loud and has either a modified or defective exhaust system.
2. Any streets within city limits (all speed zones of 35 mph or less). Motorcycles and Automobiles: 80 dB @ 25 feet (+3 dB tolerance).

Measurement Procedure: One-man teams used with microphone attached to external mast on prominently marked noise control vehicle. Vehicle parked 90° from direction of traffic flow, 25 feet from line of travel.

Compliance Procedure: Violator must post $25 bond within one week of the violation date. Corrective action must be taken within 14 days. Correction results in reduced fine.

Compliance Test: If violator wishes to have his fine reduced, he must pass compliance test (based upon ISO R362). Vehicle approaches starting line of test area at 5-10 mph in first or low gear. Upon reaching starting line, vehicle is accelerated at full throttle for 50 feet. Motorcycles and autos must produce no more than 80 dB at 25 feet.

Fines:		
	First Offense:	$25 ($15 refunded for correction)
	Second Offense:	$60 (No refund)
	Third Offense:	$75 - $300 and/or 90 days in jail.

Comments: Enforcement is conducted by commissioned police officer in Safety Office. Eleven noise ordinance signs posted throughout the city at approximate cost of $60/sign.

Contact:

JOSEPH A. ZUNICH
Noise Control Administrator
Post Office Box 1575
Colorado Springs, Colorado 80901
(303) 471-6610

EUGENE, OREGON

Population: 100,000 +

Year Program Began: 1977

Department: Eugene Police Department

Budget: $65,070

Noise Staff: 7

Citations: 1,100

Ordinance: Enforces State of Oregon Motor Vehicle Noise Regulation's Stationary Test.

Measurement Procedure: Officers work in pairs. One officer subjectively locates a violator and directs him to a parking lot. One officer takes sound measurement while other officer brings vehicle up to required engine RPM. If vehicle is in violation, first officer issues citation while second officer locates another potential violator.

Compliance Procedure:

Compliance Test:

Fines: Scheduled bail of $40.

Contact: SERGEANT ROBERT LAWS
City of Eugene
Police Department
777 Pearl Street
Eugene, Oregon 97401
(503) 687-5156

STATE OF FLORIDA

Population: 7,000,000

Year Program Began: 1974

Noise Staff: 8

Budget:

Citations: 1,700/Year

Department: Florida Highway Patrol

Fines: Collected by Local Jurisdictions

Ordinance: Florida Uniform Traffic Code: Noise Limits at 50 Feet, dB.

	Speed Zones 35 mph or Less	Speed Zones Greater than 35 mph
Automobile	72	79
Motorcycle	78	82
Heavy Truck	86	90

Also: 1. Defective Equipment Prohibited.

2. No modification to increase noise above original vehicle level.

Measurement Procedure: Enforcement is conducted by 2-man uniformed officer teams. Officers read meter connected to remote microphone placed 50 feet from travel lane. When violation is observed, officer pursues offending vehicle and citation is given. Causes of excessive noise are suggested by officer. Defective equipment citations requiring corrections are sometimes given.

Compliance Procedure: Corrective action cards showing repair of defective equipment must be completed by repair facility and returned by violator within 14 days. No retests or clearance of citations except at discretion of the courts.

Compliance Test: None

Fines: Minimum fine of $15.75 for uncontested case. For a contested case proven guilty, fine can be up to $500.

Contact: SERGEANT B.G. SMITH
Motor Vehicle Noise Enforcement
Florida Highway Patrol Training Academy
Neil Kirkman Building
Tallahassee, Florida 32301
(904) 487-2714

STATE OF MARYLAND

Population: 4 Million +

Year Program Began: 1974

Department: Maryland State Police

Noise Staff: 8

Budget: $158,000 (F/Y 1979)

Fines: $2,125 (1978)

Citations: 91 (1978)

Ordinance: Maryland State Vehicle Code: Noise Limits at 50 Feet, dB.

Lower Speed Zones*		Higher Speed Zones*	
Heavy Trucks (GVWR > 10,000 lbs.)	M/C & Autos	Heavy Trucks	M/C & Autos
86	78	90	82

(A +2 dB tolerance is incorporated)

*Autos and Motorcycles: 45 mph; Heavy Trucks: 35 mph

Measurement Procedure: Enforcement conducted at 50 feet with adjustments for other distances and reflective surfaces. Chase vehicle or stopping team within sight of measurement personnel and measured vehicle. Vehicles over 10,000 lbs. GVWR covered by BMCS procedures (Appendix E).

Compliance Procedure: Proposed stationary test and certification procedures recommended.

Fines: $50 for all violations.

Contact: CAPTAIN BRUCE DIEHL
Automotive Safety Division
Maryland State Police
1921 Landsdowne Road
Baltimore, Maryland 21227
(301) 486-3101

STATE OF OREGON

Population: 2.25 Million

Year Program Began: 1974

Department: Oregon Department of Environmental Quality

Noise Staff: 9

Budget: $204,000 - F/Y 1979 (Total Noise Control Program)

Fines: $200 in Civil Penalties

Citations: Many notices of violation

Ordinance: Near Field Motor Vehicle Test (Stationary).

Vehicle	Model Year	Maximum Level @ 20 Inches, dB (+2 dB Tolerance)
Motorcycles	1975 & Before	102
Motorcycles	After 1975	99
Front Engine Autos/Light Trucks	All	95
Rear and Mid-Engine Autos/Light Trucks	All	97

Also: Limits for Moving Test at 50 Feet.

Measurement Procedure: Subjective Screening for excessive noise. Visual inspection for defects in exhaust system. Measurement of sound level conducted at 3/4 maximum rated horsepower engine speed.

Compliance Procedure: Stationary test at 20 inches.

Compliance Test: Same limits as stationary test with +2 dB tolerance.

Fines: Fines vary in different jurisdictions. At DEQ Emission Test Stations, provisions have been made for fine cancellation upon voluntary compliance.

Contact: JOHN M. HECTOR
Oregon Department of Environmental Quality
Post Office Box 1760
Portland, Oregon 97207
(503) 229-5989

SALT LAKE CITY, UTAH
Population: 180,000

Year Program Began: 1974

Department: City/County Department of Health

Noise Staff: 5

Budget: $167,000 (1978)

Citations: 1,500/Year

Fines:

Ordinance: Motor Vehicles Less than 10,000 pounds.

GVWR:
1. Speed limit 40 mph or less: 80 dB at 25 Feet (+2 dB tolerance).
2. Speed limit over 40 mph: 84 dB at 25 Feet (+2 dB tolerance).

Measurement Procedure: Two-man team operation: Technician at measurement site with police officer giving chase and citation to offending vehicle. Site is 200 feet from intersection and less than 1% grade.

Compliance Procedure: 80 dB at 25 feet under stationary test.

Compliance Test: Stationary test at 25 feet, engine operated at approximately 3/4 throttle.

Fines: No fixed schedule; at judge's discretion. Usually $100 to $150 and suspended to $25 with proof of compliance.

Contact: RICHARD B. RANCK, JR.
Salt Lake City
County Health Department
610 South 2nd East
Salt Lake City, Utah 84111
(801) 532-2002

SAN FRANCISCO, CALIFORNIA

Population: 675,000

Year Program Began: 1973

Department: City Police

Noise Staff: 4 (2 community noise officers permanently assigned to program; 2 motorcycle officers to man chase vehicle - rotational assignment)

Budget: $80,000 +

Fines: $106,000 (1975)

Citations: Approximately 2,200/Year

Ordinance: California Vehicle Code

Section 23130a: (All modes of operation - speed zones of 45 mph or less): Automobiles (GVWR < 8,500 lbs.): 76 dB at 50 feet (+2 dB tolerance allowed). Motorcycles: 82 dB at 50 feet (+2 dB tolerance allowed).

Section 27151: Modification of vehicle exhaust system to produce more noise than originally supplied components prohibited.

Section 27150a: Defective muffler prohibited.

Measurement Procedure: Initially, noise officer conducted meter reading at a distance as close to 50 feet from vehicle travel as possible. Chase officer was signaled when a violation was observed. Currently, single officer reads hand-held meter, chases violator, and issues citation. Citations are issued only for equipment violations or faulty exhaust systems; however, noise levels are noted on citation.

Compliance Procedure: Citation must be cleared through Police Department and requires officer sign-off. Officer uses his discretion to ascertain that vehicle has been properly repaired.

Compliance Test: None conducted

Fines: $25.50/citation. No fine if vehicle is repaired.

Comments: Officers will pull over and inspect a vehicle for modified or faulty exhaust system, even if they do not violate noise standards, if, in their opinion, it is excessively loud.

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Appendix B

LEGAL CONSIDERATIONS, ENFORCEMENT TIPS, AIDS TO SUCCESSFUL PROGRAM DEVELOPMENT

A. Notes on Legal Considerations

1. On the Legality of an Officer Citing a Motor Vehicle for Being "Excessively Loud":

The courts have ruled (Smith vs. Patterson, 131 Cal. App. 2d, 241, 247-250; 280 P 2d 522; 49 ALR 2d 1194, [1955]) that "the words 'excessive' and 'unusual' when viewed in the context in which they are used are sufficiently certain to inform persons of ordinary intelligence of the nature of the offense which is prohibited and are, therefore, sufficient to establish a standard of conduct which is ascertainable by persons familiar with the operation of automobiles. Consequently, these sections are held constitutional and not subject to the objection raised regarding uncertainty and lack of definiteness."

It is, therefore, a well-settled rule that well-trained enforcement officers may, without the assistance of scientific aids, reasonably determine when a muffler is inadequate and permits the engine to emit excessive or unusual noise.

B. Aids to Successful Program Development

The success of any vehicle noise control program is dependent upon the support of the citizens of the community. The goal of the program and the methods being used must be conveyed to the community to win support. Prior to and immediately after enacting an ordinance, some public awareness campaigns that have proven successful in other communities include the following:

1. With the enactment of a noise ordinance, the necessary hearings will usually generate media coverage. This will be an opportunity to explain the purpose, methods and goals of the program. Press releases, brochures and information bulletins should be made available, and will increase the accuracy of the media reports. These information pamphlets can also be referred to when giving radio and TV interviews. These same pamphlets can be placed in libraries, state inspection stations, and other public and private buildings.

2. Posting "Noise Ordinance Enforced" signs at entrances to the city is an effective way of informing residents and visitors that your community is enforcing a vehicle noise ordinance. The average cost is $50 to $60 per sign.

3. Prior to initiating an enforcement program, it is essential that all areas of local government understand and are made aware of all aspects of the program. This includes the Mayor or City Manager, judges and prosecuting attorneys, traffic violations bureaus and all other local departments that may be affected, such as purchasing departments. (New city/county equipment must comply with the various community and vehicle noise ordinance specifications.)

4. To acquaint the public with the program, the test equipment, the personnel doing the enforcement, and various noise levels, some communities have offered several free testing clinics. These clinics have been held at shopping centers, public parks and community centers. This exercise affords vehicle owners the opportunity to determine if their vehicles would pass the noise ordinance. The public awareness benefits and community support generated from these clinics justify consideration of periodic clinics after the program is initiated.

5. When on-the-street enforcement actually begins, a good approach is to issue only warning citations for the first 30 to 90 days. This affords on-the-job training and experience in noise techniques for police officers. It also affords city officials, community leaders and other interested citizens the opportunity to observe how the actual enforcement will be accomplished. Those vehicle owners issued warning citations are also given the opportunity to repair their vehicles before actual enforcement is initiated.

6. During the introduction of a vehicle noise control program and while conducting a public awareness program it should be emphasized that the program is designed to promote voluntary compliance through public education. However, the program can generate revenues to pay for some portion of the operating expenses.

Note: *Further inputs to this section, including a sample hand-out brochure, will be added at a later date.*

C. Practical Enforcement "Tips"

1. Some Guidelines Presently Used in Establishing Reasonable Cause for Subjective Judgement of Excessively Loud Vehicles:

Vehicle in Question:

a. Emitted a sound level obviously above the other (similar) vehicles in the line of traffic.

b. Caused my conversation (speech) with (communications) fellow officer to be interfered with.

c. Emitted the staccato note common to modified glass pack or high performance oriented or non-stock exhaust system.

Note: *Each case must be accompanied by a visual inspection of the exhaust system and notation (identification) of non-stock, performance or faulty components. This advances probable cause to issue citation.*

2. Notes on Visual Inspection of Vehicle Exhaust Systems:

On Issuing a Citation (Noise Providing Reasonable Cause):

a. The officer should inspect as much of the exhaust system as possible and note:

(1) Stock manifold/exhaust pipe configuration without defects (holes, cracks);

(2) Mufflers of stock configuration (reverse flow type with steel baffles);

(3) On a dual system, a cross-over or balance pipe;

(4) Tailpipes present and in apparently good condition.

On Vehicle Correction Sign-off or Compliance Testing:

a. Inspect the exhaust system for:

(1) Presence of new components (violator may provide receipt), particularly new stock type mufflers;

(2) Check against summons copy for any noted defects and observe that repair has been completed (i.e., removal of side pipes, etc.).

3. On Achieving "Voluntary" Compliance:

The city of Boulder, Colorado sends out warning letters to persons observed (by citizens) to have noisy or modified vehicles. The public is encouraged to report the license numbers of such vehicles to the noise control office.

Appendix C

RATIONALE FOR SELECTION OF RECOMMENDED ENFORCEMENT NOISE LIMITS

INTRODUCTION

A. Recommended Current Passby Noise Limits

1. Speed Zones Greater than 45 mph

   a. Light Vehicles
   b. Motorcycles

2. Speed Zones of 45 mph or Less

   a. Light Vehicles
   b. Motorcycles

3. In-City Operation, Level Roadway, Steady-state Cruise

   a. Light Vehicles
   b. Motorcycles

B. Recommended Current Stationary Test Noise Limits

1. Light Vehicles
2. Motorcycles

C. Considerations Regarding Lowering Passby Noise Limits in the Future

D. Considerations for More Restrictive Future Stationary Test Noise Limits

1. Light Vehicles
2. Motorcycles

INTRODUCTION

Recommended noise limits for motor vehicles have been derived through analysis of both "legal" and improperly modified or defective vehicle populations. These limits have generally been based on the upper five to ten percentile values (L^5 and L^{10}) of the cumulative distribution of noise levels emitted by a specific class of legal vehicles under a given mode of operation (where recommended limits encompass higher percentages is so noted). Recommended limits have not been based on the levels emitted by the loudest legal vehicles (upper 1 percentile or L^1) because a rather small portion of the vehicle fleet emits such high levels and lowest common denominator standards were not desired. Furthermore, the sample sizes at the higher levels were generally small and therefore limited confidence in the L^1 determinations. Also, as a practical matter, it is generally assumed that the traffic enforcement officer will subjectively screen each vehicle, thereby further reducing the probability of incorrectly citing a legal vehicle. The incorporation of a +2 dB measurement tolerance further reduces such possibilities.

Noise limits discussed in the following sections are A-weighted sound levels in decibels and measured at a reference distance of 50 feet (15 m) in the case of passby, and at a distance of 20" (.5 m) for stationary tests.

A. Recommended Current Passby Noise Limits

1. Speed Zones Greater Than 45 MPH (Freeway Operation):

a. Light Vehicles:

Allowable noise emission levels for freeway operation have been based on survey data of vehicles operating under cruise conditions at 55 mph (more correctly, at 55 mph posted speed limit). Studies by the San Diego CHP (Reference D-5) indicate that noise emissions by automobiles and motorcycles are not significantly influenced by 0 to 4% highway grade at these speeds. The more recent survey data of "legal" vehicles and new vehicle emissions data supplied by industry indicate that the NANCO-recommended high speed automobile limit of 78 dB is exceeded only by the upper 5 percentile of the samples studied. The application of a +2 dB tolerance should encompass all legal vehicles.

b. Motorcycles:

The high speed noise standard for motorcycles of 82 dB is greater than the one percentile of MIC's Ortega Highway Study (Reference D-8) adjusted to 55 mph, but with a +2 dB tolerance, falls between the upper five and one percentiles of the 1975 San Diego CHP observations (Reference D-5) and the 1975 McDonnell-Douglas data (Reference D-7).

2. Speed Zones of 45 MPH or Less (In-City Operation):

a. Light Vehicles:

The logic behind establishing maximum allowable noise limits for in-city operation has been to base these limits on the highest noise-producing normal mode of vehicle operation. This mode has been identified as "urban acceleration", wherein the vehicle accelerates at a rate sufficient to "keep up" with traffic. Such rates of acceleration approximate 1/4 g, or a vehicle traversing 100 feet from rest in approximately 5 seconds. (General Motors studies indicate that 80% of vehicles observed in traffic accelerate a 100-foot distance (when not impeded by other vehicles) in 4.8 seconds or

slower, with the average 0-100 foot rate being 5.6 seconds.)* The NANCO-recommended noise limit for automobiles of 72 dB falls between the upper 5% and 1% of new production General Motors light vehicles (Reference D-11), as well as between the upper 1% and 5% levels observed in the 1978 Illinois survey of non-defective automobiles (Reference D-1). The recent surveys by EPA Region V (Reference D-14) and the California Office of Noise Control (Reference D-13) also firmly support this selection (the L^1 of California Office of Noise Control urban acceleration observations was 70 dB).

Note: *The increasing trend toward smaller and more fuel-efficient vehicles indicates that the average urban acceleration noise levels for new vehicles may be on the increase. The smaller, more efficient automobiles utilize a greater portion of their available power in order to accelerate with traffic than do the traditional American "Full-size", highly powered vehicles.*

b. Motorcycles:

The NANCO-recommended in-city maximum noise limit for motorcycles of 78 dB is consistent with the upper 1% values for operations at or under 45 mph presented in the MIC-Ortega Highway Study (Reference D-8) and the 1975 Illinois study of motorcycles operating in the urban acceleration mode (L^1 of 79 dB) (Reference D-3). The 78 dB limit +2 dB tolerance also falls between upper 10% and 5% values of the 1975 McDonnell-Douglas data (Reference D-7), adjusted to reflect 45 mph cruise conditions.

3. In-City Operation, Level Roadway, Steady-state Cruise:

a. Light Vehicles:

The NANCO-recommended limit for automobiles of 70 dB assumes vehicle operation in the steady-state cruise mode at speeds of 35 mph or less. 70 dB falls between the upper 5% and 1%

*Gray, R.F.: "A Survey of Light Vehicle Operations" (Engineering Publication 6313), General Motors Proving Ground, Milford, MI 48042, July 1975.

levels of 1966 through 1979 vehicles equipped with new exhaust systems cruising at 35 mph (Reference D-12). California Office of Noise Control observations of vehicles operating under these specified conditions also indicate an upper 1% value of 70 dB (Reference D-13).

b. Motorcycles:

The recommended level roadway noise limit for motorcycles of 74 dB reflects the upper 5% values for the MIC-Ortega Highway data for operations under 45 mph (Reference D-8) if the +2 dB tolerance is applied. With this tolerance added, the NANCO value also agrees with the upper 10% levels for the McDonnell-Douglas 35 mph cruise data (Reference D-7). The data base for newer model motorcycles in this mode of operation is insufficient to provide positive rationale for the recommended limit; however, it is the opinion of NANCO members with considerable enforcement experience that this level is reasonable.

B. Recommended Current Stationary Test Noise Limits

1. Light Vehicles:

The NANCO-recommended limit for stationary noise test emissions of 95 dB is consistent with data supplied by Walker Manufacturing (Reference D-12) of the upper one percentile (L^1) of random 1966-1979 vehicles fitted with new exhaust systems. This value plus the 2 dB tolerance (97 dB) also approximates the upper 5% value (L^5) of a large sample of 1975 vehicles (N = 304) (Reference D-12), all equipped with new Walker exhaust systems, though not all necessarily "legal" systems (SAE J986 $\leq$ 90 dB). The median values (L^{50}) for these two populations were in the range of 86 dB.

A +2 dB adjustment for rear and mid-engine vehicles has been recommended based upon the State of Oregon's experience.

2. Motorcycles:

The NANCO current recommended limit of 99 dB (+2 dB tolerance) at 20" (.5 m) at 1/2 rated engine speed is within 1 dB of the upper five percentile (L^5) of large samples of in-service 1969-1974 "legal" (unmodified) motorcycles studied by McDonnell-Douglas (Reference 7) and the U.S. EPA (Reference D-15). The 99 dB test limit is 1 dB greater than the upper one percentile (L^1) of 1974-1975 model year motorcycles studied by EPA (Reference D-15) and

the MIC Technical Committee (Reference D-16) when equipped with aftermarket exhaust systems that maintained motorcycle noise emission levels (as determined by SAE J331 tests) to be no greater than +3 dB over OEM (stock) systems.

Also note that the recommended limit +2 dB (101 dB) will correctly identify over 50% of the improperly modified motorcycles in one study (EPA tests on aftermarket equipped motorcycles with SAE J331 levels in excess of 90 dB - Reference D-15) and approximately 28% of illegally modified machines in another study conducted by the MIC (Reference D-16).

It is assumed that these measurements, when combined with subjective screening by the enforcement officer, will negate the possibility of incorrectly citing "legal" vehicles.

C. Considerations Regarding Lowering Passby Limits in the Future

Evaluation of noise emission levels by current production new vehicles provides some insight as to the lowest enforcement levels that may potentially be utilized in the future, assuming sufficient time has elapsed to allow replacement of the existing fleet with vehicles representative of current production. It must be recognized, however, that some degree of deterioration will naturally occur with vehicle age, so that future regulatory limits may have to provide some additional allowance for this factor. The upper 10 percentile noise limits (L_{10}) exhibited by recent production vehicles (latest available data) under the various regulated modes of operation are summarized in the accompanying table.

It should be noted that these levels are representative of new, properly tuned vehicles, fitted with tire tread patterns designed to minimize tire-roadway interaction noise, all operating at factory performance specifications.

Upper 10 Percentile A-Weighted Sound Levels Emitted By
Selected Populations of Recent Production Vehicles

(Reference Distance is 50 Feet (15 m) From
Centerline of Vehicle Travel Lane)

Posted Speed Zone (Mode of Operation)	Automobiles, Vans, Light Trucks (GVWR < 10,000 lbs.)	On-Highway Motorcycles
Greater than 45 mph (55 mph Steady Cruise)	72 [a]	79 [d]
45 mph or Less (Urban Acceleration)	68 [b]	- [e]
35 mph or Less Level Roadway (35 mph Steady Cruise)	65 [c]	74 [f]

a. 1973 Model Year General Motors Vehicles - Reference D-11

b. 1979 Model Year General Motors Vehicles - Reference D-11

c. 1975-76 Model Year General Motors Vehicles - Reference D-11

d. 1975-76 Model Year Vehicles - EPA - Reference D-15

e. No Data

f. 1975-76 Model Year Vehicles - EPA - Reference D-15

D. Considerations For More Restrictive Future Stationary Test Noise Limits

1. Light Vehicles:

a. Reduced Single-Number Test Level:

The first consideration for future automobile stationary test limits is based on the assumption that recommended future limits could be based upon representative emission levels of current production vehicles with an effective date reflecting suitable passage of time to allow substantial replacement of the existing vehicle population with the quieter, new generation, light vehicles. Analysis of stationary test levels (at 3/4 rated engine speed) for 1975 to 1979 new production GM vehicles (Appendix D) indicate the upper one percentile values (L^1) to be in the range of 91 - 92 dB, with L^5 values ranging from 90 - 92 dB (median values (L^{50}) ranged from 80 - 85 dB). Hence, taking into account the recommended +2 dB tolerance, a future stationary test value of 90 dB would appear justifiable. In order to establish a suitable time frame for implementation of a lower test value, motor vehicle population and use statistics, as compiled by the MVMA,* were consulted. Presently, the average age of passenger cars in use (currently registered for on-road usage) is just over 6 years. Additionally, approximately 90% of the passenger car population is 12 years of age or less. Hence, if 90% infusion is taken as the prerequisite for dominance of quieter vehicles, then 12 years beyond the 1975 model year, or 1987, would seem a reasonable schedule if lower test limits were to be implemented.

b. Additional Concept For Future Stationary Regulatory Limits:

Both the GM and Walker Manufacturing data (Appendix D) indicate a very poor correlation between new vehicle certification test levels measured under wide open throttle acceleration (SAE J986) and stationary test noise emissions at 3/4 rated RPM. This fact does not diminish the ability of the stationary test to identify the worst-case offenders through a pass/fail screening procedure, but it does suggest that the use of such a procedure for detecting vehicles, say 3-6 dB (or greater) noisier

*MVMA Motor Vehicle Facts and Figures '79'", published by the Motor Vehicle Manufacturers Association, Detroit, Michigan.

than "stock", is severely restricted. One simply cannot impose a stationary limit low enough to identify a major portion of the "noisy" vehicles without incorrectly identifying a great many "legal" vehicles. Thus, we must question the logic behind establishing a lower (lower than 95 dB) single-number test limit that will risk incorrectly citing legal vehicles and thereby impair the credibility of the vehicle noise control effort.

An alternative to specifying a lower single stationary test limit value that may warrant further study would be a requirement for manufacturers to supply OEM stationary test values by specific model vehicle, with such data either catalogued or presented on a label attached to the vehicle (along with the correct engine test RPM). Enforcement could then follow two options:

(1) Base enforcement limits on OEM exhaust system stationary test levels +2 or +3 dB to allow for reasonable system degradation and afford aftermarket suppliers some reasonable flexibility. (It is conceivable that the EPA will require manufacturers to label new vehicles at some time in the future as to their noise output under stationary test data which would enhance such enforcement prospects.); or

(2) Develop a stationary equivalent test level (S_{eq}) as has been considered for possible implementation for future model motorcycles (see Appendix C, Section D.2.) It is not known at this time (by the NANCO Task Force) if changes in SAE J986 test levels for a specific model vehicle are linearly reflected in changes of the same order in stationary test levels (as is the case with motorcycles). Such a correlation is necessary if the S_{eq} method is to be pursued. Therefore, formulation of a regulatory concept based upon the S_{eq} methodology is dependent upon further inputs from the automotive industry.

A final comment is in order concerning the need for and/or the time frame for establishing stationary automobile noise emission limits below 95 dB. The present traffic noise situation is that heavy trucks typically produce the highest in-city noise levels, followed by motorcycles and then automobiles. The fundamental NANCO enforcement philosophy concerns correction of worst-case offenders first.

Therefore, once the "cream is removed from the top" of the noisy automobile population (via a 95 dB stationary test or other means), should not further attention to automobiles be deferred until more restrictive controls on motorcycles bring their noise emission levels down to those of cars?

2. Motorcycles:

a. Reduced Single-Number Test Level:

An analysis of stationary test emission levels for new 1975-76 and 1977 model year motorcycles (Reference D-15) indicate upper five percentile values (L^5) to be in the range of 95-96 dB (median values (L^{50}) range from 89-90 dB). If it is assumed that noise emission values of the composite motorcycle population will approach those of newer, quieter motorcycles after a suitable time period has elapsed over which substantial infusion of newer technology machines has occurred, then future regulation levels may be based upon those exhibited by current production. This approach is further justified if one considers the accompanying table in which various motorcycle usage factors as a function of age of vehicle are presented. In development of this table, the following factors have been incorporated in order to arrive at the estimated composition of the motorcycle fleet as a function of time.

- Annual penetration rate of new models is stable (conservative estimate - an increase in annual sales will result in accelerated fleet replacement).

- Percent of new registrations to total fleet: 17.2% (1977).*

*1978 Motorcycle Statistical Annual, published by Motorcycle Industry Council, Inc., Newport Beach, California.

Referring to the table, two key factors combine to rapidly replace the existing fleet with newer motorcycles; the average useful life of a motorcycle is between 5 and 6 years, and the fact that 2/3 of a motorcycle's total mileage is accumulated within the first 3 years. Thus, we may observe that the infusion process of current and newer motorcycles will be 90% complete within 5-6 years, while motorcycles 4-5 years and newer account for 90% of the annual on-road mileage. Therefore, if a single-number stationary test level representative of current production motorcycles (approximately 95 dB) were to be proposed, a suitable time frame for implementation would be some 5 years hence.

ASSESSMENT OF EFFECTIVE ON-HIGHWAY MILES
DRIVEN BY MOTORCYCLES AS A FUNCTION OF AGE

(1)	(2)	(3)	(4)	(5)	(6)
Motorcycle Age In Years	Operability Rate [a] (Probability Of Motorcycle Being In Operation)	MY Motorcycles As A Percent of Total Fleet [b]	Annual Miles Driven [a]	Effective On-Highway Mileage Contribution (2) X (4)	Percent of Annual Fleet Miles Driven
0-1	1.0	17.2 [c]	3400	3400	30
1-2	.98	16.9	2500	2450	21
2-3	.96	16.5	2000	1920	17
3-4	.90	15.5	1500	1350	12
4-5	.75	12.9	1000	750	7
5-6	.55	9.5	1000 [d]	550	5
6-7	.37	6.4	1000	370	3
7-8	.26	4.5	1000	260	2
8-9	.17	.6	1000	170	1
9-10	.10		1000	100	1
10-11	.05		1000	50	1/2
11+	.03		1000	30	1/2
		100%		11,400	100%

a. Re: 1978 Motorcycle Statistical Annual, published by Motorcycle Industry Council, Inc., Newport Beach, California.

b. Assumes total population is stagnant at 1977 level with new registrations = number scrapped.

c. 1977 New Registrations/Total/Motorcycles registered for street use in 1977 = 848,000/4,916,000 = 17.2%.

d. 1000 miles/year use carried forward.

b. Stationary Equivalent Sound Level (S_{eq}) Methodology:*

The use of a single stationary test limit as presented in a. above applied to all motorcycles has some severe shortcomings, the primary one being that such a test fails to correctly identify over 1/2 of the improperly modified motorcycles (those producing SAE J331 values in excess of 90 dB). To attempt to identify more noisy motorcycles by further lowering the test limits yields the unfortunate result that now one begins to identify "quiet" motorcycles (SAE J331 values of 86 dB and less) as being noisy. Such problems relate directly to the lack of high correlation between the stationary test noise levels (which essentially measure only exhaust noise from an engine operating in an unloaded condition) and measurement of passby noise emission levels as may be experienced in the community. As previously discussed, stationary tests incorporating a single limit value provide an excellent pass/fail screening procedure that will correctly identify worst-case violators; however, it leaves over 1/2 the noisy motorcycles in operation.

A method has been presented at a recent meeting of the Acoustical Society of America* which may, in the future, provide an improved stationary test method for correctly identifying a higher percentage of the noisy motorcycle population without jeopardizing the unmodified, legal machines. As proposed, this procedure for determination of the "Stationary Equivalent Sound Level (S_{eq})" would impose only a slight degree of increased complexity on local enforcement personnel, with most of the burden for specification of S_{eq} values on a model-by-model basis resting with the motorcycle manufacturers.

The S_{eq} concept incorporates the fact that, while correlation between stationary test levels (1/2 rated engine speed measured at 20") and new product certification test levels (SAE J331 or EPA F76b test procedures) is generally poor, on a model-by-model basis a high correlation exists (average of .892) between changes in SAE J331 levels and stationary test noise emissions. Hence, on a particular model motorcycle, changes in SAE J331 emission levels have been shown to be almost directly reflected in an equal amount in the stationary test noise levels.

*Walsh, J.B. and Marcus, W.E.: "Motorcycle Noise Control Through Use of a Stationary Sound Level Test". Presented at the 97th Meeting of the Acoustical Society of America, Boston, Massachusetts, June 13, 1979.

To establish S_{eq} compliance test values, the manufacturers would be required to provide, on a model-by-model basis, both the SAE J331 acceleration test values (A_{OEM}) along with the stationary test noise level for the stock configured motorcycle (S_{OEM}). (Such stationary data is presently supplied to the State of Florida.) The stationary equivalent level is then roughly the actual O.E.M. stationary test level + the difference in decibels that that particular model motorcycle is below the applicable legal limit (A_{REG}). (Actually, the proposed S_{eq} methodology uses .892 of this difference.) Expressed mathematically;

$$S_{eq} = S_{OEM} + 0.892 \times (A_{REG} - A_{OEM})$$

Application of such a concept would insure, for example, that a new motorcycle yielding 83 dB under SAE J331 conditions (current California standard) would never be allowed to produce a higher level than that. This concept further suggests that regardless of modification to the motorcycle, its noise emissions would be held to no greater than the applicable new product certification limit in effect at time of sale. (A much tighter control than a single-number stationary limit would ever afford.)

The S_{eq} concept presents a significant difference in the application of stationary limits for control of moving vehicle noise emissions than was previously recommended by the MIC and others; that of specifying O.E.M. stationary test values and regulating to those exact values. Such a policy was unnecessarily complex in its application due to the variability in noise emissions for various model motorcycles - though all may be produced under a given certification limit (say, SAE J331 < 83 dB). The S_{eq} approach would control aftersale noise levels in a consistent manner in that all of a given model year's production would be subsequently regulated at the same level.

Application of the S_{eq} approach would necessarily be on a nationwide basis with, say NANCO, acting as clearinghouse for industry-supplied S_{eq} data for each model year's production. Local enforcement then, would involve measurement of stationary sound level at 1/2 rated engine speed with both engine test speed and S_{eq} compliance levels as specified by the manufacturer. This data would be either catalogued or presented on labels permanently affixed to each new model motorcycle. Such an approach would also provide additional flexibility to aftermarket suppliers while still maintaining motorcycles at or below their original legal new product noise level.

Appendix D1 - Motorcycle Data

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

(A-Weighted Sound Level, Measured at 50 Feet (15.2 m)
From the Line of Travel)

Source of Data/ Mode of Operation	Reference Number	N Sample Size	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
ILLINOIS 1974/78 Data Motorcycles (Stock & Mod.) Acceleration from Stop	1,2	110			-	-	84	75.2	69.7
ILLINOIS 1974 Data Motorcycles Freeway Cruise [a]	2	57			-	87	86.1	78.8	75.2
ILLINOIS M/C Study, 6/75 Accel. 100' in 4.8 seconds 1970-1975 Model C/Cs [b] Non-defective	3	13	73.6	2.8	79	79	78	73	70
ILLINOIS 1974 Low Speed Acceleration & Cruise (Stock & Non-Stock)	2	134				83-86	80.4	72.2	
FLORIDA 1975 Motorcycles < 35 mph [c]	4	250	73.9	4.4	88.2	83.5	81.5	73.5	68
FLORIDA 1975 Motorcycles > 35 mph [c]	4	182	75.5	4.8	90	84.2	81.7	75.6	68
SAN DIEGO CHP Freeway - 1975 Data Legal Motorcycles [a]	5	70	78.4	3.4	86	83	82	78	74
CALIFORNIA CHP Speed Zones > 35 mph Stock & Modified M/Cs	5	302	-	-	90+	86.8	84.7	77	71.3
Derived from 1971 CHP Low Speed Acceleration Stock Vehicles [d]	6	76	-	-	82.5	81	80.3	76.5	73.5
Derived from 1971 CHP Low Speed Acceleration Non-stock Vehicles [d]	6	32	-	-	90.5	89.4	87.7	82	75.5

Appendix D1 - Motorcycle Data

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

(A-Weighted Sound Level, Measured at 50 Feet (15.2 m) From the Line of Travel)

Source of Data/ Mode of Operation	Reference Number	Sample Size = n	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
McDONNELL-DOUGLAS (1975 MIC Study) Cruise @ 35 mph [e]	7	195	71.6	4.2	81	78.2	76.7	71.5	66.2
McDONNELL-DOUGLAS (1975 MIC Study) Cruise @ 55 mph [e]	7	189	75.9	4.0	86	83	81.5	76.2	71
McDONNELL-DOUGLAS 45 mph cruise [(35 mph + 55 mph) ÷ 2] [f]	7				83.5	80.6	79.1	73.9	68.6
MIC - ORTEGA HIGHWAY Low Speed Cruise Stock (Adj. to < 35 mph) [g]	8	63	-	-	78.2	76.5	75.5	69.5	64
MIC - ORTEGA HIGHWAY Low Speed Cruise Non-Stock (Adj. to < 35 mph) [g]	8	28	-	-	82.5	80.5	79.5	74	68.2
MIC - ORTEGA HIGHWAY High Speed Cruise Stock (Corrected to 55 mph) [g]	8	51	-	-	78.5	77.5	77	71	67
MIC - ORTEGA HIGHWAY High Speed Cruise Non-Stock (Corrected to 55) [g]	8	23	-	-	83.5	83	81	76	70.5
MIC - ORTEGA HIGHWAY Stock Motorcycles < 45 mph [h] Acceleration, Cruise, Coast	8	48	70.1	3.2	77	76	75	69	66
MIC - ORTEGA HIGHWAY Modified Motorcycles ≤ 45 mph [h] Acceleration, Cruise, Coast	8	42	75.4	5.7	95	83	80	74	70
McDONNELL-DOUGLAS "Dig-Out"	7	100			88.5	86	84.5	80	75.5

Appendix D1 - Motorcycle Data

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

(A-Weighted Sound Level, Measured at 50 Feet (15.2 m) From the Line of Travel)

Source of Data/ Mode of Operation	Reference Number	N Sample Size	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
EPA BACKGROUND DOCUMENT 35 mph Cruise 1975-76 Model Year New Motorcycles	15 (Table C-5)	13	70.8	3.4	79	79	74	70	68
EPA BACKGROUND DOCUMENT 55 mph Cruise 1975-76 Model Year New Motorcycles	15 (Table C-5)	29	75.9	2.9	84	81	79	76	72

Appendix D1 - Motorcycle Stationary Test Data at 20"

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

[A-Weighted Sound Level, Measured at 20" (.5m)]

Source of Data/ Mode of Operation	Reference Number	Sample Size N	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
McDONNELL-DOUGLAS - MIC 1975 Data - ISO Tests .5 Rated RPM @ 20" SAE J331a ≤ 90 dBA	7	192	92.1	4.3	104	100	98	92	87
EPA PROPOSED M/C NOISE EMISSION REGULATIONS BACKGROUND DOCUMENT 1977 Model Year New Vehicles .5 Rated RPM @ 20" (F50) SAE J331a ≤ 85 dBA	15 (App.H Table A)	26	89.6	3.7	97	96	95	90	84
EPA BACKGROUND DOCUMENT 1975-76 Model Year New Motorcycles .5 Rated RPM @ 20" (F50)	15 (Table C-5)	111	88.9	4.0	99	95	94	89	84
EPA M/C BACKGROUND DOCUMENT 1969-1976 Model Year In-Service Modified Motorcycles (F50) SAE J331a > 90 dBA	15 (Table C-7)	11	102.8	3.9	112	112	106	103	99
EPA M/C BACKGROUND DOCUMENT 1974-75 Model Year M/Cs Equipped with Aftermarket Exhaust Systems SAE J331a ≥ 90 dBA	15 (Table C-10)	22	101.1	4.4	108	107	107	100	97
AS ABOVE; But SAE J331a < 90 dBA	15 (Table C-10)	62	95.2	3.7	102	101	100	95	90
AS ABOVE; But SAE J331a ≤ OEM	15 (Table C-10)	16	93.1	3.7	98	98	98	93	89
AS ABOVE; But SAE J331a ≤ OEM +3 dB	15 (Table C-10)	38	93.8	3.1	98	98	98	94	89

Appendix D1 - Motorcycle Stationary Test Data at 20"

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

[A-Weighted Sound Level, Measured @ 20" (.5m)]

Source of Data/ Mode of Operation	Reference Number	Sample Size N	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
MIC TN 76-013 Equipped with Aftermarket Exhaust Systems SAE J331a ≥ 90 dBA	16	14	103.1	4.8	112	112	108	104	100
MIC TN 76-013 As Above; But SAE J331a < 90 dBA	16	31	96.2	3.5	104	102	101	96	92
MIC TN 76-013 As Above; But SAE J331a ≤ OEM* +3 dB	16	19	94.4	2.8	98	98	98	94	90
EPA M/C BACKGROUND DOCUMENT 1969-1974 In-Service Stock Motorcycles SAE J331a ≤ 90 dBA	15 (Table C-6)	277	91.8	4.6	104	100	98	91	87

Note: Sample Includes MIC Reference Data - Reference 7 .5 Rated RPM @ 20"

*OEM < 90 dBA Only

Appendix D1 - Motorcycle Data

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

(A-Weighted Sound Level, Measured at 50 Feet (15.2m)
From the Line of Travel)

Notes

a. 55 mph speed limit.

b. 750 cc maximum displacement - no Harley-Davidsons included in sample.

c. Includes stock and modified vehicles.

d. Population adjusted by removal of noisier vehicles in order to reflect current population - analysis by John Walsh, U.S. Suzuki.

e. Unmodified motorcycles - some noisy police motorcycles included in sample.

f. Derivation of 45 mph cruise levels by Jack Swing, California Office of Noise Control.

g. Adjustments to data by John Walsh, U.S. Suzuki.

h. Data analysis by Jack Swing, California Office of Noise Control.

Appendix D2 - Automobile and Light Truck Data

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

(A-Weighted Sound Level, Measured at 50 Feet (15.2m) From the Line of Travel)

Source of Data/ Mode of Operation	Reference Number	Sample Size	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
WASHINGTON Automobiles Freeway Operations Rene Foss - Washington State (12/71 - 4/72) Level and .3% Grade	9	878			86.5	83.7	82.7	79.5	76.5
ILLINOIS 1978 Survey Non-defective Automobiles Acceleration from Stop	1	2,486			73.5	69.7	67.6	63.4	60
ILLINOIS 1978 Data Defective Automobiles Acceleration from Stop	1	122	-	-	-	-	-	75.7	70.4
ILLINOIS 1974 Survey Light Trucks Freeway Cruise	2	841			84.1	82.2	81.1	76.1	72.5
ILLINOIS 1974 Survey Automobiles Freeway Cruise [e]	2	3,086			79	76.2	75.1	72.3	70
ILLINOIS Combines 1974 and 1978 Surveys Light Trucks Acceleration from Stop	1,2	633			74	71.2	70.5	66	-
FLORIDA 1975 Data Automobiles, Vans, Pickups Posted Speed < 35 mph	4	7,867	66.8	3.1	78.5	76	74	69	63.5
FLORIDA 1975 Data Automobiles, Vans, Pickups Posted Speed > 35 mph	4	10,126	69.3	3.2	80.5	77.5	76	71	66.5
MARYLAND 1973 (BBN) Study Freeway Automobiles	10	654	-	-	86	82	81	78	75.5

Appendix D2 - Automobile and Light Truck Data

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

(A-Weighted Sound Level, Measured at 50 Feet (15.2m) From the Line of Travel)

Source of Data/ Mode of Operation	Reference Number	Sample Size N	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
URBAN ACCELERATION 1973 Model Year GM [a] Light Vehicles	11	19	66.7	3.5	74	74	74	66	63
70 MPH CRUISE 1973 Model Year GM [a] Light Vehicles	11	19	74.8	1.6	79	79	77	75	73
URBAN ACCELERATION 1975-76 Model Year GM [a] Light Vehicles	11	44	64.3	4.0	73	72	71	63	60
URBAN ACCELERATION 1978 Model Year Gm [a] Light Trucks (SAE J986b < 79 dBA)	11	24	66.5	3.3	71	71	70	66	63
URBAN ACCELERATION 1979 Model Year GM [a] Light Vehicles	11	72	64.0	3.0	74	69	68	63	61
WALKER MANUFACTURING Random Vehicles (1966-79) (Equipped with New Exhaust Systems) [b] 35 mph Cruise	12	64	65	2.6	74	69	68	65	62
WALKER MANUFACTURING Random Vehicles (1966-79 (Equipped with New Exhaust Systems) [b] 55 mph Cruise	12	64	72.6	3.1	83	77	76	72	69
CALIFORNIA OFFICE OF NOISE CONTROL SS Cruise < 35 mph [c] (1/4/79)	13	122	61.7	2.9	70	67	65	61	58

Appendix D2 - Automobile and Light Truck Data

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

(A-Weighted Sound Level, Measured at 50 Feet (15.2m) From the Line of Travel)

Source of Data/ Mode of Operation	Reference Number	N Sample Size	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
CALIFORNIA OFFICE OF NOISE CONTROL Acceleration Uphill [d] (Hearst & LeConte, 3/79)	13	126	69.4	2.5	77	74	72	69	67
CALIFORNIA OFFICE OF NOISE CONTROL Urban Acceleration Level Roadway,[c] 3/79	13	42	65.3	2.2	70	69	68	65	63
SAN DIEGO CHP [e] 1975 Freeway Level - Legal Autos [f]	5	116	73.2	1.0[g]	76	75	74	73	72
SAN DIEGO CHP 1975 Freeway [e] 1% Grade - Legal Autos [f]	5	485			76	75	75	73	72
SAN DIEGO CHP [e] 1975 Freeway 2% Grade - Legal Autos [f]	5	210	72.0	1.5[g]	75	74	74	72	70
SAN DIEGO CHP 1975 Freeway [e] 3% Grade - Legal Autos [f]	5	424	72.6	1.5[g]	76	75	74	73	71
SAN DIEGO CHP [e] 1975 Freeway 4% Grade - Legal Autos [f]	5								
U.S. EPA - V - 10/78 [h] 6 & 8 Cylinder Autos Acceleration from Stop [i]	14	5,635	63.1	3.2	71.5	69.5	68	64	60
U.S. EPA - V - 10/78 [h] Vans, Pickups, Utility	14	837	65.3	3.8	76	72.7	71.2	66.2	61.5

Appendix D2 - Automobile and Light Truck Data

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

(A-Weighted Sound Level, Measured at 50 Feet (15.2m) From the Line of Travel)

Source of Data/ Mode of Operation	Reference Number	Sample Size N	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
U.S. EPA - V - 10/78 4 Cylinder Autos, Sports [h]	14	1,025	64.8	4.0	74.5	72.2	71	65.5	60.7
U.S. EPA - V - 10/78 Modified & Defective Vehicles[i] Acceleration from Stop	14	810	71.4	5.1	84	80.7	79	72.5	66
35 mph Cruise 1975-76 Model Year GM [a] Light Vehicles	11	44	62.7	1.5	66	66	65	62	61
40 mph Cruise 1973 Model Year GM [a] Light Vehicles	11	19	66.3	1.3	70	70	67	66	65
55 mph Cruise 1973 Model Year GM [a] Light Vehicles	11	19	70.9	1.5	75	75	72	71	69

Appendix D2 - Automobile Stationary Data @ 20"

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

[A-Weighted Sound Level, Measured at 20" (.5m)]

Source of Data/ Mode of Operation	Reference Number	N Sample Size	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
1978 Model Year GM Light Trucks [a] 3/4 Rated RPM @ 20"	11	21	86.2	3.0	92	90	90	85	82
1979 Model Year GM Light Vehicles [a] 3/4 Rated RPM @ 20"	11	60	82.8	4.3	92	92	89	82	78
1977 Model Year GM Light Vehicles [a] 3000 RPM @ 20"	11	176	81.2	3.6	91	90	88	80	78
1977 Model Year GM Light Vehicles [a] 3/4 Rated RPM @ 20"	11	176	79.5	3.3	88	86	84	79	76
1976 Model Year GM Light Vehicles [a] 3/4 Rated RPM @ 20"	11	24	79.5	3.5	85	84	84	79	76
1975 Model Year GM Light Vehicles [a] 3/4 Rated RPM @ 20"	11	26	83.9	3.6	92	90	90	83	80
WALKER MANUFACTURING DATA 1966-1979 Model Year Vehicles Equipped with New Exhaust Systems (Not Necessarily "Legal") 3/4 Rated RPM @ 20"	12	46	85.8	4.0	95	93	91	86	80
WALKER MANUFACTURING DATA 1975 Passenger Cars and Light Vehicles SAE J986a < 90 dBA 3/4 Rated RPM @ 20"	12	304			106.5	97.5	95	86.5	81.5

Appendix D2 - Automobile Stationary Data @ 20"

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

[A-Weighted Sound Level, Measured at 20" (.5m)]

Source of Data/ Mode of Operation	Reference Number	N Sample Size	Population Statistics						
			$\bar{X}$	σ	L^1	L^5	L^{10}	L^{50}	L^{90}
STATE OF OREGON - DEQ 1975 Survey Stock - Front Engine	17	819	91.6	3.6	102	97	96	91	87
STATE OF OREGON - DEQ 1975 Survey Modified - Front Engine	17	138	100.5	5.3	114	110	108	101	94
STATE OF OREGON - DEQ 1975 Survey Stock - Rear Engine	17	80	95.9	2.7	103	101	100	96	92
STATE OF OREGON - DEQ 1975 Survey Modified - Rear Engine	17	22	101	3.6	107	107	105	101	97
STATE OF OREGON - DEQ 1977-78 Survey Front Engine (Stock and Modified)	17	7,684	92.9	7.2	114	107	103	92	85
STATE OF OREGON - DEQ 1977-78 Survey Rear Engine (Stock and Modified)	17	414	96.3	4.7	110	105	102	95	92

Appendix D2 - Automobile and Light Truck Data

SUMMARY OF VEHICLE NOISE EMISSION LEVELS

(A-Weighted Sound Level, Measured at 50 Feet (15.2 m)
From the Line of Travel)

Notes

a. New vehicles

b. Vehicles equipped with new exhaust systems; however, not necessarily "Legal" systems.

c. "Legal" exhaust systems only.

d. Some "Sporty" exhaust systems included.

e. 55 mph speed limit.

f. Only vehicles judged "Legal" (in officers' opinion) included in survey.

g. Note: The low σ's indicate the CHP officers were very selective in which vehicles they included in this survey.

h. Measured at 12.5 feet. -11 dB correction to 50 feet incorporated.

i. Judged "Legal" vehicles.

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Vehicle Noise Emissions Data Sources

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2. Nechvatal, Michael and Hellweg, Robert: "1974 Illinois Motor Vehicle Noise Survey". Illinois EPA, November 1974. Presented at the 88th ASA Meeting, St. Louis, Missouri.

3. "Motorcycle Noise Levels - A Report on Field Tests". Illinois Task Force on Noise, June 1975.

4. Yost, William A.: "Noise Levels from 20,000 Motor Vehicles". Parmly Hearing Institute, Loyola University, Chicago, Illinois, 1976. Prepared for the Florida Department of Environmental Regulation.

5. California Highway Patrol: Unpublished vehicle noise emissions data - operation on San Diego County Freeways - 1975.

6. "Noise Survey of Vehicles Operating on California Highways". California Highway Patrol, July 1971.

7. Hornet, H. and Williamson, I.M.: "Evaluation of Stationary and Moving Motorcycle Noise Test Methods for Use in Proposed Regulations". McDonnell-Douglas A3-13E-469, December 1975. Prepared for the Motorcycle Industry Council, Inc.

8. "Study of Street Traffic Noise Contributions in Southern California". Motorcycle Industry Council, Inc. TN 78-001, January 1978.

9. Foss, Rene N.: "Vehicle Noise Study - Final Report". Prepared for Washington State Highway Commission, Department of Highways, June 30, 1975.

10. "Noise Pollution Legislation Study - Background Report". Bolt, Beranek and Newman, Inc. Report No. 2553, May 1973. Prepared for Maryland Department of Transportation.

11. General Motors Corporation: Unpublished data, 1979. Presented to NANCO, January 1979.

12. Walker Manufacturing Corporation: Unpublished data, 1979. Presented to NANCO, January 1979.

13. California Office of Noise Control: Unpublished light vehicle noise emissions data - operation on city streets - January and March, 1979.

14. Hruska, G. and Williams, Kent, U.S. EPA Region V: Unpublished light motor vehicle measurements, 1978.

15. Proposed Motorcycle Noise Emission Regulations, Background Document - Appendix. U.S. Environmental Protection Agency, Washington, D.C. (EPA 550/9-77-203), November 1977.

16. MIC Sound Committee Task Force Report - "Exhaust System Certification Program Test Results". Costa Mesa, California, March 1976. (MIC/TN 76-013).

17. State of Oregon, Department of Environmental Quality: 1975 and 1977-78 Vehicle Inspection Stationary Test Data.

Appendix E

EPA INTERSTATE MOTOR CARRIER REGULATIONS (IN-USE NOISE EMISSION STANDARDS FOR HEAVY TRUCKS)

ENVIRONMENTAL PROTECTION AGENCY
MOTOR CARRIERS ENGAGED IN INTERSTATE COMMERCE

Title 40, Code of Federal Regulations
Chapter 1, Part 202 (40 CFR Part 202)

Applicability: All motor vehicles with a GVWR over 4536 Kg (10,000 lbs.) engaged in interstate commerce. (Applies to both intrastate and interstate operations of interstate motor carriers. Does not apply to wholly intrastate operations of intrastate motor carriers.)

Effective Date: October 15, 1975.

Vehicle Pass-by Standards: Measured levels shall not exceed the following limits at a distance of 15.2 m (50 feet) from the center-line of the path of travel, on an open site, when measured with a sound level meter using "Fast" meter response.

At speeds of 56.3 km/h (35 mph) or less: 86 dB(A)

At speeds in excess of 56.3 kmph (35 mph: 90 dB(A)

Stationary Run-up Test Standard: Noise levels, measured at 15.2 m (50 feet) from the vehicle shall not exceed 88 dB(A) (Fast) when the vehicle, with the transmission in neutral, is revved from idle to wide-open throttle. (Applies to vehicles with an engine governor only.)

Visual Exhaust System Inspection: Motor vehicles are prohibited from operation:

1. Unless equipped with an exhaust system free from defects which may affect sound reduction;

2. unless equipped with a sound dissipative device;

3. if equipped with cut-out, bypass or similar device.

Visual Tire Inspection: Motor vehicles are prohibited from operation if equipped with tires (original manufacturer or retread) having a tread pattern composed primarily of cavities that are not vented to the shoulder of the tire (pocked treads) unless such tires have been shown to comply with the performance standard.

DEPARTMENT OF TRANSPORTATION - BUREAU OF MOTOR CARRIER SAFETY REGULATIONS
FOR ENFORCEMENT OF MOTOR CARRIER NOISE EMISSION STANDARDS.

Title 49, Code of Federal Regulations
Chapter II, Part 325 (49 CFR Part 325)

Applicability: BMCS enforcement of 40 CFR Part 202.

Effective Date: October 15, 1975.

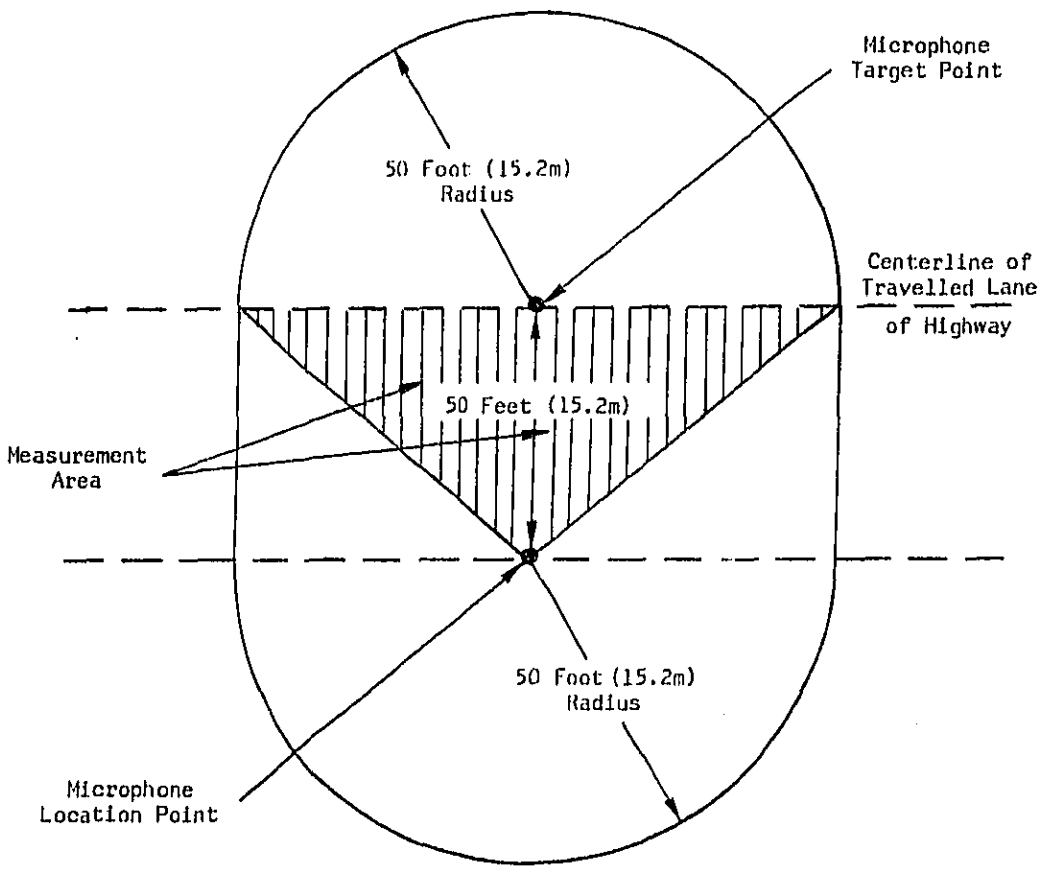
Noise Emission Standards: MAXIMUM PERMISSIBLE SOUND LEVEL READINGS (dB(A) - "Fast")

Distance Between Microphone Location and Target Point	Highway Operations Test				Stationary Test	
	Soft Site*		Hard Site**		Soft Site*	Hard Site**
	56.3 km/h (35 mph) or Less	Above 56.3 km/h (35 mph)	56.3 km/h (35 mph) or Less	Above 56.3 km/h (35 mph)		
10.7m (35 feet) or more but less than 11.9m (39 feet)	89	93	91	95	89	91
11.9m (39 feet) or more but less than 13.1m (43 feet)	88	92	90	94	88	90
13.1m (43 feet) or more but less than 14.6m (48 feet)	87	91	89	93	87	89
14.6m (48 feet) or more but less than 17.1m (58 feet)	86	90	88	92	86	88
17.1m (58 feet) or more but less than 21.3m (70 feet)	85	89	87	91	85	87
21.3m (70 feet) or more but less than 25.3m (83 feet)	84	88	86	90	84	86

*Soft Site: Having ground surface covered with grass or similar ground cover for more than 1/2 the distance between source and microphone.

**Hard Site: Ground surface covered with concrete, asphalt, packed dirt, gravel or similar ground cover for more than 1/2 the distance between source and microphone.

Test Site: Test site should conform to dimensions indicated in the figure below:



STANDARD TEST SITE:
HIGHWAY OPERATIONS

Site must be an "Open Site", clear of reflecting objects. (Provisions are included for other test site dimensions.)

Instrumentation: Sound Level Meter: Response tolerance consistent with either a Type 1 or Type 2 meter as specified in Section 3.2 of ANSI S1.4-1971. A windscreen shall be used during all measurements.

Measurement Procedure:

Microphone Height: .6 m (2 feet) to 1.8 m (6 feet) above ground surface. 1.2 m (4 feet) preferred.

Wind: Velocity not to exceed 19.3 km/h (12 mi/h), gusts to 33.2 km/h (20 mi/h) allowed.

Precipitation: No measurements allowed under any conditions of precipitation. Travel lane must be dry.

Ambient Noise: Ambient noise levels must be 10 dB(A) or more below the standard test level.

Influence of Other Vehicles: The sound level of the vehicle being measured must be observed to rise at least 6 dB(A) before the maximum sound level occurs and to fall at least 6 dB(A) after the maximum level has occurred.

Measurement Tolerances: Shall not exceed 2 dB for a given measurement (instrumentation, topography, atmospheric conditions, reflections).

Appendix F

MEASUREMENT DISTANCE CORRECTIONS AND ADJUSTMENTS
FOR SOUND REFLECTING SURFACES

A. Measurement Distance Corrections

The NANCO-recommended vehicle noise enforcement limits have been specified at a measurement distance of 50 feet (15 m) from the centerline of the vehicle path of travel to the microphone. The vehicle noise emission survey data presented in Appendix D has also been corrected to the standard 50-foot distance. However, for actual enforcement, measurement at 50 feet is not always practical or feasible. In many programs, measurement at 25 feet (7.5 m) is preferred. Therefore, the following decibel adjustments to those limits specified at 50 feet are recommended. (Reference: California Vehicle Code.)

Distance from Microphone to Center of Lane of Travel*	Sound Level Correction Factor, dB Add to Enforcement Level
21 feet (6.4m) or more but less than 29 feet (8.8m)	+ 7
29 feet (8.8m) or more but less than 32 feet (9.8m)	+ 6
32 feet (9.8m) or more but less than 35 feet (10.7m)	+ 5
35 feet (10.7m) or more but less than 39 feet (11.9m)	+ 3
39 feet (11.9m) or more but less than 43 feet (13.1m)	+ 2
43 feet (13.1m) or more but less than 48 feet (14.6m)	+ 1
48 feet (14.6m) or more but less than 58 feet (17.1m)	0
58 feet (17.1m) or more but less than 70 feet (21.3m)	- 1
70 feet (21.3m) or more but less than 83 feet (25.3m)	- 2
83 feet (25.3m) or more but less than 99 feet (30.2m)	- 3
99 feet (30.2m) or more but less than 118 feet (36m)	- 4

*Measurements closer than 21 feet or further than 100 feet are not recommended.

B. Corrections from Sound-Reflecting Surfaces*

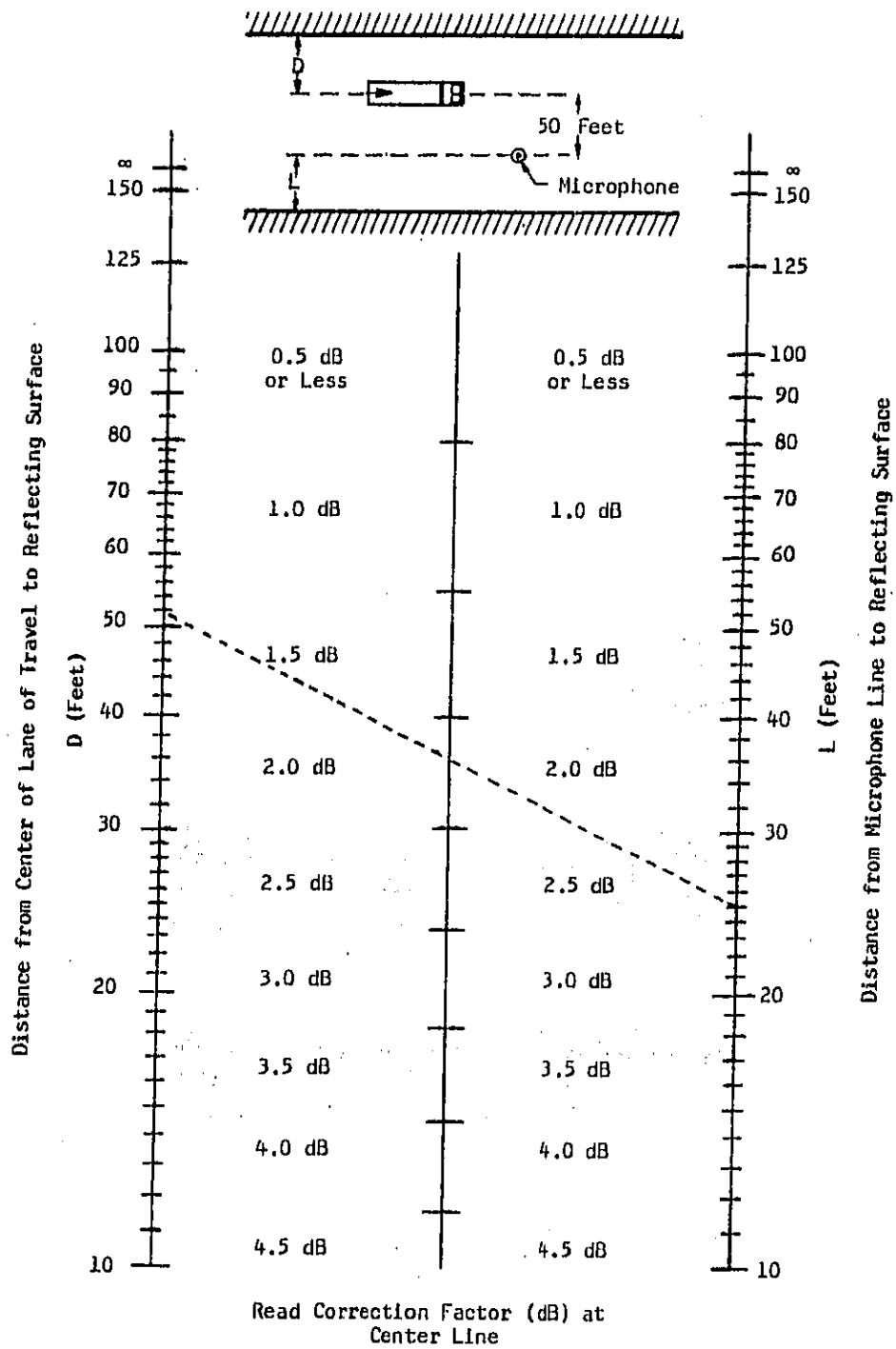
The distances between the microphone line and its nearest sound-reflecting surface and between the centerline of the lane of travel and its nearest sound-reflecting surface shall be measured. These distances shall be located on the nomogram on their respective axes, and the two marks shall be connected by a straight line. The point on the central axis that is intersected by the straight line indicates the dB correction factor that shall be applied to the sound level reading obtained from each vehicle passing through the site. (The dotted line in the nomogram illustrates a -2 dB correction for sound-reflecting surfaces at 52 feet from the center of the lane of travel and 25 feet from the microphone line.)

1. The correction factors determined by the nomogram shall be used only for sound-reflecting surfaces that are parallel to the lane of travel.

2. Basically parallel surfaces may have irregularities or projections of not more than 2 feet, measured perpendicular to the lane of travel, with the distances illustrated on the nomogram measured from the nearest projecting surfaces.

3. Sound-reflecting surfaces not basically parallel to the lane of travel shall be 100 feet or more from the microphone and microphone point. This restriction does not apply to surfaces that are perpendicular to the lane of travel and behind the parallel surface for which corrections are made, such as a fence or the side walls of a building.

*California Vehicle Code


D
50 Feet
L
Microphone
Distance from Center of Lane of Travel to Reflecting Surface
D (Feet)
∞
150
125
100
90
80
70
60
50
40
30
20
10
0.5 dB or Less
1.0 dB
1.5 dB
2.0 dB
2.5 dB
3.0 dB
3.5 dB
4.0 dB
4.5 dB
Read Correction Factor (dB) at Center Line
L (Feet)
Distance from Microphone Line to Reflecting Surface

Appendix G

RECOMMENDED STATIONARY FIELD NOISE TEST PROCEDURES

A stationary field noise emission test should be considered a pass/fail screening procedure and should incorporate rather liberal tolerances. A stationary, constant RPM test measures primarily exhaust noise (although more engine noise is reflected in motorcycle tests than in the case of automobiles); hence, the correlation to actual on-road noise emission levels is poor. As a result, the procedures described in this section and the recommended limits presented in Section II have been designed to pass "legal" vehicles and reject or fail those with faulty or improperly modified exhaust systems subjectively judged as being "obviously noisy".

G.1 Stationary Field Noise Test Procedure for Automobiles and Light Trucks

The following procedures are based upon recommendations by the Society of Automotive Engineers (SAE 1169) and are intended as general guidelines for the conduct of stationary tests of vehicle noise emission in the field.

- Engine test speed for vehicles with a maximum rated net horsepower engine speed (maximum rated speed) of 4500 RPM or less shall be 3000 RPM. For vehicles whose maximum rated speed is in excess of 4500 RPM, test at 3/4 the maximum rated speed.*

- Measurement shall be made at a distance of 20" (.5 m) from the exhaust exit along a line 45° to the exhaust axis at a height above the ground equal to that of the exhaust outlet.

*The incorporation of the 3/4 rated RPM recommendation for vehicles with a maximum rated speed over 4500 RPM has been suggested in order to more adequately reflect the noise output of imported high performance sports cars (which, incidently, are quite often modified to achieve higher performance).

- Engine test speed shall be determined by a tachometer attached to the vehicle (± 5% accuracy).

- Sound level meters shall comply with (meet or exceed) ANSI Type 2 specifications.

- Test area shall be free of reflecting objects within a 10-foot radius of the measurement position.

- The reported reading shall be the A-weighted sound level measured on "Slow" meter response (taken on the highest side, in the case of dual exhausts).

G.2 Motorcycle Stationary Field Noise Test Procedure

The field test procedure that follows is based upon a proposal by the Motorcycle Industry Council (MIC E-79) and produces fundamentally identical results to those recommended by the U.S. EPA (F50 test) and the ISO (DIS 5130) in that the test is conducted at an engine speed of one-half the maximum rated engine speed. This test condition was selected in order to maintain consistency with recognized standard test methods and is supported by the majority of available motorcycle stationary test data. An alternate engine test speed of one-half of red line was also considered in that its use does not require any catalog look-ups of correct engine test speed and the results of such tests agree on the average with tests at one-half rated speed within ± 1 dB.*

In conducting the test, it is necessary to attach an engine tachometer (± 5% accuracy) to the test vehicle. The reported sound level reading is the A-weighted level measured on "Slow" meter response at a distance of 20" (.5 m) from the exhaust exit on a line 45° to the central axis of the motorcycle. The microphone height should be in a line parallel to the ground from the exhaust exit.

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*Harrison, R., Hagle, R., and Walsh, J.: "One-Half Meter Stationary Motorcycle Noise Test: A Sensitivity Study". Presented at INTER-NOISE '78, San Francisco, California, May 1978.

A +2 dB tolerance is recommended to account for instrument accuracy (ANSI Type 2 assumed), atmospheric, site-to-site variations, and the variables in the following parameters which have been shown, experimentally (re: Harrison, et al.*), to yield errors up to 1.5 dB in stationary motorcycle test results.

Parameter	Approximate Error to Produce 1.5 dB	Recommended By MIC
Distance	-4 to +2 inches	± 1.0 inches
Microphone Elevation	-4 to +2 inches	± 1.0 inches
Azimuth	± 34°	± 10°
RPM	± 5%	± 2½% (Tach Spec)

It is estimated that such a procedure will correctly identify (or fail) from 30% to 50% of the improperly modified motorcycles in current operation (SAE J331 test levels > 90 dB at 50 feet). (An improved concept, the "Stationary Equivalent Sound Level (S_{eq})", which may potentially correctly identify 69% to 85% of improperly modified motorcycles - with some additional record-keeping complexity, is presented in Appendix C.)

*Harrison, R., Hagie, R., and Walsh, J.: "One-Half Meter Stationary Motorcycle Noise Test: A Sensitivity Study". Presented at INTER-NOISE '78, San Francisco, California, May 1978.