ILLINOIS POLLUTION CONTROL BOARD
May 26, 1977

IN THE MATTER OF MOTOR VEHICLE NOISE REGULATIONS	)	R74-10

OPINION OF THE BOARD (by Mr. Dumelle):

A proposed motor vehicle noise regulation was submitted to the Board on September 16, 1974 by the Illinois Environmental Protection Agency and the Task Force on Noise. The proposed regulation and supporting material was contained in a document entitled "Control Of Noise from Motor Vehicles - Report of the Task Force on Noise" (IIEQ 74-42), Exhibit 2 in this proceeding, prepared under contract to the Illinois Institute for Environmental Quality (Institute) by the Task Force on Noise. The Board was requested to hold public hearings for consideration of the proposal. The proposed regulation, designated R74-10, was published in Board Newsletter #92.

Public hearings were held in the following locations:

December 10, 1974	Chicago
December 11, 1974	Chicago
December 13, 1974	Peoria
June 10, 1975	Chicago

Testimony and exhibits were received from citizens, government representatives, industries, and trade associations. The proponent of the proposal was the Noise Task Force, a group of experts in the fields of law, engineering, acoustics, and economics established in 1971 under the sponsorship of the Institute. Exhibits 1, 3, 6, 8, 9, 10, 11, and 21 are the resumes of those who participated in the development of the Task Force motor vehicle noise proposal.

The Board acknowledges with appreciation the excellent work of Donna O. Farley, Technical Assistant to the Board, in this proceeding. The legal assistance of Earon S. Davis is appreciated.

The record in this matter, through the comment period following the fourth hearing, consists of 745 pages of testimony and 43 exhibits from the hearings plus written comments submitted directly to the Board. Upon consideration of all of this record, in accordance with Section 27 of the Act, the Board published a proposed regulation in Environmental Register #109.

Subsequently, in accordance with Section 6 of the Act, as amended by P.A. 79-790, the Task Force prepared for the Institute an economic impact study to measure the costs and benefits of the proposed regulation. The Institute submitted the report to the Board on July 16, 1976. The report is listed as Exhibit R74-10-44 in the record.

Hearings were held by the Board to receive comments on the economic impact study at the following locations:

September 14, 1976	Chicago
September 28, 1976	Peoria

These hearings on the economic impact study added to the record another 261 pages of testimony, 9 more exhibits and additional written comments submitted to the Board during that time. At the request of the Illinois Motor Vehicle Laws Commission, the Board held an additional economic impact study hearing on December 20, 1976 in Chicago and additional materials were obtained. The Board carefully reviewed the economic impact study as part of the record, as well as testimony, exhibits, and comments submitted relative to the study or in response to its findings. Based on consideration of the entire record pursuant to Section 27 of the Act, the Board adopts the Motor Vehicle Noise Regulations.

Need for Motor Vehicle Noise Regulations

The need for these regulations can be evaluated following the consideration of two items: 1) the effect of motor vehicle noise on people and 2) the number of people impacted by motor vehicle noise.

The effect of noise on people has already been covered in the Board's consideration of the Property Line Source Noise Regulations, and the Opinion of the Board in that matter has been made a part of the record in this proceeding (Exhibit 5 pp 12-19). To a certain extent the effects of noise from motor vehicles is similar to that from other noise sources, in that it affects speech communication, sleep, performance and behavior, annoyance, and hearing.

The effect of motor vehicle noise on people is discussed in detail in Part V of the Task Force report, identified previously and designated Exhibit 2 in this proceeding, and the accompanying 24 documents referred to in Part V which are contained in a public comment submitted to the Board by the Task Force (Comment 19). The characteristics of sound (noise) and the use of decibels (dB) as a unit of sound level have been discussed previously by the Board in Exhibit 5 and will not be repeated. It is sufficient to know that the unit of sound used in this regulation is the A-weighted sound level in decibels (dBA or dB(A)), a unit that is weighted to compensate for the sensitivity of the human ear to sounds of different frequencies.

A summary of the effects of motor vehicle noise on people contained in Part V of Exhibit 2 follows: (See Hellweg R. 20-33)

a) Speech Interference: Noise of sufficient intensity will interfere with the understanding of speech; the noise from continuous motor vehicle traffic being more disruptive than a single passing vehicle. For example, a continuous noise level of 70 dBA would allow speech at normal voice levels for a separation distance less than 2 feet, and shouting would be required at a separation of 14 feet. This example is for young healthy adults, and higher voice levels would be required for children, old people, and those with hearing impairments.

b) Sleep Interference: Vehicle noise can cause people to awaken, it can prevent them from falling asleep, and it can change the level of a persons sleep. For example, in one experiment truck noise of 70 dBA caused 35% of a group of human subjects to awaken, while 25% changed their level of sleep. This sleep disturbance, if it occurs on a regular, unrelenting basis, "may constitute a hazard to one's physical and mental health" (Exhibit 2 p. V-27).

c) Performance and Motor Behavior: General conclusions related to work situations are that even if communication is not important, noise can adversely effect the accuracy of work performed, and that intermittent noise at levels below 90 dBA can

cause distractions. A study of children exposed to freeway traffic noise in the range of 55 to 66 dBA found that those children exposed to higher noise levels had lower reading scores and auditory discrimination deficits.

d) Annoyance: Annoyance results from the unpleasant nature of some sounds, the disruption of activities, and physiological reaction. Surveys have shown that complaints are only a partial indicator of the degree of annoyance experienced. For example, at a day-night sound level of 55 dB outdoors, 17% of the people will be highly annoyed but only 1% of them will complain. The term "day-night sound level" refers to an energy averaged A-weighted sound level with a 10 dB adjustment during night time hours.

e) Hearing Loss: Motor vehicle noise of sufficient duration and intensity can cause damage to the ear and a permanent hearing loss. Especially at risk are drivers of motor vehicles and people living near heavily travelled highways who are also exposed to noise at work. The United States Environmental Protection Agency (USEPA) has established 75 dBA as an average 8-hour maximum to protect health and welfare, in terms of hearing loss, as long as there is negligible noise exposure during the other 16 hours.

The impact of motor vehicle noise on people is evidenced by the citizen complaints about motor vehicle noise contained in this record. Six citizens appeared in person at the hearings to complain, and a petition for the adoption of motor vehicle noise regulations containing 148 signatures was also introduced (Exhibit 31). Public comments were received from 8 citizens (Comments 1b,2, and 4) complaining about motor vehicle noise. The testimony of Dr. McKendry is especially pertinent (R.208-219). She lives in a subdivision along Interstate 80 in New Lenox Township, and is bothered by high levels of traffic noise in the subdivision. Measurement of traffic noise in the subdivision were made in 1973 (Exhibit 16). They revealed that during testing on one Friday afternoon 70 dBA was exceeded 22 to 60 percent of the time at 3 locations, with peak noise levels recorded in the 82 to 87 dBA range. The distances from the measuring locations to I-80 were between 180 and 470 feet, the higher sound levels being recorded at the nearer location. These figures appear to be consistent with the Task Force statement that a truck noise emission exceeding 90 dBA at 50 feet would result in sound levels exceeding 78 dBA at a home 200 feet from the highway (R.31). It should be recalled that the effects of motor vehicle noise can occur at noise levels lower than this.

Progressing now to the numbers of people affected, the USEPA estimates that 93.4 million people in the United States are exposed to day-night noise levels equal to or greater than 55 dB (Exhibit 4 p. 6-15). According to the U.S. EPA (Exhibit 4), 55 dB is the day-night level necessary to protect public health and welfare in terms of outdoor activity interference and annoyance. Exhibit 4 also estimates that the number of "equivalent noise impacted people" exposed nationwide to freeway traffic is 2.7 million and to urban street noise is 34.6 million. The term "equivalent noise impacted people" refers not only to the numbers of people exposed to noise in excess of 55 dB, but also to the degree of excess. For example, at noise levels 20 dB above the criteria level of 55 dB, 100% of the people exposed to this noise are impacted adversely; while at noise levels 10 dB above the criteria level only 50% of the people exposed are impacted. Thus the number of equivalent noise impacted people is less than the actual number of people exposed to levels exceeding the criteria, as shown by the previous numbers.

The estimate for Illinois is 114,000 equivalent noise impacted people near freeways and 1.8 million in urban areas (R.32). With projected increases in the miles of urban expressways planned and the number of vehicles registered, the impact should worsen.

The problem with expressway noise is especially serious because of the proximity of residential areas. Illinois rules require new freeways to be designed such that the nearest lane is at least 100 feet from the nearest private property, while older freeways may be closer than 100 feet from the nearest private property (R.325). In this situation, the noise levels in a residential area located immediately next to an expressway could easily exceed 80 dBA.

Our conclusion from the above discussion is that motor vehicle noise is a serious problem in that many people are exposed to excessive levels, which can be high enough to cause not only annoyance, but also temporary or permanent damage to the ear.

Relationship between Vehicle Weight and Noise Emissions

The Motor Vehicle Noise Regulations we have promulgated relate allowable levels of emitted noise from trucks to vehicle weight. This is based on the empirically observed relation between noise emission and weight. The Task Force presented three exhibits on this subject which contained the 1974 Illinois Motor Vehicle Noise Survey (Exhibit 12), the vehicle noise study performed in the State of Washington in 1971 and 1972 (See Exhibit 2), a study of vehicle noise in

Toronto, Canada in 1970 (See Exhibit 2), and the Background Document for Interstate Motor Carrier Noise Emission Regulations (Exhibit 18).

The Agency performed a noise survey in Illinois in 1974, measuring noise emissions from trucks and other vehicles (Exhibit 12). Noise levels were measured during high speeds (>35 mph) and low speed (<35 mph) cruise and during low speed acceleration. High speed operation was measured on freeways and low speed operation was measured in cities. The weights of trucks were determined from the weight coding contained on the vehicle's Illinois license plate, and the drive-by noise levels were measured at several roadside locations.

Figures 10, 11, and 14 of Exhibit 12 show the relationship between registered truck weight and vehicle noise emissions for high speed operation, while Figures 4, 5, and 6 show the noise emission for low speed operation. It can be seen from these figures that the noise levels, both mean and extreme values, increase with increasing vehicle weight. The following table shows this trend using the data from Exhibit 12, which is based on measurement of 1,454 trucks in the ≤8,000 lb. category, 256 trucks in the 8-14,000 lb. category, 403 trucks in the 14-24,000 lb. category, and 4,287 trucks in the 24,000 lb. or greater category.

OPERATING CONDITION	TRUCK WEIGHT (lb)			
	≤8,000	8-14,000	14-24,000	24,000**
Low Speed--Cruise	66/70.8*	68.7/72.9	69.7/74.2	75.9/82.2
Low Speed--Acceleration	67.5/74	70.6/78	72.5/79.7	79.7/86.4
High Speed--Cruise	76.1/82.2	79.1/84.4	81.3/87.2	87.2/92

Notes: * A/B A is mean noise level (dBA at 50 ft.)
B is noise level exceeded by 5% of vehicles (dBA at 50 ft.)
** 24,000 lb or 3 or more axles

The vehicle noise study performed in Washington also shows a relationship between vehicle weight and level of noise emission (See pp III-7 and III-11 of Exhibit 2).

Specifically, the typical high speed noise levels for the 9,000 lb. and 18,000 lb. trucks are around 84 dBA with less than 5% of the trucks exceeding 87 and 89 dBA respectively. The 36,000 lb. and 72,000 lb. trucks have typical noise levels between 87 dBA and 90 dBA. It appears that the Washington data is about 4 dBA higher than the Illinois data.

The Toronto data further demonstrate upward trends in noise emissions with increasing vehicle weight. (See pp III-7 to III-10 of Exhibit 2). In this study, the weights were based partly on the weight rating of the vehicle and partly on the type of vehicle; so that the actual vehicle weight was not known with certainty. Based on the data presented at low speeds, the trucks 15,000 lbs. or less have approximately the same noise emissions as the trucks between 15,000 and 30,000 lbs; but are noisier than the automobiles and quieter than heavier trucks above 30,000 lbs. such as dump trucks and tractor trailers. The Toronto data shows approximately a 3 dBA increase in noise emission with a doubling in vehicle weight.

International Harvester testified that noise emissions are independent of vehicle weight, because one engine, muffler, drive-train unit will, depending on the type of suspension and axles, be used on vehicles having a range of gross vehicle weights (See Exhibit 23). This is shown in Chart I of Exhibit 23. Examination of this information revealed that the SAE J-366a test procedure used is a maximum acceleration drive-by test at a speed less than 35 mph. It is representative of maximum truck noise excluding tire noise (R.432). The vehicles tested in this procedure are not loaded and consist of just the tractor portion of a tractor trailer (R.444). Therefore, the test doesn't represent noise levels for complete or loaded vehicles in all cases or for speeds greater than 35 mph, and is not consistent with the Agency's 1974 Motor Vehicle Noise Survey.

The USEPA also testified at the hearings regarding classification by vehicle weight. Although they applauded the proposal to enforce the federal interstate vehicle regulations (Rule 315), they did not agree with all Task Force conclusions, specifically the need for regulations more stringent than the federal standards for vehicles heavier than 10,000 lbs. (R.488,491). They agree that the noise levels do increase on the average with increasing weight, but discount the State of Washington and Toronto data as not including all situations of grade and acceleration (R.500).

Our concern is for controlling the small percentage of unusually noisy vehicles on the road, in order to minimize peak noise events as well as to reduce the general level of noise generated on our roads. These observed trends of increasing noise levels with vehicle weight reinforce our concern that we should focus on noisy vehicles by relating the noise they emit to what levels can be attained by proper installation and maintenance of noise control equipment and reasonable driving methods. By taking into account differing control capabilities for different weight classes of vehicles, the small percentage of violators in each class can be required to achieve a level of vehicle maintenance and operation that is consistent with good practice for that class of vehicles. The conclusion we draw from the above discussion is that there is merit in establishing numerical noise emission standards for motor vehicles based on vehicle weight.

Discussion of the Motor Vehicle Noise Regulations

The following is a rule by rule discussion of the regulations adopted by the Board.

Rule 101: Definitions

These definitions are largely self-explanatory. They are additions to those contained in our existing Rule 101 of Chapter 8: Noise Pollution; and are added to correspond to terms and terminology contained in the Motor Vehicle Noise Regulations. Many of the definitions are taken from Chapter 95-1/2 of the Illinois Revised Statutes. Several of these new definitions require further discussion and/or interpretation.

Dealer has been revised to more clearly indicate that it refers to the seller of vehicles for public use. It is not our intent that the definition should apply to the manufacturer of vehicles, unless that manufacturer sells directly to the public.

Gross Vehicle Weight (GVW) is defined in terms of either the registered weight or the loaded weight specified by the manufacturer. In Illinois, unlike most other states, second division vehicles (trucks) are registered by weight, with the license plate indicating the weight of the vehicle, for example the letter G on the license plate indicates the weight range of 16,001 to 20,000 lbs (See Exhibit 2 pp.I-13,I-14 for a description of this system). For other vehicles not subject to this registration system, the manufacturer's loaded weight would be the vehicles GVW. It was pointed out

that one vehicle model, including engine, exhaust system and drive train, could be manufactured to different weight ratings depending on the axles and suspension (R.429). In terms of the use of this parameter in the Motor Vehicle Noise Regulations, however, it seems that these same model vehicles having different weight ratings have different noise outputs and should be regulated separately.

Vehicle is defined in terms of use on a highway. Thus equipment such as haulers or bulldozers used in mining and operated on private property would not be included. There was concern expressed by the Illinois Coal Operators (Comment 9) that these regulations would be applied to them; but exception (7) under Rule 330(a) would cover this situation. It should be noted, however, that vehicles used in mining or other activities that are licensed to travel on highways, such as trucks, would be subject to compliance with Part 3 of the Noise Regulations.

Rule 102: Prohibition of Noise Pollution

This is an existing rule that has been modified to reference the definition of property in Section 25 of the Act, which includes both real and personal property. Under this definition there is no need to explicitly mention motor vehicles in Rule 102.

Rule 103: Measurement Procedures

This existing rule is amended to include additional procedures, paragraph (c), applicable to the measurement of noise from motor vehicles. Paragraphs (a) and (b) are a reorganized version of the existing Rule 103 procedures, and thus need no further discussion. Although the numerical standards are to be applied at a distance of 50 feet, paragraph (c) allows the Agency to adopt correction factors for measurements made at distances other than 50 feet but not exceeding 100 feet. Draft measurement techniques for motor vehicle noise, prepared by the Agency and submitted as Exhibit 39, contain, in Figure 5, the correction to be applied for measuring at distances other than 50 feet. For example, at 100 feet a 4 dBA correction should be added to the reading to obtain the equivalent dBA level at 50 feet. Exhibit 39 also contains requirements concerning instrumentation, measurement site location, data acquisition, and restrictions and precautions.

There was a statement that the Agency had no authority to specify measurement procedures and a suggestion that the public

participate in the promulgation of measurement techniques (R.376-378), but as pointed out by the Task Force, it is consistent with the legislative intent of the Act to delegate to the Agency the responsibility for adoption of operational procedures for the measurement of sound (Exhibit 27 pp.20-22). Furthermore, since the procedures are to be consistent with those published by established standards organizations, and are filed with the Secretary of State's Office, public input is not required.

The Agency submitted as Comment 37, the California Highway Patrol document "Sound Measurement Procedures". It is apparently a workable procedure that will be used by the Agency as a guide in drafting their own sound measurement procedures. Comment 37 also contains correction factors for measuring at distances other than 50 feet.

Rule 301: Exhaust System

This rule deals with the maintenance and modification of vehicle exhaust systems. Its importance is evidenced by the results of the California studies, which showed that of the vehicles that violated the California motor vehicle noise standards, most had modified or defective exhaust systems. For example, of 9,900 car and light truck violations recorded in 1973 in California, 7800 were the result of modified or defective exhaust systems; and of 1,100 motorcycle violations recorded, 790 were the result of modified or defective exhaust systems. (See Exhibit 2 Part III Appendix A). Enforcement of this rule should therefore have great impact in reducing noise emissions, especially from motorcycles, light trucks, and cars.

This rule generated much discussion at the hearings. Proposed Rule 301(a) requires vehicles to be equipped with adequate, maintained exhaust systems. It is anticipated that this rule would be enforced either at safety inspection stations required for certain classes of vehicles, or during inspections of vehicles that exceed the numerical noise standards. Proposed item (3) of Rule 301(a) was discussed at some length by the Specialty Equipment Manufacturers Association (SEMA). Their concern was for automobiles, used both on the highway and for racing, having a cutout which allows unmuffled operation during racing but muffled operation on the street. SEMA representatives felt that the use of equipment should be regulated rather than the equipment itself (R. 614). The Task Force response was that relatively few vehicles are involved, that these cutout devices lend themselves to making noise, that it is not obvious that these vehicles should race unmuffled (R.616-617), and that since these vehicles are used

on the highways they are not covered by the exemption contained in Rule 320(a)(8).

Proposed Rules 301(a)(3), (b) and (c) have been deleted and a new Rule 301 has been written to prohibit operation of a vehicle on a public right-of-way unless its exhaust is muffled so that it does not emit more noise than it would with the equipment originally installed. The problems of exactly duplicating original equipment, or of vehicles getting 2 dB noisier with age have been cited by SEMA (R.647,652). We have included language in the rule to indicate that our concern is with installations or modifications that result in noticeable increases in noise emissions. In addition, our intent in this rule relates specifically to replacement equipment and its noise emissions in comparison to original equipment, and not to the overall increases in noise levels of used vehicles as a result of age. Rules 301(b) and (c) were deleted in order to allow the sale and installation of a cutout or bypass device on a vehicle for use elsewhere (e.g. racing), but Rule 301 as now stated prohibits their use when operating a vehicle on a public roadway.

Rule 302: Tires

This rule prohibits tires having a tread pattern that causes excessive noise. As discussed in Exhibit 2 for heavy trucks at high speeds, tire noise predominates (See Figure 3.3 of Exhibit 2). The noise emissions for a given speed in turn depend primarily on the tread pattern; rib pattern tires being the quietest, cross bar pattern tires being 4 to 10 dBA noisier, and "pocket retreads" being the noisiest (15-20 dBA greater than rib tires) (Exhibit 2 p.III-38, Fig. 3.10). These "pocket retreads" consist of pockets that are not vented either circumferentially around the tire or to the side; the pocket traps, compresses and then releases air, resulting in high noise emissions. Our rule would not allow these types of tires to be used.

The two major types used on trucks are the rib tires and the crossbar tires, with the rib type preferred on the steering axle and the crossbar type preferred on the drive axles. The crossbar tires typically have a longer tread life while the rib tires have better lateral traction for steering. It is felt by some that crossbar tires have better forward traction, primarily on loose surfaces. (See Exhibit 2 pp III-35 to III-38).

We have specified a 1 year compliance date for this rule in order to allow the excessively noisy tires currently in use to be phased out as they wear out (R.165). The intent of this rule is to prohibit new or newly retreaded tires having this tread pattern rather than to those tires that have this tread pattern because of wear. There was discussion as to whether this rule was consistent with federal safety standards and the 1972 Noise Control Act. The Task Force felt that it was (R.635).

The Rubber Manufacturers Association objected to tread design restrictions, saying that tire noise should be regulated by noise levels, and that pocket retreads could be operated under certain conditions of load and speed to comply with the 90 dBA limit (See Comment 1). The information contained in Comment 1, however, definitely indicates that pocket retreads are noisier than other tire types; but does not indicate that pocket retreads are any safer or have better traction properties than other tires. There is no compelling reason, therefore, necessitating the further use of these tires once the ones currently in use have worn out.

Rules 310 to 313

As discussed previously, there is justification for establishing noise emission levels for trucks based on vehicle weight. In addition to trucks, the regulations cover automobiles, buses, and motorcycles.

For ease of enforcement, the weight categories of trucks are based on the Illinois license plate code letters that identify vehicles by their registered gross vehicle weights. The categories used in this regulation are related to the gross vehicle weights and license plate code letters in the following table. Our intention is that all gross

vehicle weights will be rounded off to the nearest pound.

Truck Category	Registered Gross Vehicle Weight (lbs.)	Code Letter
Light	Less than 3,000	A
	3,001 - 8,000	B
Medium	8,001 - 10,000	C
	10,001 - 12,000	D
	12,001 - 14,000	E
	14,001 - 16,000	F
	16,001 - 20,000	G
	20,001 - 24,000	H
Heavy	24,001 - 28,000	J
	28,001 - 32,000	K
	32,001 - 36,000	L
	36,001 - 41,000	N
	41,001 - 45,000	P
	45,001 - 50,000	R
	50,001 - 59,000	S
	59,001 - 64,000	T
	64,001 - 73,280	V

Rule 310

This rule establishes noise emission limits for vehicles up to and including 8,000 lbs. gross vehicle weight, excluding motorcycles and motor driven cycles. The basic limits are 74 dBA for speeds of 35 mph or less and 82 dBA for speeds greater than 35 mph.

Exhibit 2 contains a discussion of the development of the standards (See pp III-49 to III-62). For these vehicles, the major noise source at most speeds is exhaust system noise, with air intake and cooling fan noise of secondary importance. Tire noise usually does not predominate since tires used on autos and light trucks have a rib tread pattern, the quietest variety as discussed previously.

One basic premise in Exhibit 2 is that an automobile or light truck, driven at speeds exceeding 35 mph will, in almost all cases, comply with 82 dBA unless the exhaust system is modified or defective. Referring again to the 1973 California enforcement data (Exhibit 2; p. III-59, III-A1), described above in Rule 301, over 400,000 vehicles were measured for noise at speeds exceeding 35 mph. Of those, about 6,000 were found in violation of the 82 dBA level, and 5000 of the violations were attributed to modified, defective, or inadequate exhausts. Only 1/4 of 1% (1000 in 400,000) had violations which were not due to noise from the exhaust systems. This pattern is supported by data in Exhibit 29

(p. 5, 6) which indicates that of those vehicles weighing 8,000 lb. or less which exceed the low speed noise limit of 74 dBA, only 0.3% had no observable defect on visual inspection.

Combined data in Exhibit 2 at speeds exceeding 35 mph shows 4.4% of autos and light trucks exceeding 82 dBA; while the 1974 Illinois survey (Exhibit 12) shows 5% of the light trucks and only 0.2% of the automobiles in excess of 82 dBA at speeds greater than 35 mph based on freeway data. Proper muffler maintenance for that 4-5% of vehicles should enable compliance with the 82 dBA limit for high speeds.

Regarding low speed operation, Exhibit 2 indicates that for the typical vehicle, driver behavior can play an important role in noise emissions. Data for automobiles during maximum acceleration shows attainment of noise levels as high as 84 to 86 dBA whereas combined pass-by data during typical vehicle operation in California and Illinois shows only 3.8% of the vehicles exceeding 74 dBA at speeds of 35 mph or less (Exhibit 2 pp III-53 to III-55). The 1974 Illinois Survey shows that at speeds under 35 mph, 5% of the light trucks and 3.5% of the automobiles exceeded 74 dBA while accelerating and only 0.4% of the light trucks exceeded 74 dBA when not accelerating (See Exhibit 12). The California experience regarding excessive noise was, again, that defective or modified exhaust systems were responsible in almost all situations.

Higher emission limitations for low speed operation up a grade or for high speed operation with mud/snow tires were suggested by the Task Force in their April 1, 1975 submission to the Board (See Exhibits 25 and 26) and discussed at the June 10, 1975 hearing. Exhibits 29 and 30 are noise surveys conducted on motor vehicles accelerating up grades. Exhibit 29, entitled "Motor Vehicle Noise Emissions While Accelerating Up a Grade" compares noise emissions during acceleration on grades of 4.3% to 9.6% with emissions during acceleration on level roads at speeds of 35 mph or less. Comparisons were made of the effect of grades on average noise emission and on compliance with a proposed standard. The data from Table II of Exhibit 29 show that for operation on grades, it would be necessary to raise the allowable noise limits by 2 dBA to achieve the same degree of compliance as for operation on level roads. For example, 3.5% of the automobiles exceed the low speed standard of 74 dBA on level ground, 7% exceed 74 dBA on grades, but only 5% exceed 74 dBA plus 2 dBA or 76 dBA on grades.

An allowance for a 2 dBA increase in noise emissions while operating on a grade greater than 3% has been included in the

operating standards for vehicles subject to Rules 310 and 312. Alternate methods have been considered for dealing with increased emissions on a grade; for example, limiting monitoring to sites with less than 3% grade or raising the entire low speed standard by 2 dBA. However, the use of two standards based on grade provides consistent control requirements, because the noise levels are set so that the violation rate for the standard on a grade is equal to that for vehicles on level roadway. They also enable enforcement in any roadside location, which is not possible when monitoring sites are restricted (Comments 88,89). A similar increase for trucks, which had previously been included in Rule 311, has been removed, as discussed below under that rule.

The 2 dBA allowance for mud/snow tires for light vehicles is based on the 1971 California study which showed that cars equipped with snow tires emit more noise than those without them (Exhibit 2 p. III-57). Medium and heavy trucks use the noisier cross bar tires routinely, so that the monitoring data and noise standards for that class of vehicles already include the noisier tires. (Exhibit 26).

Rule 311

Rule 311 includes buses and all other vehicles weighing greater than 8000 lb GVW. There were three classes encompassing these vehicles in the original Task Force proposal. However, because Exhibit 12 showed similar noise emission levels for vehicles in the 8,001 to 14,000 lb. and the 14,001 to 24,000 lb. classes, these two classes were combined to form an 8,001 - 24,000 lb. class as stated in the proposal published in Environmental Register #109. In that proposal the regulation was further simplified by eliminating the assignment of all diesel powered vehicles to the proposed Rule 312. As had been presented in the original Task Force proposal, all vehicles with 3 or more axles were included in Rule 312 controlling vehicles over 24,000 lb GVW and all buses were controlled under Rule 311 for the 8,001 - 24,000 lb. class.

In a proposal received by the Board on October 15, 1976 (Comment 51) the Agency recommended that the medium and heavy vehicles subject to proposed Rules 311 and 312 be combined to form one class of vehicles over 8,000 lb. GVW, which would be controlled by the standards given for heavy vehicles under proposed Rule 312. The rationale given by the Agency to support its proposal was that because there are so many more heavy

trucks in violation than medium trucks the effect on enforcement rates of easing medium truck standards would be negligible; while screening procedures for enforcement would be greatly simplified for the field personnel. They cite a very small loss of benefit, as measured in the Economic Impact Study (Exhibit 44), which would result from deregulating medium trucks; and they point out that the trucks would still in fact be regulated under the equipment standards in Rules 301 and 302 and the noise standards of Rule 312.

According to Exhibit 44 (Table 2.7 p. A-19) trucks between 8,001 - 24,000 lb. GVW comprise 1% to 3% of the total vehicle miles traveled on Illinois roads. They reach an estimated maximum of 3% on low speed truck routes, with heavy trucks being 4% and the remaining vehicle miles being contributed by automobiles, light trucks, and motorcycles.

The violation rates for medium trucks under the standards of 82 dBA at low speeds, and 88 dBA at high speeds are estimated in Exhibit 12 to be about 1% and 1.6% respectively. These results are obtained by combining the light-medium and medium truck data from Figures 5 and 6 of Exhibit 12. Under this new Rule 311 they would be essentially in full compliance with the heavy truck standards.

Because of their small contribution to total vehicle miles and their very low expected violation rates, the effect of completely deregulating medium trucks is expected to be small. The estimated increase in neighborhood equivalent noise levels (L_{eq}) resulting from deregulation was calculated for low speed truck routes using the method described in Appendix II of the economic study (Exhibit 44) and data presented in Tables 2.7 and 2.9. The resulting increase of 0.02 dBA was found to be very small when compared to changes of from 0.12 to 0.83 dBA if other vehicle categories were unregulated (See Table 2.12 p. A-29). Because the contribution of medium trucks is greatest on low speed truck routes, changes in noise levels near freeways and highways or in urban traffic should be even lower.

As a result of combining the two classes only one criterion would remain for classifying trucks during enforcement, as compared to four criteria for the previous proposal. Personnel would now only have to examine truck license plates to separate light trucks subject to proposed Rule 310 from vehicles subject to new Rule 311. The previous proposal would have required identification of two weight cut-off levels, as well as the identification of vehicles with more than 2 axles which were subject to Rule 312, and the determination of the interstate status of trucks over 10,000 lb. GVW.

With these changes buses will also be regulated under the heavy truck standards. Although buses vary in weight from light to heavy trucks, they are generally quieter than trucks of equal weight because the engine is shielded to a greater extent, because they have fewer axles and tires, and because the tires used are of a quieter variety (Exhibit 2, p. III-77). Measurements of bus noise at low speed found no buses exceeding 79 dBA and at high speed found only 4% of the buses exceeding the 88 dBA standard. Under this new rule 311 buses are expected to be in total compliance with the applicable standards.

Technical data in the record demonstrate the validity of establishing separate classes for vehicles over 8,000 lb. GVW, a finding which is reinforced by the low rates of violation of the medium truck standard measured in field surveys. Vehicles could comply with the more stringent rule, effecting a slight reduction of both average and peak noise levels. The Board finds, however, that the procedures required for enforcement of separate standards are cumbersome, with only limited associated improvements in neighborhood noise levels. Consolidating the two classes will allow more effective enforcement for those vehicles which make the greatest contribution to noise levels, and on which control procedures should be focused.

Exhibits 2, 12, and 20 can be used to determine the extent of compliance by heavy trucks ($>$ 24,000 lb GVW) with the adopted high and low speed noise limits. It should be noted that this rule does not contain adjustments for operation with mud/snow tires. Surveys of these vehicles already include high speed operations with the commonly used and noisier crossbar tires, so that no additional correction is needed.

There may be some conflict in the data concerning low speed noise emissions, in that Exhibit 2 shows 15% of the heavy trucks exceeding 86 dBA, while Exhibit 29 shows 5%, and Exhibit 12 shows between 1 and 6%. The more recent Illinois data of Exhibits 12 and 29 represent, we believe, the true picture of noise emissions at low speeds from heavy trucks. In addition, Exhibit 2 includes data for operation on grades where at low speeds trucks make more noise as shown in Exhibit 29.

Data showing noise emissions at high speeds for heavy trucks is also contained in Exhibits 12 and 2. Exhibit 12 shows that, based on a sample of 3860 vehicles, 17% of the vehicles exceed 90 dBA. This is not inconsistent with

Exhibit 2 which shows that between 13% and 24% of the vehicles tested in various locations exceeded 90 dBA. The composite sample from Exhibit 2, a sample of 8,343 vehicles which does not include the Exhibit 12 data, shows 20% of the vehicles exceeding 90 dBA (Exhibit 2 p. III-23).

While this may seem to be a large number of violations, we anticipate that as the noisiest tires are phased out, the significant tire component of high speed truck noise emissions will decrease, resulting in fewer violations. In addition, the need for vehicle noise regulations is greatest in the case of heavy trucks. We have therefore, established 90 dBA as the high speed noise limit for these vehicles.

Rule 311(c) is a noise emission limit based on a stationary runup test. It could be employed at weigh stations according to the Task Force as an indicator of the drive-by noise emission level and is not, in their opinion, an invalid rule (Exhibit 27). The 88 dBA limit established is 2 dBA higher than the low speed drive-by noise limit, a difference which is at least partly attributable to the different acoustic properties of the concrete ground of a weigh station and roadside ground covers (Exhibit 4). While one could possibly characterize the stationary test as an impermissible test of the ability to pollute rather than a test of pollution, we believe this rule to be a rational and necessary enforcement tool to effectuate the legislative goal of reduction of noise pollution. In promulgating their interstate motor vehicle noise regulations, the USEPA stated that the stationary test is a means of measuring maximum propulsion system noise, and will represent actual operation under certain conditions of load, acceleration, or grade (Exhibit 17). We believe that this rule is consistent with the drive-by rules.

This rule also contained a 2dBA allowance for low speed operation up grades. This was removed after further review of survey results in Exhibit 29 (Figure 18) and comments by the Task Force (R. 584-586, Comment 55) and the Agency (Comment 51). We agree that the 86 dBA standard for heavy trucks as developed by the U.S. EPA and as evaluated for Illinois takes into account acceleration up grades because it is a standard based on compliance during maximum acceleration. Also, medium trucks now included under this Rule 311 are expected to be able to fully comply with the 86 dBA standard. We are therefore eliminating the 2 dBA allowance for operation on grades.

Rule 312

This rule applies to motorcycles and motor driven cycles. As discussed in Exhibit 2 (pp III-63 to III-76),

the noise from these vehicles is almost entirely due to the engine and drive train. Tire noise almost never predominates. In addition, these vehicles have a significant power to weight ratio, so that operator behavior significantly affects the noise emissions during operation. There is some increase in maximum noise output with increase in engine size, but in constant speed drive-by situations, the smaller engines work harder and produce more noise (See Exhibit 2 pp. III-67,68).

The proposed final draft contained a low speed noise limit of 78 dBA for motorcycles. Our review of the record shows that this level may be unduly restrictive, and the extent of non-compliance would be large (approximately 30%).

Testimony supplied by Harley Davidson was that the proposed low speed standard probably exceeded the state of the art in noise control, referring to data supplied by them on new motorcycles (Exhibit 35). Closer inspection by the Task Force of the Harley Davidson testimony contained in the Task Force's "Response to Matters Submitted at the Hearing in Chicago, June 10, 1975" (Comment 20) revealed that the statement was based on a single test of one model, and that other tests of the same model had shown levels below 78 dBA. Nevertheless, we have raised the low speed limit to 80 dBA to insure feasibility of compliance.

The 1974 Illinois noise survey, Exhibit 12, shows 11% of the motorcycles exceeding the high speed standard of 86 dBA. This can be compared with 1970-1971 data from California, reported in Exhibit 2 (p. III-71), which showed 7% of the motorcycles exceed 86 dBA. Of the motorcycles in violation in 1971, 56% had modified exhaust systems and another 11% had defective exhaust systems according to the data in Appendix A to Part III (Page III-A1) of Exhibit 2. More recent 1973 California data reported in Appendix A show a 15.4% violation rate. Of those motorcycles violating the 86 dBA standard, 64% had modified exhaust systems and 13.5% had defective or inadequate systems. The remaining 22.5% of the violations which account for only 3.5% of the total of 4,884 motorcycles which were measured, are the result of factors other than exhaust system equipment. It appears that compliance with the high speed standard would be greatly increased if motorcycles would simply be maintained and not altered to increase the noise emission.

During low speed operation, Exhibit 12 shows that 15% of the motorcycles in Illinois will not comply with 80 dBA

while accelerating but only 5% will not comply while cruising, indicating the importance of driver behavior. Further testing was conducted by the Task Force under conditions where the acceleration of the motorcycles was varied (Exhibit 32). This test, while limited in the number of vehicles measured, shows that as the acceleration rate dropped (longer time to complete the 100 ft. passby), the noise emissions decreased. At an acceleration rate of 100 feet in 4.8 seconds from a stop, only 2 motorcycles exceeded 80 dBA, and one of these had a modified exhaust system. The significance of the 100 ft. in 4.8 seconds acceleration is that 75% of Illinois automobiles accelerate at this or a slower rate during normal driving, according to Exhibit 32.

As discussed above under Rule 310, a 2 dBA increase in noise emissions when operating on a grade greater than 3% has also been included in this rule for motorcycles and motor driven cycles.

Rule 313

This Rule is identical to the federal interstate motor carrier noise limits promulgated October 29, 1974 (39 FR 38208), Exhibit 17 in this proceeding. The federal support for the rule is contained in Exhibits 17 and 18.

The federal standard is preemptive (See Exhibit 2 p. I-19) and our adoption of this rule as an Illinois standard is limited to just those vehicles covered by the federal regulations in order to assure national uniformity.

Rule 314: Horns and Other Warning Devices

This Rule applies to horn sounding. It reiterates the motor vehicle code (IRS 95-1/2 §12-601(a)) against unnecessary horn sounding. Although unnecessary horn sounding could be covered under Rule 102 in the absence of this rule, the prohibitions contained in this Rule will bring it to everyone's attention. We also have adopted language prohibiting anyone from circumventing the enforcement of the numerical noise limits by sounding his horn while driving past a monitoring site. Paragraph (b) of this rule prohibits the use of sirens, whistles, or bells except by emergency vehicles.

Rule 315: Tire Noise

This rule prohibits the operation of a vehicle so as to cause squealing or screeching of tires. Examples of such

operation would include drag racing on public roads, "jack rabbit" starts, skidding around turns, and the like. We do not intend, in this rule, to penalize tire noise that occurs solely because of low tire pressures or high temperatures during normal vehicle operation.

Rule 320: Exceptions

Paragraphs (a) and (b) are self evident and need no further explanation. Paragraph (c) exempts certain equipment and vehicles from the operational standards. It does not exempt these vehicles from the equipment or inspection standards.

Rule 321: Compliance Dates for Part 3

Compliance with these regulations is delayed for approximately 6 months. This will allow for the replacement or repair of modified or defective exhaust systems, including the time for operators of fleet vehicles to assess their compliance situation. The Task Force had suggested 90 days but we feel that the additional time may be necessary based on comments made by Commonwealth Edison (Comment 8).

Paragraph (b) is a one year delay in enforcement of the noisy tire rule to allow normal attrition to phase out these tires. This eliminates the cost burden of replacing the noisiest type tires before their useful life was exhausted.

Paragraph (c) refers to the high speed noise emission limitations, and since tire noise is an important contributor to the total vehicle noise emission levels, the one year delay in compliance allows for the normal attrition of the noisy tires. The Task Force had proposed this rule to apply to all vehicles included in these regulations, but we do not believe that the tire noise of motorcycles is significant, so motorcycles and motor driven cycles are not included in this paragraph.

Paragraph (d) picks up the federal compliance date for motor vehicles subject to the federal interstate motor vehicle noise regulations.

Rule 208(f): Exceptions

This is a new rule added to the existing property line noise regulations. Its purpose is to solve a possible conflict between the motor vehicle noise regulations and the property line noise regulations that could arise from the use of access roads by vehicles registered for use on highways. This does not mean that these vehicles are always exempted from the property line regulations since, as was pointed out by the Task Force in Exhibits 27 and 28, the motor vehicle noise regulations do not apply on private property, and noise from these vehicles, if used routinely on private property, should be included as part of the total noise emission from the property line noise source.

Economic Impact of the Motor Vehicle Noise Regulations

The Task Force on Noise included in its original report (Exhibit 2) a section (Part IV) in which the economic impact of the proposed regulations was measured. In this study the Task Force estimated for each weight class the number of vehicles expected to be in violation and the cost per vehicle of complying with the regulation. Using 1973 data, a total estimated aggregate cost burden of $13,130,000 was attributed to compliance. The compliance costs for individual vehicles in each weight class were related to 1) revenues and operating costs in the case of carrier trucks or 2) operating costs and vehicle values for vehicles used for private transportation. Results are summarized in the following table.

Vehicle Class	Number of Violations	Compliance Cost per Vehicle	Aggregate Compliance Cost	Relative Cost per Violating Vehicle*
Heavy Trucks	15,300	$114	$1,744,000	0.9%
Medium Trucks	6,200	$ 80	496,000	2.5%
Buses	0	--	0	0
Autos/Light Trucks	244,000	$ 40	9,760,000	3.6%
Motorcycles	11,300	$100	1,130,000	22.0%
			$13,130,000	

*Relative cost is the compliance cost per vehicle in violation expressed as a percent of the annual operating cost for that vehicle.

The subsequent Economic Impact Study, IIEQ Document No. 76/10 (Exhibit 44), prepared by the Task Force in accordance with

P.A. 79-790 included a more recent assessment of the same cost burdens for vehicle compliance. A number of other costs were also calculated, as well as certain expected monetary benefits from vehicular noise reduction.

The primary costs associated with the regulation are those costs involved with bringing violating vehicles into compliance. These costs were measured for vehicles used by industry, in agriculture, by state and local governments, and by people driving vehicles for private transportation in the State of Illinois. Costs to local and State governments for enforcement programs were also estimated.

Numerous secondary costs were also evaluated. These include the impact on prices, employment and the availability of goods and services (Chapter VIII); effects on the expansion of industry, attraction of new industry, and availability of energy supplies (Chapter XI); impact on Illinois agriculture (Chapter X); and impact on state and local government (Chapter XI).

Two kinds of cost calculations were performed. The first, called the financial burden, is the initial cost involved in bringing a violating vehicle into compliance with the regulation. The economic impact analysis in the original Task Force report (Exhibit 2, Part IV) calculated only these financial burdens for each vehicle class, which were called aggregate cost burdens. The true economic cost, however, is a measure of the extra cost incurred over the remaining life of a vehicle as a result of the regulation. This cost is expressed as the difference between the present value of the total costs incurred with compliance and the present value of the total normal costs which would have been incurred in the absence of the regulation.

The figures used to calculate the financial burden of compliance for each vehicle class are 1975 data. They are presented below, along with their relative costs compared to vehicle operating costs.

Vehicle Class	Number of Violations	Compliance Cost per Vehicle	Financial Burden	Relative Cost* per Violating Vehicle
Heavy Trucks				
a) retrofit	12,910	$ 135.00	$ 1,742,900	0.86%
b) tires	6,064	193.00	1,168,000	1.22%
Medium Trucks	2,000	87.50	174,000	2.3%
Buses	542	87.50	47,500	na
Autos/Light Trucks	228,800	45.00	10,296,000	3.2%
Motorcycles	23,900	110.00	2,629,000	19.6%
			$16,057,400	

*Relative cost is the compliance cost per vehicle in violation expressed as a percent of the annual operating cost for that vehicle.

These estimates are generally consistent with those of the earlier study (Exhibit 2). Exhibit 44, however, measures both retrofit and tire violations for heavy trucks and it includes violations by buses. Unit compliance costs are also increased due to increased equipment prices between 1973 and 1975. Changes in the numbers of violating vehicles in each class, whether increases or decreases in numbers, tend to reflect more recent estimates of vehicle fleet sizes and more precise violation rate estimates, as verified by noise surveys performed following the original report.

A summary of the financial burdens and economic costs imposed by the regulation is presented in Table 10 of Exhibit 44. It is reproduced below for reference. The Task Force calculations show a net total financial burden of $16,692,000 and a net total annual economic cost of $4,041,000. The financial burden includes the burdens listed above for each vehicle class plus an additional $310,600 for agricultural and government vehicles and $324,000 in enforcement costs.

Assuming that these primary costs are completely passed on by industry and government in the form of price increases and taxes, the impact on the people of Illinois was determined to be so small as to be imperceptible. This would hold true for food and product price increases as well as for effects on employment. The primary costs were concluded to be the most relevant costs, and therefore the ones to be used for benefit cost analysis.

The annual economic cost is the amount that would be paid annually, based on 10% interest rate, if the economic cost incurred were paid off by equal annual payments indefinitely into the future (Exhibit 44 p. 23, 24). This measure was used to establish a consistent base for comparison of costs with the expected benefits, which were also calculated on an annual basis.

The benefit of the regulations will be a reduction in neighborhood noise levels, to which traffic noise is a major contributor. The regulations are designed to reduce peak annoyance noise for land areas adjacent to roadways, and therefore will also reduce daily background noise levels in urban/suburban locations (Exhibit 44, pp A-4,5).

To estimate dollar benefits of the regulation the projected noise reduction (in dBA) was calculated and translated to a dollar

Table 10

Financial Burden and Economic Cost for All Vehicle Classes-Summary

Cost Category	Financial Burden	Annual Economic Cost[1]
Heavy Trucks		
Per violating vehicle	$135	$12.50
Average per vehicle, all heavy trucks	$20.38	$1.89
Total, all vehicles	$1,742,900	$161,400
Tires (Heavy Trucks		
Per violating vehicle	$193	$7
Average per vehicle, all heavy trucks	$13.65	$0.50
Total, all vehicles	$1,168,000	$42,600
Medium Trucks		
Per violating vehicle[2]	$87.50	$50.40
Average per vehicle, all medium trucks	$1.40	$.80
Total, all vehicles (including buses)	$221,500	$128,100
Automobiles and Light Trucks		
Per violating vehicle[3]	$45	$25.90/$1.14
Average per vehicle, all vehicles	$1.65	$.50
Total, all vehicles	$10,296,000	$3,093,400
Motorcycles		
Per violating vehicle	$110	$15
Average per vehicle, all vehicles	$12	$1.65
Total, all vehicles	$2,629,000	$360,900
Agricultural Vehicles[4]		
Heavy trucks, total	$180,300	$12,600
Medium trucks, total	51,000	$29,400
Light trucks, total	252,000	$145,000
Total, all vehicles	$483,300	$187,000

Table 10 (continued)

Cost Category	Financial Burden	Annual Economic Cost[1]
State Government Vehicles[5]		
Total, all heavy trucks	$7,700	$500
Local Government Vehicles[5]		
Total, all heavy trucks	$83,900	$5,900
Enforcement		
State	$108,000	$71,100
Local	$216,000	$142,200
Totals, all categories		
Gross	$16,956,300	$4,193,100
Net[6]	$16,692,000	$4,041,000

[1]Calculated on the basis of a 10% interest rate.

[2]The per vehicle economic cost for medium trucks exceeds that for heavy trucks because the former cost is treated as recurring whereas the retrofit cost is essentially non-recurring.

[3]The first figure for annual economic cost refers to vehicles with deteriorated mufflers and the second to vehicles with modified mufflers.

[4]The medium and light truck figures include sums (for vehicles of 12,000 lbs. or less) that have been previously included in the light and medium truck categories. The net additional sums in the agricultural sector occur only in the medium and heavy truck segments. For heavy trucks the additional costs are those shown in the table. For medium trucks (with 27,650 in the 12,0001-24,000 lb. class, and with 442 of these in violation) the additional costs are as follows: Financial Burden $38,700; Annual Economic Cost, $22,300.

[5]The figures cover vehicle costs only and exclude duplicating sums attributable to increased freight costs.

[6]Excludes the duplication arising in connection with farm vehicles and described in footnote 4 above.

value. This was done by applying a dollar value per dBA to the number of dBA's of reduction in noise.

The dollar values used were based on results of several econometric studies that have demonstrated a relationship between neighborhood noise levels and the value of property in the neighborhood. The measure, which is calculated by multiple regression techniques, quantifies the change in property values associated with a change of one dBA in noise level (Exhibit 44 pp. 122-127; Exhibit 45). The use of land values can be considered to be a surrogate for the perceived effects of neighborhood noise (R. 781-783); it is expressed by the increased price a property buyer is willing to pay for quieter residential surroundings.

To calculate the value per dBA of noise reduction the Task Force first used a regression equation developed by Jon P. Nelson in a study performed for the U.S. Department of Transportation. (See Exhibit 44 p. 124 for reference; Ex. 45). He uses the Traffic Noise Index (TNI) in dBA as the noise measure, and the value per dBA reduction is dependent on the average value of the dwellings in his regression sample. In Illinois in 1975 the average value of owner-occupied homes was $30,000 and the value of rental units was $13,000. Using Nelson's equation the average estimated capitalized worth of 1 dBA reduction in TNI was $124 for each home and $55 for each apartment. Annual average benefits, based on a 10% interest rate, were thereby estimated to be $12.40 and $5.50 respectively per dBA noise reduction per housing unit.

To estimate the total annual dollar benefit per dBA the unit benefits were multiplied by the number of homes and apartments that would experience the noise reduction. These numbers were estimated for three categories of land areas, using noise exposure data in a U.S. EPA report (Exhibit 44, p. 133) and Illinois population data. The three land categories were urban and suburban areas, areas near freeways and highways, and areas near airports or other major noise sources.

The procedure used to estimate the dBA reduction in noise brought about by the regulation is described in detail in Appendix II of Exhibit 44. The reduction is given as equivalent noise levels (L_{eq}), which are the energy average values of noise levels (in dBA) over a period of time. The average reduction in L_{eq} was calculated from noise survey data which gave the distribution of noise levels for vehicles within each weight class and the proportion of the total vehicle fleet which is in each weight class. A reduction of 1 dBA in L_{eq} was assumed to be equal to 1 dBA in TNI. An average noise reduction of 2 dBA was calculated for urban and suburban areas and one of 0.67 dBA was obtained for areas near freeways and highways. Areas near other large noise sources were not expected to benefit

from vehicular noise reduction because of the dominance of those other sources in noise generation.

An aggregate annual benefit of $63,318,000 was calculated. The results are presented in Table 12 (Exhibit 44 p. 136), which is included here. The estimated total of 3,798,000 households represents the total number of households in Illinois. Of those, some 404,000 households (or 11%) are said to be located near other major noise sources, and are therefore not expected to receive any benefit from the regulation. The greatest benefit is expected to be to households in urban and suburban areas. This is because the largest noise reduction (2 dBA) occurs in those areas, and that is also where the greatest number of households are located (an estimated 86% of the total households). The urban/suburban benefits of $62,483,000 represent almost 99% of the total annual benefits estimated.

The benefit-cost comparison based on these calculated annual costs of $4,041,000 and annual benefits of $63,318,000 yields a high benefit cost ratio of 15.7 for the regulation. Such a ratio indicates a substantial benefit from regulation while incurring relatively small costs. The costs are not only small when compared to the estimated benefits, but they are also extremely modest when compared to the total operating costs and net revenues of the motor vehicle industry.

The Task Force designed two variant cases for benefits in order to test the sensitivity of the benefit estimates to key variables used in their calculations. For the first variant case the annual worth per household of 1 dBA reduction was cut in half, to $6.20 per home and $2.75 per apartment unit. In addition the amount of noise reduction in urban/suburban areas was reduced from 2 dBA to 1 dBA. The resulting benefits of $16,038,000 (Exhibit 44, p. 139) yielded a much lower but still substantial benefit cost ratio of 3.97. The Task Force concluded that the "balance of benefits over costs is largely insensitive to possible errors in the estimation of costs" (Exhibit 44 p. 140).

The second variant case was based on the results of a Chicago noise study by Vaughn and Huckins (Exhibit 44 p. 144), which found that when a neighborhood L_{eq} was less than 50 dBA, noise reductions were not reflected in increased property values. The capitalized value for noise reductions above that level, however, were much higher than those calculated using Nelson's work. Assuming that half of the urban/suburban households are subjected to less than 50 dBA background noise levels, the number of households benefited in that category were halved. The capitalized value per household was held the same rather than raised, as would be indicated by the

Table 12

Calculation of Aggregate Benefits Resulting From the Proposed Regulation
Base Case

Location	(1) Number of Households	(2) Expected dB(A) Reduction	(3) Annual Worth of Reduction Per dB(A) Per Household	(4) Total Annual Worth of Reduction, All Households (1)x(2)x(3)
Urban and Suburban Areas				
Houses	1,926,000	2.0	$12.40	$47,765,000
Apartments	1,338,000	2.0	$ 5.50	$14,718,000
Near Freeways and Highways				
Houses	77,000	0.67	$12.40	$ 639,700
Apartments	53,000	0.67	$ 5.50	$ 195,300
Near Airports and Other Major Noise Sources				
Houses	238,000	0.0	$12.40	$0.0
Apartments	166,000	0.0	$ 5.50	$0.0
Totals	3,798,000			$63,318,000

Chicago study, to maintain a more conservative estimate. The resulting benefit of $32,047,000 yields a benefit cost ratio of 7.9.

It is noted in the second variant case that even if none of the households along freeways or highways were benefited by noise reductions, the total benefits would equal $31,241,000 with an associated benefit cost ratio of 7.7. This ratio results from benefits to only 50% of the estimated urban/suburban households, which according to the estimates in the study equals 43% of the total households in Illinois.

The Task Force also calculated the noise reductions which would result from control of each of the vehicle classes (Exhibit 44, p. 131), from which the costs and benefits attributable to each specific class were estimated. It was concluded that noise control was cost beneficial for each of the individual vehicle classes as well as for the overall regulation (Exhibit 44, pp. 142-143, 145-147). This finding reinforces the validity of tailoring noise control to the noise characteristics of different vehicle classes.

The consolidation of the medium and heavy vehicle classes under a new Rule 311 will result in changes in costs for compliance and in benefits of noise reduction. Because all medium vehicles are expected to be in full compliance with the noise standards under this rule, the annual economic cost of $128,100 attributed to these vehicles is eliminated from the cost estimates. As described above, a noise increase of 0.02 dBA is estimated to result from deregulating medium vehicles. Assuming this increase will be experienced in all locations, the net loss in benefits expected using base case benefit values (Table 12) will be $649,933 annually. The ratio of 5.1 for these benefit and cost increments demonstrate that from a strictly economic standpoint it would be cost-beneficial to control this class of vehicles under the separate standards proposed in previous Rule 311 as published in Environmental Register #109.

Another question relevant to the analysis is that of what portion of the costs and benefits can be attributed to this regulation in those instances where it duplicates other noise regulations. The three cases considered were 1) the federal regulation controlling noise from interstate trucks in excess of 10,000 lb GVW, 2) the existing Illinois Motor Vehicle Code prohibition of modified or defective exhaust systems, and 3) local noise control ordinances such as the one in effect in

Chicago. The Task Force found, when costs and benefits which could be associated with each of these cases were removed from the proposed regulation, "...that while some of the details in the cost benefit ratios would change that the general balance would not be substantially affected" (R. 1006). Therefore the original findings as to cost benefit hold true, regardless of the presence of those other noise regulations.

During the economic impact study hearings a number of comments and criticisms were expressed. These covered both cost and benefit estimations, as well as enforcement capability and associated costs.

As stated above, cost estimates for vehicular noise control equipment were calculated from an estimated number of violating vehicles and an estimated average cost per vehicle for control. Violation rates have been discussed above under Rule 310-313 dealing with each vehicle class. The unit costs are averages based on costs reported by the U.S. EPA (Exhibit 44, p. 15) and dealers estimates of costs for control equipment (Exhibit 44 pp. 28, 38, 49, 62).

The State Chamber of Commerce (R. 811-817; Exhibit 48) and the Illinois Trucking Association have questioned both the violation rates and equipment costs used for heavy truck compliance cost estimates. The Association presented a retrofit cost for gas powered trucks which was identical to the Task Force overall estimate for both gas and diesel trucks. The Association's cost estimate for diesel powered units, was a higher $295 per vehicle (1973 dollars). That higher cost, along with their much higher violation rate estimates, yields a total heavy truck cost estimate 6 times that of the Task Force (R. 706-710). As stated above, the violation rates used by the Task Force are consistent with results of a number of surveys, and they must be considered to be more reliable estimates than those presented by the Trucking Association (R. 969-976; Comment 20). The remaining question therefore is the accuracy of the unit cost estimates used by the Task Force.

Additional per vehicle heavy truck retrofit cost estimates are presented in a letter from the American Trucking Association (Exhibit 50) and the Wyle report (Exhibit 52), both of which were submitted by the State Chamber of Commerce. Exhibit 50 gives estimates of $235 and $222 average cost per vehicle (probably 1975 or 1976 dollars), but it does not specify the vehicle weight or noise emission characteristics prior to retrofitting for the trucks involved.

In Appendix G of the Wyle report a detailed listing of specific costs for retrofitting heavy trucks is given in Table G.

2-3 (Exhibit 52 pp. G-11,12). The costs are broken down by required treatment, as determined by the existing truck noise level and the noise level to be achieved. The noise levels cited are measured by the SAE J366B test procedure (low speed, maximum powered units).

According to the Wyle report, these noise levels have a one-to-one relationship with observed highway performance at low speed, when tire noise is not a contributing factor; though they average about 9 dBA higher than levels recorded by roadside measurements (Exhibit 52 p. E-1). We may then use costs associated with changes in these noise levels as estimates of incremental costs of noise reduction, though because of the expected 9 dBA difference in measurement results they may overestimate costs for attainment of a given dBA level under the Illinois regulation.

According to the Task Force report (Exhibit 2, p. III-27) 15% of heavy trucks exceed 86 dBA in the low speed drive-by mode of operation. Half of that 15% exceed 88 dBA. These trucks can be brought into compliance by retrofit of exhaust systems and for some of the trucks by additional modification of the cooling and/or intake systems.

Referring to Table G.2-3 in the Wyle report (Exhibit 52), in order to reduce noise from 88 dBA to 86 dBA a total range of $50-300 cost per truck (1973 dollars) is estimated. Consistent with the Task Force assessment, the control said to be needed is retrofitting for exhaust and cooling system. By weighting this maximum range of costs by the percent of vehicles requiring each treatment, a range of average cost per vehicle of $90-150 is obtained. These costs, which would be applicable to at least half of the trucks in violation at low speed, are consistent with the Task Force 1973 estimate of $114. The remaining violating trucks would probably require somewhat higher retrofit costs, averaging $146-265 according to the Wyle report cost estimates for noise reductions from 90 dBA to 86 dBA. The Task Force brought out the point that the Wyle retrofit cost estimates were based on the translation of manufacturers estimates for quieting new vehicles to the quieting of in-use vehicles, assuming somehow comparable costs (R. 947-8). Based on sensitivity analysis performed by the Task Force, even if their cost estimate is low, which it does not appear to be, at this magnitude of difference it would not change the overall benefit-cost balance for regulating heavy trucks, though it would reduce the benefit cost ratio (Comment 53).

The Chamber of Commerce also questioned cost estimates for light trucks and automobiles. Their argument was that some models (particularly older vehicles) could not comply with the noise limits

by using currently available exhaust equipment; that expensive redesign of equipment would be necessary (R. 810-811; Exhibit 48). Nonetheless, as demonstrated in survey results in Exhibit 29 and discussed in Exhibit 27 (pp. 24-26), compliance is shown to be possible with standard equipment and reasonable driver behavior. Anticipated costs associated with redesign would therefore not be incurred as a result of this regulation.

Similar questions were raised regarding compliance by medium trucks and buses with the low speed 82 dBA limit (Comment 48). In the case of medium trucks now controlled by heavy truck noise standards they are already essentially 100% in compliance. A comment by General Motors (Comment 10) was cited wherein they state that their diesel powered buses of 30,000 GVW or more are designed to not exceed a maximum of 86 dBA; and therefore some buses will not be able to comply with the 82 dBA limit. Survey results support the consistently maintained position of the Task Force that by design buses are quieter than similar weight trucks and can in fact attain the 82 dBA noise levels with proper control equipment (Exhibits 2, 12; Comment 53 p. 19). Under the new Rule 311, as with medium trucks, buses are expected to already fully comply with the standards, and no costs for compliance will be expected.

Costs associated with vehicle noise testing by owners to ascertain their compliance were suggested as additional costs which were not considered in the study. Other costs which would be incurred as a result of litigation to determine interstate carrier status under new Rule 313 were also brought forth as omissions from the analysis (R. 812; Comment 48). As stated by the Task Force (R. 883), litigation costs are incurred by choice of the owners rather than as a necessary response to regulation, and as such are not appropriately included in the analysis. Under new Rule 311 no such determination will be necessary. If included, both testing and litigation costs would be very difficult to quantify.

Estimated costs for State enforcement of the regulation were provided by the State Police to the Task Force, based on use of 30 teams of two officers each, with each team having its own sound level meter. Costs include training, salaries, equipment, and overhead costs. There are also local enforcement cost estimates included in the total (R. 857, Exhibit 44 pp. 94-100). The State Police estimates are based on their judgment of reasonable field coverage within their capability at the time. Should these resources not be fully available, which according to testimony of the Motor Vehicle Laws Commission the Police have since told them to be the case (R. 903-909; Exhibit 47), then the estimated enforcement costs will be lower.

Several questions have also been raised about the use of property values to measure incremental benefits of noise control. The use of a statistical analysis rather than personal interviews was criticized, as well as the apparent reliance on results of only one econometric study in benefit calculations (R. 784-789; R. 814, R. 901).

The limitations of the use of property values are recognized and should be taken into account when interpreting results of benefit cost analysis. The Task Force considers property value to be a conservative estimate of benefits which only measures perceived benefits of noise reduction (R. 781-783; Exhibit 44 p. 126). References presented in Exhibit 45 discuss these limitations and specify that the method can only be used to measure incremental benefits with changes in noise levels rather than absolute benefit values. It is noted that benefits such as a reduction in long-term hearing loss and benefits in other than residential households (e.g. schools, business districts, or hospitals) are not included in this measure.

Within these limitations, however, the Task Force carefully evaluated several econometric studies in selecting the dollar value per dBA reduction, and they used values generated by two different studies in the base case and one variant case for benefits (R. 790-791). Their estimates of benefits from neighborhood noise reduction resulting from in-use motor vehicle noise regulation may be considered reasonable, though very probably conservative.

The Wyle Research Report No. WCR75-2, entitled "Community Noise Countermeasures: Cost-Effectiveness Analysis" (Exhibit 52) was cited in testimony by the Motor Vehicle Laws Commission (R. 788-789, 910) and the Illinois Chamber of Commerce (R. 814-817, 995-999). They both stated that findings of this report as to costs and benefits for vehicular noise control were much different from those of the Task Force and that it should have been considered by the Task Force in its analysis. The Task Force responded that, "The Wyle Report sought (among other things) to measure the reduction in community noise levels that the quieting of various noise sources, including motor vehicles, might bring." (Exhibit 55, p. 11) They explain that the report addresses the question, "...if you have a budget of X million dollars, how should it be allocated among alternative quieting or abatement opportunities in order to achieve the maximum noise reduction." (R. 930) It does not contradict the Nelson property value study because it does not develop dollar figures for benefits but only a noise impact index in L_{eq}.

Review of the Wyle Report verifies the Task Force's description of the study. The study addresses the control of community noise in Portland, Oregon by considering trucks, buses, autos, railroad operations, and aircraft as noise sources. Control techniques evaluated included source modification, rerouting of moving sources, barriers, building insulation, and relocation of human receptors. The cost-effectiveness of various combinations of these control techniques was evaluated, assuming three levels of total expenditure ($5, 10, and 30 million). Because the Wyle Report considers more than just vehicular sources of community noise and a variety of control techniques, and because it does not measure benefits of noise reduction in dollars, its conclusions cannot be directly compared to those of the Economic Impact Study (Exhibit 44). The report does provide estimates of unit costs for equipment to reduce noise emitted by individual vehicles, and several of those costs have indeed been considered in this Opinion in discussion of cost estimates used by the Task Force.

The Comments of the Council on Wage and Price Stability Regarding Proposed Noise Emission Standards for Medium and Heavy Duty Trucks before the U.S. Environmental Protection Agency on May 9, 1975 were cited by the Motor Vehicle Laws Commission (R. 899-913) and submitted as Exhibit 47. The Commission felt that consideration should be given to the conclusions of the Comments, which questioned the benefit-cost of noise standards of 80 dBA and 75 dBA for new medium and heavy duty trucks, while acknowledging the benefit of an 83 dBA new vehicle standard. As with the Wyle Report, this assessment cannot be compared directly with the Task Force benefit-cost analysis because the document relates to a different subject. The Council was analyzing standards for new vehicles under a maximum noise test to be phased in over a number of years, while the Task Force proposal is designed to control in-use vehicle noise under roadway operation and measured by a drive-by noise test (Exhibit 55). It is noted that the benefit measure used by the Council was the change in property value measure developed in the Jon Nelson study, the same measure used by the Task Force in its base case of benefits.

The Board has reviewed and considered the results of the Economic Impact Study along with the rest of the record in its consideration of the need for regulation, the technological feasibility, and the economic reasonableness of the proposed motor vehicle noise regulation. The findings of the study of much greater benefits than costs for control are considered to be conservative estimates of net benefit because of assumptions in the calculations made by the Task Force which tended to overestimate costs and underestimate benefits (Comment 76) and because of the conservatism of the residential property values used as a measure of benefit, as discussed above.

The Board finds that the enactment of this regulation will, as has been fully discussed above, create some adverse economic impact on the people of the State of Illinois. However, the Board further finds that such adverse impact will be literally dwarfed by the benefits which this regulation will bestow upon the people of Illinois.

Enforcement Of The Regulation

In its letter of January 19, 1977 (Comment #79), the Motor Vehicle Laws Commission reiterated its concern regarding the costs of enforcing the proposed regulation. In essence, the Commission's fear is that if the State Police will not enforce the regulations then these costs will be borne by the taxpayers in some other way which has not been dealt with in the Economic Impact Study. The Commission assumes that the Agency would spend great sums of money to purchase equipment, etc. These fears arise from the budgetary constraints of the State Police and the apparent position of the State Police that they would not be required by law to enforce the proposed regulations (See Comment #21). Budgetary constraints are a reality for all state agencies. There is no reason to be surprised that not every vehicle which violates the regulations will be quickly located and enforced against. The expectation, rather, is that enforcement agencies will, as commanded by the legislature in Section 44(a) of the Environmental Protection Act, fulfill their duties. Furthermore, the costs to both State and local governments of enforcing these regulations have been fully considered in the Economic Impact Study (Exhibit #44, pages 94-100). These estimates reflect the costs for a given level of enforcement, regardless of whether and to what extent they will be assumed by the State Police or the Agency.

It is the intent of the opening portion of the Board's Order to allow and encourage the local enforcement and adoption of these regulations. By making it clear that any local government may adopt compatible ordinances, the Board has recognized that in many cases local government is a proper enforcement agency, and that the local Circuit Court is an appropriate forum for prosecution of either the Board regulation or compatible ordinances.

This Opinion contains the Board's findings of fact and conclusions of law.

Mr. James L. Young will file a dissenting opinion.

I, Christan L. Moffett, Clerk of the Illinois Pollution Control Board, hereby certify the above Opinion was adopted on the 26th day of May, 1977 by a vote of 4-1.

Christan L. Moffett, Clerk
Illinois Pollution Control Board