applicability. This requires the evaluation of not only simple site configurations as was undertaken in this paper but also of complex geometries where the full extent of the model is exercised. Finally, it is recommended that, as a result of this analysis, further investigation of site-to-site bias error and the noise reduction performance of berms is warranted from this analysis.

References

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SPECIFIC DIFFERENCES BETWEEN THE "REVISED DESIGN GUIDE" AND THE TWO AUTHORIZED NOISE PREDICTION METHODS OF THE FHWA

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The National Cooperative Highway Research Project 3-7/3 has recently resulted in the publication of a revised design guide for prediction of roadway traffic noise. This guide is a composite product of NCHRP Reports 117/144 and the Transportation Systems Center prediction methods—the two methods authorized by the Federal Highway Administration for use on federal-aid highway projects. The revised design guide (RDG) supplements these two authorized methods (117/144 and TSC) with data taken as part of NCHRP 3-7/3 and as part of an FHWA research project on noise barrier effectiveness. In addition, the RDG supplements the two authorized methods with additional mathematical structuring, derived from physical reasoning, with the hopes of extending the prediction validity to low-volume traffic situations.

In brief, the RDG structure consists of an L_{10} nomograph (similar to the TSC nomograph but with revised source data and revised distance dependence), a barrier nomograph (similar to the FHWA barrier nomograph but with revised distance dependance and revised estimates of the noise around the barrier ends), and a series of worksheets—all leading to a hand-method calculation for simple roadway geometrics. As a partner to the hand method, the RDG includes a computer program (similar to the TSC program but with revised source levels, variable propagation drop-off, revised low-volume mathematics, segment adjustment and many other factors) for the detailed prediction of roadway noise levels, both for complex roadway geometrics and for detailed barrier design. In addition, this computer program contains a diagnosis capability that pinpoints "hot spots" along the roadway and enables the user to balance any barrier design up and down the roadway, to avoid under- or over-design of expensive roadway barriers.

In this paper, these three noise prediction methods (117/144, TSC, and RDG) are coalesced into a common framework, to enable users of these methods (a) to compare the physical assumptions of the methods step by step in the calculation logic; and (b) to anticipate how the RDG will change the predicted noise levels, relative to those predicted by 117/144 and TSC. The common framework consists of three graphs and two equations that coalesce the three methods into the following calculation logic: emission levels (EL) of individual vehicles at 50 ft (15.24 m); to the energy-mean A-level (L_{eq}) at 50 ft (15.24 m), from the entire stream of traffic; to the L_{eq} at any distance D; and finally, to the 10-percentile A-level (L_{10}) at this same distance (with an ad hoc adjustment, necessary only in the 117/144 method).

We first present this common framework, for predicting the L_{10} for an infinite straight roadway. Next, we present three examples using the framework to compute the noise levels for medium, high, and low density traffic. Then we present a series of graphs and tables that complete the comparison of the three prediction methods, in all their finer details. And finally, we summarize the framework and identify under what conditions the RDG predictions will differ from 117/144 and TSC by 5 dBA, by 10 dBA, and by 15 dBA. In this summary, we emphasize the RDG improvements that result from (1) inclusion of medium trucks as a noise source; (2) a variable propagation constant; (3) more realistic low-volume mathematics; and (4) the inclusion of a diagnostic print-out in the RDG computer program.

The Common Framework for Roadway Noise Prediction

In this section, we present the common framework for roadway traffic noise. This framework coalesces the distinctly individual mathematics of the three prediction methods of interest: the 117/144 method, the TSC method, and the RDG method. The framework was designed to illuminate the logical relationships among these three distinct methods. It is not the "official" framework for any of the three. Instead, it is a physically realistic composite of each method's stated physical assumptions, unstated assumptions and generally unstated physical logic. Our emphasis is upon the common attributes of each method.

Use of the framework for noise computation results in predictions within 1 or 2 dBA of "official" predictions, i.e., predictions using the actual mathematics of each method separately.

The framework consists of five steps:

1. Emission levels (EL) of individual vehicles at 50 ft (15.24 m);
2. Conversion to L_{eq} at 50 ft (15.24 m) from an entire stream of vehicles;
3. Conversion to L_{eq} at Distance D;
4. Conversion to L_{10} (and L_{50}) at Distance D; and
5. An ad hoc adjustment, necessary only in the 117/144 method.

Emission Levels

Figure 1 contains all the emission level (EL) assumptions of the three prediction methods. Plotted are the emission levels as a function of speed for three types of roadway vehicles: automobiles (which include 4-wheel trucks); medium trucks (all 6-wheel vehicles, including 6-wheel buses); and heavy trucks (all vehicles with more than 6 wheels, including applicable buses). Only the RDG incorporates medium trucks. The other two methods prescribe heavy-truck EL's for medium trucks as well. Note that the level-mean EL's are plotted in Figure 1, rather than the energy-mean EL's, which are from 1 to 3 dBA higher.

In 117/144, the emission level assumptions are explicit, but the distinction between level-mean EL's and energy-mean EL's is neglected; this neglect effects the subsequent step in our framework. In TSC, the emission level assumptions are also explicit and listed as level means. In RDG, the emission level assumptions are again explicit and listed as energy means.

Conversion to L_{eq} at 50 ft (15.24 m)

Equation 1 converts from emission levels (EL) to L_{eq} at 50 ft (15.24 m) in engineering units.

$$L_{eq}\underset{(50\text{ ft.})}{(15.24\text{ m})} = (\text{Level-mean EL}) + 10\log\left(\frac{V}{S}\right) - 12 - \begin{cases} 4 \text{ for RDG} \\ 2 \text{ for TSC} \\ 0 \text{ for 117/144} \end{cases} \quad (1)$$

where

V = vehicle volume, in veh/hr, and
S = vehicle speed, in mph.

To convert to SI units, replace the -12 with +20. Then V must have units of veh/sec and S units of meters/sec.

This equation follows directly from integrating the passage of V vehicles along an infinite straight roadway located 50 ft (15.24 m) from the observation point. The equation assumes a 3 dBA difference between level-mean EL's and energy-mean EL's, as was explicitly measured in the RDG study.

Note that empirical adjustments to this equation are required for each of the three prediction methods. The -4 dBA adjustment is explicit in the RDG, as an empirical adjustment required to match predictions with measurements. The -2 dBA adjustment is necessary in TSC to account for a lesser difference between the level-mean and energy-mean EL's. This lesser difference follows directly from the supporting EL data in TSC. (The scatter of EL's about the level-mean EL is less than in the RDG data.) The 0 dBA adjustment for 117/144 results from neglecting the distinction between level-mean EL's and energy mean EL's; by this neglect, the level was not increased to convert from level-mean to energy-mean in the development of 117/144, and therefore the level did not have to be decreased empirically to match L_{eq} measurements.

Note that these empirical adjustments tend to wash out the differences in emission levels among the three prediction methods.

Conversion to L_{eq} at Distance D

Figure 2 converts from L_{eq} at 50 ft (15.24 m) to L_{eq} at Distance D. Plotted are the two propagation lines that correspond to divergencies of -3 dB per distance-doubling and -4.5 dB per distance-doubling.

In TSC, the -3 dB/DD follows directly from the line-source mathematics incorporated; this divergence is derived for an incoherent line source, infinitely long. In 117/144 the -4.5 dB/DD is forced upon the mathematics and justified by comparison with many experimental measurements. The great bulk of these measurements was made some 4 or 5 ft (1.2 m or 1.5 m) above absorptive, flat terrain, and therefore incorporates the influence of the nearby ground (which is ignored in the TSC mathematics). In addition, the bulk of these measurements was made adjacent to heavy traffic flows, where the level difference between L_{eq} and L_{50} is very small, and therefore unimportant. These data therefore obscured the conceptual differences between L_{eq} and L_{50}, and as a result this propagation factor was ascribed to L_{50} under all traffic conditions. In our common framework, we associate the propagation factor with L_{eq}, as is physically reasonable, and account for the confusion between L_{eq} and L_{50} in a subsequent step in the framework (ad hoc adjustment).

In the RDG, the divergence switches from -3 dB/DD to -4.5 dB/DD, as a function of observer height and type of ground cover, as shown in the figure.

Conversion to L_{10} at Distance D

Figure 3 converts the L_{eq} to the L_{10} at Distance D. Also plotted are conversion lines to L_{50}. Both the TSC and the RDG methods incorporate a computer program and a simplifying nomograph. The conversion to L_{10} differs for computer and nomograph, and therefore four L_{10} conversion lines are plotted.

Conversion to L_{10} is a function of the parameter VD/S, which is "parameter A" of 117/144. In effect, VD/S is the Distance D, normalized by the average spacing between vehicles on the roadway. The statistics of the noise fluctuations depends only on this parameter VD/S, when the vehicles are equally spaced along the roadway. This equal spacing is explicit in the RDG method. Since the statistics of the fluctuations depend only on VD/S, then so do the conversions from L_{eq} to any of the percentile levels.

This figure is the most complex portion of the common framework; its interpretation is reasonable, but not immediately intuitive.

The two nomograph conversions are easiest to interpret. They indicate a conversion that is independent of VD/S; i.e., the L_{10} nomographs ignore the statistics of the fluctuations and are essentially nomographs for L_{eq} (plus three decibels). Both methods state this explicitly.

The computer conversions for RDG are next easiest to interpret, since they are explicit in RDG. In RDG, a Gaussian conversion curve is developed for high values of VD/S and a conversion curve for equally spaced vehicles is developed for low values of VD/S. Then these two conversion curves are patched together in the vicinity of 300 ft/mile (91.44 m/km), to result in the conversion curves shown in Figure 3.

Figure 4 aids in interpreting the 10 log (VD/S) slope for low VD/S. At the top of Figure 4, a vehicle proceeds along a roadway, past an observer location. The vehicle is illustrated at two successive positions on the roadway, corresponding to its L_{10} position under two traffic conditions: volume = V_o and volume = $2V_o$.

The level history for these two traffic conditions is shown underneath the roadway. For a volume of V_o, the vehicle noise increases slowly from a relative level of -35 dB to a peak of 0 dB, and then recedes. Also shown are the tail ends of the level histories for the vehicle immediately preceding and the one immediately following. Since the traffic is equally spaced, the interval between (normalized) distances -55 and +55 includes the full statistics of the noise history. The level exceeded for 10 percent of this interval is the L_{10} for the full hour. This L_{10} is shown in the figure, and is 15 dB down from the peak level. The vehicle's position on the roadway, when it is producing the L_{10} at the observer, is shown at the top.

If now the volume doubles to $2V_o$, then the interval between vehicles is halved, as shown in the middle illustration. Again the L_{10} is shown, this time down only 9 dB from the peak. In the process of doubling the traffic volume the L_{10} has thereby increased 6 dB. The reason is apparent from the roadway sketch at the top. The vehicle's

Figure 1. Emission levels (level mean).

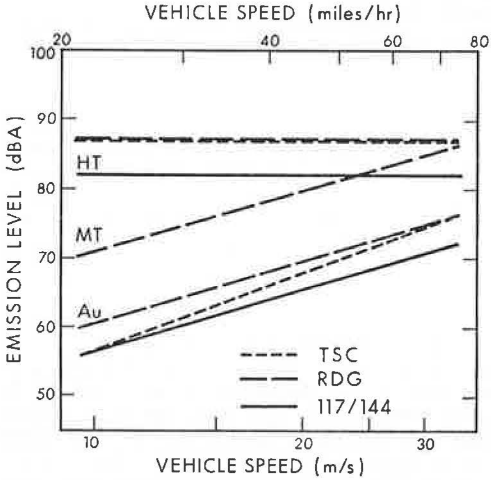


Figure 2. Conversion of L_{eq} from 15 m (50 ft) to other distances.

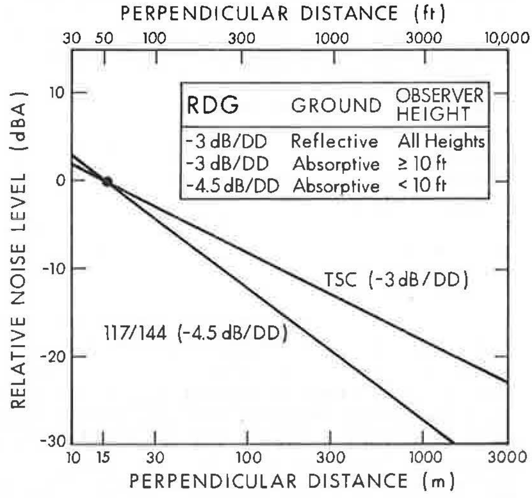


Figure 3. Conversion from L_{eq} to L_{10} and L_{50}.

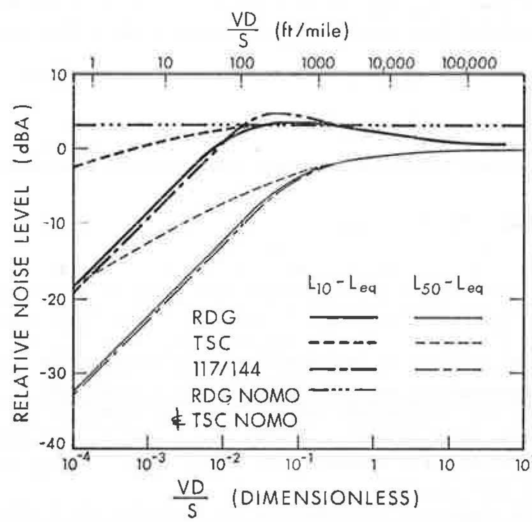
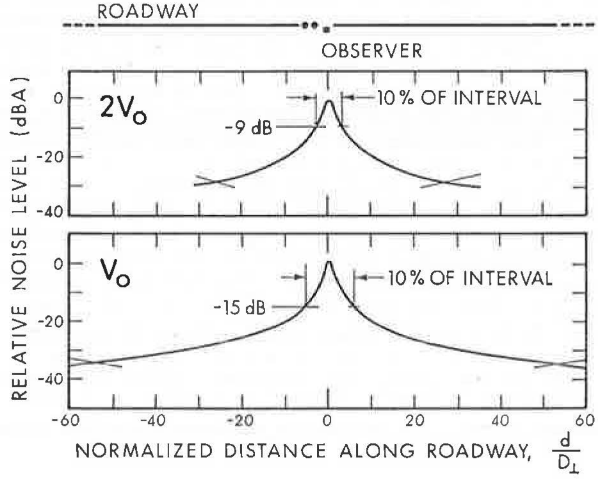


Figure 4. 6 dB/double-volume at low VD/S.



position when it actually produces the L_{10} at the observer has been cut in half as the volume was doubled; and the level from this point source has therefore increased the expected 6 dB. A similar figure for L_{50} would show the same 6 dB increase per double-volume, at these low traffic volumes (strictly, at low values of VD/S). The resulting 6 dB/double-volume increase is incorporated explicitly for L_{50} in 117/144, where it was generated from a computer simulation of randomly spaced vehicles at low traffic volumes. As is apparent, the L_{10} does not obey conservation of energy principles, as does the L_{eq}.

Another strange attribute of the L_{10} at the low VD/S is its distance dependence; this attribute is apparent from Figure 5, also. If the observer in this figure were to halve his distance to the roadway, the L_{10} would not increase; he would be halving his distance to an empty portion of the roadway. When he observes his L_{10}, no vehicles occupy the roadway in front of him; the nearest vehicle is far down the roadway, as shown. In fact, he could walk directly across the roadway and the L_{10} would still not increase. (The peak noise would increase, of course.) In essence, the L_{10} has become an "ambient" noise statistic, produced by distant traffic far down the roadway.

These two attributes of the L_{10} (6 dB/DD and 0 dB/DD) are implicit in Figure 3 of our framework. For low VD/S, as the volume is doubled, VD/S doubles also, and the conversion to L_{10} increases 3 dB. Added to the 3 dB increase in L_{eq}, this conversion results in 6 dB/double-volume. Similarly, as the distance is halved, VD/S is halved also, and the conversion to L_{10} decreases by 3 dB. This decrease cancels the 3 dB increase in L_{eq}, for a net change of zero.

For 117/144, this same conversion behavior exists, as shown in Figure 3. Since the equations in 117/144 were initially generated by randomly scattering vehicles onto a simulated roadway, this L_{10} behavior was expected. In fact, the difference between the L_{10} and the L_{50} curves in Figure 3 (i.e., the $L_{10} - L_{50}$), is explicit in the 117/144. And as mentioned above, the 6 dB/double-volume dependence for L_{50} also is explicit in 117/144. The distance dependence, however, is obliterated in 117/144 by the confusion between L_{eq} and L_{50}. As a result, the "official" distance dependence of 117/144 can only be fit into our common framework by an ad hoc adjustment, discussed below. This confusion lies not in the equations of 117/144 (which are not generally used) but only in the (commonly used) graphs. To duplicate the graphs from the equations, all distances D in the hyperbolic tangent functions must be frozen at 100 ft (30.48 m). (Note also the error in equation 20 of 117/144, where the speed term should have a coefficient of 20 rather than 30.)

In the TSC computer method, the statistics are intermediate between the RDG statistics and the statistics of the nomographs, as shown in Figure 3. It can be shown that the statistics behind this TSC conversion are not valid for very low VD/S.

This completes our discussion of Figure 3. As is apparent, conversion to L_{10} is the most complex part of roadway noise prediction.

Ad hoc Adjustment for 117/144

Equation 2 is the ad hoc adjustment for 117/144.

ADD $L_{50} - L_{eq}$ at 30 m [100 ft (30.48 m)]

SUBTRACT $L_{50} - L_{eq}$ AT PROPER DISTANCE (2)

As discussed above, this adjustment is necessary to force our common framework to predict the "official" (graphical) noise levels of 117/144. The adjustment follows directly from the discussion in the paragraphs above.

Three Examples Using the Common Framework

Here we present three examples of roadway noise predictions, using the common prediction framework developed above. We present these examples to show how the framework illuminates the relationships among the three methods, and how it indicates the seeds of discrepancy among the three methods.

Each example is given in Tables 1, 2, and 3. Along the left side are the successive steps in the common framework. Each line shows the computation result after that particular step has been accomplished. Along the top are columns for the three prediction methods, further subdivided into "computer method" and "nomograph method". Calculations are reported separately for automobiles and heavy trucks. In these examples, we ignore medium trucks, since their inclusion would only cloud the differences due to other factors. Changes in predicted levels caused by inclusion of medium trucks are relatively obvious.

The bottom line of each table includes the "official" results, i.e., the noise levels calculated using the actual published procedures. This line is included for comparison purposes to illustrate the accuracy of this common framework in predicting the "official" levels. The line immediately above (line 8) results from the common framework calculations.

Medium VD/S Example

Table 1 summarizes the medium VD/S example. VD/S equals 100 ft/mile (30.48 m/km) for trucks and 2000 ft/mile (609.60 m/km) for automobiles. At these values, the conversions from L_{eq} to L_{10} are nearly equal for all prediction methods (see Figure 3). In addition, the example distance of 100 ft (30.48 m) eliminates the ad hoc adjustment for the 117/144 method. For both these reasons, the predicted levels do not differ markedly among methods (see line 8 of the table).

Predicted automobile levels are all within 2½ dBA of each other. Predicted truck levels show the expected difference between 117/144 and TSC; the TSC level is approximately 5 dBA higher. As the progressive steps of the calculation indicate, most of this difference is due to the higher emission levels assumed in TSC, aided somewhat by the conversion from 50 to 100 ft (15.24 m to 30.48 m). For trucks, the RDG predictions fall closer to 117/144 than to TSC in spite of the higher emission levels. As steps 5 and 6 indicate, this higher emission level is mostly washed out by the different conversion from EL to L_{eq} at 50 ft (15.24 m). In summary, this example contains no surprises. We consider it the typical case for moderate traffic volumes and low to moderate distances.

High VD/S Example

Table 2 summarizes the high VD/S example. VD/S equals 9100 ft/mile (2773 m/km) for trucks and 91,000 ft/mile (27730 m) for automobiles. A comparison along line 8 shows that 117/144 and TSC differ by up to 12½ dBA, while the RDG predicts levels intermediate between the two.

In comparing 117/144 with TSC, approximately 5 dBA of the discrepancy enters as a result of TSC's louder trucks (line 5), while another 5 dBA is due to the propagation to 1000 ft (304.80 m). The difference is made slightly larger by the ad hoc adjustment to 117/144, although not seriously.

The RDG predictions fall closer to those of 117/144, for two reasons: (1) the increased truck noise emissions are washed out by the empirical adjustment in the conversion to Leq at 50 ft (15.24 m) (lines 5 and 6), and (2) we used the -4.5 dB/DD divergence for our RDG predictions, which equals that used in 117/144 (line 7). Note that if we had used the -3 dB/DD divergence in RDG, our result would have more nearly equalled the TSC result. This variability in the propagation divergence in the RDG method greatly enhances its usefulness for predictions at these large distances.

Low VD/S Example

Table 3 summarizes the low VD/S example. VD/S equals 12 ft/mile (3.65 m/km) for trucks and 55 ft/mile (16.7 m/km) for automobiles.

First examine the automobile columns along line 8. The predictions of 117/144 exceed those for TSC by 6 dBA. This entire discrepancy is due to the ad hoc adjustment to 117/144, resulting from an incorrect transferral from equations to graphs.

Next, examine the truck columns along line 8. The very low VD/S applies only to the trucks in this example. For this reason, the conversion to L_{10} is legitimately negative; however, this legitimate conversion only appears in the RDG computer and in 117/144, line 8a. The conversion is washed out in 117/144 (line 8b), however, by the ad hoc adjustment, which prevents the legitimate statistics at low traffic volumes from surfacing in the 117/144 method. We believe that the RDG computer program realistically predicts the noise levels at these low VD/S conditions. Note that the RDG nomograph does not. In fact, both nomographs predict higher values than their computer counterparts in this region where the conversion to L_{10} is not in the vicinity of +3 dBA.

Many subtleties can be detected in Tables 1 through 3. We pass over the remaining distinctions among the methods and will summarize them later.

Table 1. Medium VD/S example.

	117/144		TSC Comp.		TSC Nomo.		RDG Comp. (-4½dB/DD)			RDG Nomo.		
	Au	HT	Au	HT	Au	HT	Au	MT	HT	Au	MT	HT
1. Volume	800	40	800	40	800	40	800	0	40	800	0	40
2. Speed	40	40	40	40	40	40	40		40	40		40
3. Distance	100	100	100	100	100	100	100		100	100		100
4a. VD/S	2000	100	2000	100	2000	100	2000		100	2000		100
4b. (V(100ft)/S)	2000	100										
5. EL	64	82	65½	87	65½	87	68		87	68		87
6. L_{eq} at 50 ft	65	70	64½	73	64½	73	65		71	65		71
7. L_{eq} at D	60½	65½	61½	70	61½	70	60½		66½	60½		66½
8a. L_{10} at D	63½	68½	64½	73	64½	73	63½		68½	63½		69½
8b. L_{10} at D (with ad hoc adj.)	63½	68½										
9. L_{10} at D per "official" method	64½	69	64½	73	65	73	63½		67½	62½		68

Table 2. High VD/S example.

	117/144		TSC Comp.		TSC Nomo.		RDG Comp. (-4½dB/DD)			RDG Nomo.		
	Au	HT	Au	HT	Au	HT	Au	MT	HT	Au	MT	HT
1. Volume	5000	500	5000	500	5000	500	5000	0	500	5000	0	500
2. Speed	55	55	55	55	55	55	55		55	55		55
3. Distance	1000	1000	1000	1000	1000	1000	1000		1000	1000		1000
4a. VD/S	91000	9100	91000	9100	91000	9100	91000		9100	91000		9100
4b. (V(100ft)/S)	9100	910	----		-----		---		--	---		--
5. EL	68	82	71	87	71	87	72		87	72		87
6. L_{eq} at 50 ft	75½	79½	76½	82½	76½	82½	75½		80½	75½		80½
7. L_{eq} at D	56	60	63½	69½	63½	69½	56		61	56		61
8a. L_{10} at D	57	62	64½	71½	66½	72½	57		63	59		64
8b. L_{10} at D (with ad hoc adj.)	56½	60										
9. L_{10} at D per "official" method	57½	61½	65	71½	66	72	56		63	58		63½

Table 3. Low VD/S example.

	117/144		TSC Comp.		TSC Nomo.		RDG Comp. (-4½dB/DD)			RDG Nomo.		
	Au	HT	Au	HT	Au	HT	Au	MT	HT	Au	MT	HT
1. Volume	100	15	100	15	100	15	100	0	15	100	0	15
2. Speed	45	30	45	30	45	30	45		30	45		30
3. Distance	25	25	25	25	25	25	25		25	25		25
4a. VD/S	55	12	55	12	55	12	55		12	55		12
4b. (V(100ft)/S)	222	50	---	--	---	--	---		--	---		--
5. EL	65½	82	67½	87	67½	87	69½		87	69½		87
6. L_{eq} at 50 ft	57	67	57	70	57	70	57		68	57		68
7. L_{eq} at D	61½	71½	60	73	60	73	61½		72½	61½		72½
8a. L_{10} at D	62	65½	63	74½	63	76	62½		67½	64½		75½
8b. L_{10} at D (with ad hoc adj.)	69	71										
9. L_{10} at D per "official" method	68	72½	62	74½	63	77	61½		67½	63		74

Completion of the Comparisons Among the Three Prediction Methods

The three roadway noise prediction methods (117/144, TSC, and RDG) differ in many of their smaller details. Here we attempt to summarize these remaining differences in graphical form.

The first comparisons are illustrated in Figures 5 through 8. These figures compare (a) the level adjustments for upgrade roadways, (b) the barrier attenuation for barriers subtending the full line source, (c) attenuation due to intervening rows of buildings, and (d) the attenuation due to intervening vegetation. The differences among methods are large in some instances, as the figures show.

These figures are generally self-explanatory, although some comments are necessary concerning the larger differences. The TSC gradient adjustment is zero, since the TSC method assumes that all trucks are "full throttle" along any expressway. The model therefore assumes no additional noise on up-grades. The barrier attenuations differ mainly in the upper limits they allow on maximum attenuation achievable. These differences reflect different engineering conservatism. TSC does not incorporate attenuation due to rows of buildings. In practice, this additional attenuation is grafted onto the TSC method from 117/144. Attenuation due to vegetation is significantly overestimated in the TSC method. For example, the attenuation due to thick grass, as shown in Figure 8, applies whenever the line-of-sight between source and observer comes within 3 m of the ground surface. In addition, the upper limits of 30 dBA attenuation are not achievable in practice, with any practical reliability.

Several miscellaneous, but important, differences remain. They are summarized in Figure 9. The ground-effect attenuation is extremely important. In the RDG method, the difference between the -4.5 dB/DD at low observer heights over absorbent ground and the mathematically derived -3 dB/DD is attributed to the effect of the absorbent ground. As a corrollary, whenever a barrier is built to shield an observer from the roadway, if the resulting propagation path from barrier top to observer makes an angle greater than 10 degrees with the horizontal plane, this ground effect is lost. The resulting insertion loss of the barrier is therefore computed as less than the barrier attenuation by the amount of the lost ground-effect attenuation.

Also as a result of this ground-effect attenuation, the noise energy received from the far ends of the roadway is deemphasized in the RDG computer program, analogous to the natural deemphasis due to atmospheric absorption, increased ground-effect attenuation, and miscellaneous intervening trees, shrubs and houses, as well as due to wind and thermal gradients (which affect propagation from large distances). This deemphasis follows directly from the mathematical manner in which the RDG computer program generates the reduction from -3 dB/DD to -4.5 dB/DD. As a result, less energy is predicted around the ends of very long roadside barriers in the RDG method than is predicted for 117/144 and TSC.

Summary of the Important Differences Among the Three Prediction Methods

In the section on common framework for roadway noise prediction, the graphs and equations of the common framework contain within them the major differences among the three roadway noise prediction methods, as these methods are used to predict unobstructed noise from infinite, straight roadways. These differences center around the improved RDG predictions at low VD/S, the inclusion of medium trucks in the RDG method, and the flexibility in the rate of divergence (-d dB/DD to -4.5 dB/DD) in the RDG method. The differences among the three methods are explicit in the graphs and equations of the common framework.

These differences were also illustrated in the three examples of the section on examples using the common framework, where the common framework was used to approximate the "official" predictions.

Tables 4 and 5 summarize all the major differences among the three methods. The tables are constructed in this manner: (a) for users who have been using 117/144 for their noise predictions, Table 4 summarizes the changes in predicted noise levels if a switch is made to the RDG method; (b) similarly, for TSC, Table 5 summarizes the change in predicted noise levels if a switch is made from TSC to the RDG method.

With each change is tabulated the particular circumstances that will produce the change. Some of these circumstances are extreme, such as D = 3000 ft (4828 m), but are included for completeness.

Changes of 10 dBA are relatively prevalent in the tables, while extreme changes of 15 dBA are rare. We hope this common framework and summary table will be of use to engineers and planners who use these methods for roadway noise prediction.

Figure 5. Gradient adjustment.

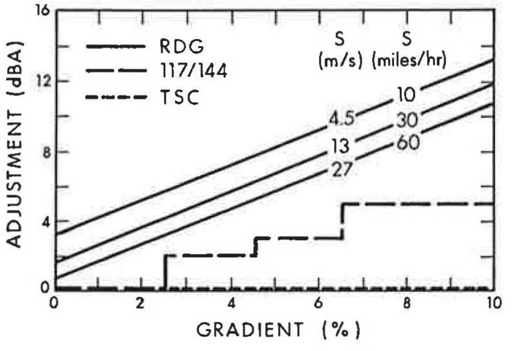


Figure 6. Barrier attenuation.

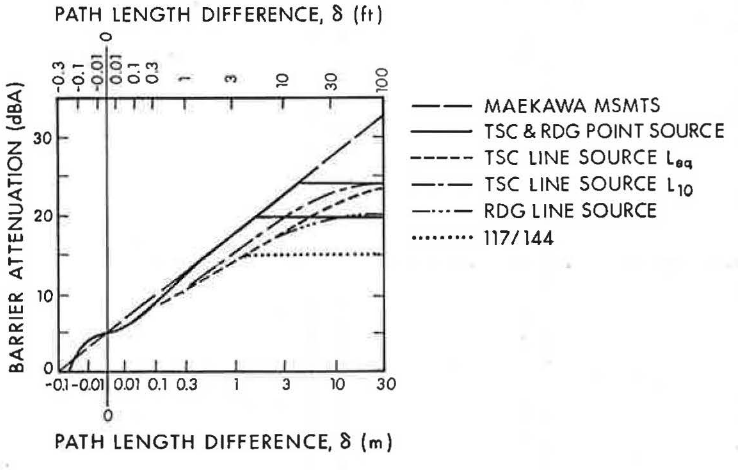


Figure 7. Attenuation due to rows of buildings.

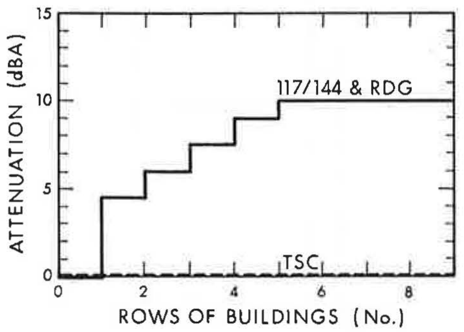


Figure 8. Attenuation due to vegetation.

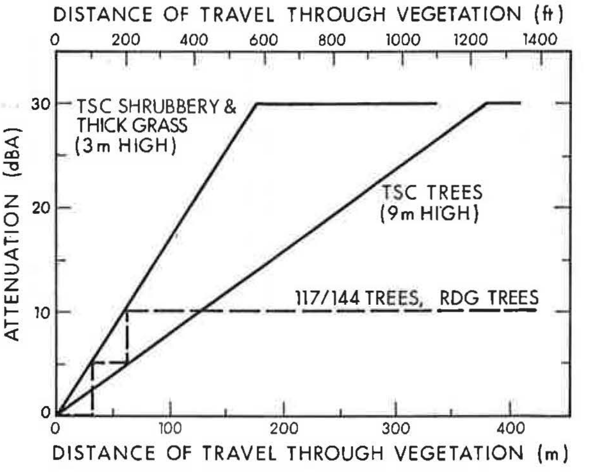


Figure 9. Miscellaneous comparisons.

ADJUSTMENT	117/144	TSC	RDG
Road Surface	yes	no	yes
Interrupted Flow	yes, but not valid	no	no
Ground-Effect	Ignored	Ignored	Incorporated (Computer)
RDWY — OBS	Ignored	Incorporated (Computer)	Incorporated (Computer)
Computer Input	Laborious	Manageable, Poorly Defined	Manageable, Well Defined
dB-Addition	Poor	OK	OK

Table 4. Summary of changes: 117/144 to Revised Design Guide.

		5 dBA Change		10 dBA Change		15 dBA Change
Auto EL's, including conversion to L_{eq}		---		---		---
HT EL's, including conversion to L_{eq}		---		---		---
MT's separated from HT's	↓	55 miles/hr	↓	30 miles/hr	↓	20 miles/hr
Gradient adjustment	↑	lower speeds	↑	15% grade		---
	↑	higher speeds, 8% grade				
Road surface adjustment		---		---		---
Distance	↑	600 ft, hard ground or upper floor	↑	3000 ft, hard ground or upper floor		---
Ad hoc adjustment	↑	D=300 ft, and VD/S <1000 ft/mile	↑	D=1000 ft, and VD/S <1000 ft/mile	↑	D=3000 ft, and VD/S <1000 ft/mile
	↓	D=30 ft, and VD/S <1000 ft/mile				
Conversion from L_{eq} to L_{10} (computer)	↓	VD/S=50ft/mile	↓	VD/S=10ft/mile		---
Conversion from L_{eq} to L_{10} (nomograph)		---		---		---
Barriers	↓	δ > 100 ft		---		---
				---		---
Vegetation		---		---		---
Rows of buildings		---		---		---
Interrupted flow	↓	trucks dominate		---		---

Table 5. Summary of changes: TSC to Revised Design Guide (RDG).

		5 dBA Change		10 dBA Change		15 dBA Change
Auto EL's, including conversion to L_{eq}	↑	low speed		---		---
HT EL's, including conversion to L_{eq}		---		---		---
MT's separated from HT's	↓	55 miles/hr	↓	30 miles/hr	↓	20 miles/hr
Gradient adjustment	↑	3% grade	↑	8% grade	↑	15% grade
Road surface adjustment	↑	rough, autos and MT's only				
	↓	smooth, autos and MT's only				
Distance	↓	600 ft, absorptive, ground and 1st floor	↓	3000ft, absorptive, ground and 1st floor		---
Ad hoc adjustment		---		---		---
Conversion from L_{eq} to L_{10} (computer to computer)	↓	VD/S=20ft/mile		---		---
Conversion from L_{eq} to L_{10} (nomograph to nomograph)		---		---		---
Barriers	↑	δ > 60 ft		---		---
Vegetation	↓	100 ft of trees	↓	200 ft of trees		
Rows of buildings	↓	1 row of bldgs	↓	> 4 rows of bldgs.		
Interrupted flow		---		---		---