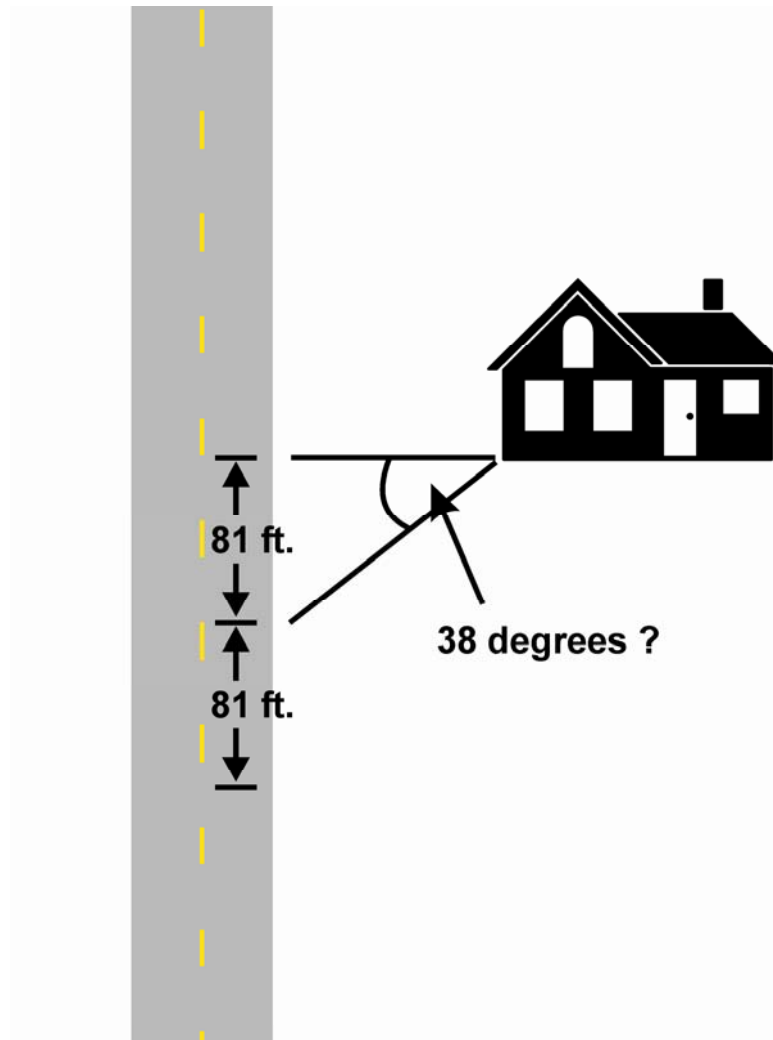


Rumble Stripe Noise Study

Noise Study Approach

- Data collection of noise at 50 ft from roadside
- Collect data from passenger vehicle on/off rumbles
- Data input into MINNOISE model and predicted hourly noise levels are generated

Optimum Noise Levels



Model Parameters

- Terrain – soft ground
 - Soils, grasses, prairie, etc. (non developed)
- Hourly Traffic Volume
- Traffic Distribution

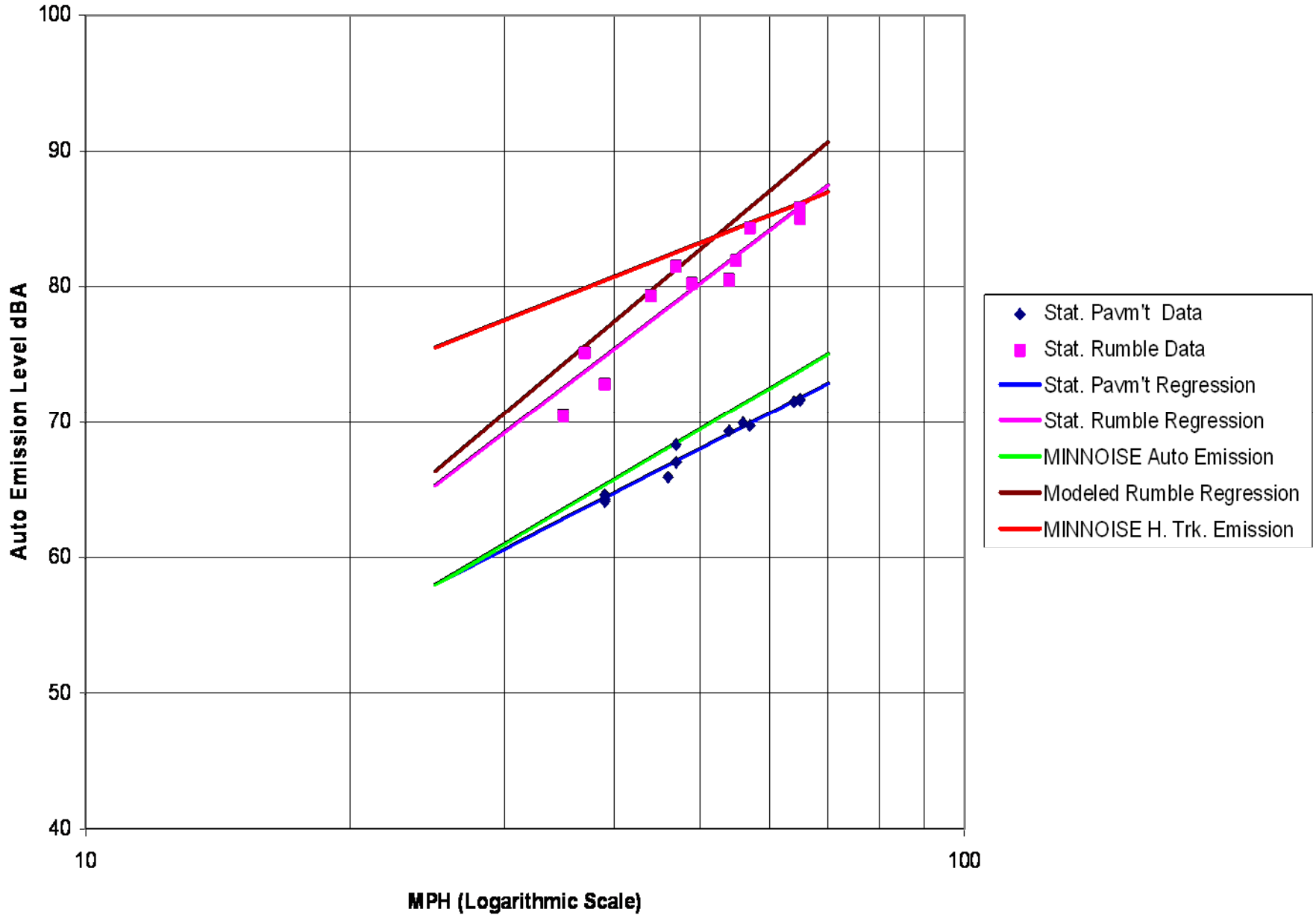
Data Provided

- ADT – 500, 750, 1000, 2000, 5000
 - Converted to maximum hourly volume (TDA)
- Traffic Distribution
 - Rural – 91.1% auto, 5% light truck, 3.9% heavy truck
 - Urban – 96.1% auto, 2.7% lt truck, 1.2% heavy truck
- Hit rate – 5%

TABLE 1 OTST supplied input and calculated results.

OTST Input.							
	(5% hit rate)						
ADT	Hourly Volume	# of hits	Vehicle Breakdown			@ 55 mph	
500	44	2		Rural	Urban		
750	66	3	Auto	91.10%	96.10%		
1000	88	4	Medium Truck	5%	2.70%		
2000	176	9	Heavy Truck	3.90%	1.20%		
3000	264	13					
5000	440	22					
Calculated Hourly Volumes							
		Rural			Urban		
ADT	Autos	MTs	HTs		Autos	MTs	HTs
500	40	2	2		42	1	1
750	60	3	3		63	2	1
1000	80	4	3		85	2	1
2000	160	9	7		169	5	2
3000	241	13	10		254	7	3
5000	401	22	17		423	12	5

FIGURE 1 Exterior Rumble Stripe Regression



Modeled Distances

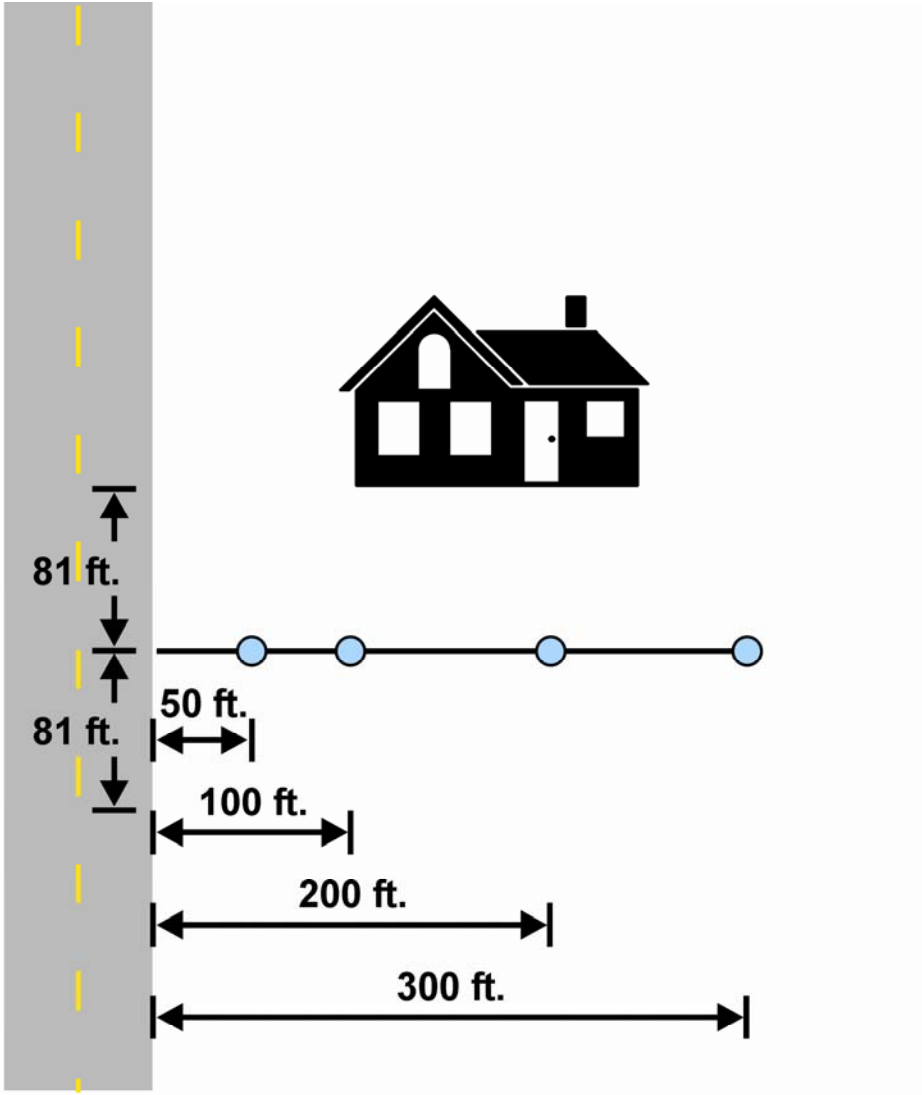


TABLE 2 Rural Comparison of hourly descriptors and 2 second average rumble stripe level

ADT	Descriptor	50 feet		100 feet		200 feet		300 feet	
		Pavment	Rumble	Pavment	Rumble	Pavment	Rumble	Pavment	Rumble
Veh/Day		dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
500	L10	58.5	59.5	55	55.5	51	51.5	48.5	49
	L50	45.5	46.5	43	43.5	40	40	38	38.5
	2 Sec. Avg.		82		75		67		62.5
750	L10	60.5	61.5	57	57.5	53	53.5	50.5	51
	L50	48.5	49	45.5	46	42.5	43	40.5	41
	2 Sec. Avg.		82		75		67		62.5
1000	L10	62	63.5	58.5	59	54.5	55	52	52.5
	L50	50	51	47.5	48	44.5	44.5	42.5	43
	2 Sec. Avg.		82		75		67		62.5
2000	L10	65.5	67	62	62.5	58	58	55.5	55.5
	L50	54.5	55.5	52	52.5	49	49	47	47
	2 Sec. Avg.		82		75		67		62.5
3000	L10	67.5	69	63.5	64.5	59.5	60	57	57.5
	L50	57	58	54.5	55	51	51.5	49.5	49.5
	2 Sec. Avg.		82		75		67		62.5
5000	L10	70	71.5	66	67	62	62.5	59.5	59.5
	L50	60.5	61.5	57.5	58	54.5	55	52.5	52.5
	2 Sec. Avg.		82		75		67		62.5

TABLE 3 Urban Comparison of hourly descriptors and 2 second average rumble stripe level

ADT	Descriptor	50 feet		100 feet		200 feet		300 feet	
		Pavment	Rumble	Pavment	Rumble	Pavment	Rumble	Pavment	Rumble
Veh/Day		dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
500	L10	57	58.5	53.5	54	49.5	50	47	47.5
	L50	44.5	45	41.5	42	38.5	38.5	36.5	37
	2 Sec. Avg.		82		75		67		62.5
750	L10	59	60.5	55.5	56	51.5	52	49	49.5
	L50	47	47.5	44	44.5	41	41.5	39.5	39.5
	2 Sec. Avg.		82		75		67		62.5
1000	L10	60.5	61.5	56.5	57.5	52.5	53	50	50.5
	L50	48.5	49	45.5	46	42.5	43	41	41
	2 Sec. Avg.		82		75		67		62.5
2000	L10	64	65.5	60	61	56	56.5	53.5	54
	L50	53	54	50.5	50.5	47	47.5	45.5	45.5
	2 Sec. Avg.		82		75		67		62.5
3000	L10	66	67.5	62	63	58	58.5	55.5	55.5
	L50	55.5	56.5	53	53	50	50	48	48
	2 Sec. Avg.		82		75		67		62.5
5000	L10	68.5	70	64.5	65.5	60.5	61	57.5	58
	L50	59	60	56	56.5	53	53	51	51
	2 Sec. Avg.		82		75		67		62.5

TABLE 4 Rural Difference between hourly descriptors and 2 second average rumble stripe level and background noise

ADT	Descriptor	50 feet	50' Ave. Level	100 feet	100' Ave. Level	200 feet	200' Ave. Level	300 feet	300' Ave. Level
		Descriptor Diff.	2 Sec. Excursion	Descriptor Diff.	2 Sec. Excursion	Descriptor Diff.	2 Sec. Excursion	Descriptor Diff.	2 Sec. Excursion
Veh/Day		dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
500	L10	1	23.5	0.5	20	0.5	15.5	0.5	13.5
	L50	1	36.5	0.5	32	0	27	0.5	24
750	L10	1	21.5	0.5	18	0.5	13.5	0.5	11.5
	L50	0.5	33.5	0.5	29.5	0.5	24	0.5	21.5
1000	L10	1.5	20	0.5	16.5	0.5	12	0.5	10
	L50	1	32	0.5	27.5	0	22.5	0.5	19.5
2000	L10	1.5	16.5	0.5	13	0	9	0	7
	L50	1	27.5	0.5	23	0	18	0	15.5
3000	L10	1.5	14.5	1	11.5	0.5	7	0.5	5
	L50	1	25	0.5	20.5	0.5	15.5	0	13
5000	L10	1.5	12	1	9	0.5	4.5	0	3
	L50	1	21.5	0.5	17.5	0.5	12	0	10

TABLE 5 Urban Difference between hourly descriptors and 2 second average rumble stripe level and background noise

ADT	Descriptor	50 feet	50' Ave. Level	100 feet	100' Ave. Level	200 feet	200' Ave. Level	300 feet	300' Ave. Level
		Descriptor Diff.	2 Sec. Excursion	Descriptor Diff.	2 Sec. Excursion	Descriptor Diff.	2 Sec. Excursion	Descriptor Diff.	2 Sec. Excursion
Veh/Day		dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
500	L10	1.5	23.5	0.5	21	0.5	17	0.5	15
	L50	0.5	37	0.5	33	0	28.5	0.5	25.5
750	L10	1.5	21.5	0.5	19	0.5	15	0.5	13
	L50	0.5	34.5	0.5	30.5	0.5	25.5	0	23
1000	L10	1	20.5	1	17.5	0.5	14	0.5	12
	L50	0.5	33	0.5	29	0.5	24	0	21.5
2000	L10	1.5	16.5	1	14	0.5	10.5	0.5	8.5
	L50	1	28	0	24.5	0.5	19.5	0	17
3000	L10	1.5	14.5	1	12	0.5	8.5	0	7
	L50	1	25.5	0	22	0	17	0	14.5
5000	L10	1.5	12	1	9.5	0.5	6	0.5	4.5
	L50	1	22	0.5	18.5	0	14	0	11.5

External Noise Summary

- L10 and L50 values are not changed
 - 2 second event
- A distinct noise is produced by a vehicle hitting a rumble stripe
- Is noise level appropriate?

Representative Noise Levels

Sound Pressure Level (dBA)

140-----
130-----
120-----
110-----
100-----
90-----
80-----
70-----
60-----
50-----
40-----
30-----
20-----

Noise Source

Jet Engine (at 75 feet)
Jet Aircraft (at 300 feet)
Rock and Roll Concert
Pneumatic Chipper
Jointer/Planer
Chainsaw
Heavy Truck Traffic
Business Office
Conversational Speech
Library
Bedroom
Secluded Woods
Whisper

Representative Noise Levels

Sound Pressure Level (dBA)

140-----
130-----
120-----
110-----
100-----
90-----
80-----
70-----
60-----
50-----
40-----
30-----
20-----

50' - 82
100' - 75
200' - 67
300' - 62

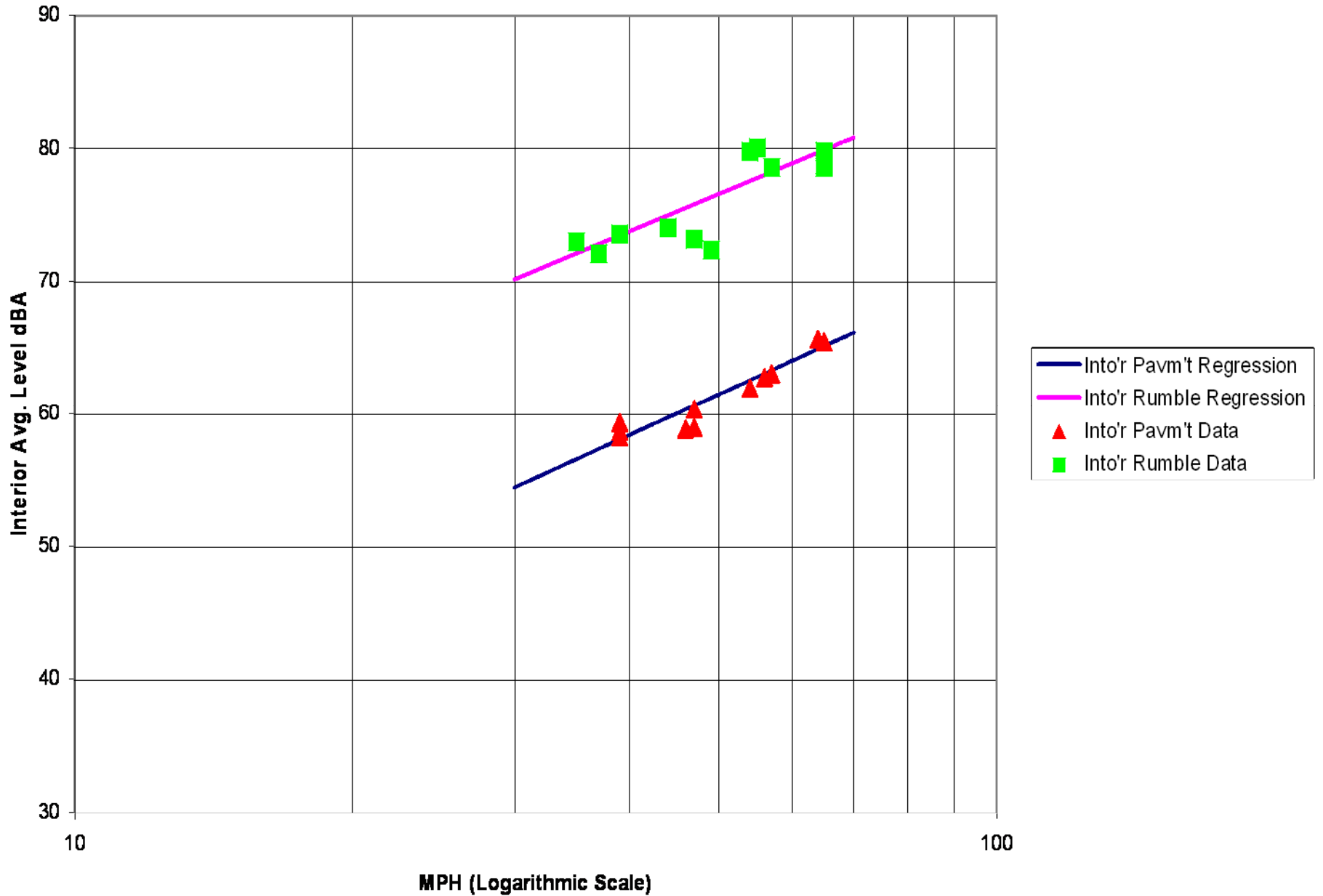
Noise Source

Jet Engine (at 75 feet)
Jet Aircraft (at 300 feet)
Rock and Roll Concert
Pneumatic Chipper
Jointer/Planer
Chainsaw
Heavy Truck Traffic
Business Office
Conversational Speech
Library
Bedroom
Secluded Woods
Whisper

Interior Noise Levels

- Examined interior noise levels
- Nearly uniform noise levels produced
 - 15 dBA at all speeds

FIGURE 2 Interior Rumble Stripe Regression



Questions