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Human and Community Response to Military Noise

Results From Field-Laboratory Tests of Small Arms, 25 mm Cannons, Helicopters, and Blast Sounds

by
Paul D. Schomer, L. Ray Wagner, and L. Jerome Benson

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Foreword

This study was conducted for the Assistant Chief of Staff for Installation Management (ACS(IM)) under Project 4A162720A896, "Environmental Quality Technology"; Work Unit TG5, "Human Response Noise Models." The study was a combined, leveraged effort with U.S. Army Europe and 7th Army reimbursable funds provided by Military Interdepartmental Purchase Requests (MIPRs) FE-57-90 and FE-58-91. The ACS(IM) technical monitor was Tim Julius, DAIM-ED-C. The USAREUR Deputy Chief of Staff, Engineer (AEAEN) point of contact was Armod LePage, Environmental Division.

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LTC David J. Rehbein is Commander and Acting Director of USACERL, and Dr. Michael J. O'Connor is Technical Director.

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Background

Proper assessment of the annoyance generated by Army testing and training sounds remains a question that is not fully answered in 1994 (Schomer 1986; Schomer and Neathammer 1987; Schomer and Averbuch, August 1989; Schomer, Buchta, and Hirsch, April 1991; Schomer, Hoover, and Wagner, November 1991). The most difficult sounds to assess are the impulsive sounds generated by large weapons, small arms, and helicopters because, in contrast to more common transient sounds (e.g., aircraft and wheeled motor vehicles), the impulsive character of these sounds adds to the annoyance that they generate. The nature of this "addition" is not well understood. Currently, general community noise is assessed using the A-frequency weighting and some form of time-average sound level (American National Standard, 1988 and 1990). In the United States, the A-frequency-weighted day-night average sound level is used. For clearly impulsive sounds, adjustments or "penalties" may be added to the formulation to account for the increase in annoyance generated by the impulsive character of the sound (Sutherland and Burke, 1979; International Organization for Standardization, 1990). Adding an impulsive-sound penalty is current U.S. Army practice for the sound of small arms and helicopters (Air Installations Compatible Use Zones, November 1977; Army Regulation [AR] 200-1, April 1990).

In the mid-1980s, several European countries collaborated on a joint Council of European Communities (CEC) research project to develop improved penalties for assessing the sound of small arms, metal and wood hammering, and other impulsive, everyday sounds. Separate Nordic and Australian studies have also centered on the sound of small arms. The CEC studies specifically excluded helicopters, large blasts (e.g., mining, demolition, and artillery), and sonic booms. Rice (1989) provides a summary of the CEC results that involved teams from Italy, the United Kingdom, The Netherlands, and Germany. The CEC results suggested that a large impulse penalty should only be applied to "highly" impulsive sounds such as small-arms fire and metal and wood hammering, and that this penalty should be about 10 decibels (dB) at an outdoor measured A-weighted time-average sound level of 50 dB, decreasing by 1 dB for every 3 dB increase in outdoor measured sound level up to 80 dB. Vos (1990) and Buchta (1990) participated in the CEC studies, and both have published independent analyses of their respective data. Both researchers found a similar level-dependent penalty, but suggested that the largest penalty was closer to 12 dB.

A report by Eystein (1984) for the Nordic countries and a report published jointly by the military construction institutes of three Nordic countries (Nordic Defense Institutes 1986) each provides summaries of research, guidance, and conclusions with respect to small arms sounds. Eystein (1984) concluded that a maximum A-frequency-weighted and impulse-time-weighted sound pressure level of 70 dB was a good approximate threshold of annoyance. The latter report proposed a form of an "equal-energy" measure that they termed "RSS." The RSS measure makes use of the so-called impulse time-weighting and "corrects" for the influence of long-term background sound. No specific guidance was given on the value for any penalty.

An Australian study (Hede and Bullen 1981) on the topic of small arms did not consider time-average sound-level descriptors. The study did find, however, that A-weighted sound exposure level (ASEL) or flat-weighted peak sound pressure level were the best descriptors out of the group they considered. Like Eystein (1984) and the Australian study made the point that more of the variance was explained by respondents' attitudes than by acoustical measures.

The study at Munster, Germany (Schomer et al. 1994) supports an equal energy model and suggests a penalty on the order of 10 dB. The study showed some indication of a level dependence as was found by the CEC, but this level dependence varies with the subject situation. The results differ for each condition: windows closed or open, subjects indoors, or subjects outdoors.

Blast sound, which is one type of high-energy impulsive sound, is assessed using the standardized C-frequency-weighting. In the United States, average C-weighted day-night sound level (CDNL) is currently used as the fundamental unit of assessment (American National Standard, 1986). Criterion CDNL values for various degrees of impact are provided in American National Standard S12.4 by estimates of the percent of a community "highly annoyed" in differing environments to the long-term day-night average C-weighted sound level. The U.S. Department of Defense (DoD) has established an average A-weighted day-night sound level (ADNL) of 65 dB as the start of impact and an ADNL of 75 dB as the start of severe impact. Information from American National Standard S12.4 can be used to establish the equivalent corresponding CDNL criterion levels for large-amplitude impulsive sound of 62 and 70 dB, respectively. Thus, based on information in American National Standard S12.4, the criterion levels for CDNL vary with respect to the ADNL criterion levels. This variation is, in effect, comparable to adding a level-dependent offset of as much as 5 dB (i.e., an ADNL for aircraft sounds of 75 dB is equivalent to a CDNL of 70 dB for large-amplitude impulsive sounds in terms of the percent of the community that is "highly annoyed"). Precise values for these offsets remains a question.

Two studies (Bullen and Hede 1984; Buchta 1989) support the use of CDNL or C-weighted sound exposure level (CSEL) for the assessment of blast sound from firing ranges. Others (Levein and Åhrlin 1988), especially in the Nordic countries, have looked only at single-event descriptors such as maximum sound pressure level. These latter studies provide little guidance on the efficacy of CSEL and CDNL for blast sound assessment.

Over the last several years, the U.S. Army Construction Engineering Research Laboratories (USACERL) has performed a series of experiments that had two purposes: (1) to better determine penalties for impulsive sound sources like helicopters and small arms, and (2) to better understand human and community response to blast sound. These experiments differed from other research in that they used subjects placed in real houses, judging real test sounds generated during the experiment, outdoors and at realistic distances from the test houses. The experiments were performed as paired-comparison tests. Artificial sound generated through a loudspeaker in the test rooms was the control sound. Helicopter tests were performed in Champaign, IL (Schomer and Neathammer 1987) and Tustin, CA (Schomer, Hoover, and Wagner, 1991). Tests of blast sounds were performed in Grafenwöhr Training Area, Germany and tests of blast, vehicle, and small arms sound were performed in Munster, Germany (Schomer et al. 1994).

Objective

A major purpose of the present test was to replicate the Munster study in the United States. This new study, performed in several stages at Aberdeen Proving Ground (APG), MD, is identical to the study performed at Munster except that for about half of the new tests, two levels of helicopter sound have been substituted one-for-one with the two levels of tracked-vehicle sound used at Munster. For the other half of these new tests, two sound levels of 25 millimeter (mm) cannon fire from the Bradley Infantry Fighting Vehicle has been substituted for the tracked vehicle sounds used at Munster. So, this study concentrates on blast, 25 mm cannon, small arms, and helicopter sounds. A given test uses either helicopters or 25 mm cannon fire, but not both.

The overall purpose of these studies was to further define and develop offsets or "penalties" that can be added to measured levels of military sounds (e.g., tank or rifle fire and helicopter noise) so that the resulting assessments are equivalent, in terms of annoyance, to assessments for common, normal transient urban sounds assessed by ASEL or by A-weighted time-average sound.

Approach

This test follows the paired-comparison methods developed and used by USACERL for the past several years, using real houses with real test sources of sound. Small arms are fired to create small arms sound; tanks drive by the houses to create tracked-vehicle sound; and plastic explosives are set off to create blast sound. But an innovation was added to this and the Munster test. Instead of using just control sounds that are electrically generated through loudspeakers in each test room, this test also used real, wheeled vehicles as a source of control sound. Six sizes of wheeled vehicles were used to create six levels of control sound. The subjects compared the sound of a truck driving by to a burst of small arms or 25 mm cannon fire, an explosive sound, or a helicopter flying by.

Measures such as time-average sound level or average day-night sound level are logarithmic transformations of the total sound exposure (Schomer, July 1992) occurring during the averaging time period. Total sound exposure is the sum of the sound exposures from the individual events, such as from cars on a highway, aircraft flybys, and gunfire. This study concentrated on examining the sound exposure from individual (1) small arms, (2) 25 mm cannon, (3) helicopters, and (4) blast events, the building blocks to total sound exposure and to any measure of time-average sound pressure level.

According to most noise regulations worldwide, most sounds, including that from helicopters, 25 mm guns, and small arms, are assessed using A-weighting. This study examined the penalties in A-weighted sound level needed to properly assess those three sound sources. However, since blast sound is assessed using C-weighting, this study also examined offsets between C-weighted and A-weighted levels to properly assess blast sound. (The latter assessment is termed an offset rather than a penalty because of the shift from C-weighting for blast sounds to A-weighting for other sounds.) Thus, the variable of interest in this study was ASEL or CSEL. This study did not differentiate between sounds having the same ASEL but differing spectra. Spectral content, while certainly important, cannot be part of the central analysis when the purpose is to develop offsets or penalties to be added to an A- or C-weighted sound exposure level.

In this report, the term "real" is used for sounds that propagate directly from the source to the subject. These sound signals are to be contrasted with recorded or artificial sounds. Artificial sound was generated by an electronic device. In this test, one of the control sounds was "real" and the other was "artificial."

Real sounds are different from recorded sounds because the latter are colored, at least in some degree, by the recording and playback process. For example, the true sensation of vehicle motion can only be generated by an array of loudspeakers, and even then, as for stereophonic reproduction, the sense of realistic motion might be available only at one listening position. Some experiments have used monophonically recorded sound (e.g., moving vehicle sound) and have even varied the amplitude by adding or subtracting gain. Such sound signals are not considered to be "real" and hence are termed "recorded" (and electronically colored).

This study was performed at the USACERL's test facility at APG, MD. This facility was specially constructed to study human and community response to sound and the effect of structural changes on the extent of response.

Mode of Technology Transfer

These data will be used to help set joint North Atlantic Treaty Organization/ Committee on the Challenges of Modern Society (NATO/CCMS) noise assessment procedures and criteria. They will be used in the United States to help reformulate National Academy of Science (NAS) recommendations. In turn, these data and NAS reports will influence American National Standards Institute (ANSI) Standards and Army policy.

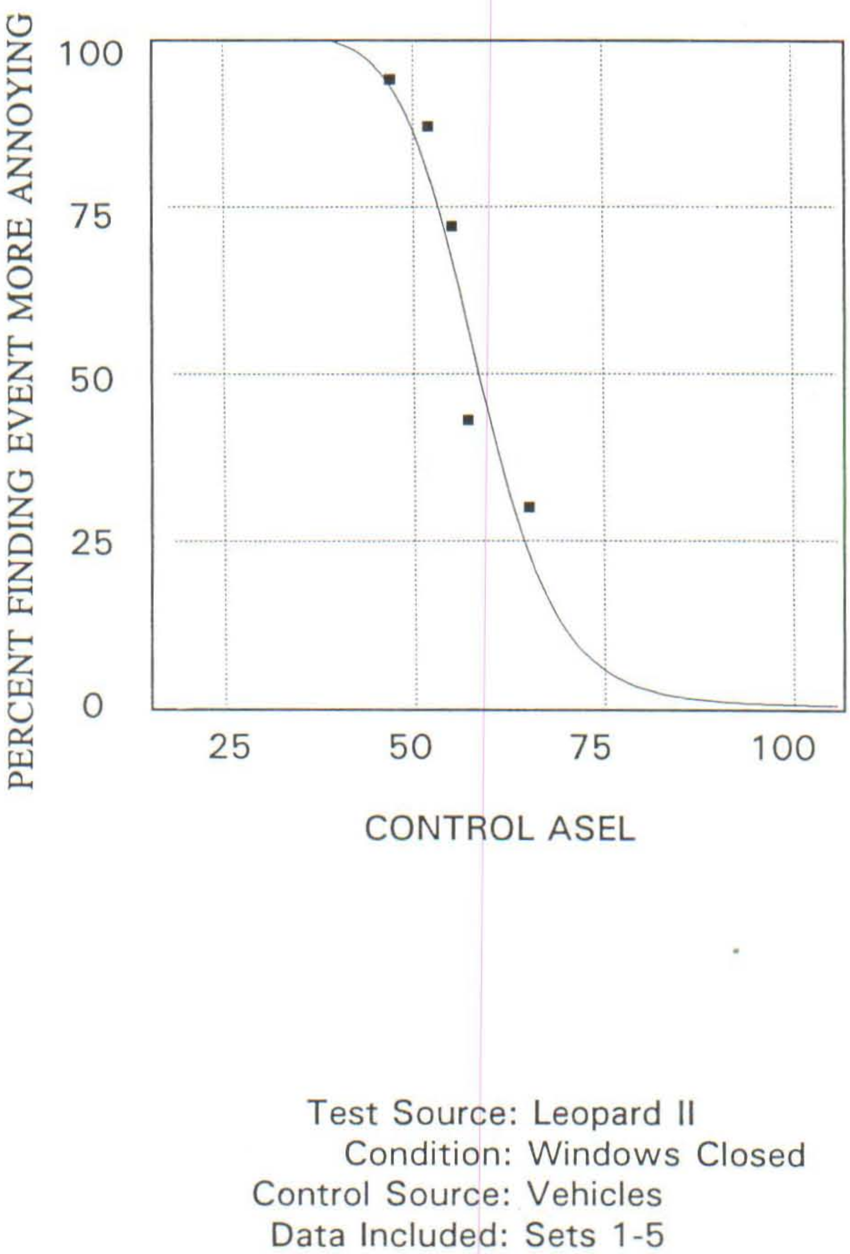
2 General Study Concepts

Study Design

The study was designed as a paired comparison test where the subjects were presented pairs of sounds and asked, for each pair, which was more annoying, the first sound or the second sound. For this study, the test sound was one of four categories of military sounds that came from: (1) small arms fire, (2) 25 mm cannon fire, (3) helicopters, or (4) large blasts. The other sound in a pair was one of two control sounds, which were: (1) the sound of a wheeled vehicle passing by, or (2) a computer-generated white noise. Either the test sound or the control sound was presented first; the order was random, but balanced. This study used juries of subjects placed in adjacent rooms on the front side of the test house, and, during warm weather phases of the test, at an outdoor location that was in line with the other test rooms.

Figure 1 shows a hypothetical curve expected from the experiment for a single military source. The theoretical curve assumes a transitional shape in the general form of a sigmoid or Gaussian cumulative probability curve. When the control is very quiet, 100 percent of the subjects will find the test source to be more annoying; when the control is very loud, 100 percent of the subjects will find the control to be more annoying.

Many actual curves of the type indicated in Figure 1 were generated; each yields a pair of numbers: a military test sound exposure level (SEL) (A-weighted for all sounds except blast sound) and corresponding control sound ASEL. This pair of levels (point) occurs when 50 percent of the subjects perceived the test sound to be more annoying than the control sound and 50 percent perceived it to be less annoying. This 50 percent point is marked on Figure 1. This point is taken as the equivalency point, that is, the point where the test sound causes the same annoyance as the control sound. The number of decibels that the test sound differs from the control sound is the "offset" or "adjustment." This is the decibel difference between the test sound SEL and the control sound ASEL for equivalent annoyance. For the hypothetical example in Figure 1, the military test sound had a ASEL of 62 dB; the equivalent wheeled-vehicle control sound ASEL is 59 dB at the 50 percent point. So a -14 dB offset or "penalty" must be added to the test sound CSEL to make it equivalent to a control sound generating the same annoyance. In this example, the penalty is negative; it is a bonus.



In this hypothetical example, the Leopard II is compared with wheeled-vehicle control sounds. The "equivalency" point is when the Leopard II had an indoor-measured ASEL of 62 and the equivalently-annoying control vehicle ASEL was 59. This indicates that in terms of decibels, the Leopard II creates 3 dB less annoyance than an equivalent wheeled vehicle; it has a "negative penalty."

Figure 1. Typical curve expected for a single test sound source and a range of control sound levels.

Wheeled-vehicle and artificial control sounds have their own separate advantages and disadvantages.

Vehicle noise as control sound

Advantages:

- Penalties or offsets can be related to the sound level of common traffic noise.
- Traffic noise is the most-common environmental sound.
- Most assessments of traffic noise use some form of A-weighted time-average sound pressure level.

Disadvantages:

- Spectrum of the sound from actual vehicles varies from one vehicle to another.
- The spectral variations may be part of the underlying reasons for differences in the reactions of subjects to the sounds.

Pink noise as control sound

Advantage:

- There are no shifts in the spectrum with changes to the level of the control sound.

Disadvantage:

- Impulsive-sound penalties determined from such tests cannot be related to the level of commonly experienced sounds.

For the above reasons, the sound of wheeled vehicles was selected as the control sound for the purpose of determining the impulsive-noise penalties associated with impulsive military sounds.

Previous analyses and reports (Borsky 1965; Kryter et al. 1968; USEPA 1974; Schomer and Neathammer 1985; Army Regulation 200-1) of high-amplitude impulse sound have commented on how important vibration and rattle are in determining human reaction to impulsive sounds. This study, using real houses and standard 2- to 3-mm-thick single-glazed windows included natural rattles induced by the blast sounds. These sound-induced rattles are nonlinear reactions to the blast stimulus. In the past, attempts to correlate subject response with blast-sound-induced rattles have failed (Schomer and Neathammer 1987). Therefore, this study did not attempt to quantify rattles. Rather, as in nearly all previous research, it relied primarily on correlations between outdoor-measured blast sound levels and the corresponding responses of the listeners.

Test Site and Sound Sources

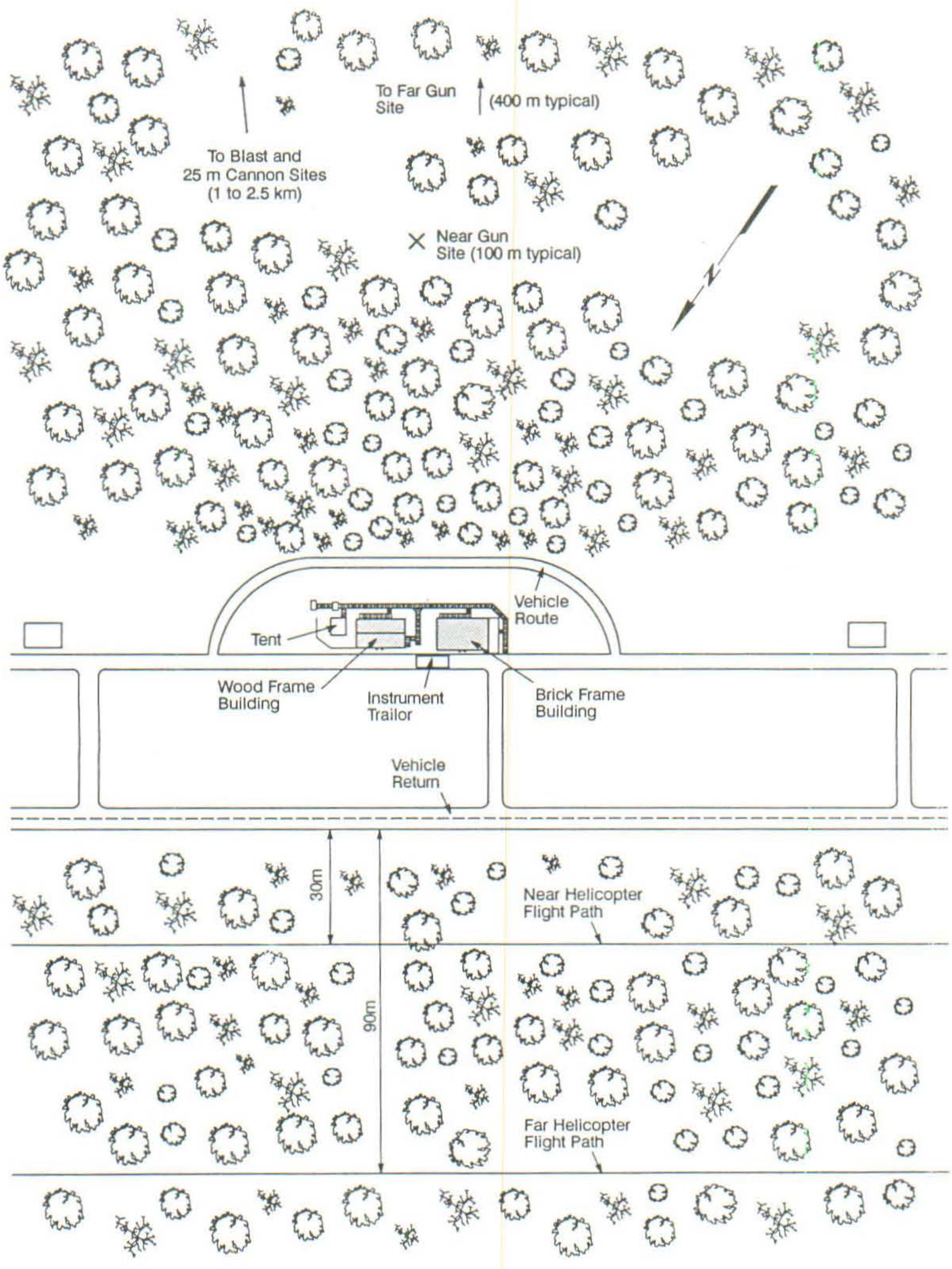
Figure 2 shows a map of the test site including the test subject houses, vehicle roadways, helicopter flight tracks, and firing sites.

The helicopter was a standard UH-1H "Huey" flying at two distances from the test house; a "near" distance of about 60 meters (m) and a "far" distance of about 150 m. The distances were chosen so the ASELs of the helicopter flybys differed by about 10 dB between the near and the far distances. The helicopter flew equal operations in each direction. The line of flight for the helicopter is shown on the map of the test site in Figure 2. Figure 3 shows the helicopter overflying the test houses.

The small arms were American M-16 rifles fired from "near" and "far" distances, which were typically 100 and 400 m from the test house. These distances varied a little from day to day to achieve near constant received ASEL at the test house. Unlike the Munster study, live ammunition was used in the APG study. Firing rates and number of rounds varied at the near site. A rate of 60 shots in 30 seconds (s) was used at both sites throughout the entire study. In addition, a ten times slower rate of 6 shots in 30 s was used at the near site.

The 25 mm cannon also had "near" and "far" firing positions, which are shown in Figure 2. The typical distances for the "near" and "far" 25 mm cannon firing positions were 1,000 to 1,400 m and 1,800 to 2,500 m, respectively; the distances were varied in an effort to maintain nearly constant received levels. The 25 mm cannon fired a standard 8-shot training sequence in about 10 s. This sequence is: bang, bang-bang-bang, bang-bang-bang-bang; 1-3-4. Figure 4 shows a Bradley with its 25 mm cannon.

The main blast site was located 1 km west of the test houses. An alternate blast site 1.8 km from the test houses was used, based on weather-related sound propagation conditions, to reduce the received level of the blast sounds. Nominally, large and small blast charge sizes of 2 kilograms (kg) and 500 grams (g) were used, but these were changed (e.g., up to 4 kg or down to 1 kg for the large blast) when needed to obtain received, flat-weighted peak sound pressure levels that were as close as possible to 124 and 119 dB for the large and small blasts, respectively.



This map shows the test houses, control "trailer," roads and staging area for the wheeled vehicles, helicopter lines-of-flight, and the near- and far-gun fire sites. The 25 mm cannon and blast sites were more distant.

Figure 2. Map of the immediate test site area.

Figure 3. Helicopter overflying the test facilities.

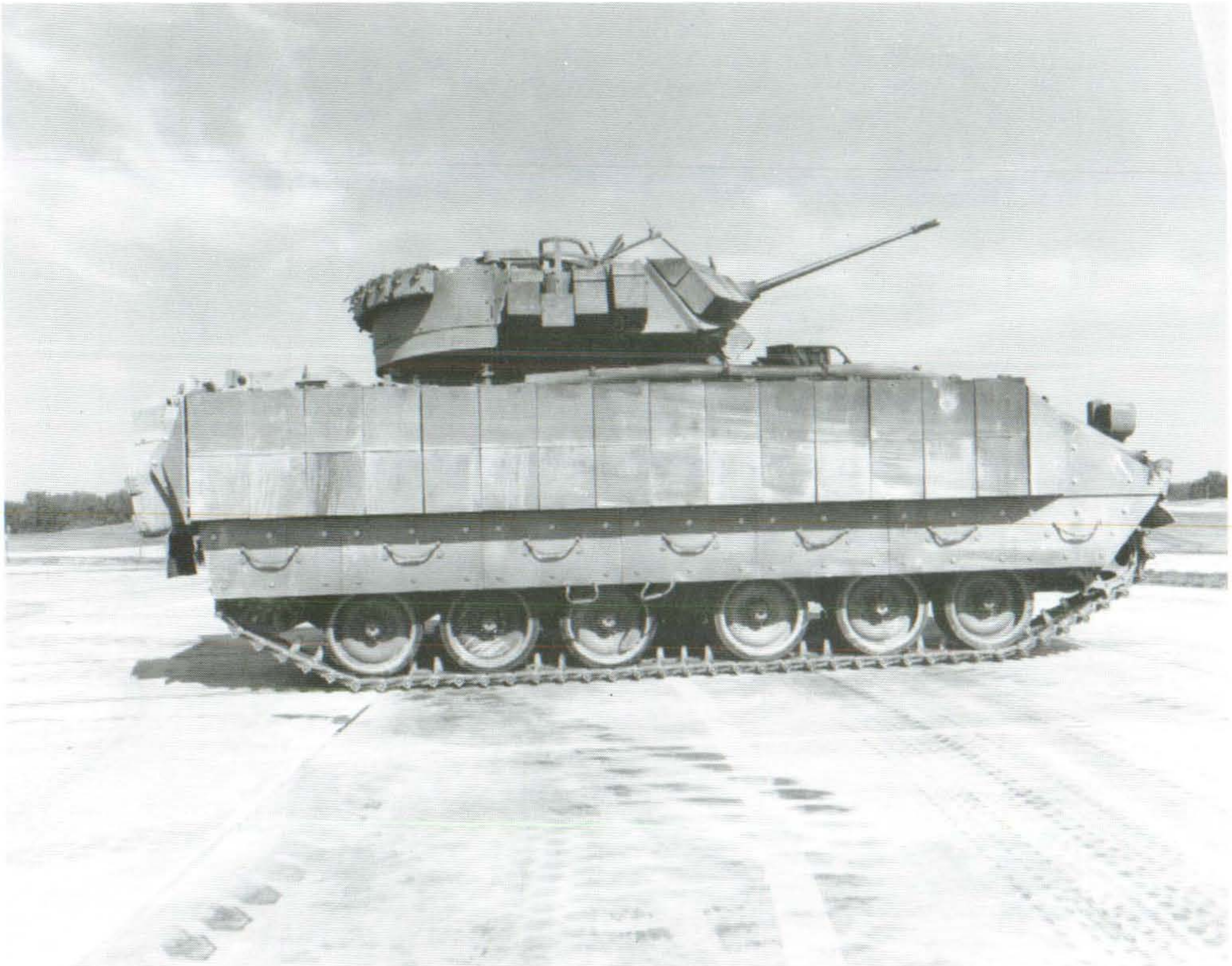


Figure 4. Bradley fighting vehicle with 25 mm cannon.

Control Sound Sources

The wheeled control-sound vehicles, except for the smallest, were supplied by the U.S. Army. These vehicles generated ASELs ranging from about 65 to 95 dB (in roughly 5 dB steps) at a microphone in line with the front face of the test houses, but sufficiently away so the reflected sound was negligible. The vehicles were designated V1 through V6 with V1 having the highest sound exposure level (SEL). Vehicle V1 was a tank retrieval truck, V2 was a 2-1/2 ton military-type cargo truck, V3 was a 5 ton civilian-type cargo truck, V4 was a HUMM-V utility vehicle, V5 was a 1 ton, four-wheel drive pickup truck, and V6 was a small rental car. Figures 5 through 9 show vehicles V1 through V5 (all except the rental car). The test house is in the background of some of these figures. All of the wheeled vehicles passed by the test house on a specially constructed gravel road at a distance of about 15 m. The direction of travel was dictated by the orientation of the exhaust; in one case to obtain the higher sound level (V2), and in another case to obtain a lower sound level (V3). The vehicles returned by looping back on an alternate hard road 170 m from the test house as shown in Figure 2.

The computer-generated control sound had a "haystack" shape for the time variation of the sound pressure level with the final shape determined by the time variation of the sound being tested. For the blast sounds, a 0.45 s, 200 to 1500-hertz (Hz) band of white noise was used; for the tracked-vehicle and small arms sounds, an octave band of pink noise with midband frequency of 500 Hz was used as the control sound. Figures 10(a) and 10(b) illustrate the temporal amplitude envelopes for the two computer-generated control sounds. The A-weighted temporal amplitude envelopes for a passby of vehicle V2 and a helicopter are also included in Figure 10(b). The two computer-generated sounds in Figures 10(a) and 10(b), respectively, are the same as used previously for testing blast (Schomer, Buchta, and Hirsch, April 1991) and helicopter (Schomer and Neathammer 1987; Schomer, Hoover, and Wagner, November 1991) sounds.

As shown in Table 1, the nine military test sounds were compared with wheeled-vehicle control sounds. The four military sources having the higher sound levels (i.e., large blast, near helicopter, near 25 mm cannon, and near small arms [60 shots]) were compared with the five larger control vehicles, V1 through V5. The other military sources (i.e., small blast, far helicopter, far 25 mm cannon, near small arms [6 shots], and far small arms) were compared with V2 through V6. The near helicopter, near 25 mm cannon, near small arms (60 shots), V2 and large blast sounds also were tested by pairing each with computer-regulated pink- or white-noise control sounds (see Table 1). There were five different levels of control sound for each source.

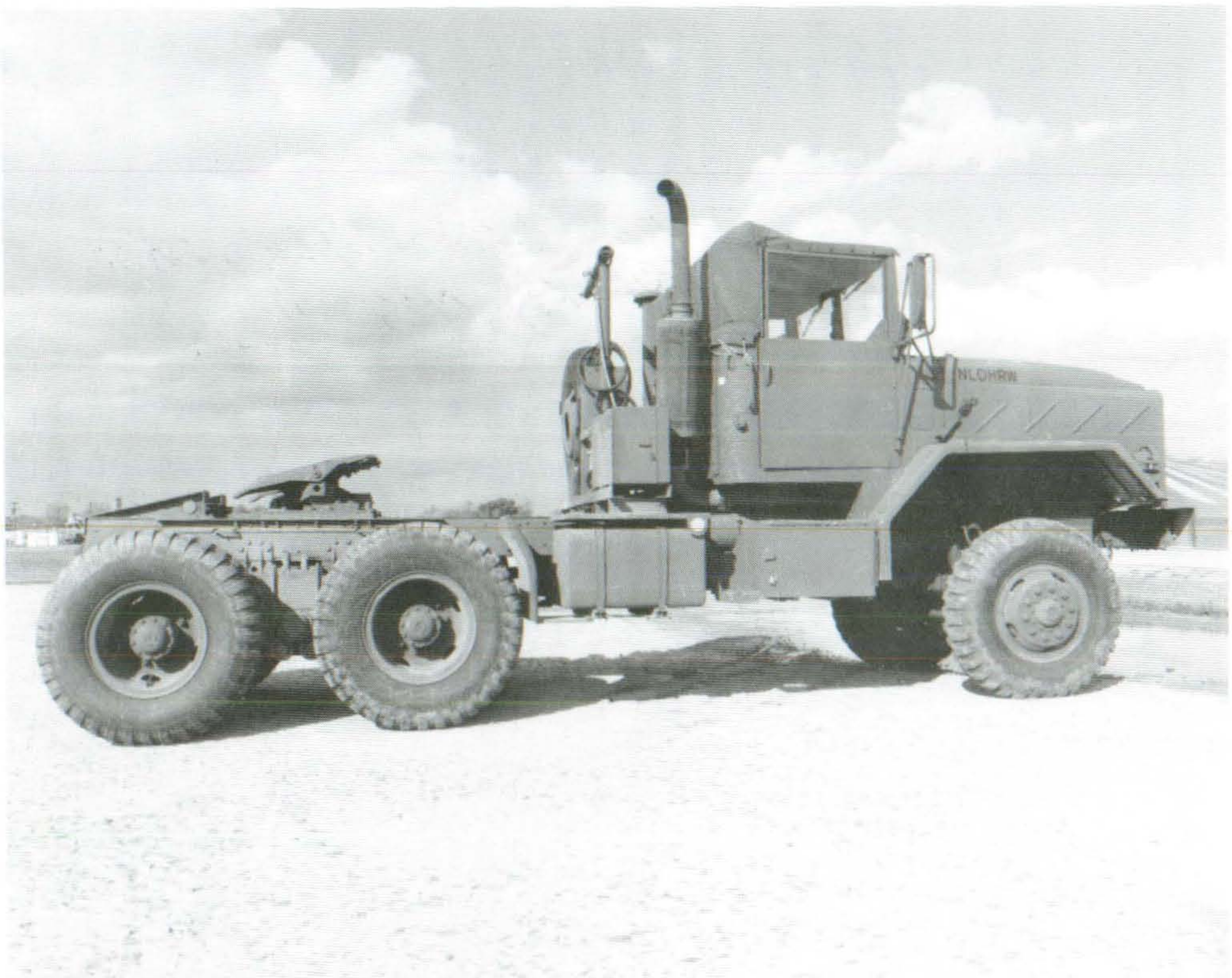


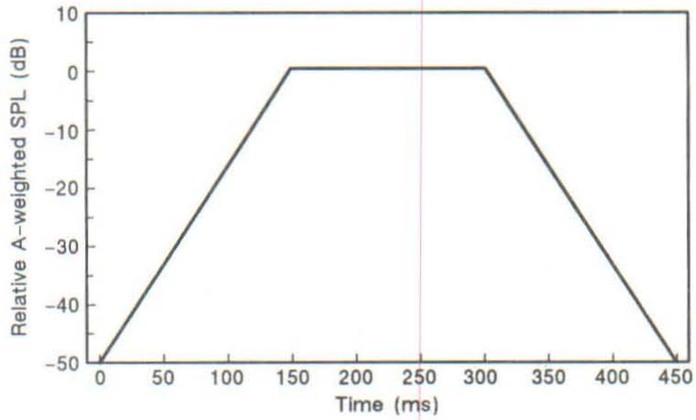
Figure 5. Control vehicle 1—10 ton tractor used as a tank retreival vehicle.

Figure 6. Control vehicle 2—2 1/2 ton military type cargo truck.

Figure 7. Control vehicle 3—5 ton civilian type cargo truck.

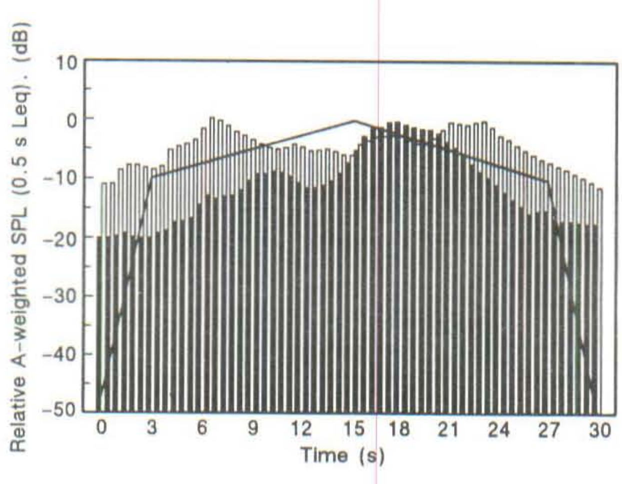
Figure 8. Control vehicle 4—HUMM-V utility vehicle.

Figure 9. Control vehicle 5—1 ton, 4-wheel drive pickup truck.



This sound was used as the control sound for the large blast test sound

(a)



This sound was used as the control sound for near Huey helicopter, near gun fire (60 shots), near 25 mm cannon, and control vehicle 2 sounds.

(b)

Figure 10. (a) White-noise control sound amplitude envelope and (b) Pink-noise control sound amplitude envelope.

Table 1. Test sounds and associated control sounds.

Test Sounds	Control Sound Source	
	Wheeled Vehicles	Loudspeaker Sound
Large Blasts	V1-V5	White Noise
Near Helicopter	V1-V5	Pink Noise
Near 25 mm Cannon	V1-V5	Pink Noise
Near Guns; 60 Shots	V1-V5	Pink Noise
Small Blasts	V2-V6	* * *
Far Helicopter	V2-V6	* * *
Far 25 mm Cannon	V2-V6	* * *
Near Guns; 6 Shots	V2-V6	* * *
Far Guns; 60 Shots	V2-V6	* * *
Vehicle 2	* * *	Pink Noise

Together, the wheeled-vehicle and computer-regulated control sounds resulted in 55 comparisons that were presented to the subjects in seemingly random order (with consideration for the return time for the control vehicles) during each half of a test session. Each test session used either helicopters or 25 mm cannon, but not both. The order of test and control sound within each pair was also random. For the second half of a test session, each pair of sounds was presented in a different random order, but the order of presentation of sounds within each pair was reversed relative to the order in the first half. Table 2 lists these test pairings.

Table 2. Middle levels for the white/pink noise control sound by set.

Set Test Source	Jan 92	Jun 92	Aug 92	Nov 92	Jan 93
Large Blast	75/80*	80	80	70	75
Loud Helicopter/Near 25mm	70	80	80	75	80
Near Gun, 60 shots	75	85	85	80	80
Control Vehicle 2	75	85	85	80	85

* For January 1992 a control sound level of 75 was used for the first two sessions and 80 was used for the others. The control sound levels at the tent for June and August 1992 were 10 dB above the indoor levels.

Note: These levels were adjusted in ±5 dB steps depending on received test sound levels and the response data already collected. The goal was to have the equivalency point at the middle of the control range which was the sound level of V3 or V4 for the vehicles and the middle level for the white/pink noise control sounds. The most accurate estimate of a "penalty" possible is provided when the equivalency point lies in the middle of the analysis range.

The test subjects used the test form, Figure 11, to mark which sound was more bothersome or annoying. The first 11 lines in each of the two sections of each test form were used. Test form numbers 1 through 5 were used for the 110 pairs of sounds. Subjects marked the form after each pair of sounds was presented. The subjects were also to mark how difficult it was to decide on a scale of 1 to 5 with the endpoints anchored by the descriptions "very easy" and "very hard."

The white/pink-noise control sound levels were adjusted in ±5 dB steps; the absolute level depended on received test sound levels and the response data already collected. The goal was to have the equivalent-response point in the middle of the control sound level range produced by vehicles V3 or V4 for the control-sound vehicles and the middle of 5 sound levels for the white/pink-noise control sounds. These adjustments were needed because the most accurate estimate of an offset or penalty is determined when the equivalency point lies in the middle of the analysis range.

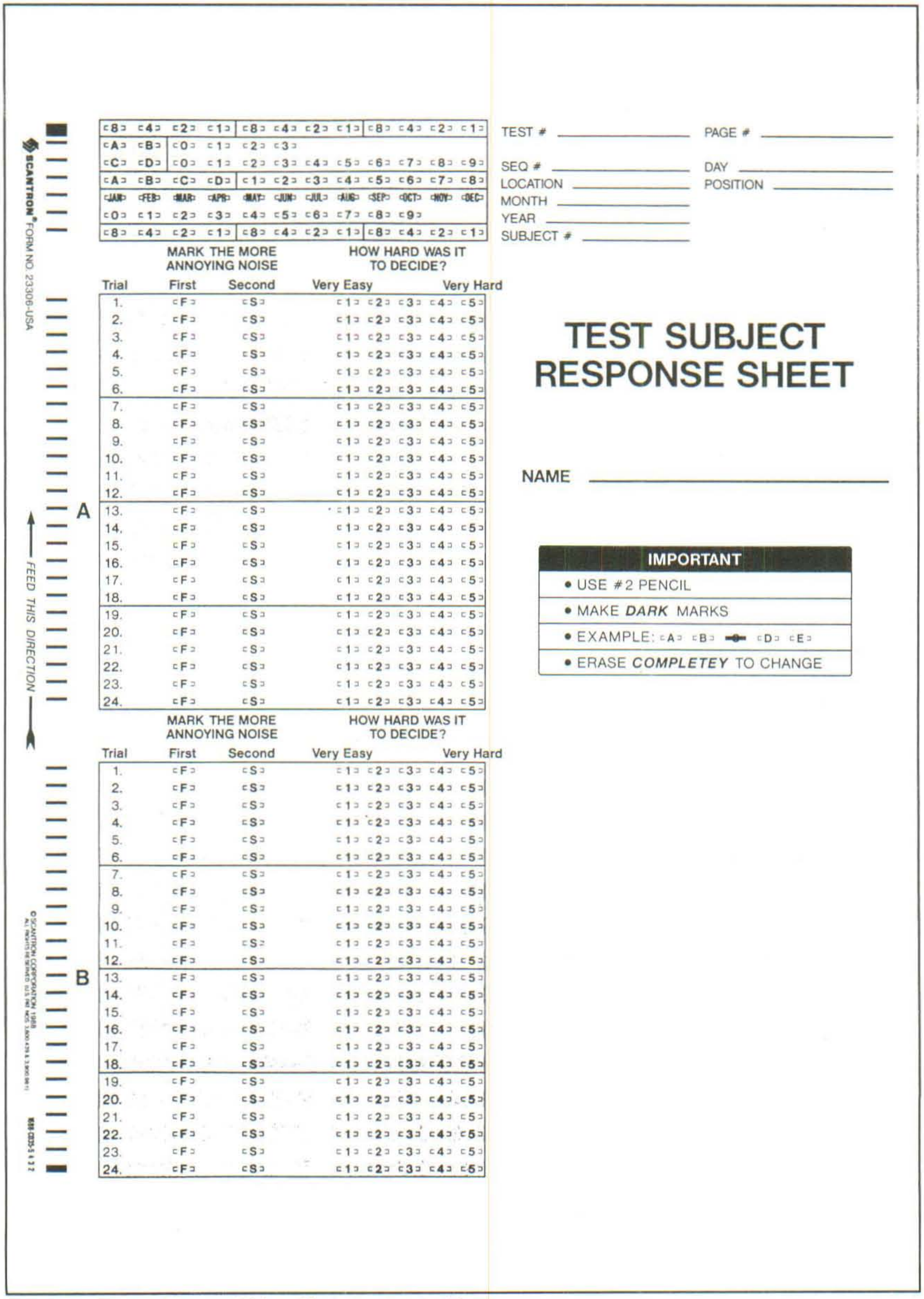
A desk top computer was used to regulate the artificial control sound that was played back from a 2-channel digital audio tape recording; one channel contained the white noise (200 to 1,500 Hz), the other channel contained the pink noise (500-Hz octave band). The amplitude envelope of either control sound was shaped with a programmable attenuator connected to the personal computer. This process regulated the ASEL and 10-dB down time of the artificial control sound.*

Two loudspeakers produced the computer-regulated control sound in each house. The outdoor control sound was the same as the indoor sound, except the outdoor level was 20 dB higher. This 20 dB gain had been found (Schomer, November 1991; Schomer, April 1991) to be the correct shift to obtain listener-response data so the 50 percent point lies in the middle of the control sound range. Table 3 contains the actual "base" levels by set.

Test Facility Structures

The test facility comprised two specially constructed "duplexes," identical on the inside, each containing two isolated spaces. One half of each duplex includes a test "living room" identical to the test room used in earlier tests at USACERL (Schomer 1989). The other half of each duplex includes a living room identical to the living room of the test house used in Grafenwöhr, Germany (Schomer 1991). So, one half is designated the American half and one half is designated the German half. The American half includes standard American windows, doors, and ceiling heights; the

* 10-dB down time: time period when the sound level is within 10 dB of the maximum level.



SCANTRON® FORM NO. 23306-USA

8	4	2	1	8	4	2	1	8	4	2	1
A	B	0	1	2	3						
C	D	0	1	2	3	4	5	6	7	8	9
A	B	C	D	1	2	3	4	5	6	7	8
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0	1	2	3	4	5	6	7	8	9		
8	4	2	1	8	4	2	1	8	4	2	1

TEST # ______ PAGE # ______

SEQ # ______ DAY ______

LOCATION ______ POSITION ______

MONTH ______

YEAR ______

SUBJECT # ______

TEST SUBJECT RESPONSE SHEET

NAME ______________________

IMPORTANT

- USE #2 PENCIL
- MAKE ***DARK*** MARKS
- EXAMPLE: A B ▬ D E
- ERASE ***COMPLETEY*** TO CHANGE

A

Trial	MARK THE MORE ANNOYING NOISE: First	Second	HOW HARD WAS IT TO DECIDE? Very Easy				Very Hard
1.	F	S	1	2	3	4	5
2.	F	S	1	2	3	4	5
3.	F	S	1	2	3	4	5
4.	F	S	1	2	3	4	5
5.	F	S	1	2	3	4	5
6.	F	S	1	2	3	4	5
7.	F	S	1	2	3	4	5
8.	F	S	1	2	3	4	5
9.	F	S	1	2	3	4	5
10.	F	S	1	2	3	4	5
11.	F	S	1	2	3	4	5
12.	F	S	1	2	3	4	5
13.	F	S	1	2	3	4	5
14.	F	S	1	2	3	4	5
15.	F	S	1	2	3	4	5
16.	F	S	1	2	3	4	5
17.	F	S	1	2	3	4	5
18.	F	S	1	2	3	4	5
19.	F	S	1	2	3	4	5
20.	F	S	1	2	3	4	5
21.	F	S	1	2	3	4	5
22.	F	S	1	2	3	4	5
23.	F	S	1	2	3	4	5
24.	F	S	1	2	3	4	5

FEED THIS DIRECTION

B

Trial	MARK THE MORE ANNOYING NOISE: First	Second	HOW HARD WAS IT TO DECIDE? Very Easy				Very Hard
1.	F	S	1	2	3	4	5
2.	F	S	1	2	3	4	5
3.	F	S	1	2	3	4	5
4.	F	S	1	2	3	4	5
5.	F	S	1	2	3	4	5
6.	F	S	1	2	3	4	5
7.	F	S	1	2	3	4	5
8.	F	S	1	2	3	4	5
9.	F	S	1	2	3	4	5
10.	F	S	1	2	3	4	5
11.	F	S	1	2	3	4	5
12.	F	S	1	2	3	4	5
13.	F	S	1	2	3	4	5
14.	F	S	1	2	3	4	5
15.	F	S	1	2	3	4	5
16.	F	S	1	2	3	4	5
17.	F	S	1	2	3	4	5
18.	F	S	1	2	3	4	5
19.	F	S	1	2	3	4	5
20.	F	S	1	2	3	4	5
21.	F	S	1	2	3	4	5
22.	F	S	1	2	3	4	5
23.	F	S	1	2	3	4	5
24.	F	S	1	2	3	4	5

Figure 11. The machine-readable subject response test form.

Table 3a. Order of the sound pairs for the first half of each test.

FIRST HALF					
	1ST EVENT	2ND EVENT		1ST EVENT	2ND EVENT
1	V2	+5 Pink Noise*	29	V1	Near Gun-60 shots
2	+10 Pink Noise	Leo II	30	-10 Pink Noise	Near Gun-60 shots
3	V5	Small Blast	31	+5 Pink Noise	Loud Helicopter**
4	V3	Near Gun-60 shots	32	Large Blast	V3
5	V6	Far Gun-60 shots	33	+10 Pink Noise	V2
6	V2	Loud Helicopter**	34	Far Gun-60 shots	V5
7	Small Blast	V4	35	-10 White Noise	Large Blast
8	Large Blast	+10 White Noise	36	V4	Loud Helicopter*
9	+10 Pink Noise	Near Gun-60 shots	37	Small Blast	V6
10	Loud Helicopter**	-10 Pink Noise	38	Quiet Helicopter**	V2
11	Near Gun-60 shots	V5	39	Far Gun-60 shots	V3
12	Near Gun-6 shots	V2	40	Large Blast	+5 White Noise
13	V3	Quiet Helicopter**	41	Near Gun-60 shots	-5 Pink Noise
14	V4	Large Blast	42	V2	-10 Pink Noise
15	Loud Helicopter**	V1	43	V5	Near Gun-6 shots
16	-5 White Noise	Large Blast	44	V3	Small Blast
17	Near Gun-60 shots	+5 Pink Noise	45	Large Blast	-0 White Noise
18	Quiet Helicopter**	V5	46	V2	Far Gun-60 shots
19	Large Blast	V2	47	Quiet Helicopter**	V4
20	Near Gun-6 shots	V3	48	Loud Helicopter**	V3
21	V4	Near Gun-60 shots	49	V5	Large Blast
22	Loud Helicopter**	-0 Pink Noise	50	-0 Pink Noise	Near Gun-60 shots
23	V1	Large Blast	51	-5 Pink Noise	V2
24	Near Gun-60 shots	V2	52	V6	Quiet Helicopter**
25	Near Gun-6 shots	V6.	53	-5 Pink Noise	Loud Helicopter**
26	V5	Loud Helicopter*	54	V4	Far Gun-60 shots
27	V4	Near Gun-6 shots	55	V2	Small Blast
28	V2	-0 Pink Noise			

* The designation "+5 Pink Noise" shows that the control sound level for that set and test sound was pink noise presented at 5 dB above the "base" sound level as given in Table 2.

** During the last two test periods, the Loud Helicopter was replaced by the Near 25mm Cannon and the Quiet Helicopter was replaced by the Far 25mm Cannon.

Table 3b. Order of the sound pairs for the second half of each test.

SECOND HALF					
	1ST EVENT	2ND EVENT		1ST EVENT	2ND EVENT
1	-0 Pink Noise*	Loud Helicopter**	29	Large Blast	-5 White Noise
2	V2	Quiet Helicopter**	30	V5	Near Gun-60 shots
3	Near Gun-60 shots	-10 Pink Noise	31	-0 Pink Noise	V2
4	Large Blast	V5	32	Large Blast	V1
5	Loud Helicopter**	+5 Pink Noise	33	V3	Large Blast
6	Quiet Helicopter**	V3	34	Loud Helicopter**	-5 Pink Noise
7	Near Gun-6 shots	V4	35	Quiet Helicopter**	V6
8	V2	Near Gun-6 shots	36	Near Gun-6 shots	V5
9	Far Gun-60 shots	V6	37	V3	Far Gun-60 shots
10	V5	Quiet Helicopter**	38	V2	Near Gun-60 shots
11	Loud Helicopter**	+10 Pink Noise	39	Near Gun-60 shots	V4
12	-5 Pink Noise	Near Gun-60 shots	40	+10 White Noise	Large Blast
13	V2	-5 Pink Noise	41	V3	Near Gun-6 shots
14	V4	Small Blast	42	Far Gun-60 shots	V2
15	V5	Far Gun-60 shots	43	Loud Helicopter**	V5
16	Near Gun-60 shots	+10 Pink Noise	44	Large Blast	V4
17	Small Blast	V3	45	+5 Pink Noise	Near Gun-60 shots
18	V1	Loud Helicopter**	46	V2	+10 Pink Noise
19	Small Blast	V2	47	Near Gun-60 shots	-0 Pink Noise
20	-0 White Noise	Large Blast	48	V3	Loud Helicopter**
21	V6	Small Blast	49	+5 White Noise	Large Blast
22	Far Gun-60 shots	V4	50	V2	Large Blast
23	Loud Helicopter**	V2	51	V6	Near Gun-6 shots
24	Near Gun-60 shots	V3	52	Small Blast	V5
25	Near Gun-60 shots	V1	53	-10 Pink Noise	Loud Helicopter**
26	Large Blast	-10 White Noise	54	V4	Quiet Helicopter**
27	-10 Pink Noise	V2	55	+5 Pink Noise	V2
28	Loud Helicopter**	V4			

* The designation "-0 Pink Noise" shows that the control sound level for that set and test sound was pink noise presented at 5 dB above the "base" sound level as given in Table 2.

** During the last two test periods, the Loud Helicopter was replaced by the Near 25mm Cannon and the Quiet Helicopter was replaced by the Far 25mm Cannon.

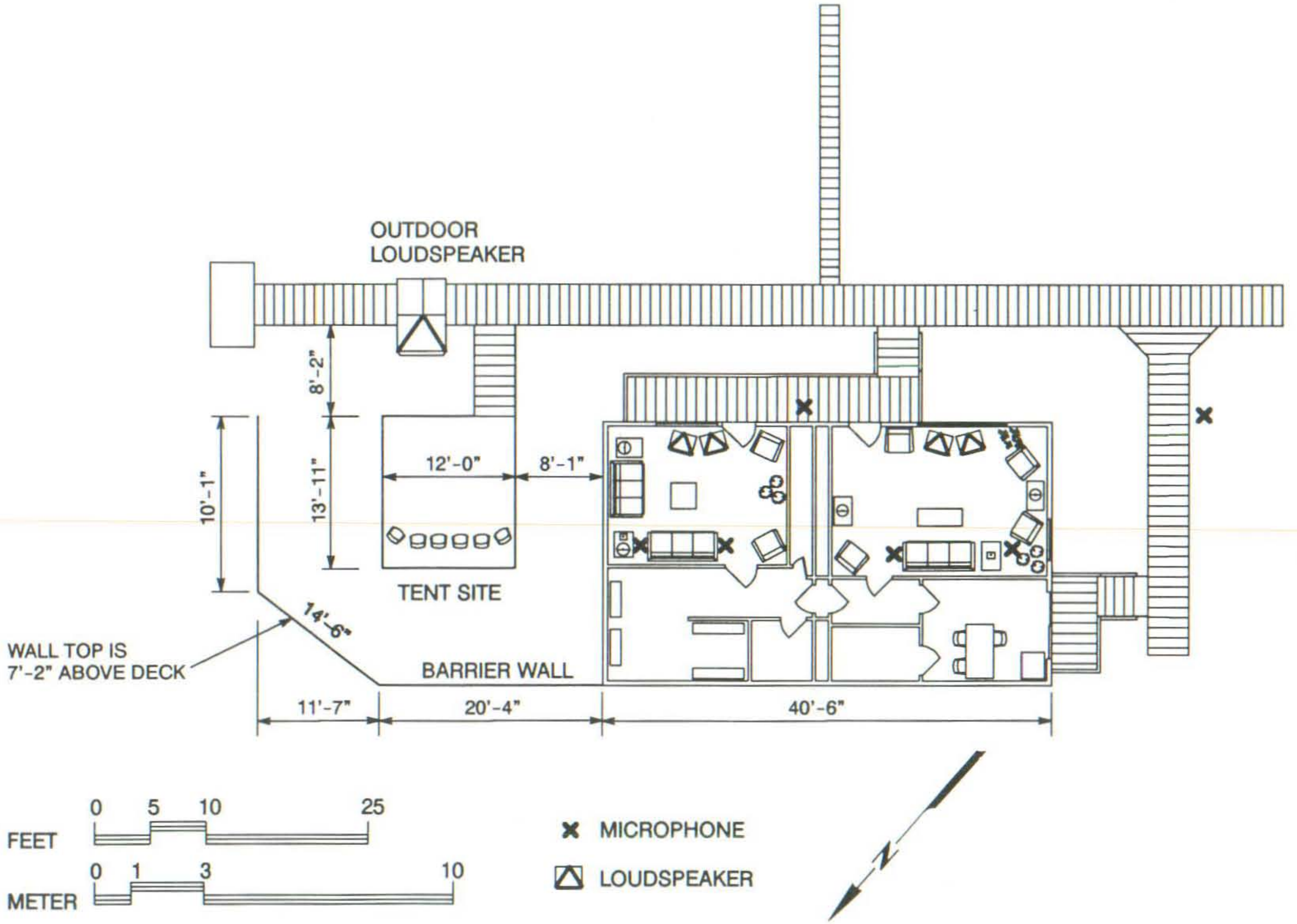
German half includes windows and doors taken from Grafenwöhr and is constructed to the standard German ceiling height. Each room has one large window and door facing the vehicle road, and the small arms, 25 mm cannon, and blast firing sites. In each German room, the door is a glass patio door; in each American room, the door is wood and there is an additional, small window on the side of the room in addition to the large front window. Figure 12 shows the layout of one duplex. Appendix A describes the structures and the immediate site in more detail.

Each duplex half is separated from its other half by vibration isolation and triple walls with special acoustical treatment. Each half has its own heating , ventilating, and air conditioning (HVAC) and electrical systems so nothing penetrates from one half to the other. The construction of the two duplexes differed. One has typical American wood-stud walls, a crawl space, and a trussed, asphalt-shingled roof. The other has 30 centimeter (cm) masonry walls and a poured concrete floor and ceiling. The latter mimics German construction, which typically has these features. Although the masonry wall at APG is heavier than a typical German masonry wall, the windows are the limiting factor in either case in terms of acoustical transmission. The American walls use nominal 2 inch (in.) x 6 in. (exact dimensions—4 cm x 14 cm) studs rather than the nominal 2 in. x 4 in. (exact dimensions—4 cm x 9 cm) studs in order to increase stiffness and improve low-frequency sound isolation performance.

The test facility is located within the main weapons test area of APG; an area that is several hundred square km in size. Because of its location, no problems occurred using live ammunition and no neighbors were near to be bothered by the test sounds. However, because of sound from other non-acoustical testing during the day at APG, it was necessary to perform these tests during the evenings and on Saturdays.

The subjects were placed in each of the four test living rooms. They sat on chairs and couches towards the rear of each room, as distant as possible from the wall containing the front windows and facing the road and firing sites. A test supervisor sat with each group. All windows were covered by closed drapery to prevent subjects from seeing the passing vehicles. (All other sound sources were obscured by trees.)

An outdoor group created when tests were performed during summer months (two of the five test periods) was located just northeast of the test house (Figure 12). The outdoor group faced the sound sources but were visually screened from the sound sources by being in a large tent. An absorbant barrier wall behind and to the side of the tent protected respondents from other extraneous sounds.



The outdoor location is also shown. It indicates the location of the subjects and the loudspeakers that produced the white/pink noise control sound. It also indicates the location of the two indoor and three of the four outdoor microphones.

Figure 12. The layout of one duplex.

The control computer and measurement equipment were in the instrument "trailer," a permanent part of the test facility. This is also where the coordinator of the vehicles, blasts, small arms, and computer-generated sounds was located.

Test Subjects

The subjects—hired for the test by a local contractor—came from the local area and represented a reasonable cross section of the general public in terms of age and gender. Subjects participated in the experiment only once. Overall, about 350 subjects were used for this study. Because the paired-comparison methodology reduces the need to have subjects with perfect hearing and the desire was to have a cross-sectional representation of the community, subjects were not screened for perfect hearing acuity. The elderly, even with an age-related hearing loss, were used in this test to form the typical community cross section. However, subjects who could not communicate over the telephone were excluded.

Acoustical Data Collection

The acoustical measurement instruments consisted of eight indoor and four outdoor microphones. Two Brüel and Kjær (B&K) 4145 "1-inch" microphones were placed in each subject room at the subjects' ear height and located to obtain a good approximation to the stimuli heard by the subjects. Two B&K 4921 outdoor microphone systems were located about 80 to 100 mm (the thickness of the windscreen plus a small air space) from the southeast face of each test duplex. A third B&K 4921 microphone was located in a "free-field" setting midway between and about 50 cm forward of the line formed by the front faces of the test houses.* A fourth B&K 4921 microphone was located just behind the subjects in the outdoor group. The subject group microphone was at ear height, about 1 m. The other three outdoor microphones were at a height of about 2.5 m. Figure 12 shows the microphone positions near the eastern duplex.

To ensure more accurate measurement of both low-level (small arms and vehicles) and high-level (blast) sounds, a computer-controlled attenuator was developed. It was used during the June 1992 test. In general, the eight indoor microphones were used to measure the sound signals received by the subjects. With the exception of blast sounds, the free-field microphone was used to obtain the general outdoor sound levels

* The term "free-field" is used without quotations to designate this microphone position for the remainder of this paper although a microphone at only a height of 2.5 m is not exactly in a free-field.

used for analysis; the microphones on the front (southeast) faces of the test houses were used to determine the blast sound levels.

The equipment room shown in Figure 13 housed all the equipment for analyzing and recording the signals taken from the houses and three outdoor microphones. Both the indoor and outdoor signals were recorded on Panasonic 3500 DAT recorders. Also, the microphone signals were amplified with a Tektronix AM502 amplifier and analyzed using a USACERL-developed integrating noise monitor and SEL meter (Model 380). Figure 14 shows the instrumentation.

Control Sound

A personal computer (Figure 15) was used to regulate the control sound that was compared with each test sound. The starting point in generating a control sound was playback of a DAT recording. One channel contained the white noise (200 to 1,500 Hz), the other channel contained the pink noise (500 Hz octave band). The amplitude envelope (Figure 10) of either control noise type was created with a programmable attenuator connected to the personal computer. By using the programmable attenuator, the computer regulated the SEL and 10-dB down time of the control sound.

The white/pink-noise control sounds were presented at 5-dB intervals. The levels were -10, -5, 0, +5, and +10 dB with respect to the base level ASEL (see Table 3). The control sound would gradually rise from inaudible to 10 dB below its maximum level, and then rise to the maximum at a different rate. The sound would then decay in approximately the same manner. (See Figure 3 for examples of the amplitude envelopes of the two control sounds.) The sound in each room was generated by two loudspeakers. The outdoor control sound was the same as the indoor sound, except the outdoor level was 20 dB higher. This 20 dB gain was used because the A-weighted attenuation of a typical American house from outdoors to indoors is about 20 to 25 dB (A-weighted). For the white/pink-noise control sound sources, the control levels were adjusted in ±5 dB steps depending on received test sound levels and the response data already collected. The goal was to have the equivalency point at the middle of the control sound range which was the middle level for the white/pink noise control sounds. Table 3 contains the actual "base" levels by set.

Conduct of The Test

Each test required approximately 3 hours to complete. Random groups of five or six subjects were taken to the test house by a supervisor who gave them information on

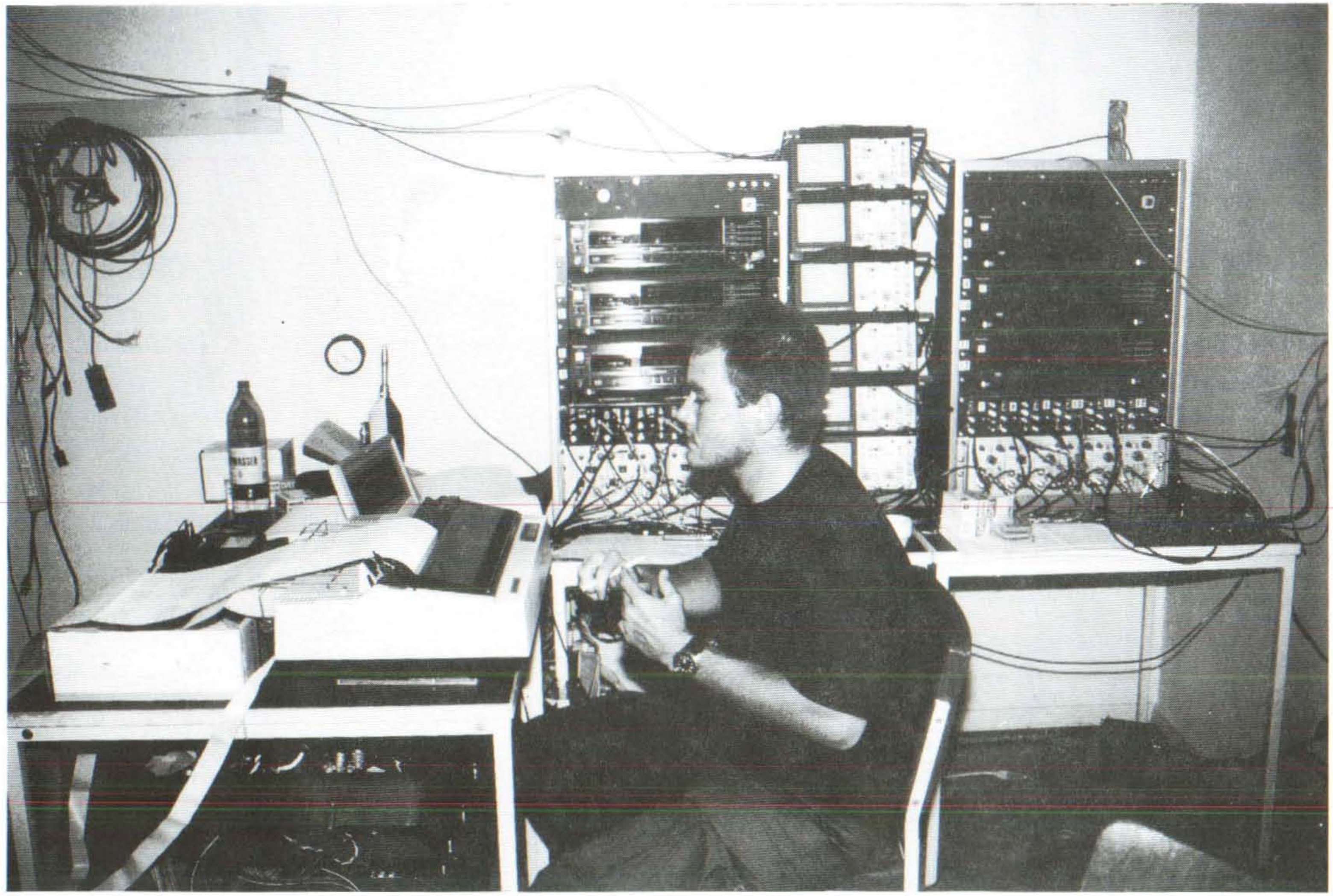


Figure 13. The instrument control room–data collection station.

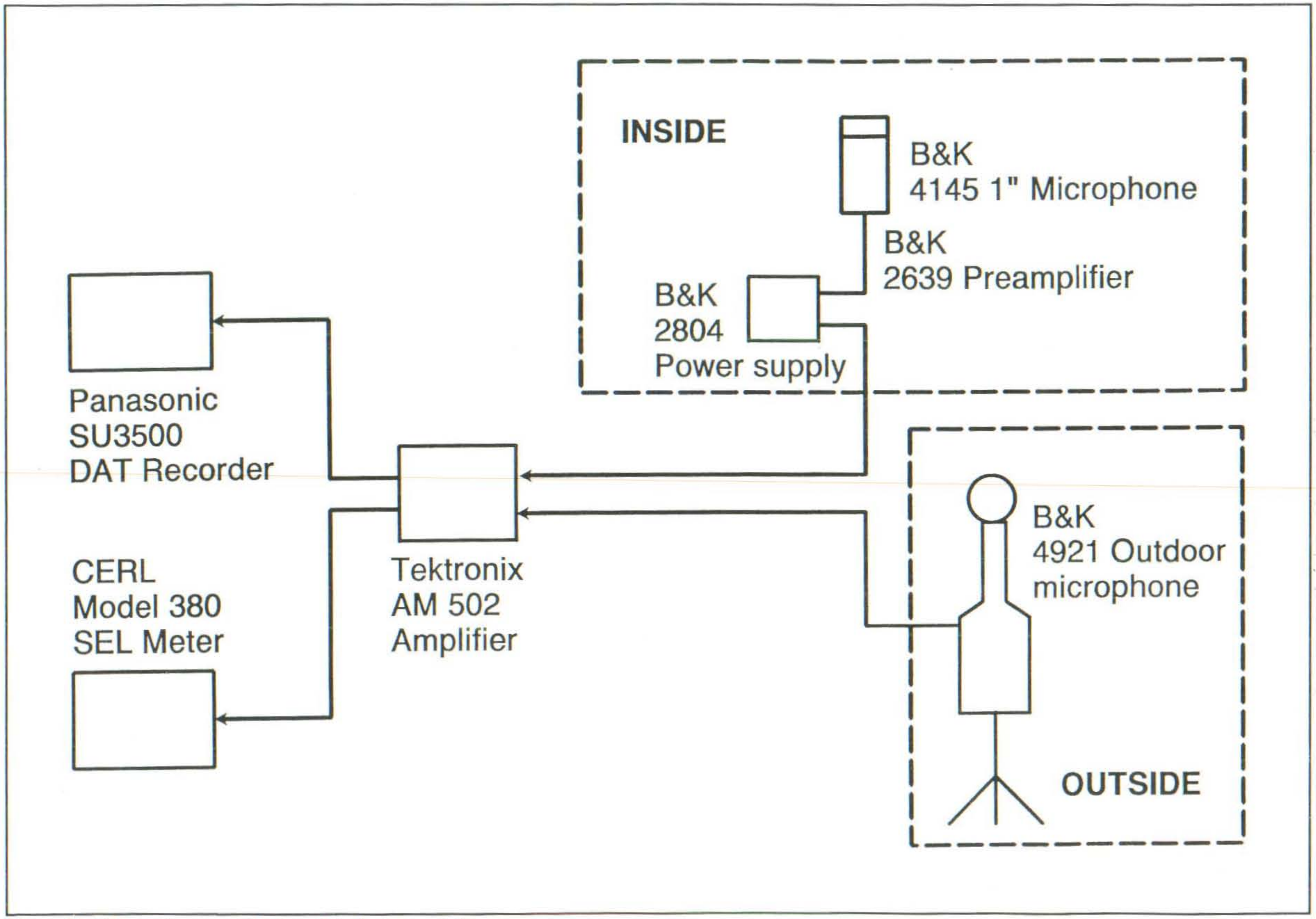


Figure 14. Schematic representation of the instrumentation.

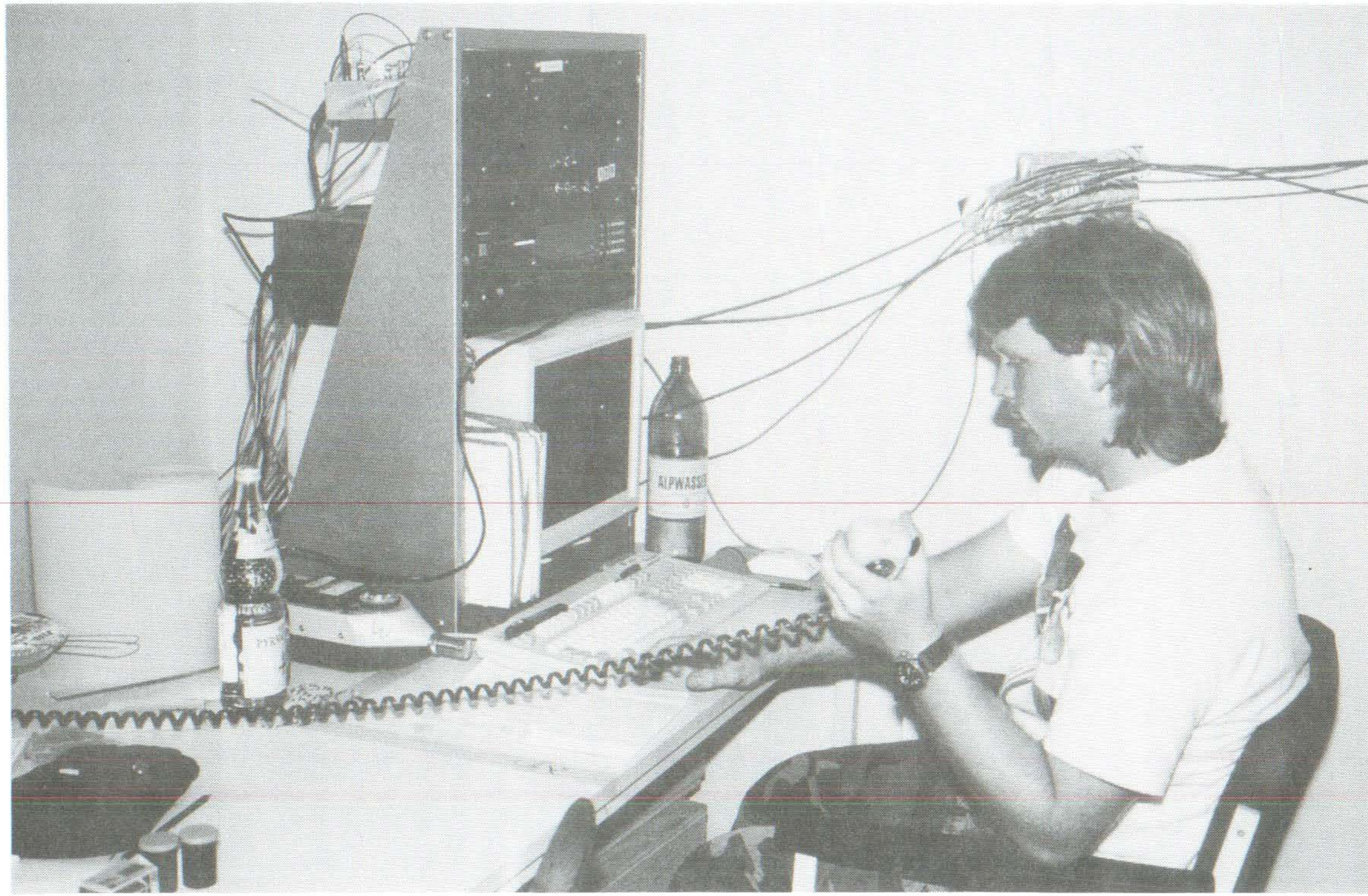


Figure 15. The instrument control room–test control station.

test conduct and remained with them throughout the test. (Figure 16 shows a typical indoor group of test subjects.) First, to train the subjects, a pretest used two pink-noise samples as the pair of sounds. Typically, three pairs of sounds were presented. For the first two pretest pairs, the ASEL of the two sounds in each pair clearly differed; their levels were 10 dB apart. In the first pair, the first sound had the higher level, and in the second pair, the second sound had the higher level. In the third pair, the ASELs of the two sounds were equal. Supervisors would check the participants' answers after each pretest run and use the first two pretest pairs to verify that everyone understood the instructions. If a test subject chose the "wrong" answer during the pretest, the supervisor would repeat the instructions to everyone. If necessary, more pretest pairs were run until everyone fully understood the instructions.

The subjects were told to mark which sound was more bothersome or annoying (Figure 11); the sound they would rather not hear again given the choice. The subjects were also told to mark how difficult it was to make this decision on a scale of 1 to 5 with the endpoints anchored by the descriptions "very easy" and "very hard." It is important to note that test participants were required to decide which sound of a pair was more annoying or bothersome for every pair of sounds. They could not say that the two sounds were of equal annoyance, but they could indicate that it was "very hard" to decide. The primary purpose for including the "degree of difficulty" scale was to ensure that the subjects made a choice as to which sound was more annoying in a pair.

Judgments of the annoyance of each pair of sounds were accomplished in four segments. First, a red light would light and subjects would concentrate on the first sound. Second, a yellow light would light and the participants would listen to the second sound. Third, a green light would light and the subjects would have approximately 5 s to mark the form. Finally all lights would be turned off and the subjects would wait until the red light was turned on again to signal the start of the next pair. The red and yellow light segments for the vehicles and small arms lasted for approximately 30 s; for the blasts, these lights were lit for 5 to 10 s. Figure 17 shows the signal lights and loudspeakers in a subject test room.

A computer controlled signal lights and generation of control sounds. The operator of the computer used a portable radio to contact supervisors at each of the test sound source sites (i.e., near and far small-arms sites) to ensure the arrival of each sound at its proper time.

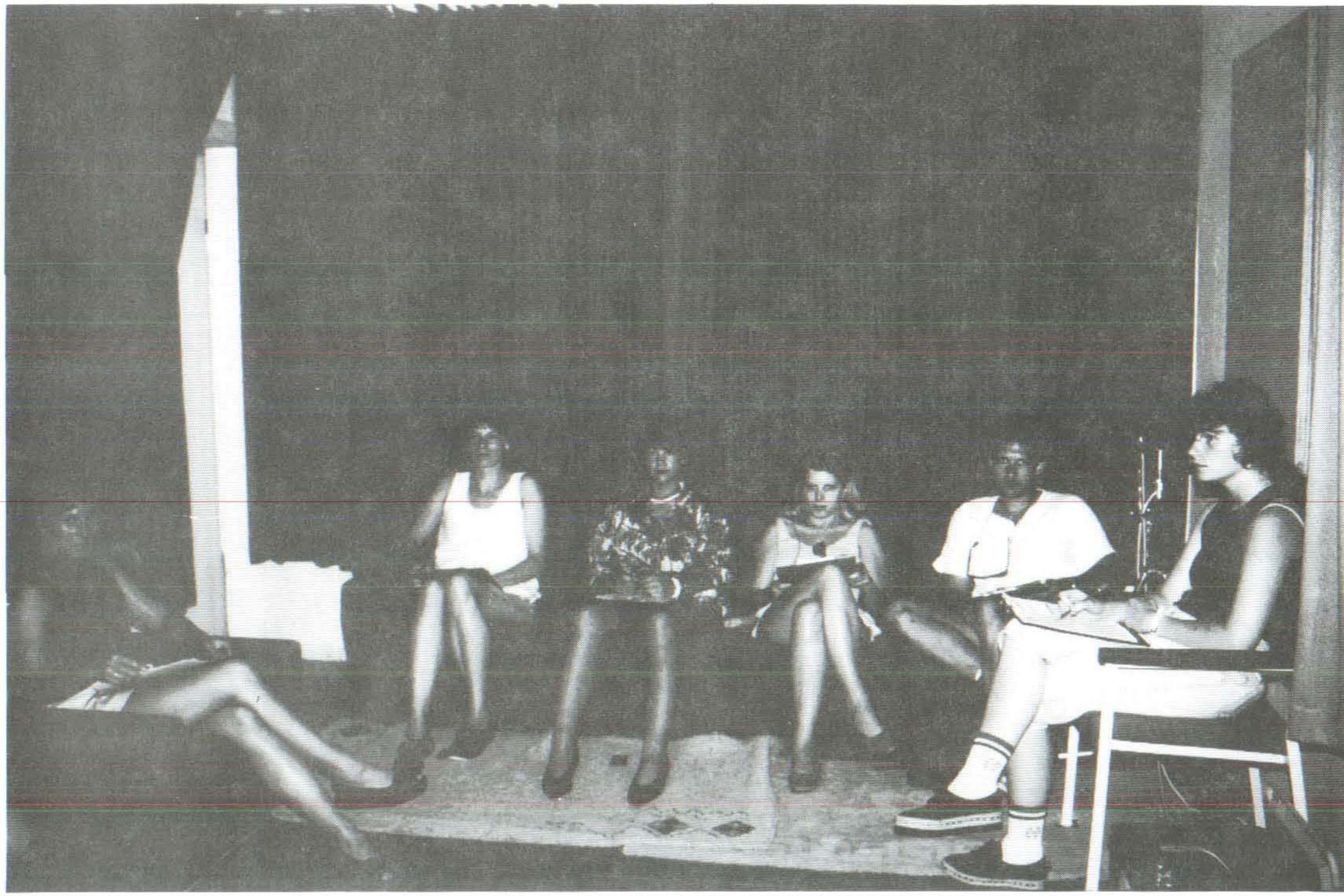


Figure 16. Subjects seated in a test room.

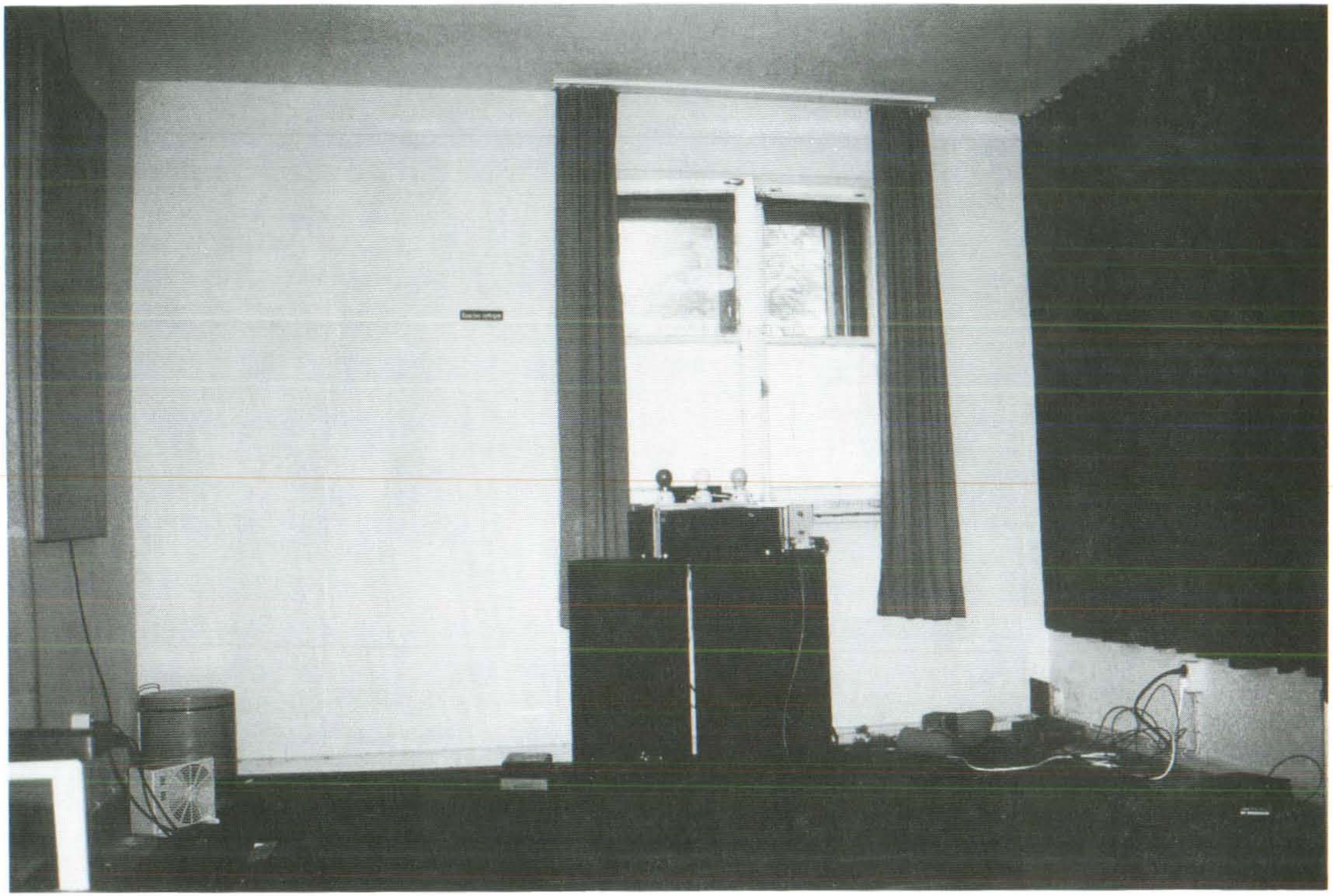


Figure 17. A subject room showing the front wall, control lights, and loud speakers for generating the pink/white-noise control sound.

Test Conditions

Table 4 lists the three conditions tested. The subjects were located indoors with the windows in each room closed (like most previous research in this general subject) during: the first measurement period, which consisted of a pretest and six good test sessions; the fourth measurement period, which consisted of three test sessions; and the fifth measurement period, which consisted of two good test sessions. (Recording problems and high instrument noise floors rendered useless the data from two other test sessions during the fifth test period.) Second, during the second and third measurement periods, which together consisted of six test sessions, the windows were partially open (about 50 mm), enabling air flow but not allowing the subjects to see the test stimuli. Third, during the second and third measurement periods, subjects also occupied the outdoor area (see Figure 12).

Table 4. Test conditions by measurement period.

Condition	Test Sessions
subjects indoors; windows closed	Jan 92, Nov 92, Jan 93
subjects indoors; windows open	Jun 92, Aug 92
subjects outdoors	Jun 92, Aug 92

3 Data Analysis

Acoustical Data

The acoustical levels for the small arms, tracked-vehicle, and wheeled-vehicle sound were kept constant from test to test, so the resulting data could be aggregated based on test condition (windows closed, subjects indoors; windows open, subjects indoors; or subjects outdoors). The blast sound levels were not constant from day to day because of changes in sound propagation conditions. Table 5 lists the blast levels by test. For analysis, the blast data were grouped by like levels within a test time period as indicated in Table 5. Appendix B contains the measured average data for sound sources for each set.

Table 6 lists the ASELs for the small arms, helicopters, 25 mm cannon, and wheeled vehicles. The ASELs in Table 6 represent the average values of the measured sound exposures and were rounded to the nearest 0.5 dB. Because the levels for these four sounds were kept almost constant from one test session to another, the resulting data could be aggregated across test sessions within each of the three test conditions. These aggregated sound exposure levels (SELs) were used throughout the analysis.

Subject Responses

Responses of the subjects were analyzed to determine the test sound ASEL (CSEL for blast sounds) at which 50 percent of the subjects felt that the test sound was more annoying than the control. This analysis concentrated on group-pooled responses using the average SEL data (Tables 5 and 6).

Test-subject responses were analyzed for each test sound source paired with each of its five respective control sounds to find the percentage of subjects that were more annoyed by the test-sound source at each control sound level. The result of such an analysis should have the form of a transitional function.

However, it is not feasible to test with extremely high- or low-level control sounds. For example, control ASELs at or below 20 dB are virtually inaudible and unmeasurable (at a field test site), and control ASELs at or above 110 dB are well above recommended

Table 5a. Large-charge blast sound data by measurement set.

Test Period	Test Set	Test Grouping	Free-field CSEL (dB)	Free-field Peak level (dB)	Pressure-doubled CSEL (dB)	Pressure-doubled CSEL (dB)	Indoor CSEL (dB)
January 1992	1	A	107	129	110	128	98
	2	B	101	125	107	130	93
	3	C	94	116	97	119	84
	4	B	102	120.5	105	127	88
	6	A	106	127	108	128.5	93
	7	B	102	124	105	126	89
June 1992	1	D	94	116	96	117	81
August 1992	2	E	100	122	103	123	95
	3	F	105	128	109	132	101
	4	F	101	124	105	128	99
	5	E	100	123	104	127	99
November 1992	1	G	103	123	105	123	90
	2	G	106	127.5	109	127	90
	3	G	105	127	108	130	90
January 1993	1	H	98	119	101	119	85

Note: In January 1992, set 5 did not occur, and in August 1992, set 1 was a pretest.

Table 5b. Small-charge blast sound data by measurement set.

Test Period	Test Set	Data grouping	Free-field CSEL (dB)	Free-field Peak level (dB)	Pressure-doubled CSEL (dB)	Pressure-doubled CSEL (dB)	Indoor CSEL (dB)
January 1992	1	I	99	119	101.5	121	96
	2	I	96	117	103	124	88
	3	J	92.5	112	95	115	81
	4	J	93	113	96	116.5	80
	6	B	99	120	102	123	90
	7	I	97	117	100	120	85
June 1992	1	K	92	112	93	115	78
August 1992	2	L	95.5	117	98	120	91
	3	L	99	121	103	125	93
	4	L	96	117	100	121	95
	5	M	95	117	98	120	95
November 1992	1	N	94.5	115	99	119	85
	2	N	95	116	98	120	86
	3	N	95	116	97	120	85
January 1993	1	O	92	112	96	116	83

Note: In January 1992, set 5 did not occur, and in August 1992, set 1 was a pretest.

Table 6a. All of the test sound source ASEL data used for the overall analysis.

Test Sound Source	Near Guns 60 shots	Near Guns 6 shots	Far Guns 60 shots	Near Helicopter	Far Helicopter	Neat 25 mm Cannon	Far 25 mm Cannon
OUTDOOR DATA (Free-Field), ASEL (dB)*							
Jan 92	85	76	75	88	78		
Jun 92	86	74	76	88	78		
Aug 92	85	75	75	88	78		
Nov 92	85	75	76			70	70
Jan 93	85	76	77			72.5	74
OUTDOOR DATA (Tent Group), ASEL (dB)							
Jun 92	83	74	75	90	82		
Aug 92	82	73	74	86	76		
INDOORS AT SUBJECTS—WINDOWS CLOSED, ASEL (dB)							
Jan 92	55	46	46	65	54		
Nov 92	54	45	46			51	49.5
Jan 93	52	44	42			51	50.5
INDOORS AT SUBJECTS—WINDOWS OPEN, ASEL (dB)							
Jun 92	67	58	58	70	65		
Aug 92	66	57	58	68	59		

*These data are energy averaged ASEL, rounded to the nearest 1/2 dB.

Table 6b. All of the control source ASEL data used for the overall analysis.

Control Sound Source	Vehicle 1	Vehicle 2	Vehicle 3	Vehicle 4	Vehicle 5	Vehicle 6
OUTDOOR DATA (Free-Field), ASEL (dB)						
Jan 92	97	93	88	81	75	70
Jun 92	96	90	85	79	73	69
Aug 92	98	90	87	80	72	67.5
Nov 92	98	92	88	80	76	72
Jan 93	96	92	89	81	76	71
OUTDOOR DATA (Tent Group), ASEL (dB)						
Jun 92	93	89	83	79	74	72
Aug 92	95	89	84	80	74	70
INDOORS AT SUBJECTS—WINDOWS CLOSED, ASEL (dB)						
Jan 92	67	63	59	55	51	48
Nov 92	68	64	61	59	56	49
Jan 93	68	63	60	57	51	50
INDOORS AT SUBJECTS—WINDOWS OPEN, ASEL (dB)						
Jun 92	77	72	66	62	59	50
Aug 92	76	71	68	63	57	55

*These data are energy averaged ASEL, rounded to the nearest 1/2 dB.

levels for hearing conservation. So, in this analysis, a transitional curve was fitted to the data, but constrained to be very near to 100 percent for control ASELs at or below 20 dB, and also constrained to be very near 0 percent for control ASELs at or above 110 dB. One of the following three transition functions was used to produce a plot for each test sound and corresponding set of five control sounds. Selection of the best-fit function was made on the basis of which yielded the smallest error. The curve having the largest F-statistic (i.e., minimum mean square residuals) was selected. Once the plots were generated, the SEL of the test sound source and the corresponding ASEL of the control sound for each equivalency point were determined by computer solution of the curve fitted to the data.

Each of the three potential transition functions has four independent parameters, a, b, c, and d. Each curve relates the percent of the judgments that found the test sound to be more annoying (%) to the ASEL of the control sound (L_{AE}) in decibels.

The Sigmoid function has the form:

$$\% = a + b/\{1 + \exp[-(L_{AE} - c)/d]\}, \tag{1}$$

the Logistic Dose Response function has the form:

$$\% = a + b/[1 + (L_{AE}/c)^{d}], \tag{2}$$

and the Cumulative Distribution function has the form:

$$\% = a + (b/2)\{1 + \mathrm{erf}\,[(L_{AE} - c)/(2^{1/2}d)]\} \tag{3}$$

where erf is the Error function.

Appendixes C, D, E, and F contain complete listings and transition curve figures for all of the data. The tables in these appendixes include the F-statistic and the corresponding standard error for each transition curve, type of curve fit, 90 percent confidence limits, t-value, and standard error for each of the four independent parameters.

4 Results

Helicopter, Small Arms, and 25 mm Cannon Results—Wheeled-Vehicle Control Sounds

As described in the Munster article (Schomer et al. 1994), the data were analyzed using both the free-field microphone and the indoor microphone. Both sets of results are discussed below.

Table 7 summarizes the results for the three test conditions of windows closed, windows open, and outdoors. This table includes consolidated data for the four indoor rooms together and for the outdoor group. In this table, the penalties are the amounts in decibels to be added to the test SELs to make them equivalent in terms of annoyance to their corresponding control SELs. The penalties in Table 7a are for acoustical measurements made near the subjects; those in Table 7b are for acoustical measurements made outdoors in a free field.

Environmental noise is normally measured and assessed on the basis of outdoor data. For example, airport or highway noise contours predict outdoor free-field sound levels; not the sound levels at the ears of residents inside houses. So, to assess military sounds compared with traffic sounds, it is **mandatory** that the penalties be based on outdoor-measured SELs—even though the judgments were made by subjects situated indoors. Table 7b lists these penalties.

Small arms results

The data gathered using the outdoor, free-field microphone indicate an average penalty of 12 dB for all indoor test conditions, windows open or closed, 60 shots or 6 shots, near or far position. With acoustical measurements indoors near the subjects, the results are much the same, but the scatter is a little greater and the penalty is about 10 dB. Sound level causes no apparent variation. This is in contrast to earlier results by Rice (1989), Vos (1990), and at Munster (Schomer et al. 1994) where there was some indication of a level dependence to the results. Here the penalty is fairly constant at 12 dB.

For subjects outdoors, the small arms penalty appears to be about 9 or 10 dB.

Table 7a. Computed penalties for measurements made near the subjects.

Test Sound Source	Near Guns 60 shots	Near Guns 6 shots	Far Guns 60 shots	Near Helicopter	Far Helicopter	Near 25 mm Cannon	Far 25 mm Cannon
OUTDOOR (TENT) GROUP, ASEL (dB)*							
Jun 92	10	8.5	10	2.5	1		
Aug 92	7.5	9.5	12.5	2	5		
AVERAGE	8.8	9	11.2	2.3	3		
INDOORS—WINDOWS CLOSED, ASEL (dB)							
Jan 92	11	8	6	-7	-1		
Nov 92	13	**	**			13	13
Jan 93	15	**	**			11	11
AVERAGE	13	8	6	-7	-1	12	12
INDOORS—WINDOWS OPEN, ASEL (dB)							
Jun 92	9	12	15.5	2	-3.5		
Aug 92	11	13	12	2	1.5		
AVERAGE	10	12.5	13.8	2	-1		
INDOOR AVERAGES							
AVERAGE							

*All of the computed penalties (ASEL) rounded to the nearest 1/2 dB.
** These low-level indoor data were inadvertently corrupted by HVAC noise.

Table 7b. Computed penalties for measurements made outdoors in a free field.

Test Sound Source	Near Guns 60 shots	Near Guns 6 shots	Far Guns 60 shots	Near Helicopter	Far Helicopter	Near 25 mm Cannon	Far 25 mm Cannon
OUTDOOR (TENT) GROUP, ASEL (dB)*							
Jun 92	9	8	9	6.5	4.6		
Aug 92	6	7.5	12.5	1.5	3		
AVERAGE	7.5	7.8	10.8	4	3.8		
INDOORS—WINDOWS CLOSED, ASEL (dB)							
Jan 92	15	12	12	2	3		
Nov 92	12	11	9			19	18
Jan 93	12	10	8			12.5	15.5
AVERAGE	13	11	9.7	2	3	15.8	16.8
INDOORS—WINDOWS OPEN, ASEL (dB)							
Jun 92	9	15	16	2.5	1		
Aug 92	12	14	14	1	0		
AVERAGE	10.5	14.5	15	1.8	0.5		
INDOOR AVERAGES							
AVERAGE	12.0	12.4	11.8	1.8	1.3	15.8	16.8

*All of the computed penalties (ASEL) rounded to the nearest 1/2 dB.

25 mm Cannon results

Penalties for the 25 mm cannon appear to be about the same as for small arms when measured indoors by the subjects—12 dB versus 10 or 11 dB for the small arms. However, because of the low frequencies present in the cannon spectrum, the outdoor, free-field computed penalties are larger—about 16 dB versus 12 dB for the small arms. So at the subjects' ears, the 25 mm cannon appears to be judged similarly to small arms in terms of annoyance, but it may need a larger penalty when it is compared to other sounds on the basis of outdoor, free-field measurements.

Helicopter results

The most surprising result was found for the helicopters. Although many have thought that helicopter sound should be penalized because of its "impulsive" character, little or no penalty was found. In fact, with acoustical measurements indoors at the subjects, the penalty is sometimes negative—a bonus. This result is considered to be particularly reliable because a penalty was clearly found by the same subjects in the same test for small arms sound.

Small Arms, 25 mm Cannon, and Helicopter Results; Pink Noise as a Control Sound

Loudspeakers produced the pink-noise signal near each group of subjects. Therefore, the following analysis is only for acoustical data measured by the microphones near the subjects. (The outdoor free-field microphone did not measure any loudspeaker sound.) Table 8 shows the results for the three test conditions of windows closed, windows open, and subjects outdoors for the three sources (nearby small arms [60 shots], nearby 25 mm cannon, and nearby helicopter) each of which had both wheeled-vehicle and pink noise as a control sound. Table 8 also includes the results for vehicle V2 with pink noise as a control sound.

As at Munster, the results using the pink-noise control sound were substantially different from the results using wheeled-vehicle control sounds. The difference both in this study and in the Munster study was of the order of 10 dB, and in both studies the results were internally consistent (as Table 8 demonstrates for this study). For each test condition, the value of the penalty found for vehicle V2 using pink noise as a control sound was quite similar to the difference in penalty found between using

Table 8. All of the computed penalties (ASEL) using pink noise as the control and comparison with the corresponding penalty using vehicles as a control.

Test Sound Source	Vehicle 2	Near Gun-60		Near Helicopter		Near 25 mm	
Control	Pink Noise	Pink Noise	Vehicles plus*	Pink Noise	Vehicles plus*	Pink Noise	Vehicles plus*
OUTDOOR COMPUTED PENALTY (Measurement near Tent Group), ASEL (dB)							
Jun 92		outdoor pink noise was incorrect					
Aug 92	6.5	15.5	14	12.5	8.5		
PENALTIES COMPUTED INDOORS—WINDOWS CLOSED (Measurement near Subjects), ASEL (dB)							
Jan 92	9	24	20	2	2		
Nov 92	9	26	22			19	22
Jan 93	11.5	22.5	26.5			19.5	22.5
AVERAGE	9.8	24.2	22.8	2	2	19.5	22.3
PENALTIES COMPUTED INDOORS—WINDOWS OPEN (Measurement near Subjects), ASEL (dB)							
Jun 92	5	20	14	4	7		
Aug 92	7	18.5	18	8.5	8		
AVERAGE	6.5	19.3	16.5	6.3	8		

*This column contains the corresponding penalty from Table 6 (where the control sound was vehicles) plus the penalty for V2 given in column 2 of this table.

wheeled-vehicle or pink-noise control sound for near small arms (60 shots), the near 25 mm cannon, or the near helicopter. Because of the internal consistency in each study and the replication of the results in both, this difference of about 10 dB between the penalty determined using the two different control sound sources is considered to be very reliable and real.

The 10-dB difference between the ASELs of equally annoying pink-noise and wheeled-vehicle sounds casts some doubt on testing methodologies that use artificial, machine-generated sounds as a control to develop *absolute* penalties. Since the goal of absolute penalties is to make assessment of some study sound equal to assessment of normal environmental sounds such as motor vehicle traffic, the large differences in penalties derived using the two different control sounds indicates that artificially-generated control sounds should not be used as a surrogate for real sounds when testing annoyance to determine *absolute* levels for penalties.

Blast Sound Results

In the following, results are given both for acoustical data gathered near the subjects' ears and for acoustical data collected outdoors, but with the subjects indoors.

Because sound propagation conditions and resulting received blast SELs changed greatly from day to day, the data were grouped by like levels within test sessions. On some occasions, for example, nearly all of the subjects found the blast more annoying for all control sound levels when the blast sound levels were especially high on one day, and conversely, the opposite occurred when the blast sound levels were very low on another day. In one case, no reliable transition curve could be developed for the data.

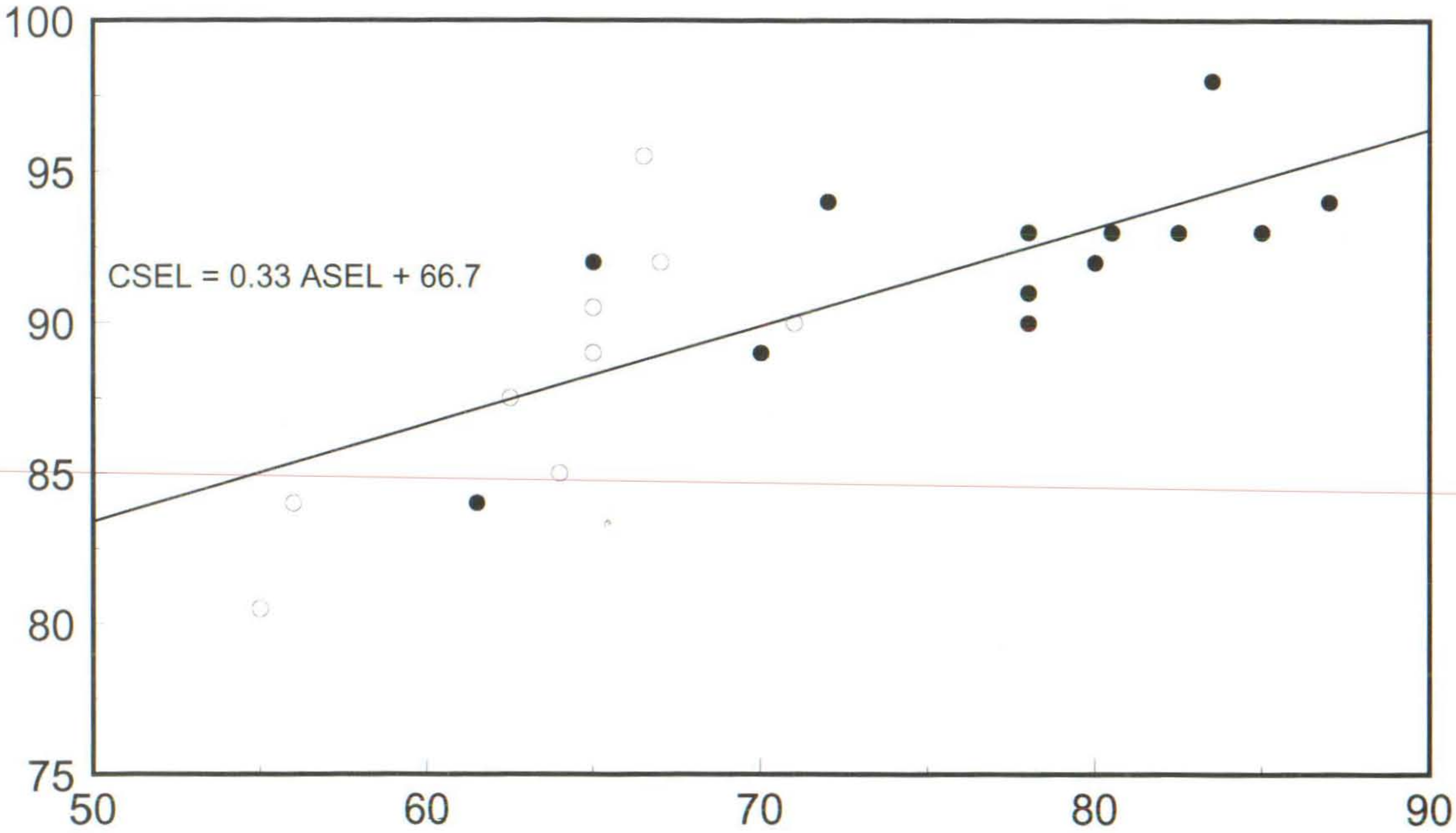
This problem was so acute because, as shown below, a 1 dB change in CSEL of a blast corresponded to about a 2 dB change in ASEL for an equivalently annoying control sound. Since the range of control SEL was about 20 dB, a shift of only 10 dB in the received blast SEL could shift the subject responses from one extreme to the other, from all finding the blast more annoying to none finding the blast more annoying than the control sound. Because of this problem, several sets of blast data points do not include the 50 percent point within the data range. In these cases, the 50 percent point was determined by extrapolation. However, the extrapolation was required to be small and the closest data point to 50 percent was at about 55 to 60 percent. One data set was excluded because it required what was considered to be too great an extrapolation (more than 10 percentage points from the nearest data point) to determine the 50-percent point.

Figure 18 shows the data and regression line for CSEL compared with both wheeled-vehicle and white-noise control SELs. The data were measured indoors near the subjects with the windows closed. The slope of the regression line is 0.33. Thus, in Figure 18, a 1-dB change in the CSEL of the blast sound corresponded in terms of annoyance to about a 3 dB change in control sound ASEL. However, the range of SELs for the control sounds was only about 30 dB, and the range of SELs for the blast sounds was only about 15 dB.

As at Munster, the blast data exhibited no difference between using the wheeled-vehicle control sound or the white-noise control sound. But the white-noise sound was much different in spectrum and amplitude envelope from the pink-noise control sound. Given the difference in the earlier results for the two control sounds (pink noise and vehicles), the lack of difference between white noise and vehicles may be purely coincidental.

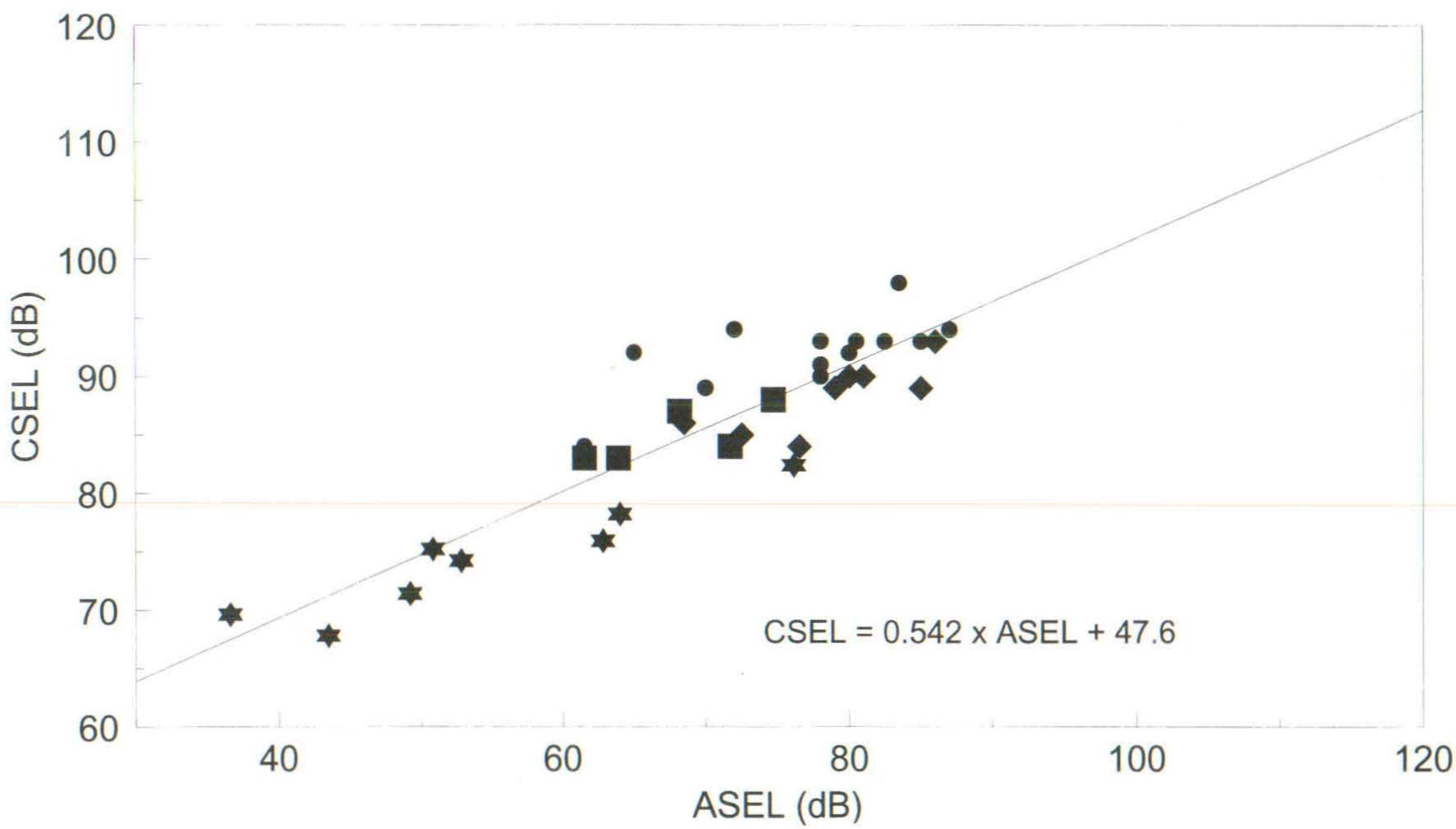
Figure 19 shows the data and regression line for earlier results from the Grafenwöhr Training Area and Munster along with these results from APG and eight earlier data points from a prior test at APG. All of the data are for a windows-closed test condition with acoustical measurements made indoors, near the subjects. The control sound in each case was white noise. At each site, the large-charge-size blast sound source was typically about 2 kg of explosives (known as C-4 or military TNT); the small blast sound source was about 500 g of explosives at a site about 1 km from the test houses, and the control sound was white noise. The most important features are the comparatively good agreement among the data sets and the 0.54 slope of the regression line. In Figure 19, a 1-dB change in CSEL corresponded to a change in equivalent control sound ASEL of about 1.8 dB. Also, in contrast to Figure 18, the SELs for the control sound shown in Figure 19 varied almost 50 dB and the SELs for the blast sounds varied about 25 dB.

In the Munster study (Schomer et al. 1994), it was found that for a combination of open- and closed-window data, the indoor measurements did not correlate well with indoor blast sound responses, but measurements of **outdoor** CSELs of blast sounds correlated well with judgments made indoors for both windows-open and closed test conditions, and even for subjects outdoors. The conclusion was that ASELs or CSELs measured indoors for blast sounds are not good predictors of annoyance judgments made indoors. So in this report only the outdoor measured acoustical data are used to analyze the responses to blast sounds when using wheeled-vehicles as the control sound source.



Both white noise (closed circles) and wheeled-vehicle (open circles) control sound data are included.

Figure 18. Data and regression line for indoor measured blast sound data at APG.



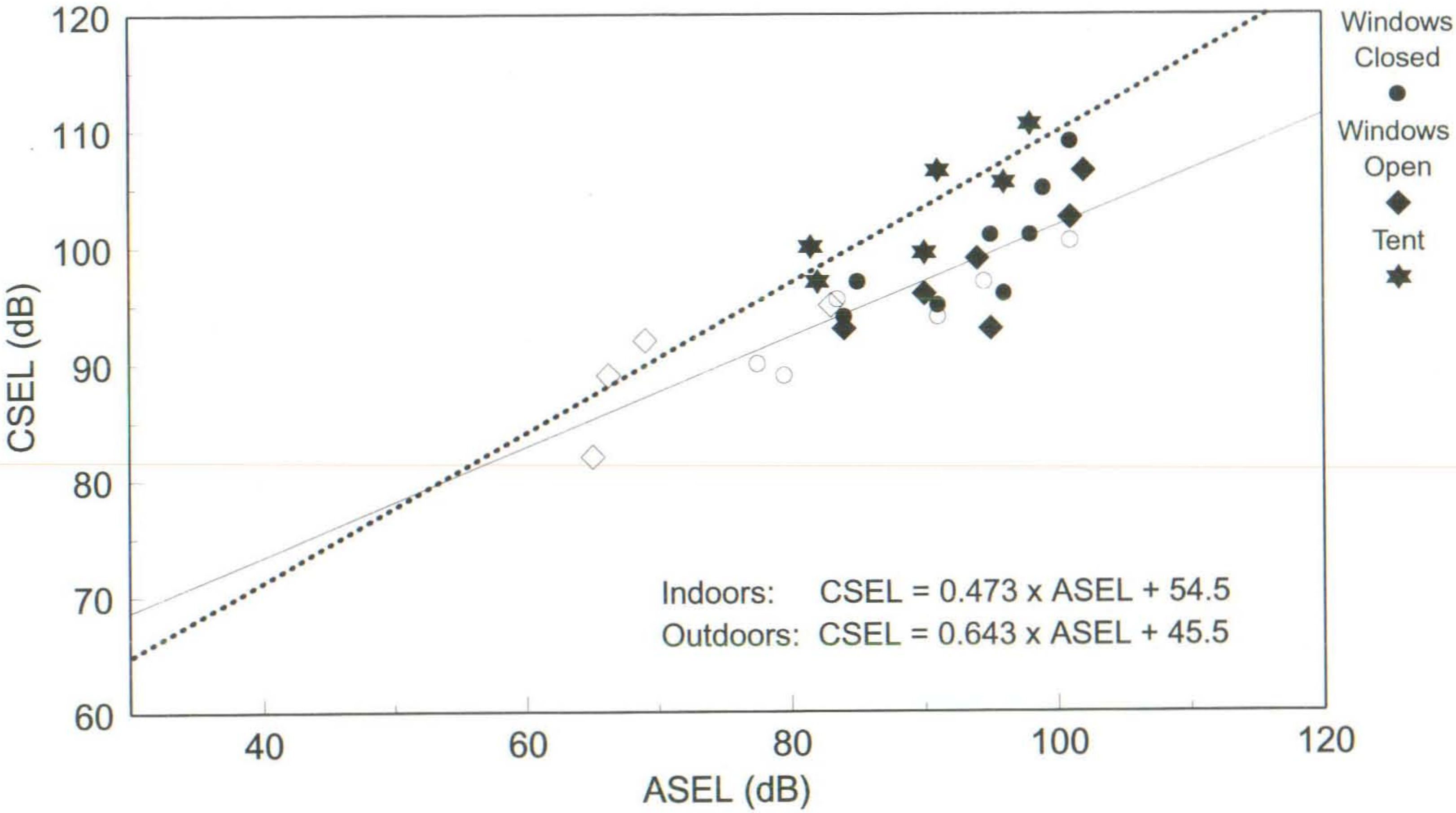
Munster = squares, APG series 1 = diamonds, APG series 2 = circles, and Grafenwöhr = stars. In each study, subjects were indoors with the windows closed, and identical acoustical measurements were made indoors near the subjects. At each test site, the large charge-size blast sound source was typically 2 kg (or 5 lb) of explosives (C-4 or military TNT), the small blast sound source was about 500 g of explosives, and the blast site was located about 1 km from the test house.

Figure 19. Data and regression line for blast sounds for Munster, APG series 1 and 2, and Grafenwöhr using white-noise control sounds.

Figure 20 shows the results of the indoor judgments of blast sounds for all wheeled-vehicle control sounds measured outdoors at the face of the test houses both in this study and in the Munster study. White-noise control sound data were not included because the loudspeakers were near the groups of subjects, and the microphone on the face of the test house did not measure the loudspeaker sound levels.

The most salient feature of the data in Figure 20 is its slope of about 0.50. A 1-dB change in CSEL of the blast sound corresponded to a change on the order of 2 dB in the ASEL of the equivalently annoying vehicle control sound. The point of subjective equality was at about 103 dB. Above 103 dB, the CSEL of the blast sounds should include a positive offset (in addition to measuring with C-weighting); below 103 dB, the offset becomes increasingly negative (indicating a reduction in the annoyance of blast sounds relative to the annoyance of the control sounds).

Figure 20 also includes the results from APG for the outdoor group. A regression line fit to these six data points shows a steeper slope than for the indoor subject; but it shows a slope that is less than one. These outdoor-subject data would seem to indicate that blast noise is less of a problem outdoors than indoors for the same outdoor-measured CSEL.



Windows closed = circles and windows open = diamonds. The acoustical measurements for the blast sounds were made outdoors near the center of the test house (pressure doubling except for some grazing incidence blast sounds at Munster). Vehicle data were measured using a nonreflecting microphone in an open area at window height (about 2 to 2.5 m above ground). The solid symbols are APG data and the open symbols are Munster data. CSEL equal ASEL when each is about 103 dB. The stars show outdoor data.

Figure 20. Data and regression line for blast sounds using wheeled-vehicle control sounds.

5 Conclusions

Measured near a subject's ears, the real sound of a passing vehicle did not compare in terms of annoyance with a computer-generated pink-noise sound producing the same ASEL. Equal annoyance responses differed by approximately 10 dB. This 10 dB difference replicated the result found in Munster. The large differences in penalties derived using two different control sounds indicated that artificial sounds should not be used as a surrogate for real sounds when testing annoyance to determine *absolute* levels for penalties, since the goal of such absolute penalties is to make the assessment of a military sound equivalent in terms of annoyance to the assessment of normal environmental sounds such as motor vehicle traffic.

The data in Table 7 further support a small arms penalty that is on the order of 10 dB. The variations from test to test and condition to condition suggest that this penalty is not a constant. It is some complicated function of many variables. However, for purposes of environmental noise assessment, the near maximum value of this penalty appears to be on the order of 10 dB. A penalty of 10 dB is in reasonably good agreement with other research on impulsive-sound penalties for small arms sounds. The data tend to support an equal-sound-exposure model for small arms since the penalty is constant when the rate of fire changes from 60 shots in 30 seconds to 6 shots in 30 seconds, for the same test condition and site.

For the 25 mm cannon, the outdoor-measured data support a penalty that is closer to 15 dB than to 10 dB. This result is strengthened by the fact that when measured indoors, the penalty for small arms is similar. The difference may lie in the building transmission from outdoors to indoors for the lower frequency 25 mm cannon sound as compared with small arms sound. Since this is the first set of data for this type of weapon, the results should be treated as very preliminary. Given the variation in small arms results from test to test and condition to condition, somewhat different results should be expected in any replication of the 25 mm cannon test.

The results for helicopter sound compared with wheeled-vehicle control sound show no penalty. This somewhat surprising result draws increased confidence on two different bases. First, results with the same subjects in the same test find penalties for small arms and 25 mm cannon sound when no penalty is found for helicopters. Second, the 10 dB "penalty" found in this test using the pink-noise control sound is consistent with earlier studies at Tustin (Schomer 1991) and Champaign (Schomer 1989).

The relationship between the CSEL of a large-amplitude impulsive sound and the ASEL of its equivalently-annoying control sound was definitely level dependent with a slope on the order of 1:2 (i.e., a 1 dB change in the CSEL of blast sounds corresponded to about a 2 dB change in the ASEL of an equivalently annoying control sound). With outdoor acoustical measurements, the annoyance (indoor subjects) generated by a large-amplitude impulsive sound and its equivalently annoying control sound were equal when the CSEL of the impulsive sound and the ASEL of the control sound were each about 103 dB.

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Appendix A: USACERL Acoustic Test Facility at Aberdeen Proving Ground

Acoustic Test Facility Development

Introduction

The purpose of the test structures is to provide a field test site for fabrication methods to shield residents from blast noise of large Army weapons, and other generators of noise.

The two structures, each of which includes two strictly isolated areas, are built to the typical level of normal home construction of different continents. The halves are referred to as the "American" half (imperial measurement), and the "German" half (metric measurement).

Each half has completely separate HVAC and electrical systems to ensure sound separation.

No openings or puncture in the walls, floors, or ceilings, other than the doors required for passage, were allowed between the "American" and "German" half of each structure.

The work of the Contractor consisted, in general, of site preparation, construction of the wood framed building, and retrofit of a magazine which represents masonry construction.

The Architect was retained to prepare sufficient Drawings and Specifications for review by governmental agencies having jurisdiction, and to secure approvals for issuing required general building permit. The Architect was to also provide additional consulting services when and if so requested during the construction and modification phases of the work.

The various division's listed represent the entire spectrum of construction. Only those divisions with special requirements for the acoustic testing contain information, all other divisions are listed with the statement: "Not used at this time"

Acoustic Test Facility Development

DIVISION 1 - GENERAL REQUIREMENTS

This project was designed to be executed in three phases:

I. Initial construction and renovation, and test calibration.

IIa. All remaining doors and windows placed.

b. Windows modified

III. siding removed from wooden house, replaced with brick.

I. Initial construction and renovation

WOODEN FACILITY

Scope: Fabrication of the wood frame field laboratory test site shall include rough openings for all future fenestration but no exterior windows of doors, to be installed, except the sliding door in the bedroom. The interior and exterior walls will be finished smoothly

BRICK FACILITY

Renovation of the magazine shall include:

a. Installation of reinforcing beams within the existing brick of the structure to accomidate future openings.

b. Provide rough framed openings for future exterior doors and windows, but interior walls finished smoothly for phase I.

c. Provide in the space labled bedroom, a sliding door, fill brick around opening.

d. Removing existing doors and non-essential columns, fill brick to match existing.

e. Plumbing: No plumbing or water is required

f. Electric: Will be two exterior electric panels, one on each structure having separate isolated feeds to each "side" of both buildings. Wire mold at base boards for interior distribution

g. HVAC: Electric heat pumps with condenser units (2) per structure

Acoustic Test Facility Development

h. Furnishings as required to give a "home like" feel.

II a. All remaining doors and windows placed

Scope: Placing of 12 windows (6 per structure) and 4 Doors (2 per structure) into existing framing of test facilities. Installing requires removal of existing interior chip board and exterior skins. Provisions will be made for eventual removal and replacement of the windows.

Major Requirements:

a. Locate rough framing openings. Remove existing surfacing materials from areas of future openings. Remove existing temporary framing materials. Prepare openings to accept windows and doors.

b. Place windows and Doors. Provide attachment of window and doors to allow for future removal (removal in part B).

c. Finish work. Provide finish trim at all windows and doors. Leave site as found. Remove construction spoilage, verify procedure with security

Acoustic Test Facility Development

II b. Windows modified

Scope: Removal of 4 Windows (2 per structure) in existing framing of test facilities and installing upgraded window. Provisions will be make for eventual removal and replacement of these windows.

Major Requirements:

a. Remove existing American manufactured windows. Prepare openings to accept upgraded windows.

b. Place windows. Provide attachment methods of window to allow for future removal.

c. Finish work. Provide finish trim at all windows. Leave sight as found. Remove construction spoilage.

III. Siding removed from wooden house, replaced with brick.

Scope: Removal of existing wood siding of test facility. Installing of brick facing

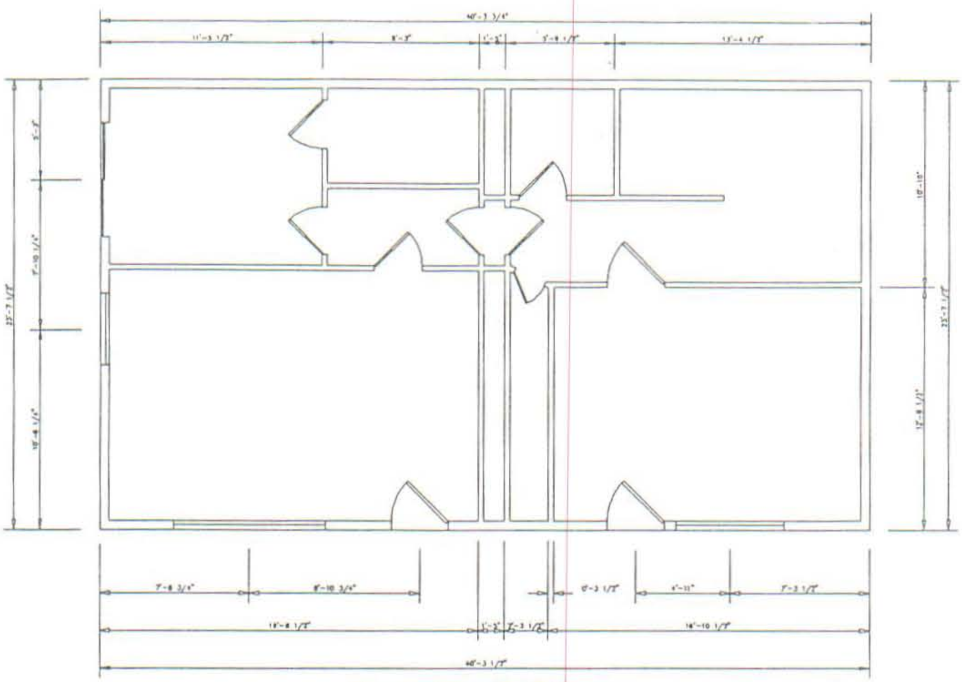
Major Requirements:

a. Removal of wood siding, (or if possible leave in place).

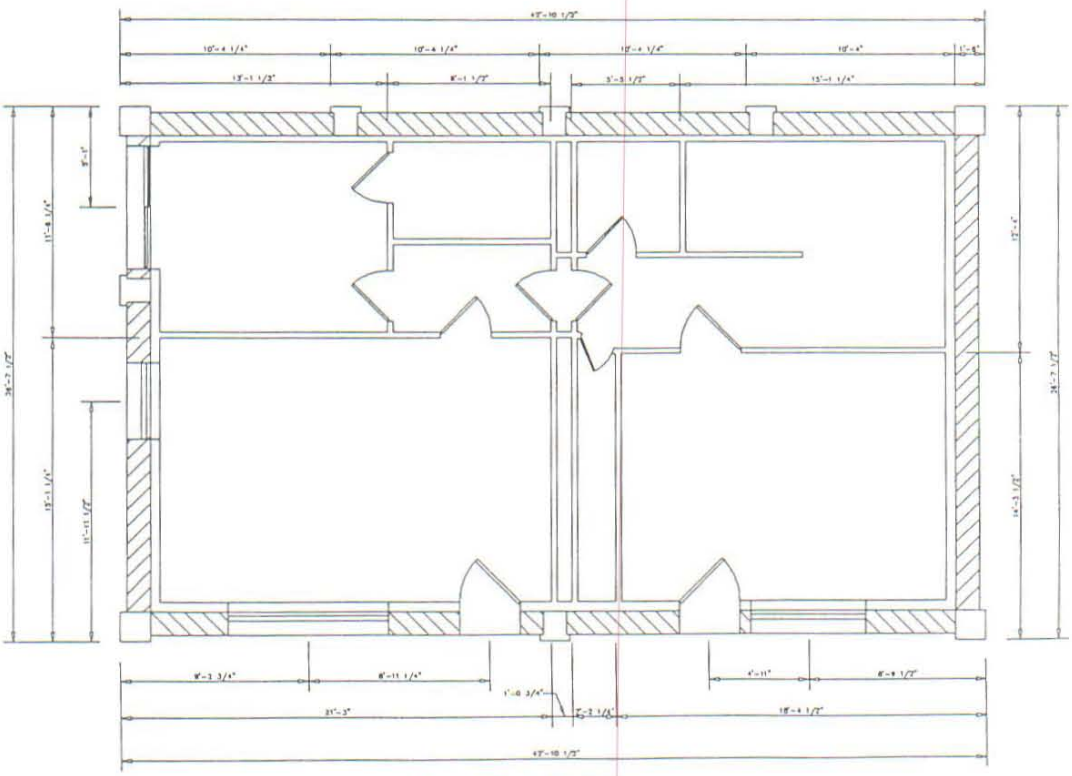
b. Place brick siding

c. Finish work. Provide finish trim at all windows and doors. Leave sight as found. Remove construction spoilage, verify procedure with security.

Acoustic Test Facility Development



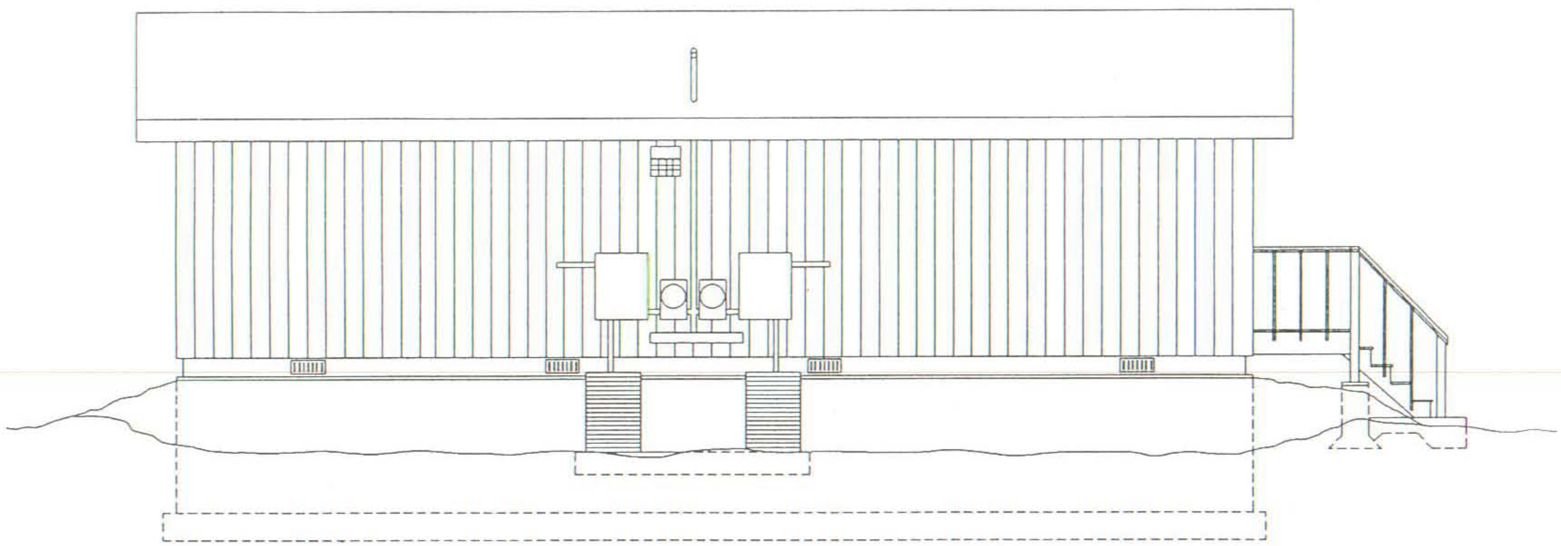
Frame Test Building



Brick Test Building

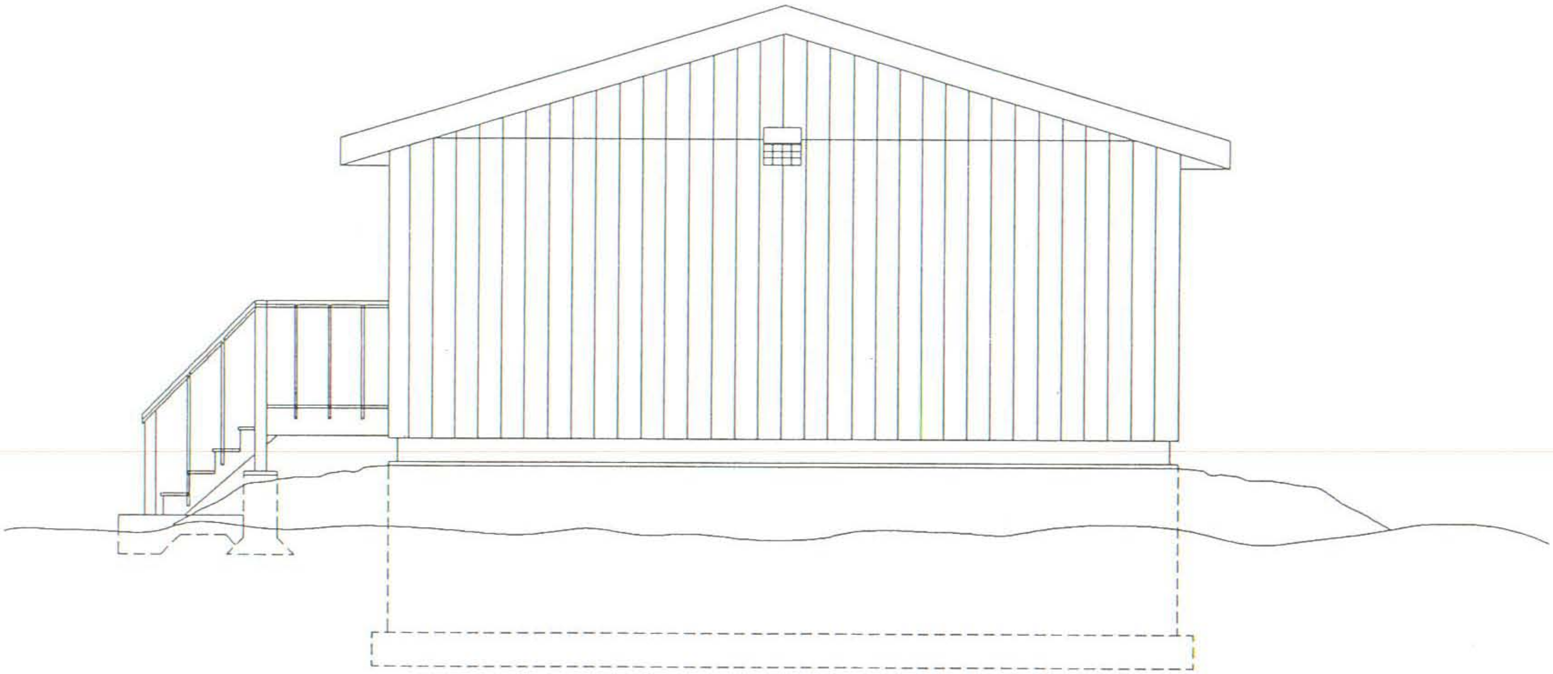
Acoustic Test Facilities

South Elevation - Frame Bldg.



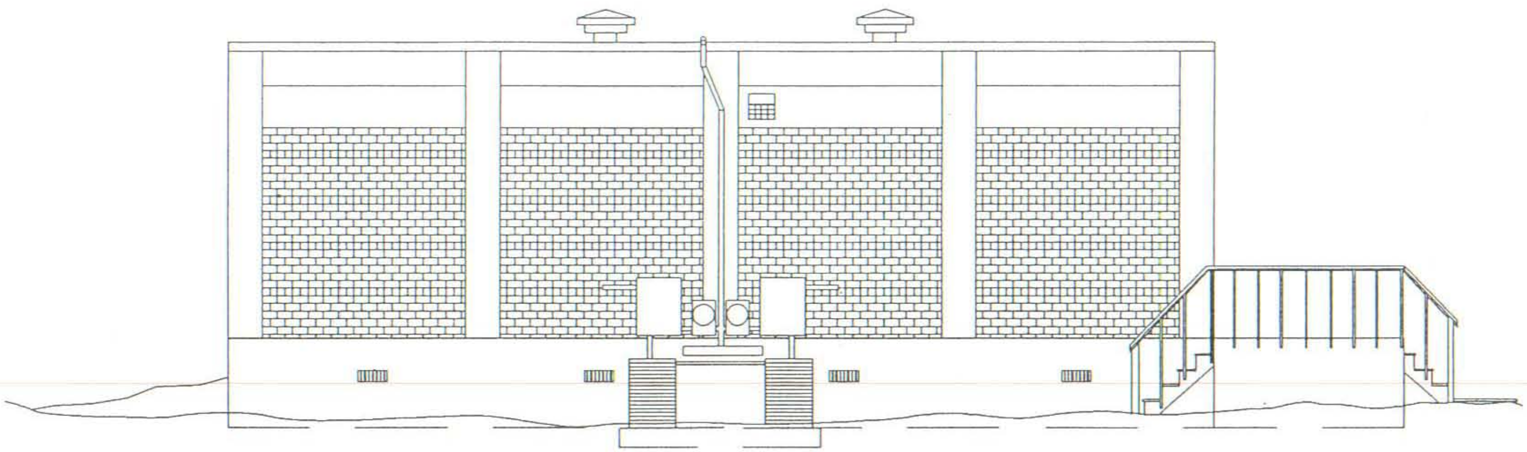
North Elevation - Frame Bldg.

West Elevation - Frame Bldg.



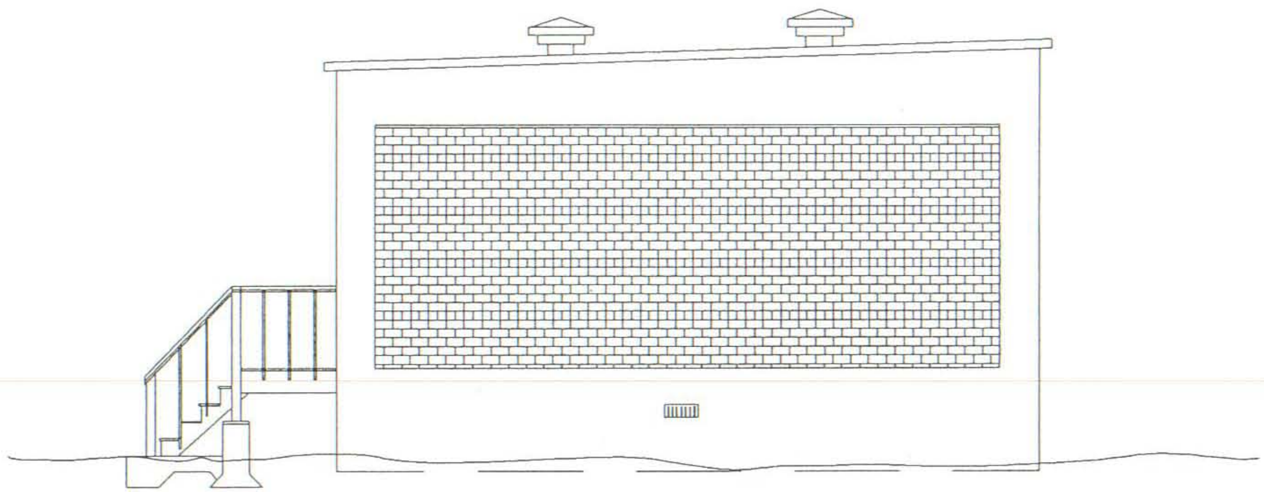
East Elevation - Frame Bldg.

South Elevation - Brick Bldg.



North Elevation - Brick Bldg.

West Elevation - Brick Bldg.



East Elevation - Brick Bldg.

Acoustic Test Facility Development

DIVISION 2 - SITE WORK

Site work requirements are preparation of site for test buildings, construction of road to circle buildings for use during future acoustic testing. Site must be in remote location and of adequate size for required blast detination and helicopter fly over. (figures 1 & 2)

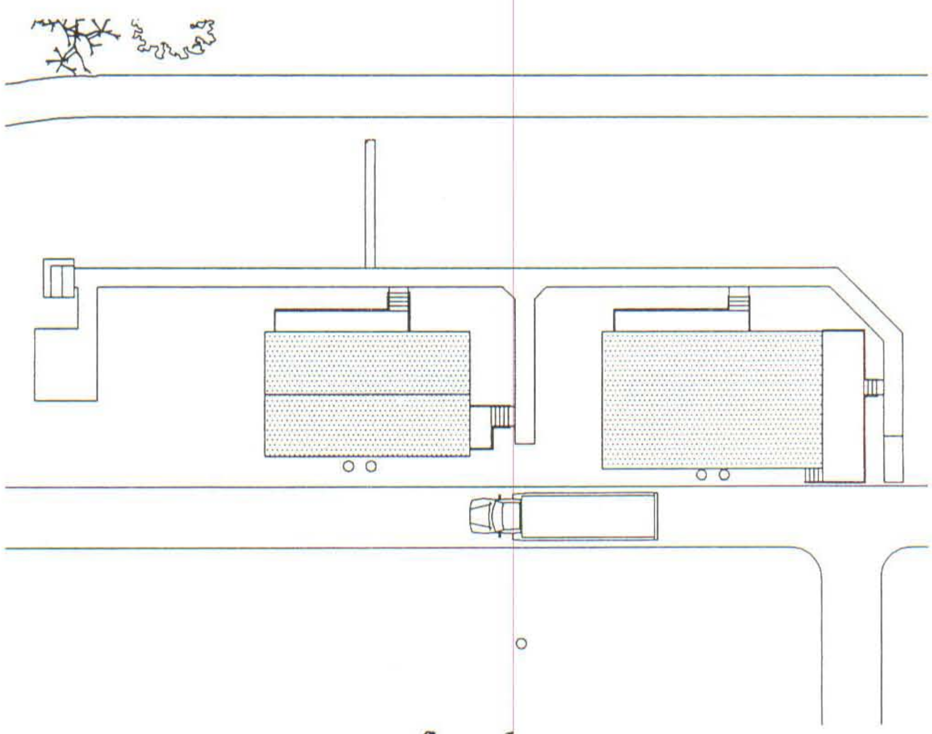


figure 1

Acoustic Test Facility Development

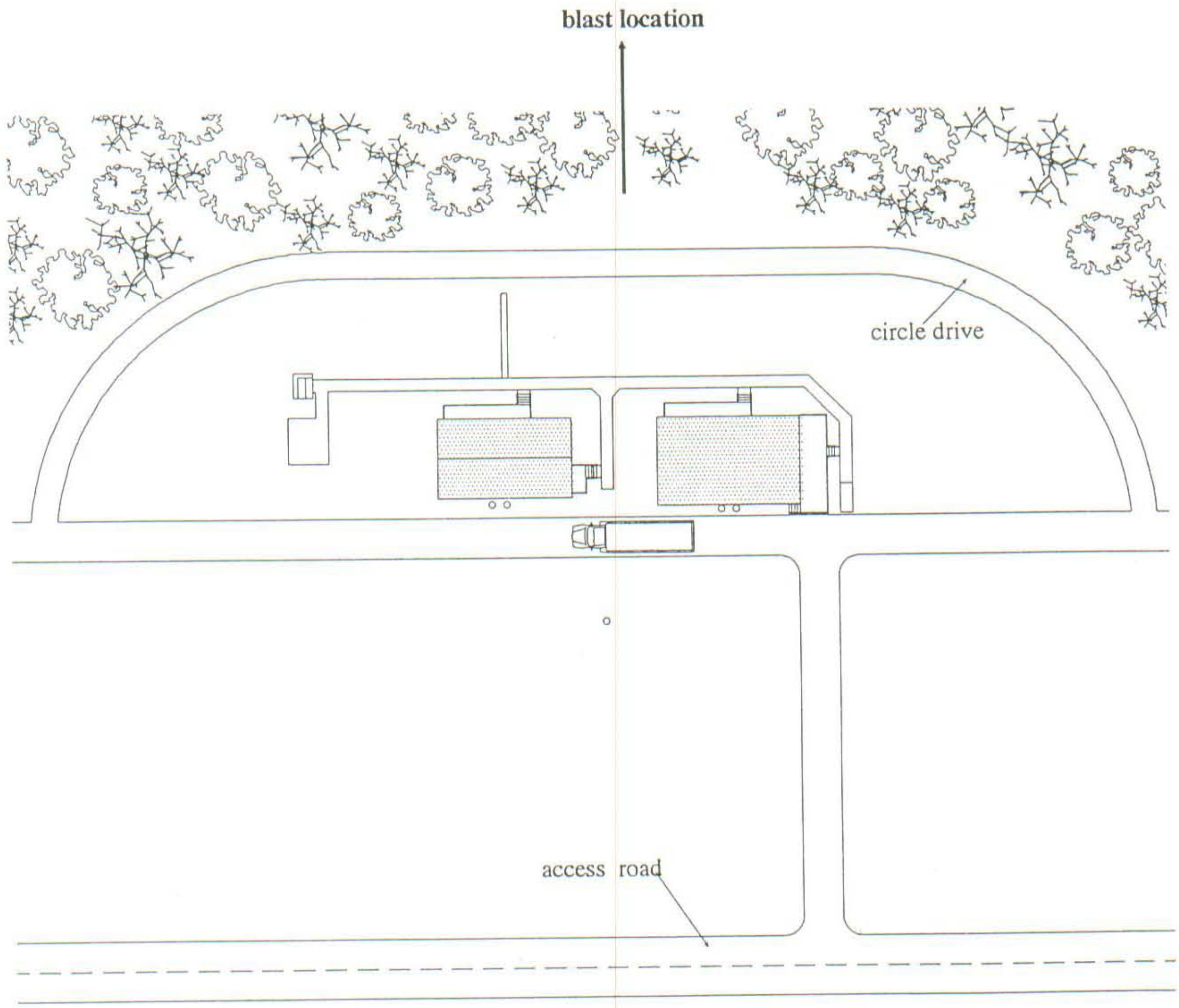


figure 2

Acoustic Test Facility Development

DIVISION 3 - CONCRETE

Not used at this time.

DIVISION 4 - MASONRY

Foundation of frame building must be constructed to accomodate the addition of a brick facade for phase III of Acoustic testing (figure 3).

DIVISION 5 - METALS

Not used at this time

Acoustic Test Facility Development

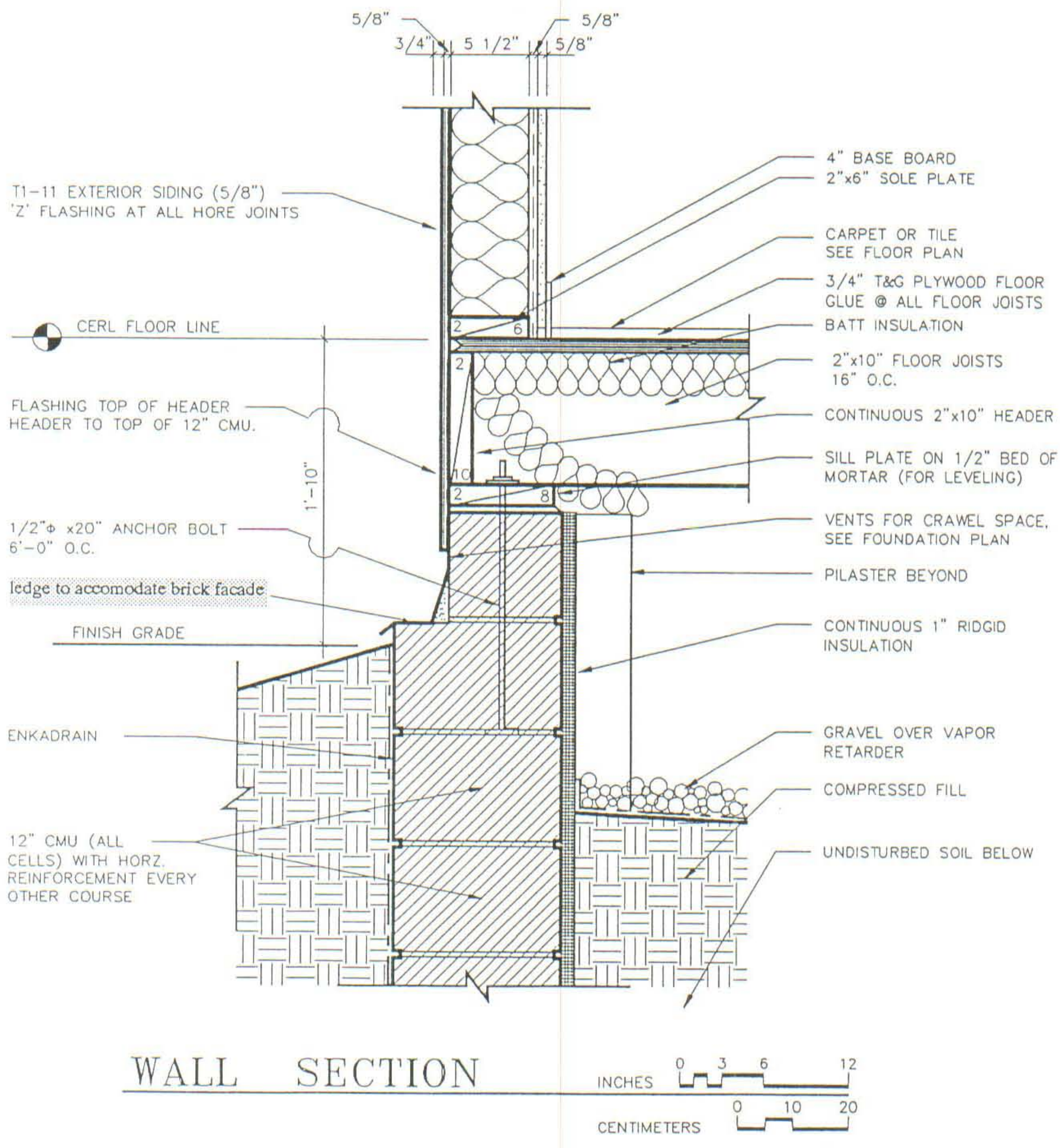
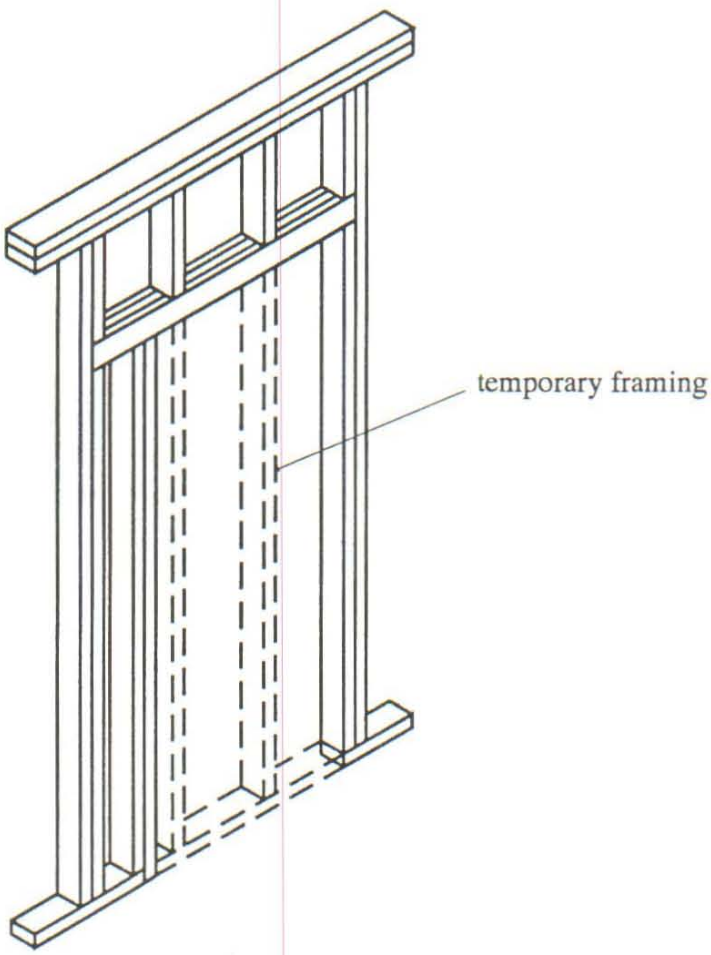


figure 3

Acoustic Test Facility Development

DIVISION 6 - WOOD AND PLASTICS

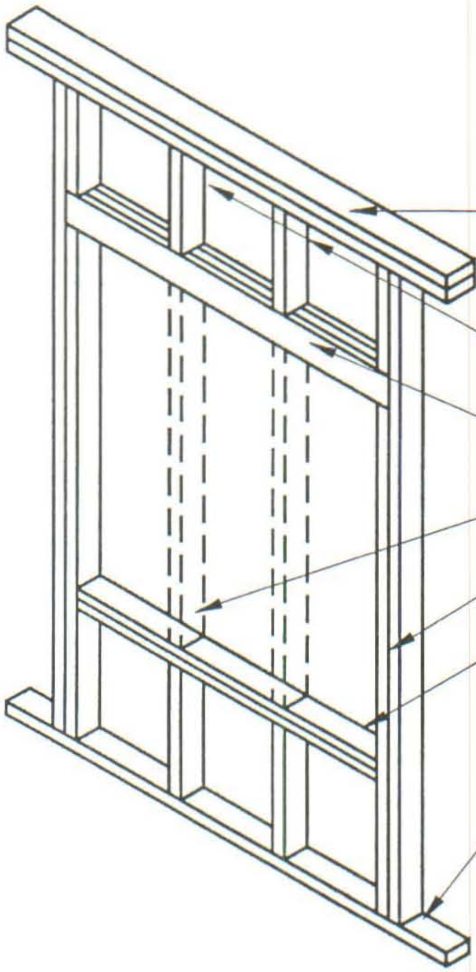
Frame building is to be constructed as solid walls for phase I of Acoustic testing. However, provisions maust be made during framing for the addition of doors and window at a later date for phase II of testing in both structures (figures 4 &5).



DOOR OPENING

figure 4

Acoustic Test Facility Development



WINDOW OPENING

figure 5

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

Not used at this time

Acoustic Test Facility Development

DIVISION 8 - DOORS AND WINDOWS

In phase II part a. doors and windows are to be placed in the test rooms. These windows are to be market standards. Standard American windows and doors for the "American " rooms (figure 6 & 7) and window and doors from Germany for the "German" rooms (figures 8 - 11). These are to be installed by standard hard mounting.

For phase II part b. the windows will be replaced by higher grade acoustically designed windows. These are to be installed by an approved method of mounting to prevent sound transfer and rattling.

American:

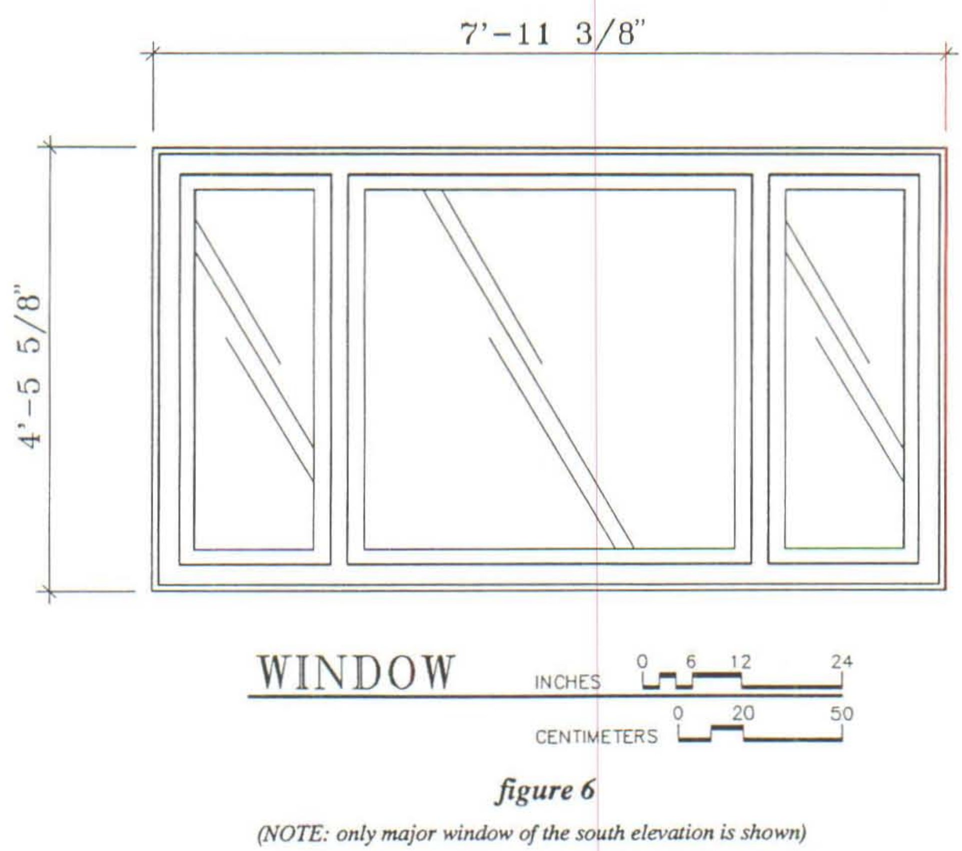


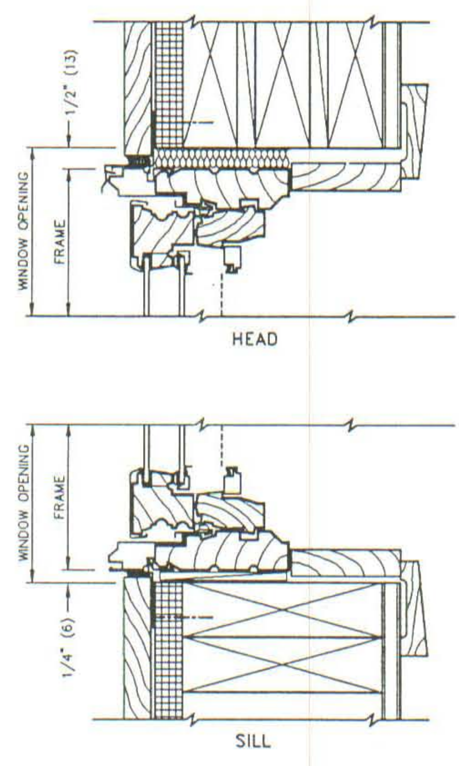
figure 6

(NOTE: only major window of the south elevation is shown)

Acoustic Test Facility Development

2*6 FRAME – DRYWALL

3/4" (19) Sheathing 1/2" (13) Drywall



WINDOW SECTION

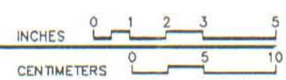


figure 7

Acoustic Test Facility Development

German:

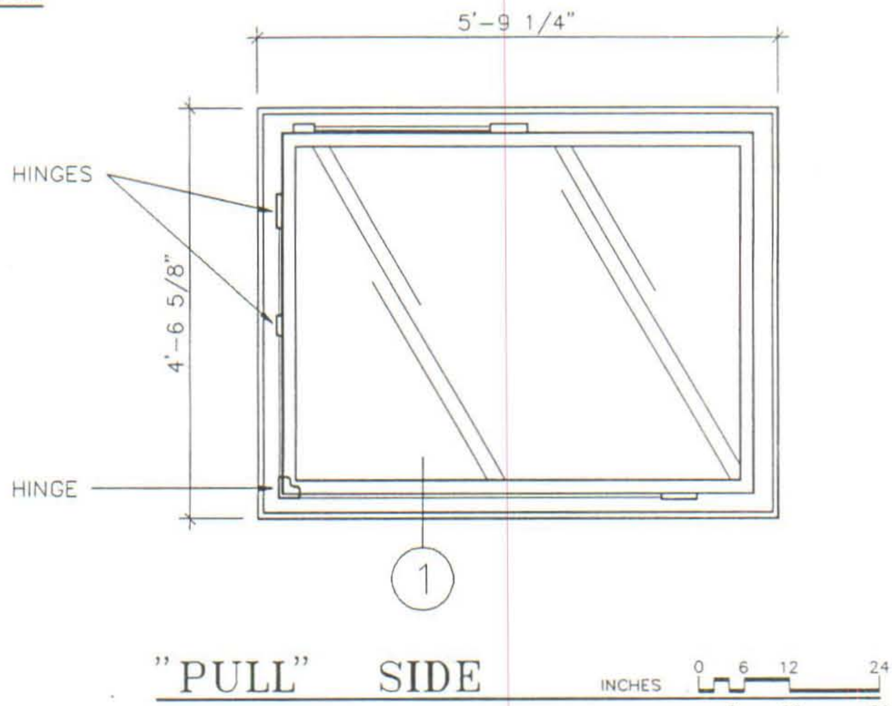


figure 8

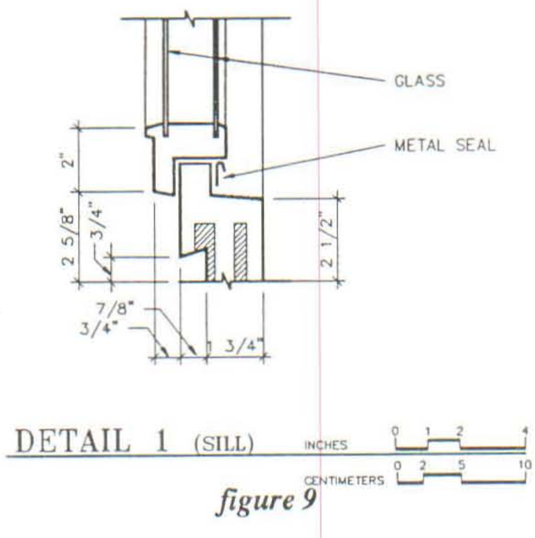


figure 9

Acoustic Test Facility Development

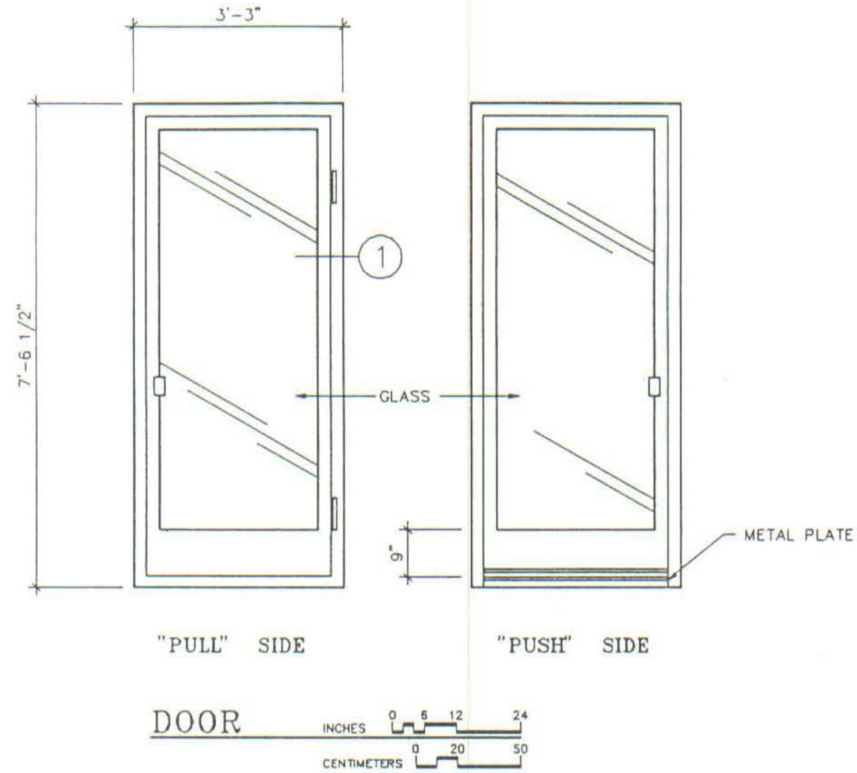


figure 10

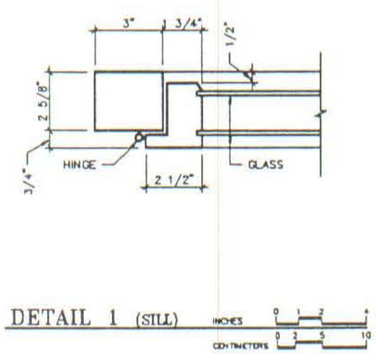


figure 11

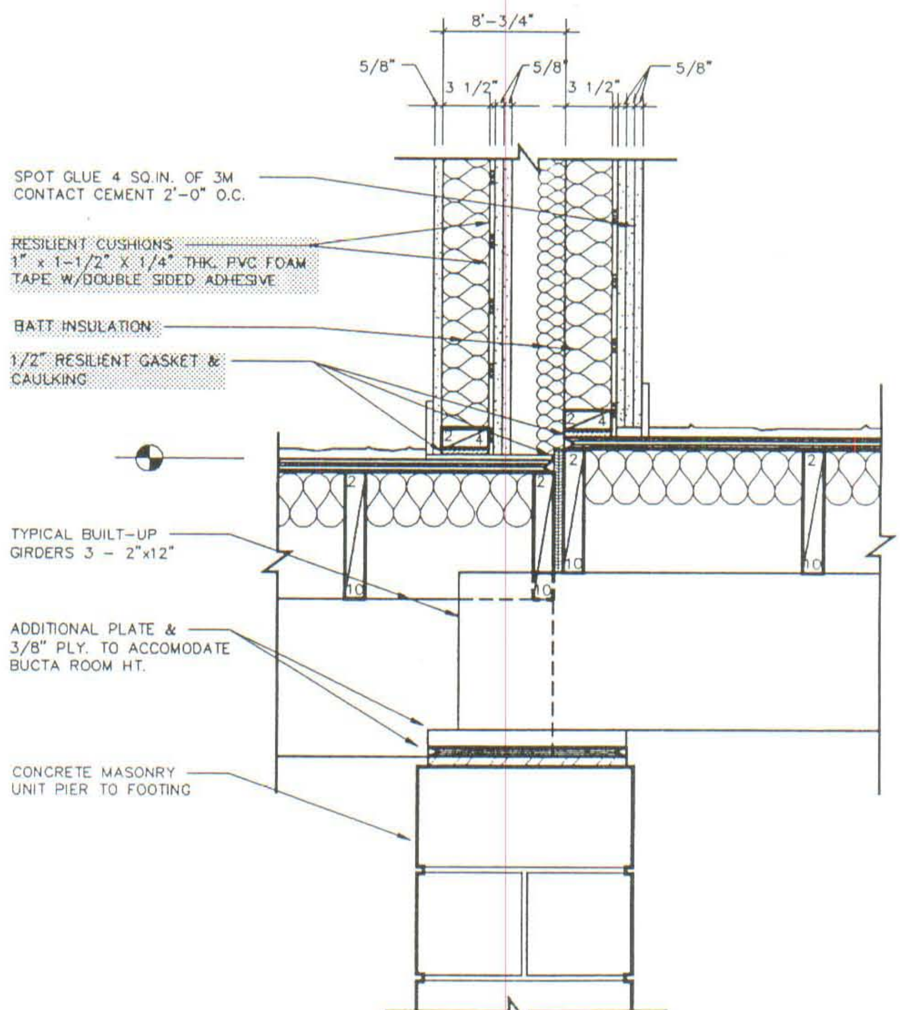
DIVISION 9 - FINISHES

Not used at this time

Acoustic Test Facility Development

DIVISION 10 - SPECIALTIES

To prevent sound transfer, test rooms are to be constructed as two independent and separate units. NO opening, or puncture in walls, floors or ceilings between the "American" and "German" half of each structure are to be made. Resilient Cushions, gaskets and caulking are used in the wall construction as well as batt insulation in the air space between the interior walls. (figure 12).



(NOTE: variation in floor levels is to accomodate different standards of construction. see Division 13)

figure 12

DIVISION 11 - EQUIPMENT

Power and Phone lines are to be provided for each test building and sound equipment trailer (figure 13).

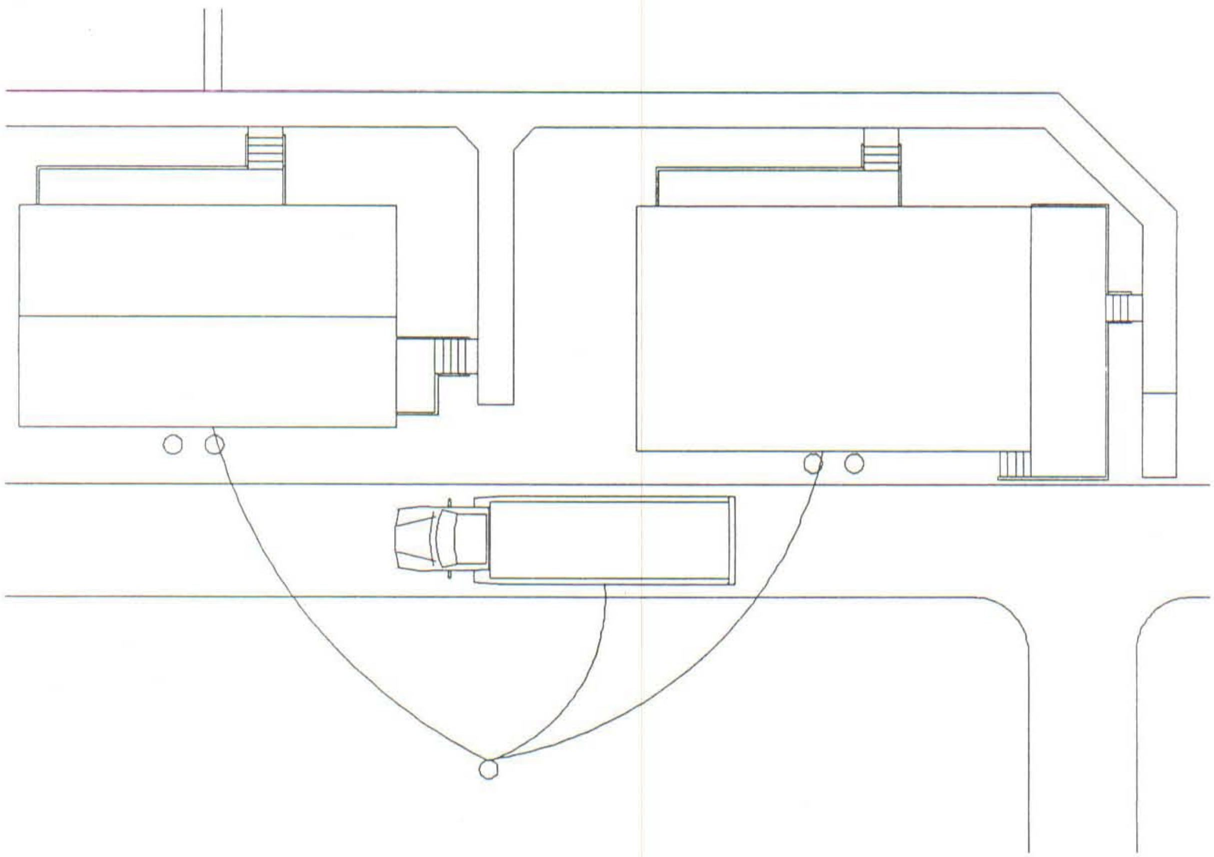


figure 13

Acoustic Test Facility Development

DIVISION 12 - FURNISHINGS

Furniture layout must provide seating for six test subjects approximately equal distance from window, (facing blast location) and seating for a test supervisor in each room. Furniture, art work, plants and finishes must give appearance of a residential atmosphere as opposed to a sterile test environment. Space must be provided for sound speakers, microphones and test equipment. (figures 14 &15)

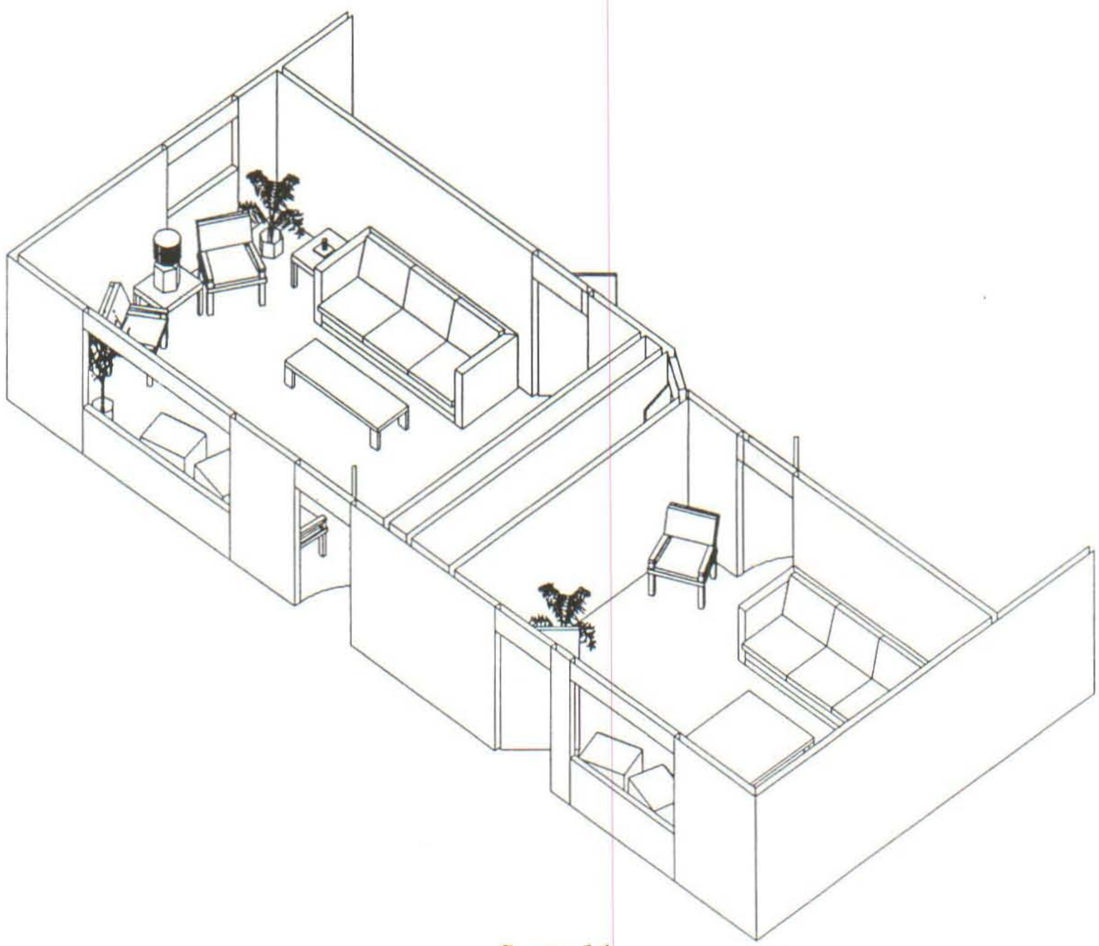


figure 14

Acoustic Test Facility Development

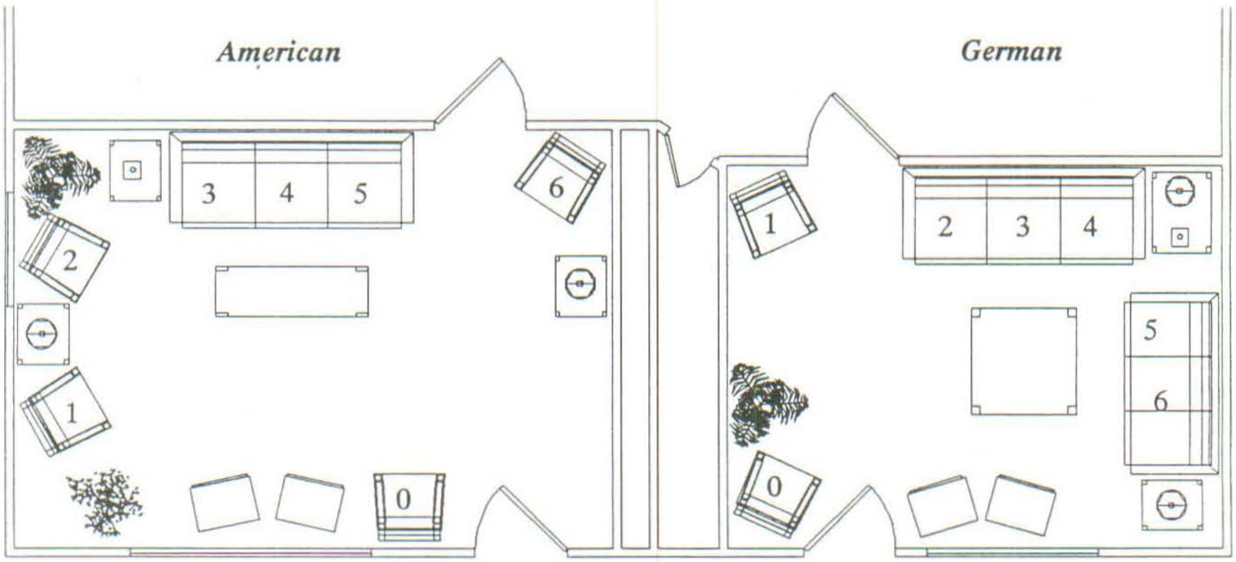


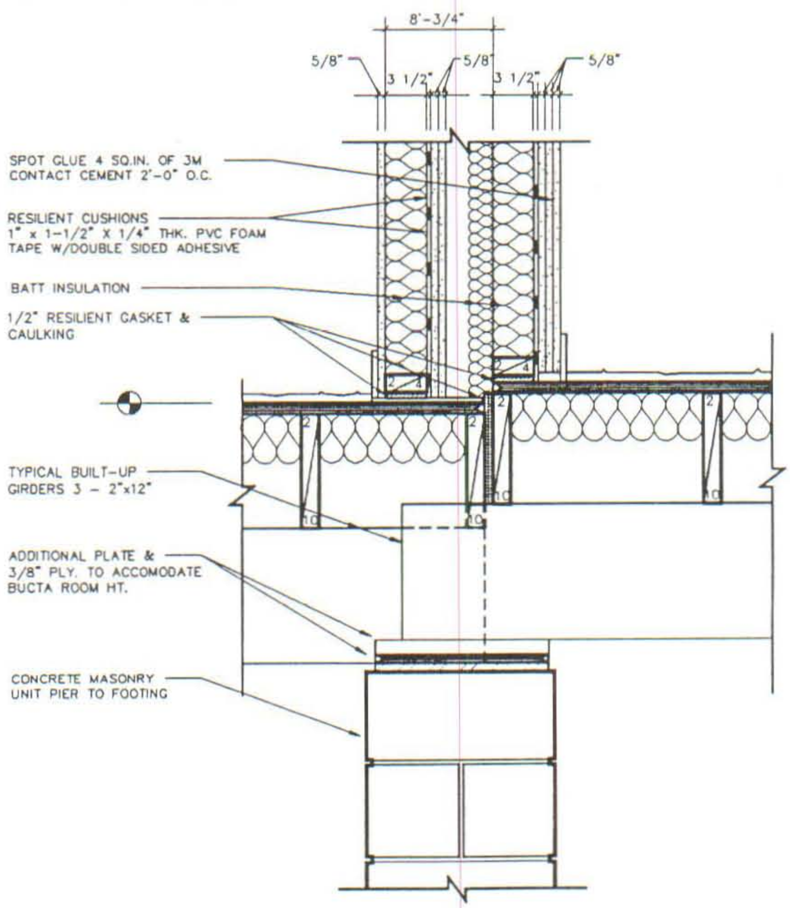
figure 15

Test subject positions 1 - 6
Supervisor position - 0

DIVISION 13 - SPECIAL CONSTRUCTION

Each of the test rooms in the two test houses must be constructed to replicate ech countries average room size and built to their standards of measurement (American = Imperial and German = metric). To accomodate the difference in standard ceiling heights, the ceiling in the brick building was lowered in the German room due to concrete floor. For ease of construction in the frame building, the floor level of the German room was raised (figure 16).

To Ensure sound integrity all eave vents and attic vents are not to be installed until all acoustic testing is complete. (figure 17)



WALL SECTION

figure 16

Acoustic Test Facility Development

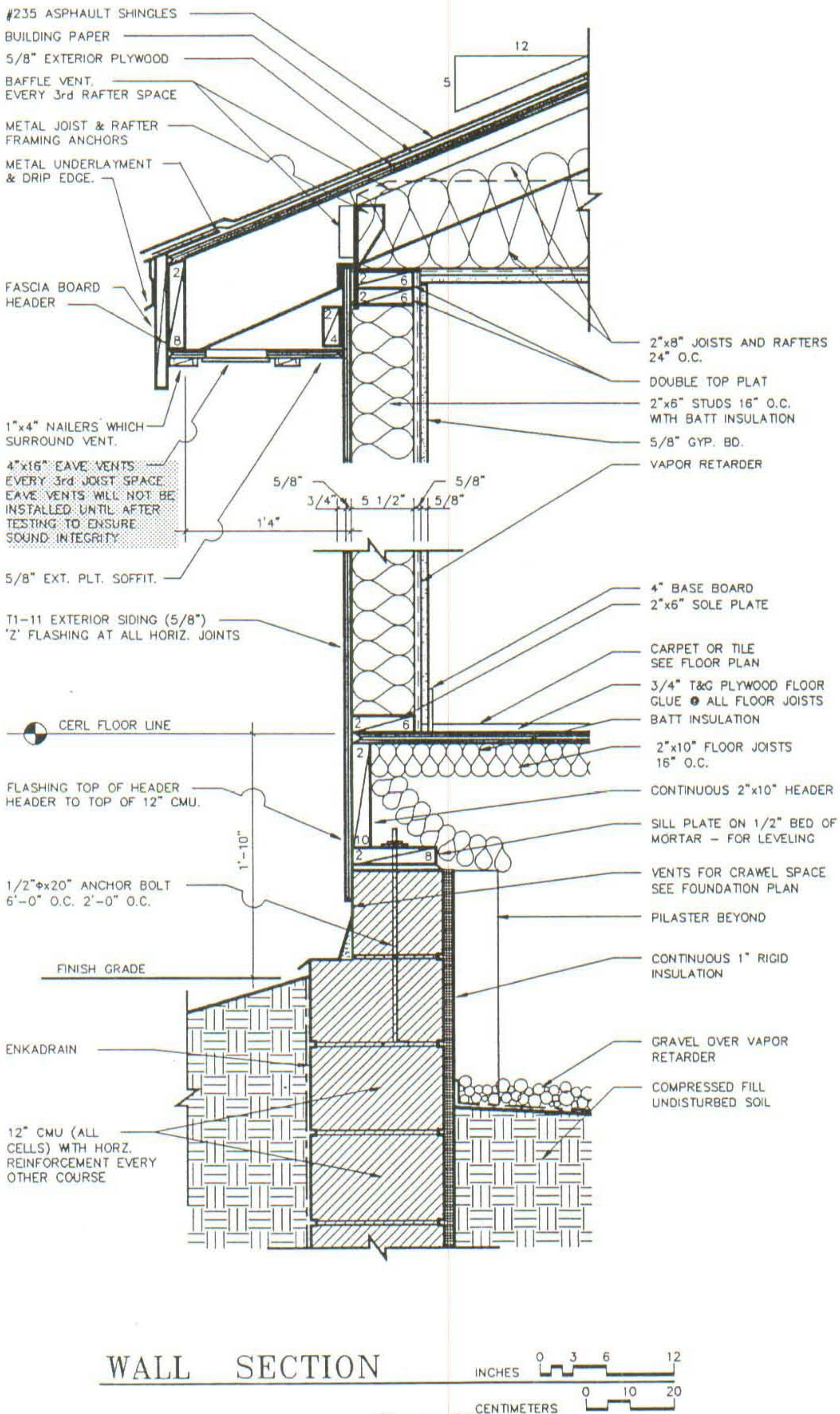


figure 17

DIVISION 14 - CONVEYING SYSTEMS

Not used at this time

DIVISION 15 - MECHANICAL

To ensure sound isolation, each test room must have separate hvac systems (figure 18).

DIVISION 16 - ELECTRICAL

To ensure sound isolation, each test room is to be wired separately with no connection between the rooms (figure18).

Acoustic Test Facility Development

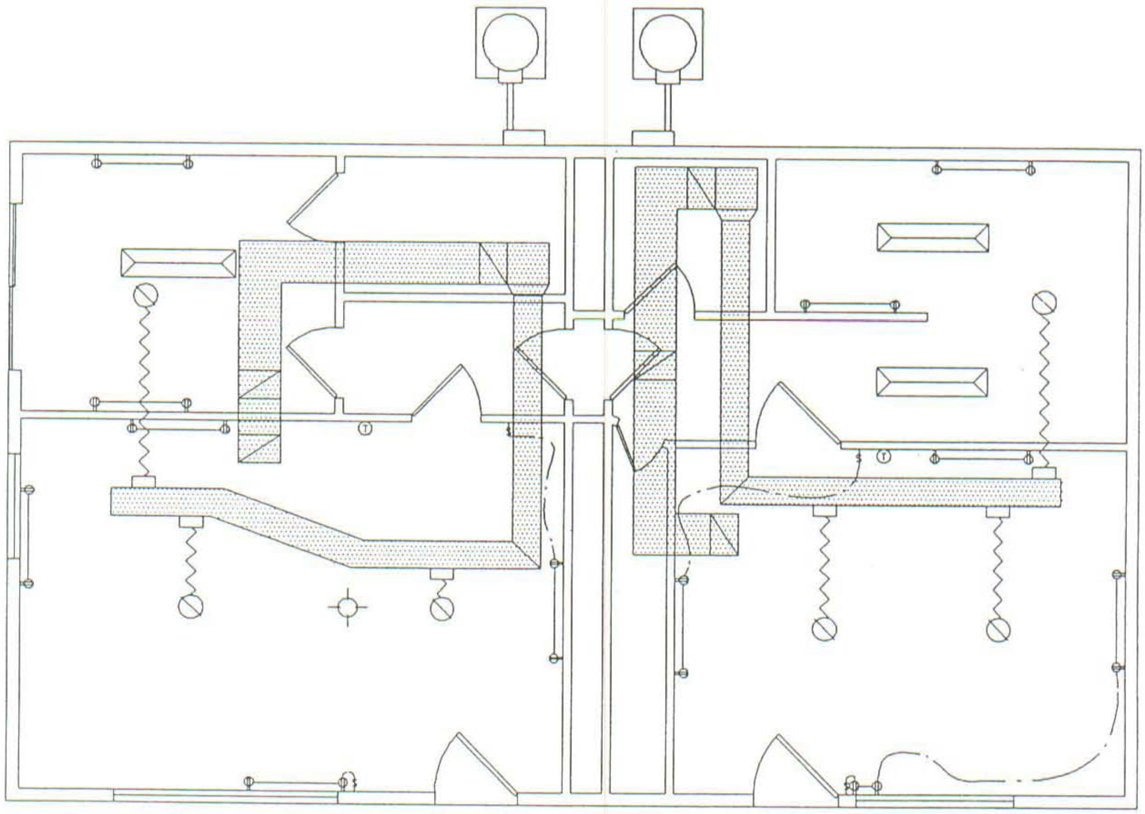


figure 18

Appendix B: Measured Acoustical Data

This appendix contains listings of the measured acoustical data by test time period and individual tests during that time period. The nonblast data are listed in a summary fashion for the entire test period; the blast data are listed by individual test.

In this appendix, "A", "B", "C", and "D" refer to indoor measurements in the four test rooms. "FF" denotes the free-field microphone, and "PD" denotes the pressure-doubling microphone. CSEL is C-weighted sound exposure level and FPEAK is the flat-weighted peak sound pressure level. Room A is brick construction, American design, Room B is brick construction, German design, Room C is wood frame construction, American design, and Room D is wood frame construction, German design.

Jan92	A	B	C	D	FF	PD
NG-60	57.5	57.5	56	56.5	84.5	88
NG-6	51	51	52	52	75.5	78.5
FG-60	52.5	52.5	53	53	76.5	80.5
LH	64	64	66	67	89	88.5
QH	56	55	57	58	80	78
V1	68	70	66.5	67	96.5	101
V2	64.5	64.5	64	65	92	96
V3	60	61	61	61	86	90
V4	55	56	57.5	57.5	79	84
V5	53	54	54.5	56	74.5	78
V6	47.5	48	48	50	70	72

	FF-CSEL	FF-FPEAK	PD-CSEL	PD-FPEAK	Indoor CSEL
TEST 1					
HB	107	129	110	128	98
LB	99	119	101.5	121	96
TEST 2					
HB	101	125	107	130	93
LB	96	117	103	124	88
TEST 3					
HB	94	116	97	119	84
LB	92.5	112	95	115	81
TEST 4					
HB	102	120.5	105	127	88
LB	93	113	96	116.5	80
TEST 6					
HB	106	127	108	128.5	93
LB	99	120	102	123	90
TEST 7					
HB	102	124	105	126	89
LB	97	117	100	120	85

JUN92	A	B	C	D	FF	PD	TENT
NG-60	68	66.5	73	71	86	89	83
NG-6	57	57	64	60	74	77.5	74
FG-60	57	55	57	59	76	78	75
LH	69	68	72.5	71	88	88.5	90
QH	59	58	61	65	78	79	82
V1	77	77	77.5	79	96	100	93
V2	72	72	74	73.5	90	95	89
V3	66	66	67	67	85	89.5	83
V4	61	61	62.5	65	79	83.5	79
V5	57.5	57	62	60	73	78	74
V6	49.5	50	55	52	69	72	72

Blast

	FF-CSEL	FF-FPEAK	PD-CSEL	PD-FPEAK	Indoor CSEL
HB	94	116	96	117	81
LB	92	112	93	115	78

Aug92	A	B	C	D	FF	PD	TENT
NG-60	66.5	65	65	66	85	88	82
NG-6	58	57.5	58	57	75	79.5	73
FG-60	59	58	58.5	56.5	75	79	74
LH	68	67	68.5	67.5	88	87	86
QH	60	59	60.5	58	78	76.5	76
V1	76	75	76	77	96	99	95
V2	71	71	71	72	90	95	89
V3	68	67	68	69	87	91	84
V4	63	62.5	63	64	81	85	80
V5	57	56.5	56.5	58	76	79	74
V6	56.5	55	55.5	54.5	71	74	72

Blast

	FF-CSEL	FF-FPEAK	PD-CSEL	PD-FPEAK	Indoor CSEL
TEST 2					
HB	100	122	103	123	95
LB	95.5	117	98	120	91
TEST 3					
HB	105	128	109	132	101
LB	99	121	103	125	93
TEST 4					
HB	101	124	105	128	99
LB	96	117	100	121	95
TEST 5					
HB	100	123	104	127	99
LB	95	117	98	120	95

nov92	A	B	C	D	FF	PD
NG-60	53	55	54	54	85.5	89.5
NG-6	48	52	53.5	48	77.5	81
FG-60	50	52	53.5	47	73.5	78
N25	52	48	51	51	70	74
F25	51	49	47	47	70	74.5
V1	66	68	69	68	98	101.5
V2	63	65	64	64	92	97
V3	59	60	61	62	88	92.5
V4	57	58	58	59	80	84
V5	54	56	56.5	57	76	80
V6	47	50	47.5	47	72	75

Blast

	FF-CSEL	FF-FPEAK	PD-CSEL	PD-FPEAK	Indoor CSEL
TEST 1					
HB	103	123	105	123	90
LB	94.5	115	99	119	85
TEST 2					
HB	106	127.5	109	127	90
LB	95	116	98	120	86
TEST 3					
HB	105	127	108	130	90
LB	95	116	97	120	85

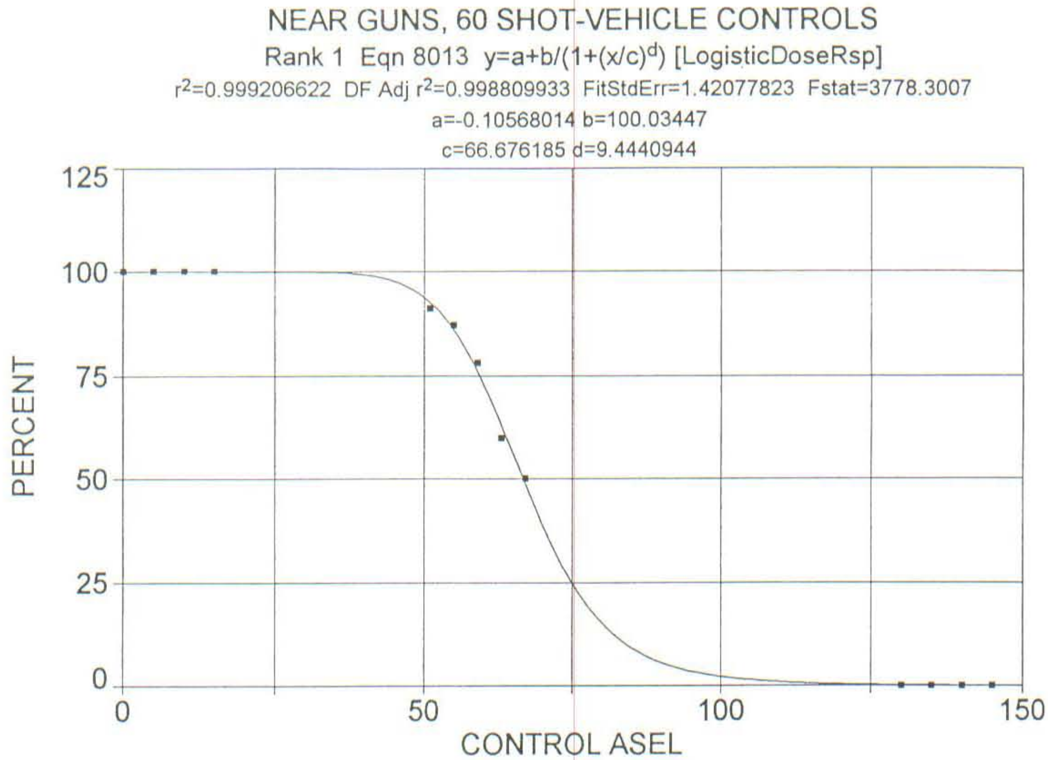
jan93	A	B	C	D	FF	PD
NG-60	51.5	52	52.5	53	84.5	88.5
NG-6	43.5	44	46	44	75.5	79
FG-60	*	*	*	*	76	80
N25	50	52	51	51	72.5	80
F25	50	50	51.5	51	74	77
V1	68.5	70	68	68	96	101
V2	62.5	64	65	63	92	96.5
V3	60	62	60.5	60	88.5	92
V4	58	57	58	57	81	85
V5	51	51.5	50.5	52	76	79
V6	46	51	49	46	71.5	73

Blast

	FF-CSEL	FF-FPEAK	PD-CSEL	PD-FPEAK	Indoor CSEL
HB	98	119	101	119	85
LB	92	112	96	116	83

Appendix C: Nonblast Sound Transition Curves—Acoustical Measurements Near the Subjects

This appendix contains the transition curves for the nonblast sound data for subjects indoors and outdoors with the **acoustical measurements made near the subjects**. As discussed in the text, only these data include the pink-noise control sounds because these could only be heard or measured by the subjects. Each curve represents an entire test period, so there are five sets of curves for the five test periods. Each curve represents an entire test period, so there are two sets of curves for the two test periods that included outdoor subjects.



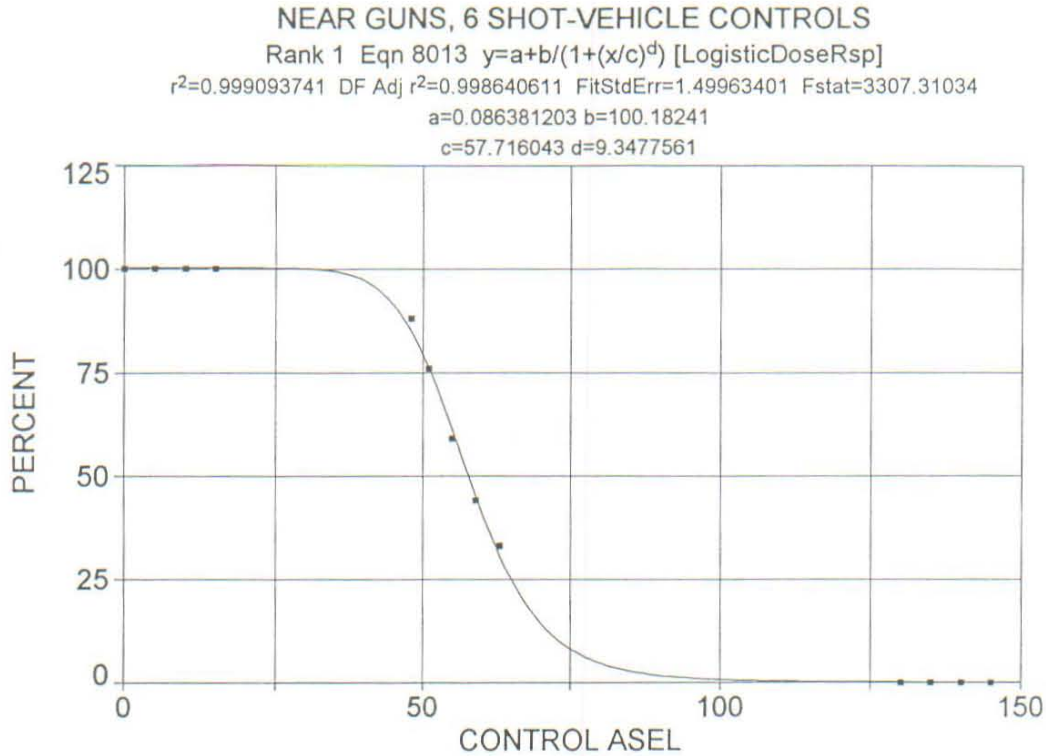
Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9992066222	0.9988099333	1.4207782300	3778.3007040

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.10568014	0.716923567	-0.14740782	-1.73233514	1.520974862
b	100.0344692	1.013792109	98.67355285	97.73423796	102.3347005
c	66.67618471	0.355711793	187.4444033	65.86909677	67.48327266
d	9.444094439	0.532603504	17.73194201	8.235650202	10.65253868

Date	Time	File Source
May 18, 1994	9:25:48 AM	c:\tcwin\noise.prn

January 1992 Test Period
Indoor Measured Acoustical Data

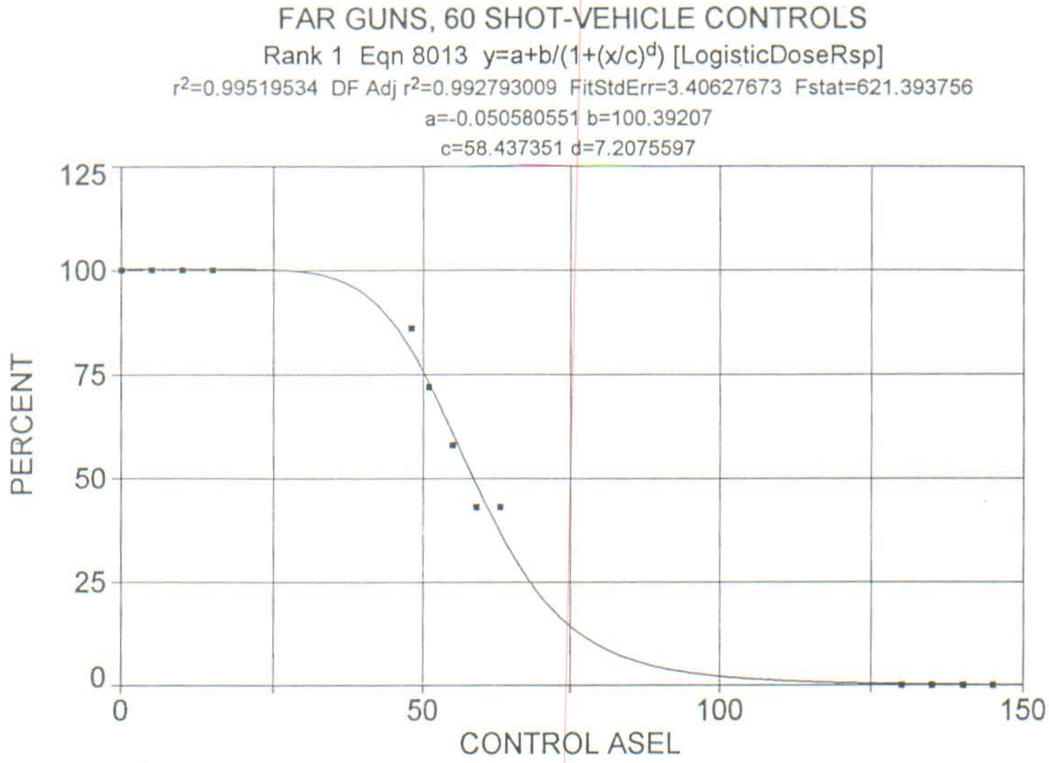


Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9990937406	0.9986406108	1.4996340118	3307.3103392

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.086381203	0.751211240	0.114989232	-1.61807040	1.790832804
b	100.1824149	1.062921260	94.25196269	97.77071264	102.5941171
c	57.71604268	0.255064984	226.2797572	57.13731609	58.29476927
d	9.347756102	0.413054437	22.63080910	8.410561265	10.28495094

Date	Time	File Source
May 18, 1994	9:30:29 AM	c:\tcwin\noise.prn



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9951953395	0.9927930093	3.4062767338	621.39375642

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.05058055	1.739304800	-0.02908090	-3.99695501	3.895793907
b	100.3920699	2.457790665	40.84646889	94.81549573	105.9686442
c	58.43735115	0.753004854	77.60554378	56.72882995	60.14587235
d	7.207559677	0.826193626	8.723814184	5.332977703	9.082141650

Date	Time	File Source
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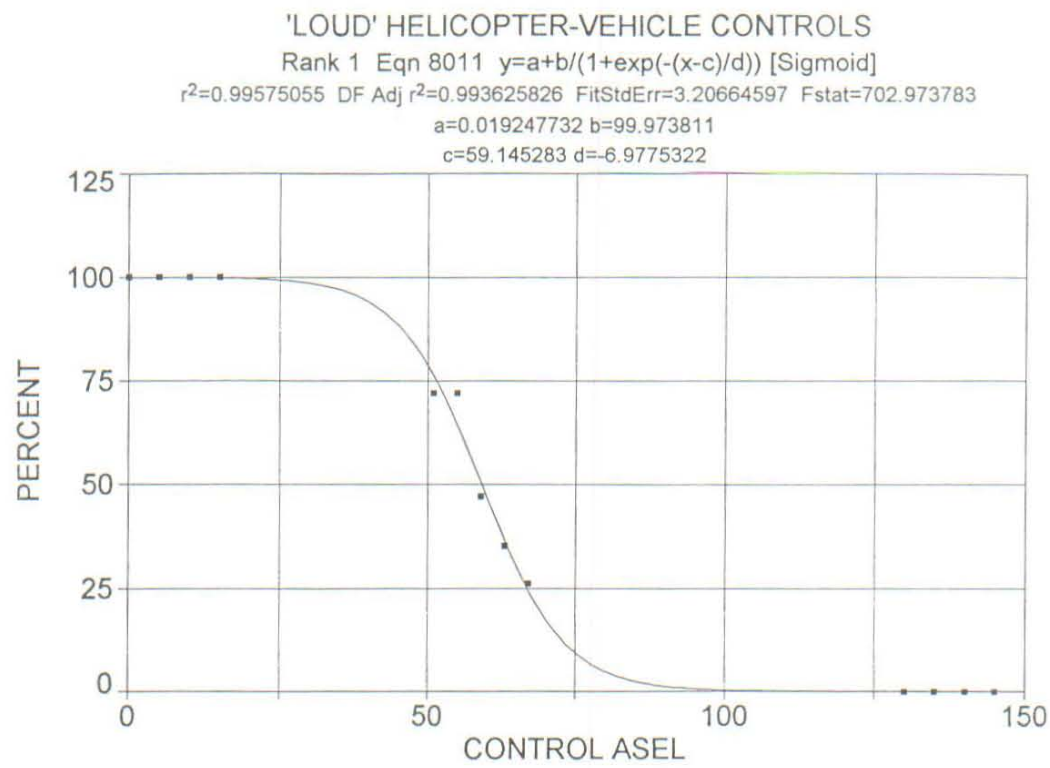
January 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9957505504	0.9936258256	3.2066459724	702.97378326

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.019247732	1.599840813	0.012031030	-3.61069161	3.649187074
b	99.97381110	2.285219213	43.74801793	94.78879078	105.1588314
c	59.14528279	0.585818911	100.9617165	57.81609610	60.47446948
d	-6.97753223	0.669765058	-10.4178803	-8.49718750	-5.45787695

Date	Time	File Source
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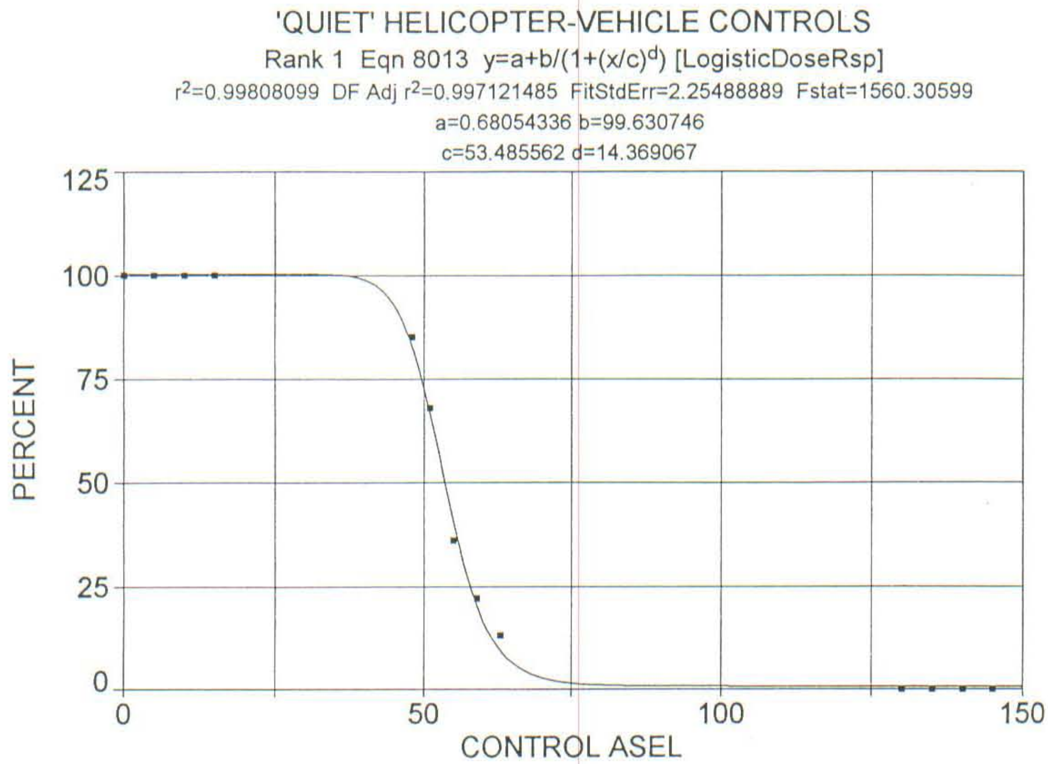
January 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9980809899	0.9971214848	2.2548888852	1560.3059943

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.680543360	1.098292780	0.619637471	-1.81141468	3.172501396
b	99.63074593	1.585195024	62.85078139	96.03403698	103.2274549
c	53.48556221	0.260659889	205.1929138	52.89414112	54.07698329
d	14.36906652	0.869918085	16.51772365	12.39527647	16.34285657

Date	Time	File Source
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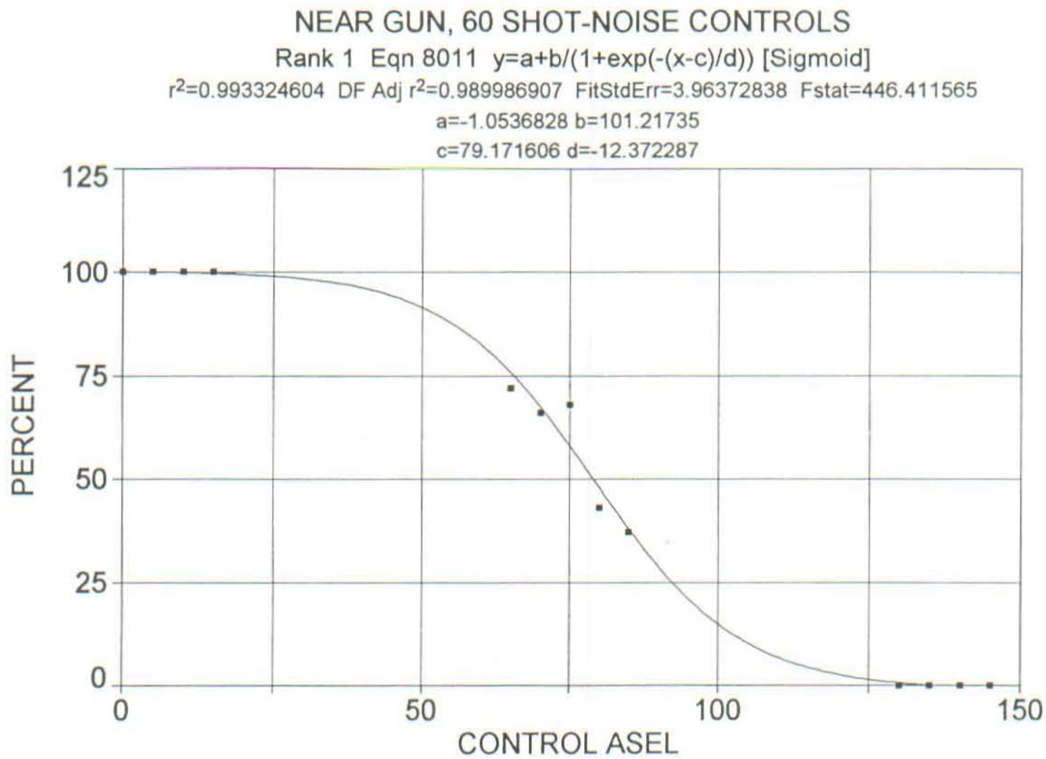
January 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9933246044	0.9899869065	3.9637283845	446.41156496

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.05368276	2.243672429	-0.46962415	-6.14443601	4.037070495
b	101.2173493	3.214266333	31.49003187	93.92437879	108.5103197
c	79.17160562	1.338785980	59.13686487	76.13398346	82.20922777
d	-12.3722867	1.931929199	-6.40410980	-16.7557140	-7.98885947

Date	Time	File Source
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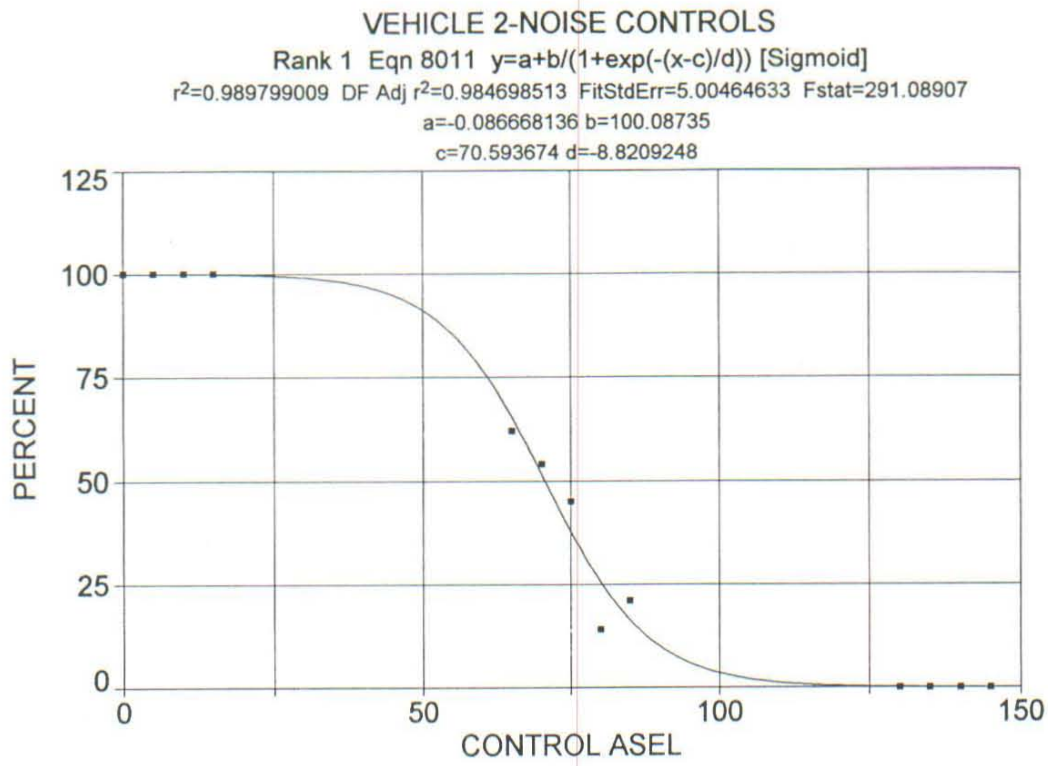

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9897990088	0.9846985133	5.0046463293	291.08906962

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.08666814	2.514090459	-0.03447296	-5.79098308	5.617646814
b	100.0873463	3.593609079	27.85148416	91.93367076	108.2410219
c	70.59367386	1.213314701	58.18249282	67.84073824	73.34660948
d	-8.82092484	1.414818486	-6.23466892	-12.0310600	-5.61078966

Date	Time	File Source
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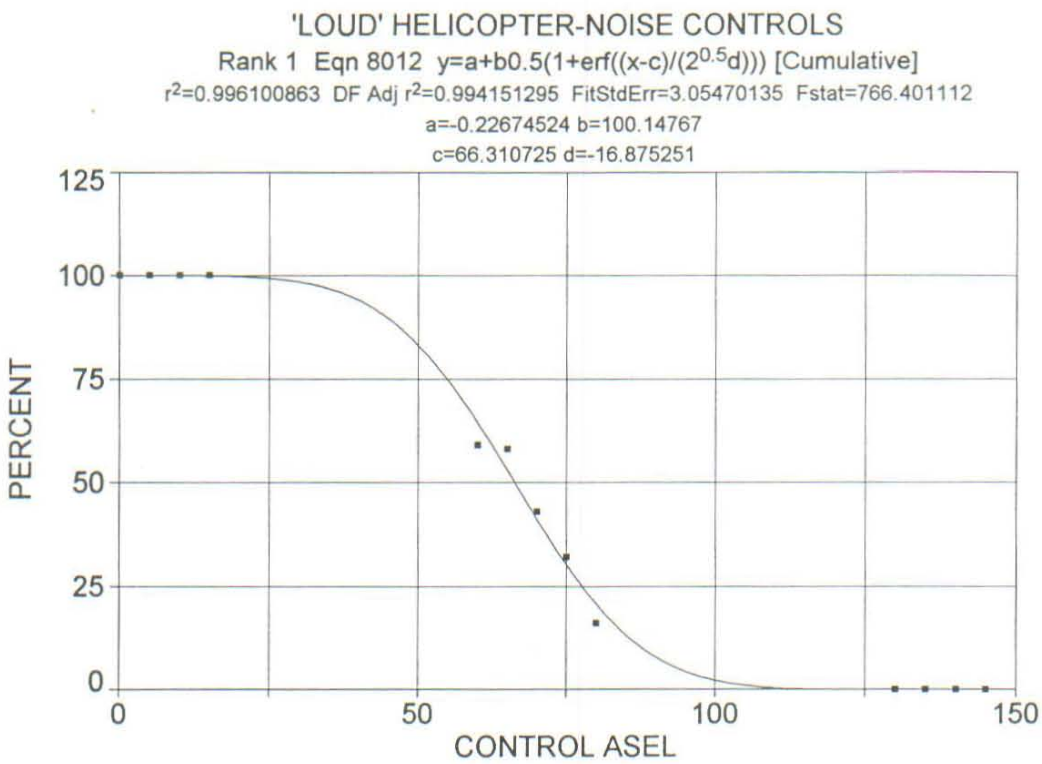

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9961008634	0.9941512952	3.0547013464	766.40111179

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.22674524	1.526146343	-0.14857372	-3.68947641	3.235985927
b	100.1476664	2.174486711	46.05577305	95.21389128	105.0814416
c	66.31072479	0.841916823	78.76161035	64.40046786	68.22098172
d	-16.8752507	1.697655493	-9.94032698	-20.7271255	-13.0233759

Date	Time	File Source
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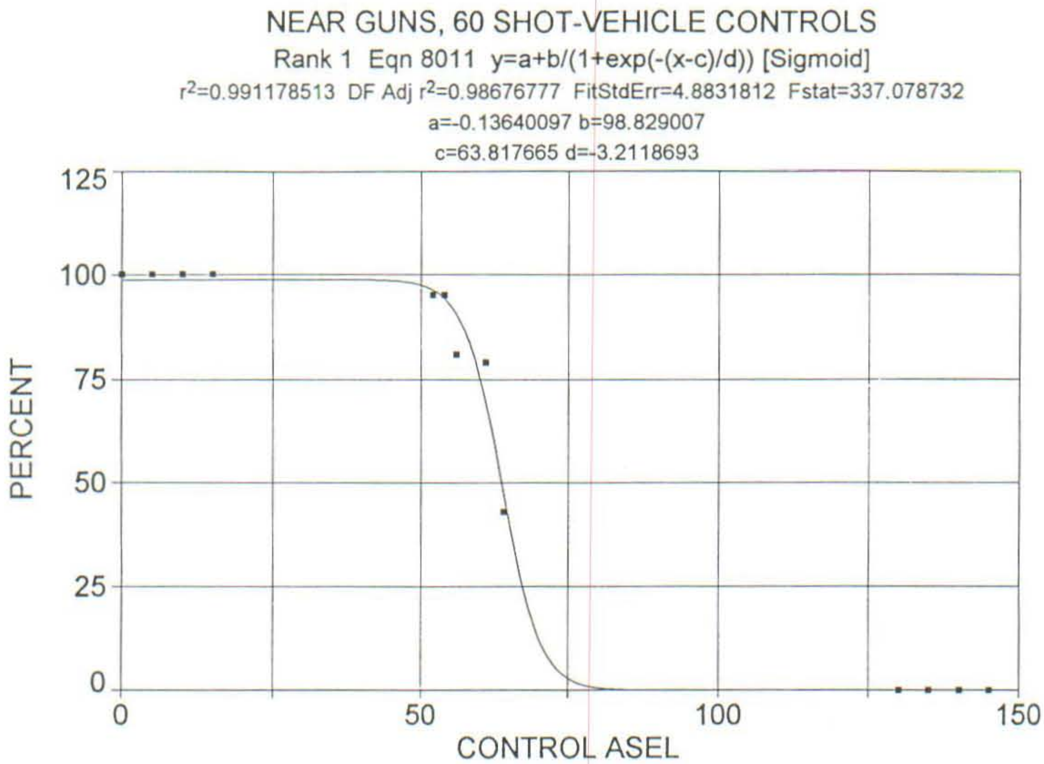

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9911785133	0.9867677700	4.8831812023	337.07873158

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.13640097	2.440972774	-0.05587976	-5.67481643	5.402014500
b	98.82900652	3.352444328	29.47968612	91.22251877	106.4354943
c	63.81766515	0.590072181	108.1523027	62.47882805	65.15650224
d	-3.21186932	0.720914425	-4.45527126	-4.84757933	-1.57615931

Date	Time	File Source
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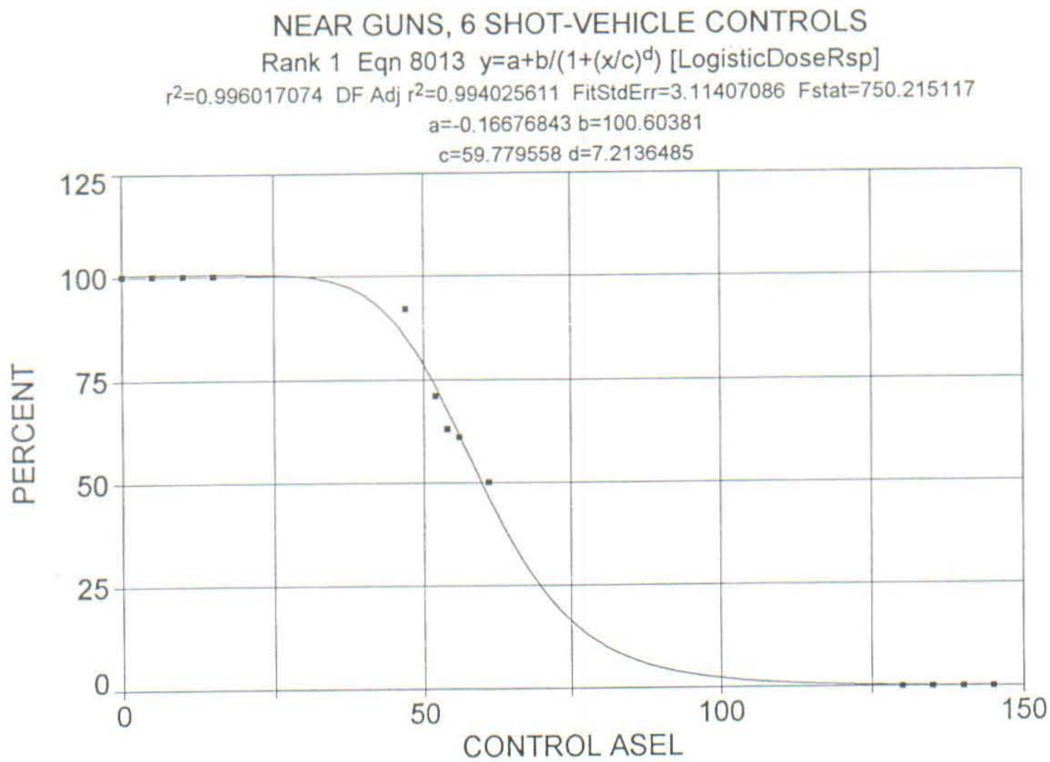


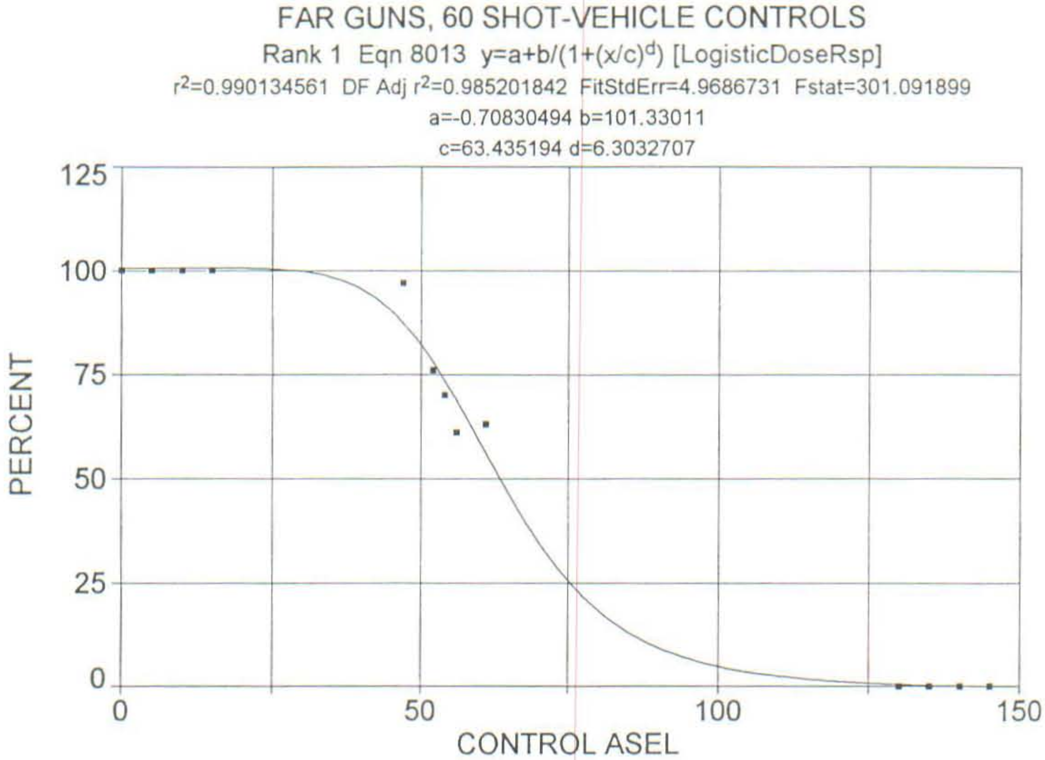
Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9960170741	0.9940256111	3.1140708642	750.21511743

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.16676843	1.597767773	-0.10437589	-3.79200417	3.458467311
b	100.6038088	2.261855660	44.47843888	95.47179888	105.7358186
c	59.77955779	0.875041054	68.31628929	57.79414404	61.76497154
d	7.213648477	0.934676315	7.717803862	5.092926026	9.334370927

Date	Time	File Source
May 18, 1994	10:20:27 AM	c:\tcwin\noise.prn

June 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9901345613	0.9852018419	4.9686730962	301.09189928

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.70830494	2.821181187	-0.25106680	-7.10938966	5.692779778
b	101.3301118	3.923392949	25.82716366	92.42817711	110.2320465
c	63.43519401	2.495060301	25.42431298	57.77405731	69.09633071
d	6.303270656	1.594935206	3.952054372	2.684461831	9.922079480

Date	Time	File Source
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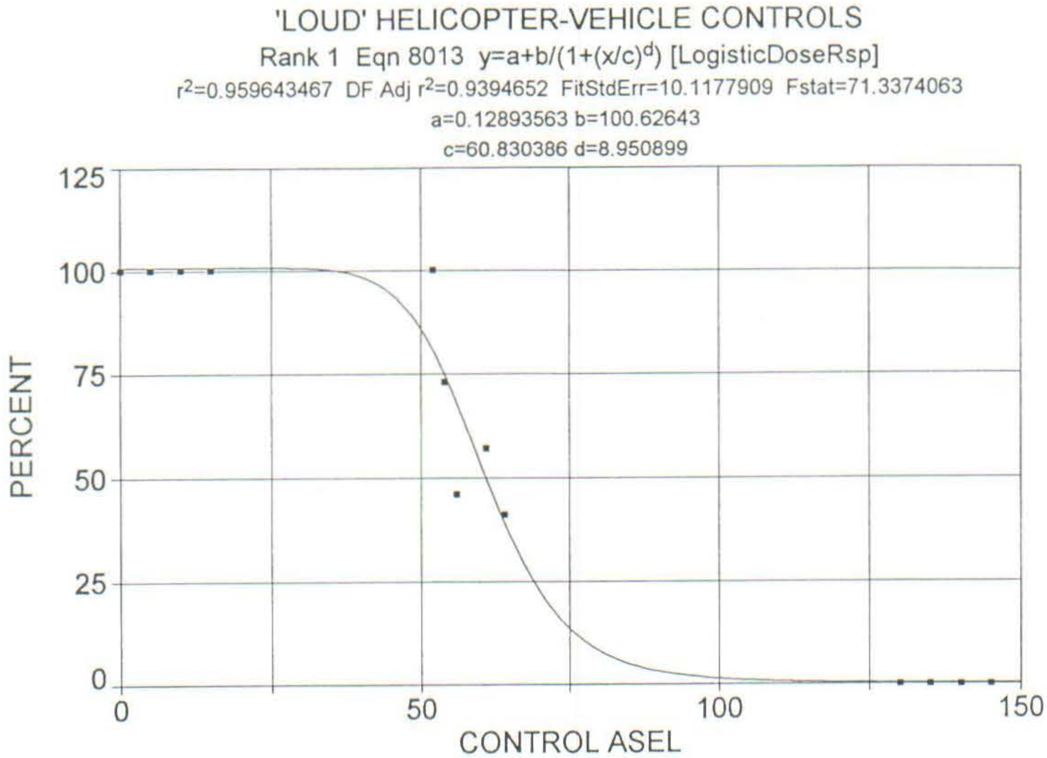
June 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9596434669	0.9394652003	10.117790896	71.337406331

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.128935633	5.091499790	0.025323704	-11.4233608	11.68123211
b	100.6264274	7.203939595	13.96824974	84.28113632	116.9717184
c	60.83038591	1.941817811	31.32651558	56.42452202	65.23624980
d	8.950898961	2.988591328	2.995022731	2.169971040	15.73182688

Date	Time	File Source
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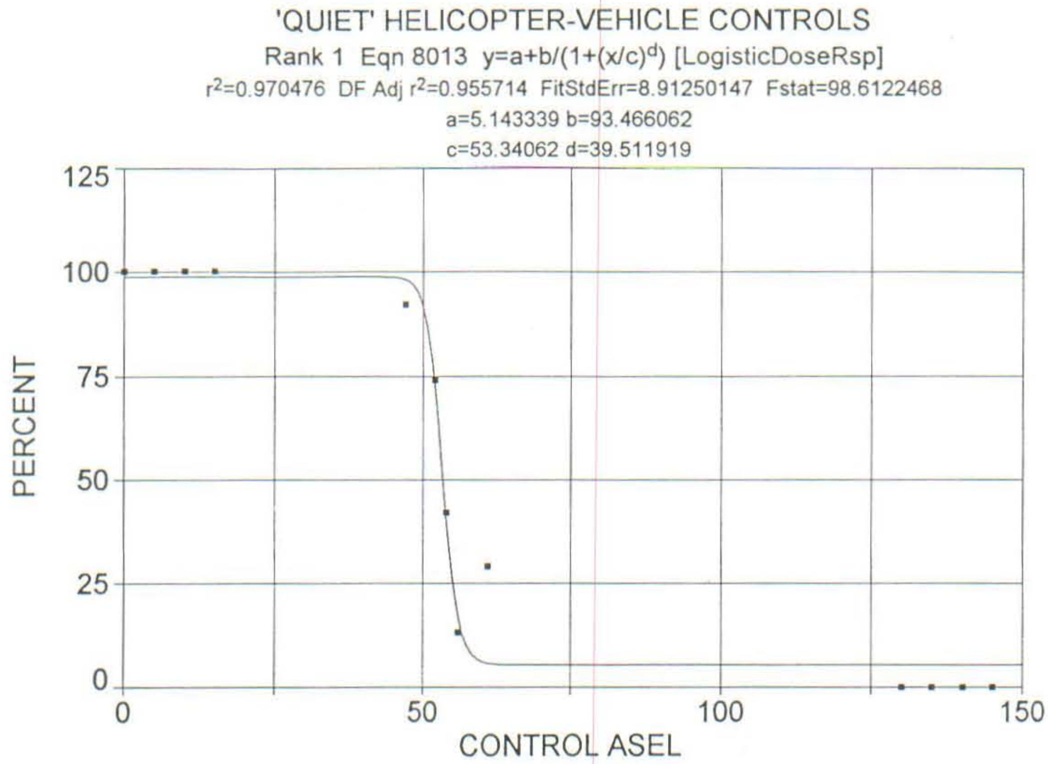

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9704759997	0.9557139996	8.9125014700	98.612246799

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	5.143339018	4.000837793	1.285565495	-3.93431320	14.22099123
b	93.46606240	5.741028975	16.28036765	80.44002458	106.4921002
c	53.34062037	0.448490716	118.9336109	52.32302281	54.35821792
d	39.51191892	12.72117613	3.105995743	10.64836116	68.37547668

Date	Time	File Source
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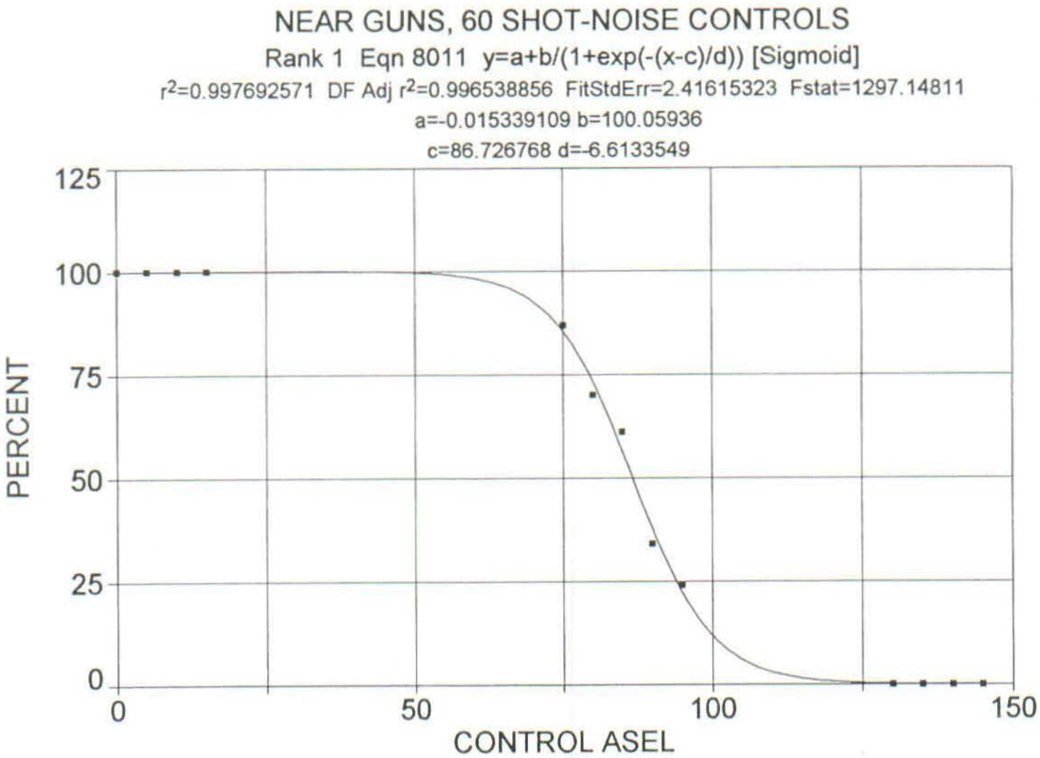
June 1992 Test Period
Indoor Measured Acoustical Data



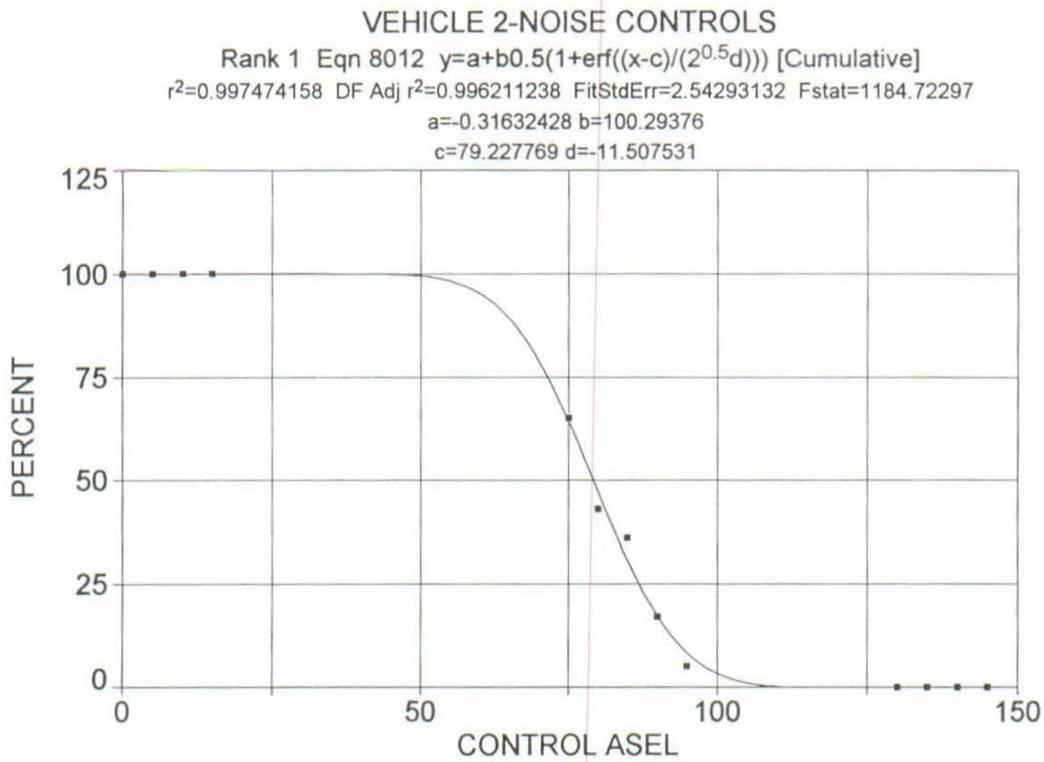
Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9976925706	0.9965388559	2.4161532347	1297.1481057

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.01533911	1.211883430	-0.01265725	-2.76502727	2.734349051
b	100.0593627	1.717824714	58.24771406	96.16172525	103.9570002
c	86.72676821	0.450649340	192.4484527	85.70427288	87.74926355
d	-6.61335494	0.440531215	-15.0122278	-7.61289288	-5.61381700

Date	Time	File Source
May 12, 1994	3:14:49 PM	c:\tcwin\ngf.prn

June 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8012 y=a+b0.5(1+erf((x-c)/($2^{0.5}$d))) [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9974741585	0.9962112377	2.5429313207	1184.7229739

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.31632428	1.253866474	-0.25227908	-3.16126936	2.528620797
b	100.2937623	1.790000720	56.03001227	96.23236196	104.3551627
c	79.22776931	0.526323330	150.5306051	78.03357440	80.42196423
d	-11.5075309	0.877475655	-13.1143592	-13.4984686	-9.51659323

Date	Time	File Source
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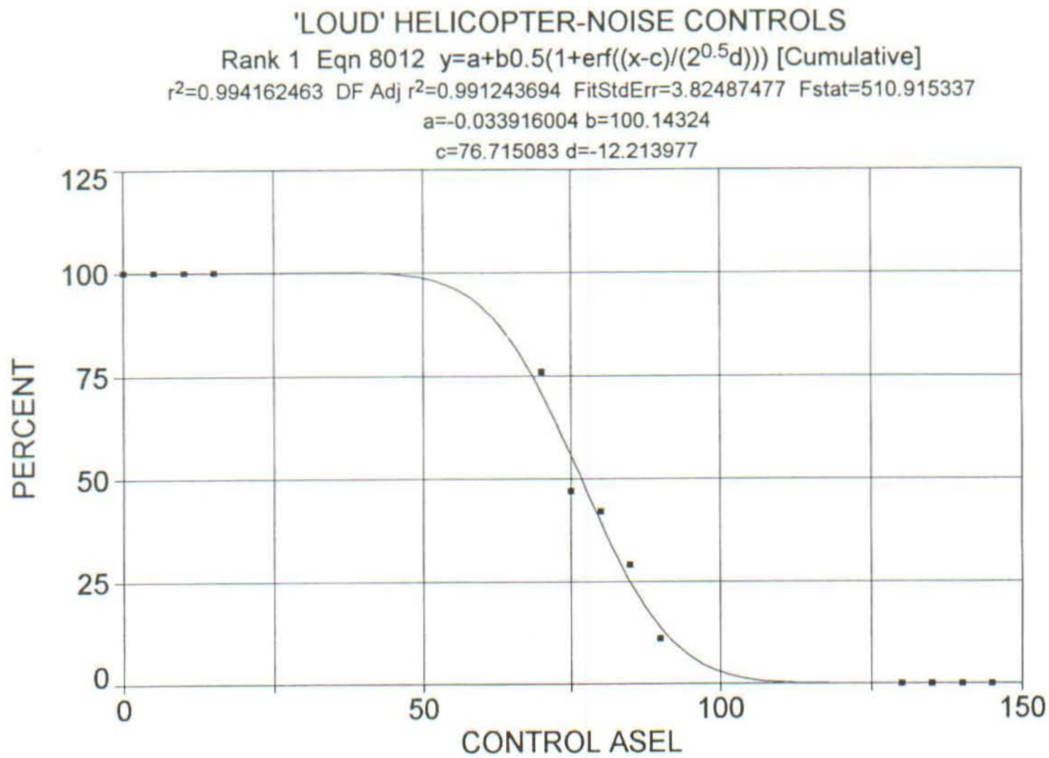


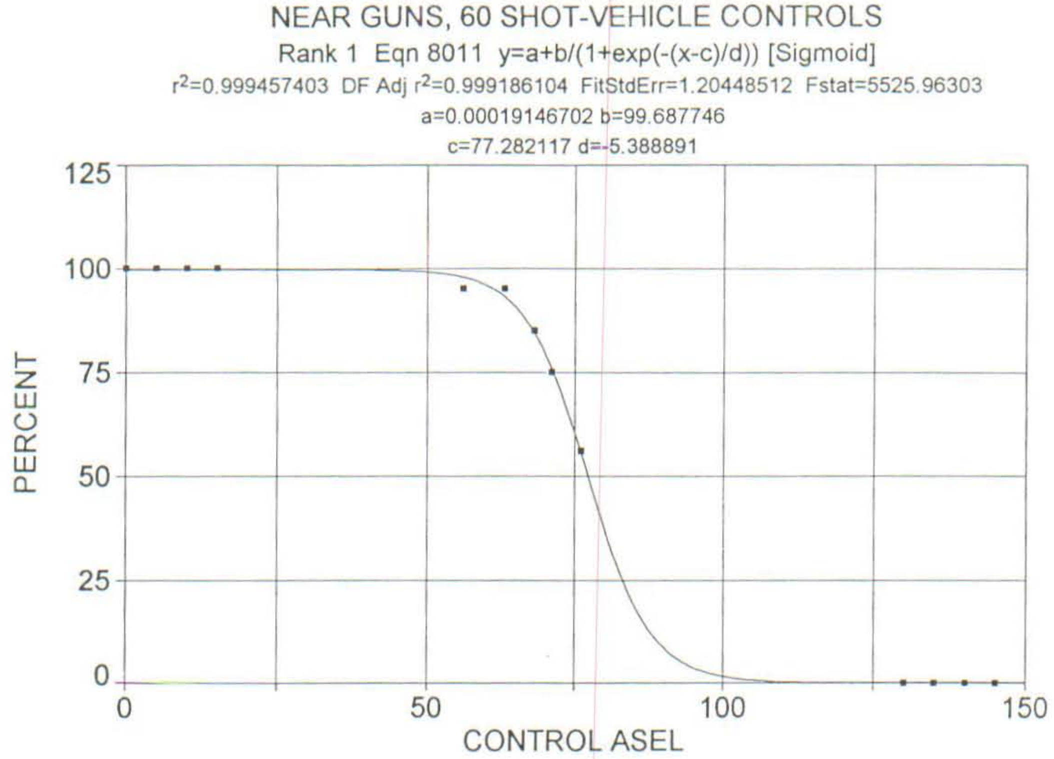
Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9941624626	0.9912436939	3.8248747714	510.91533709

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.03391600	1.900338327	-0.01784735	-4.34566552	4.277833515
b	100.1432362	2.701259973	37.07278722	94.01424526	106.2722271
c	76.71508329	0.787645608	97.39797002	74.92796438	78.50220221
d	-12.2139773	1.303728629	-9.36849663	-15.1720565	-9.25589806

Date	Time	File Source
May 12, 1994	3:17:08 PM	c:\tcwin\ngf.prn

June 1992 Test Period
Indoor Measured Acoustical Data

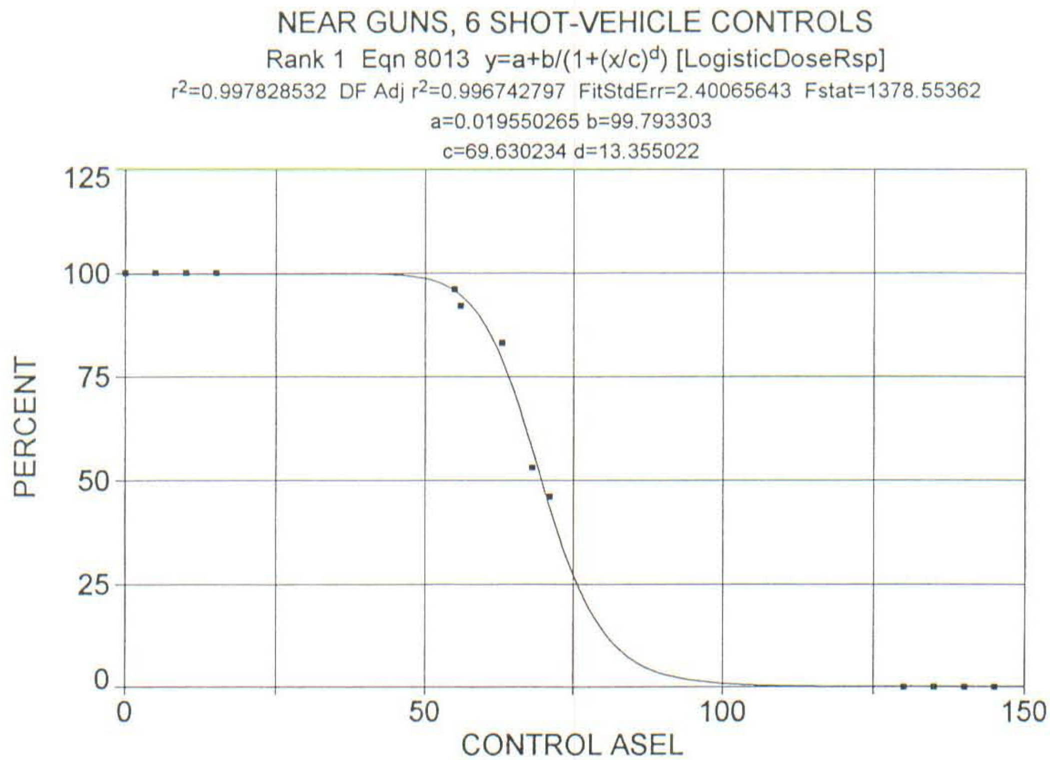


Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9994574028	0.9991861042	1.2044851200	5525.9630282

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.000191467	0.602291099	0.000317898	-1.36636959	1.366752526
b	99.68774608	0.826006809	120.6863490	97.81358798	101.5619042
c	77.28211742	0.304268205	253.9934053	76.59175178	77.97248306
d	-5.38889101	0.309436520	-17.4151746	-6.09098323	-4.68679878

Date	Time	File Source
May 18, 1994	2:38:28 PM	c:\tcwin\noise.prn

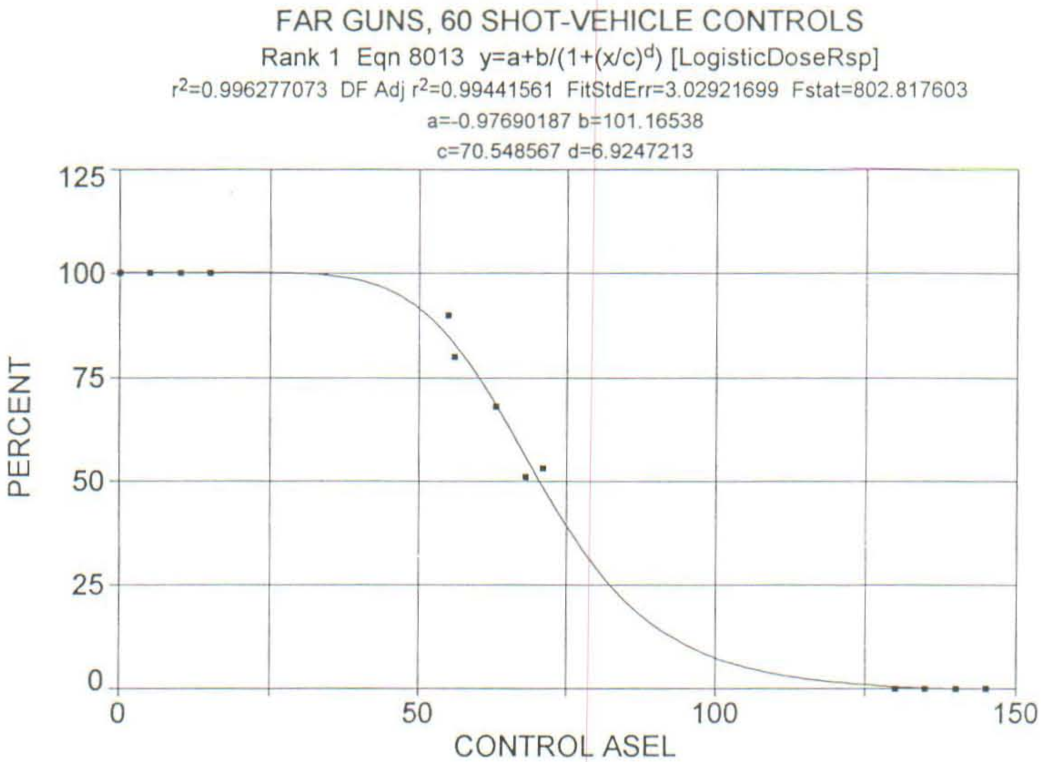


Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9978285316	0.9967427974	2.4006564321	1378.5536228

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.019550265	1.201132245	0.016276530	-2.70574412	2.744844654
b	99.79330250	1.663205677	60.00057834	96.01959223	103.5670128
c	69.63023426	0.394203795	176.6351190	68.73581035	70.52465816
d	13.35502196	1.295114355	10.31184769	10.41648801	16.29355592

Date	Time	File Source
May 18, 1994	11:19:57 AM	c:\tcwin\noise.prn



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9962770731	0.9944156097	3.0292169906	802.81760315

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.97690187	1.715827287	-0.56934744	-4.87000731	2.916203572
b	101.1653772	2.395351447	42.23404347	95.73047364	106.6002807
c	70.54856655	1.061461037	66.46364218	68.14017745	72.95695565
d	6.924721321	0.824366465	8.400052184	5.054285064	8.795157577

Date	Time	File Source
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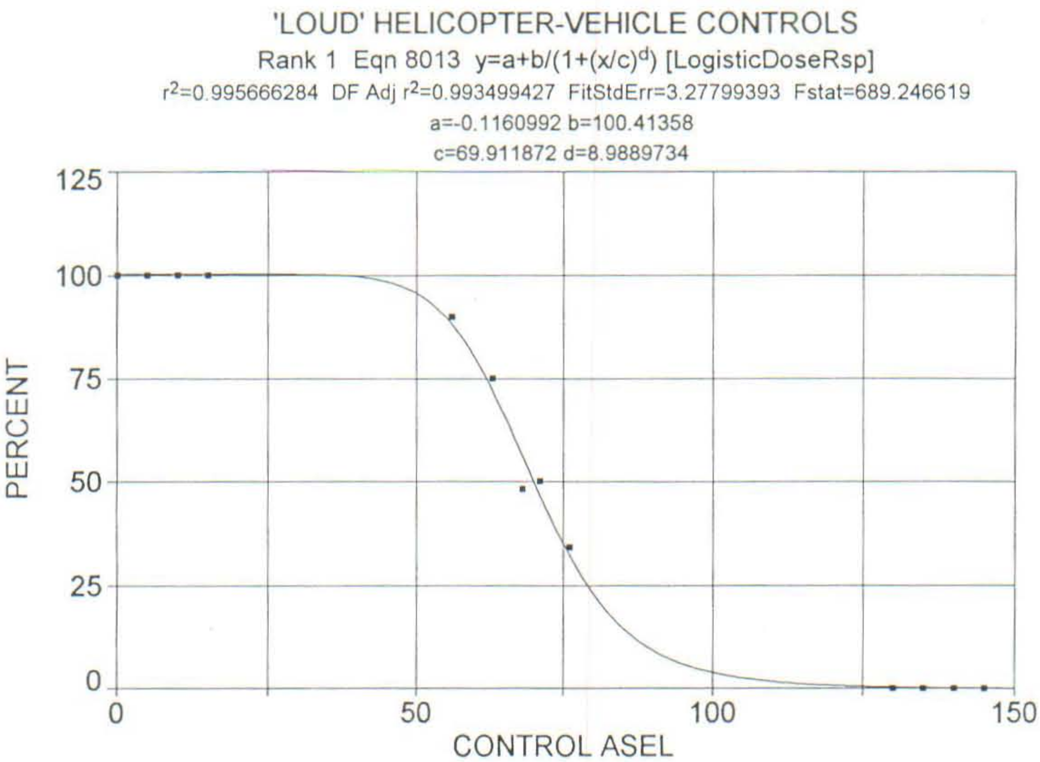


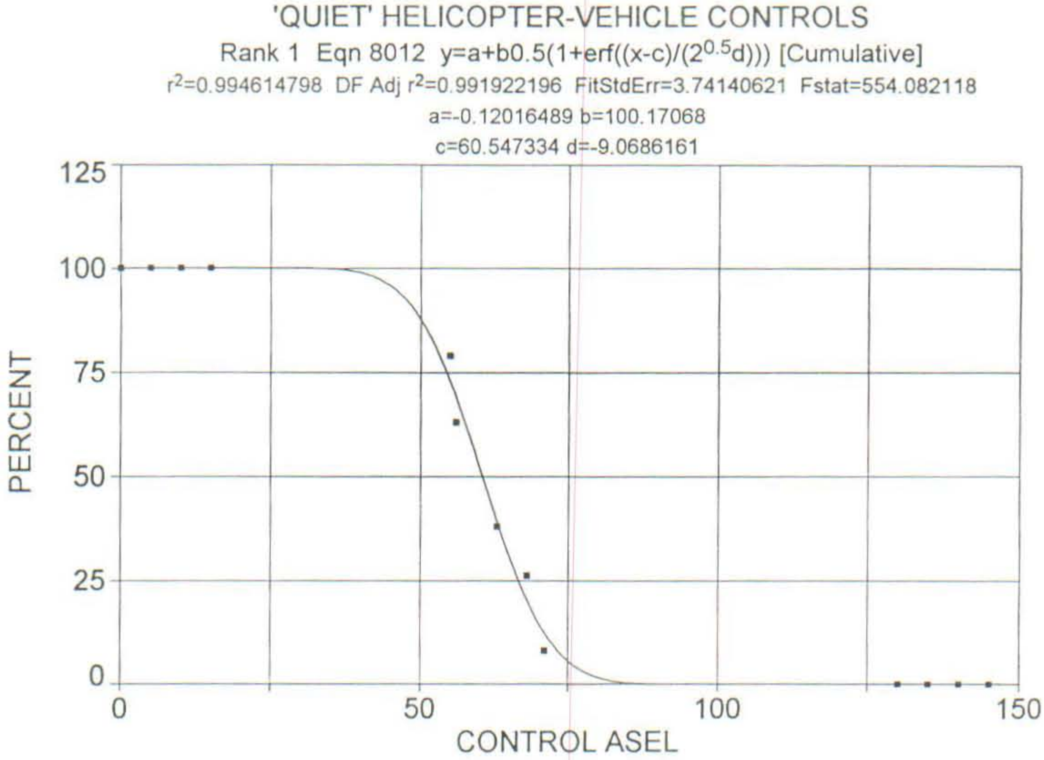
Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9956662844	0.9934994265	3.2779939313	689.24661874

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.11609920	1.677279259	-0.06921876	-3.92174156	3.689543164
b	100.4135774	2.368856376	42.38905254	95.03878952	105.7883652
c	69.91187157	0.682899902	102.3749913	68.36241415	71.46132899
d	8.988973412	0.958260325	9.380512976	6.814740311	11.16320651

Date	Time	File Source
May 18, 1994	11:32:18 AM	c:\tcwin\noise.prn

August 1992 Test Period
Indoor Measured Acoustical Data



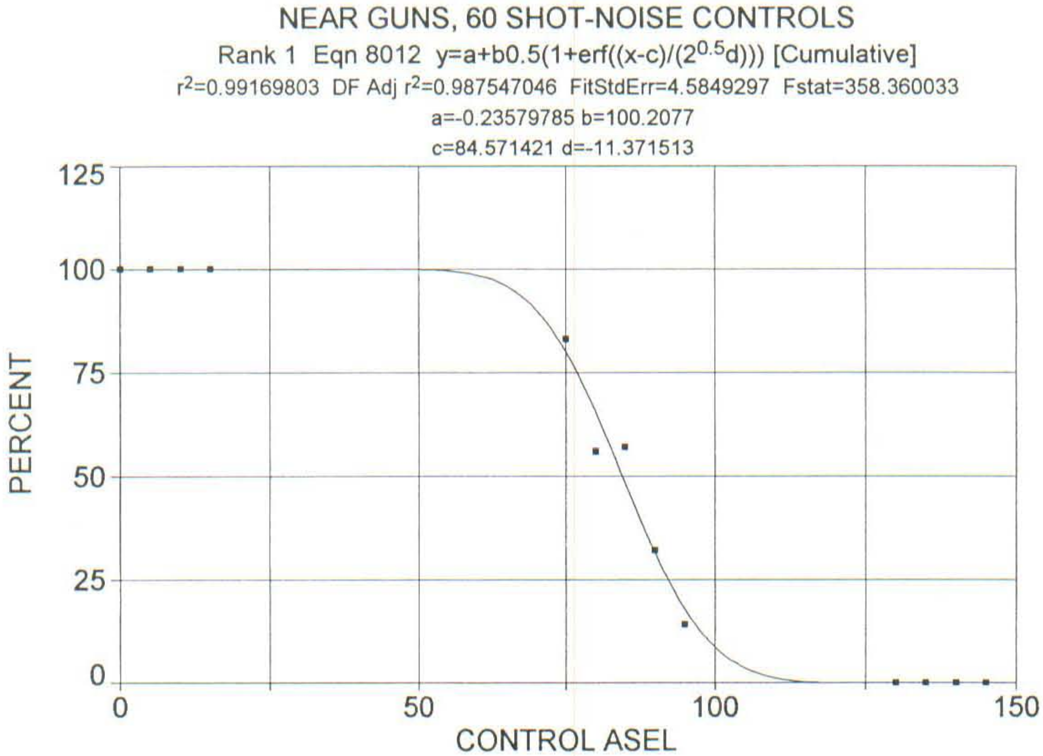
Rank 1 Eqn 8012 y=a+b0.5(1+erf((x-c)/($2^{0.5}$d))) [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9946147975	0.9919221963	3.7414062063	554.08211823

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.12016489	1.855749323	-0.06475276	-4.33074473	4.090414951
b	100.1706846	2.641171027	37.92661802	94.17803179	106.1633375
c	60.54733446	0.600948116	100.7530148	59.18382055	61.91084838
d	-9.06861608	0.833776987	-10.8765488	-10.9604042	-7.17682794

Date	Time	File Source
May 18, 1994	11:25:28 AM	c:\tcwin\noise.prn

August 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8012 $y=a+b0.5(1+\mathrm{erf}((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9916980304	0.9875470456	4.5849297004	358.36003313

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.23579785	2.282925053	-0.10328760	-5.41561287	4.944017160
b	100.2077048	3.241065018	30.91814086	92.85392975	107.5614798
c	84.57142095	0.873480920	96.82114292	82.58954704	86.55329485
d	-11.3715127	1.362213968	-8.34781683	-14.4622915	-8.28073388

Date	Time	File Source
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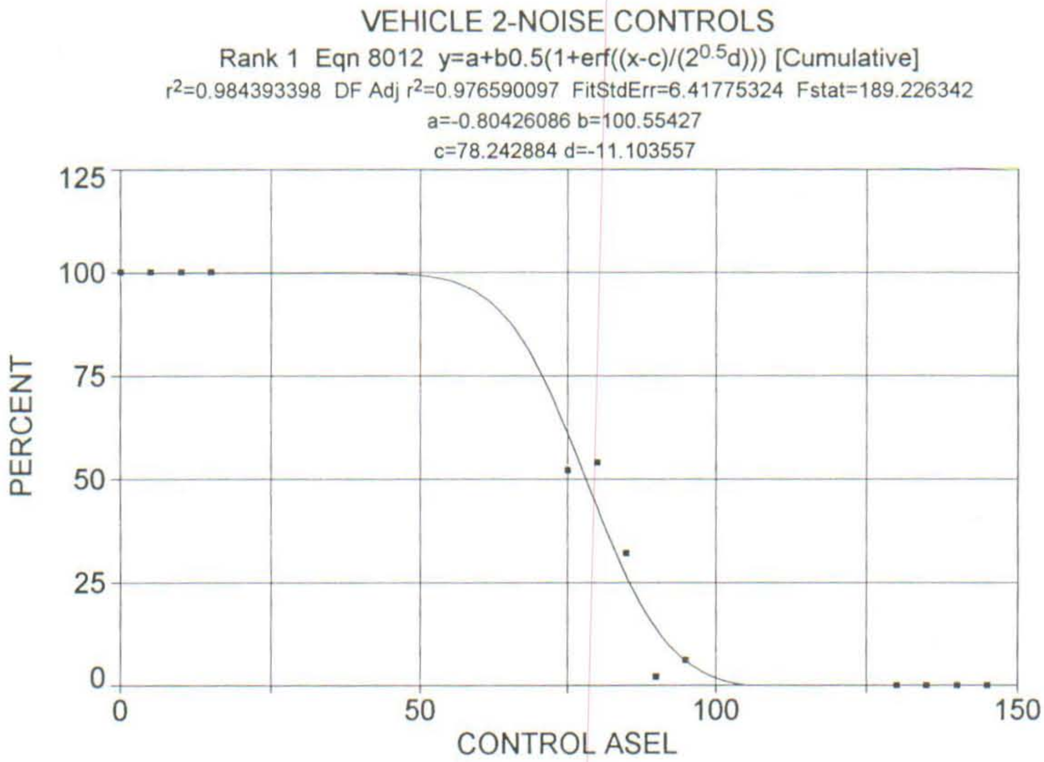


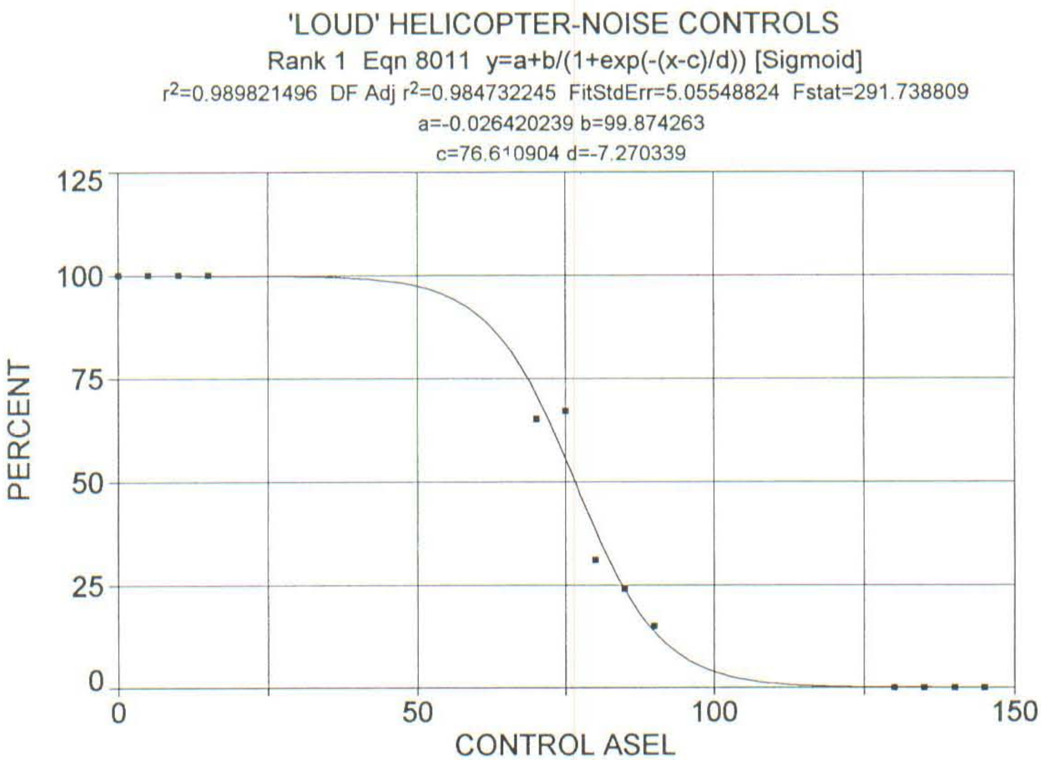
Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9843933981	0.9765900971	6.4177532369	189.22634176

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.80426086	3.145779929	-0.25566342	-7.94183995	6.333318220
b	100.5542718	4.505069106	22.32025070	90.33255013	110.7759936
c	78.24288422	1.330091117	58.82520619	75.22499017	81.26077828
d	-11.1035570	2.233591558	-4.97116716	-16.1714374	-6.03567662

Date	Time	File Source
May 12, 1994	4:08:19 PM	c:\tcwin\augh.prn

August 1992 Test Period
Indoor Measured Acoustical Data

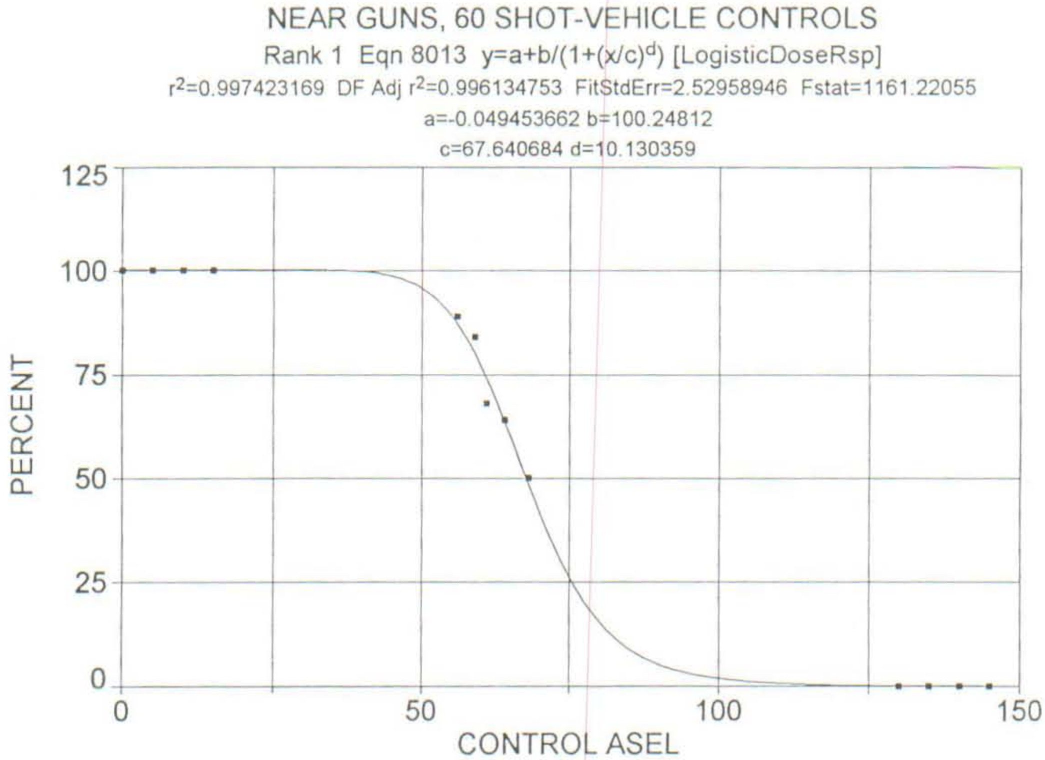


Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9898214965	0.9847322447	5.0554882398	291.73880862

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.02642024	2.515805127	-0.01050170	-5.73462566	5.681785184
b	99.87426282	3.584850722	27.86008974	91.74045940	108.0080662
c	76.61090427	1.024941404	74.74661867	74.28537595	78.93643260
d	-7.27033896	1.072345538	-6.77984726	-9.70342431	-4.83725360

Date	Time	File Source
May 12, 1994	4:09:58 PM	c:\tcwin\augh.prn



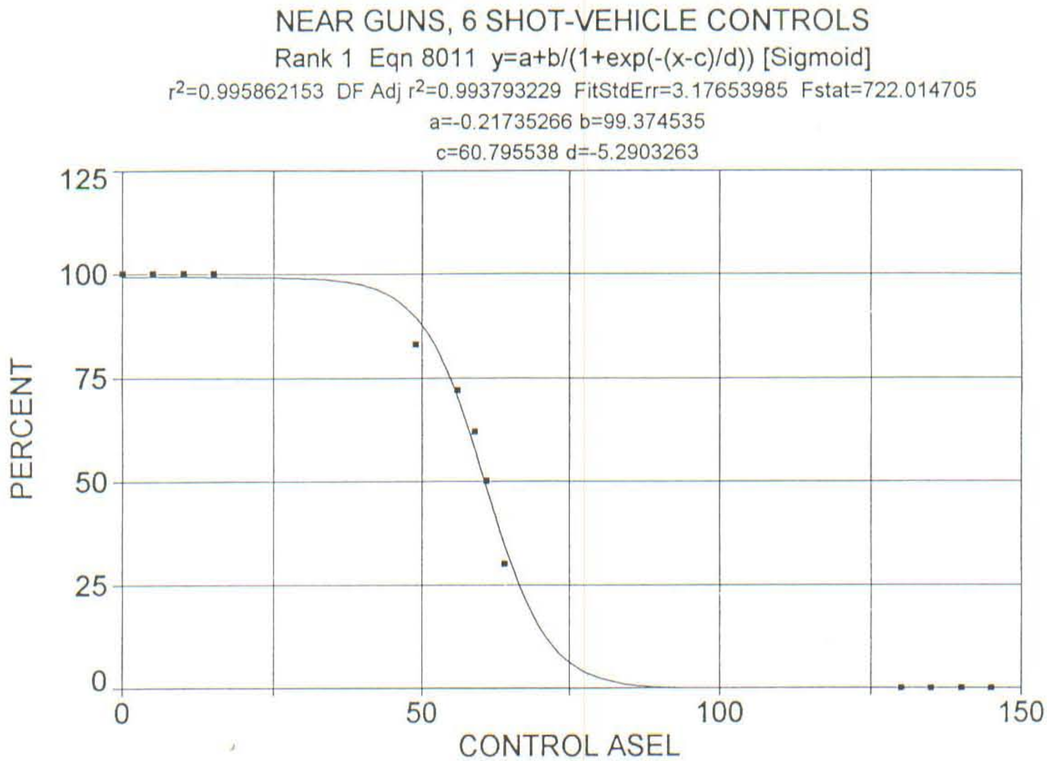
Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9974231687	0.9961347530	2.5295894609	1161.2205466

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.04945366	1.273163675	-0.03884313	-2.93818289	2.839275563
b	100.2481208	1.803273598	55.59229664	96.15660510	104.3396365
c	67.64068360	0.611773987	110.5648247	66.25260646	69.02876074
d	10.13035861	1.013239745	9.997987801	7.831380621	12.42933660

Date	Time	File Source
May 18, 1994	2:42:08 PM	c:\tcwin\noise.prn

November 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9958621529	0.9937932293	3.1765398494	722.01470524

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.21735266	1.586560375	-0.13699615	-3.81715952	3.382454189
b	99.37453468	2.236647015	44.43013761	94.29972166	104.4493477
c	60.79553781	0.449956121	135.1143698	59.77461534	61.81646027
d	-5.29032629	0.592984408	-8.92152682	-6.63577105	-3.94488154

Date	Time	File Source
May 18, 1994	3:04:36 PM	c:\tcwin\noise.prn

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9998658182	0.9997987273	0.5674157442	22354.726671

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.10296200	0.286664274	-0.35917277	-0.75338542	0.547461414
b	100.1522484	0.405792866	246.8063312	99.23152961	101.0729672
c	61.15546374	0.109860162	556.6664254	60.90619786	61.40472962
d	8.393857179	0.184628700	45.46344742	7.974946138	8.812768220

Date	Time	File Source
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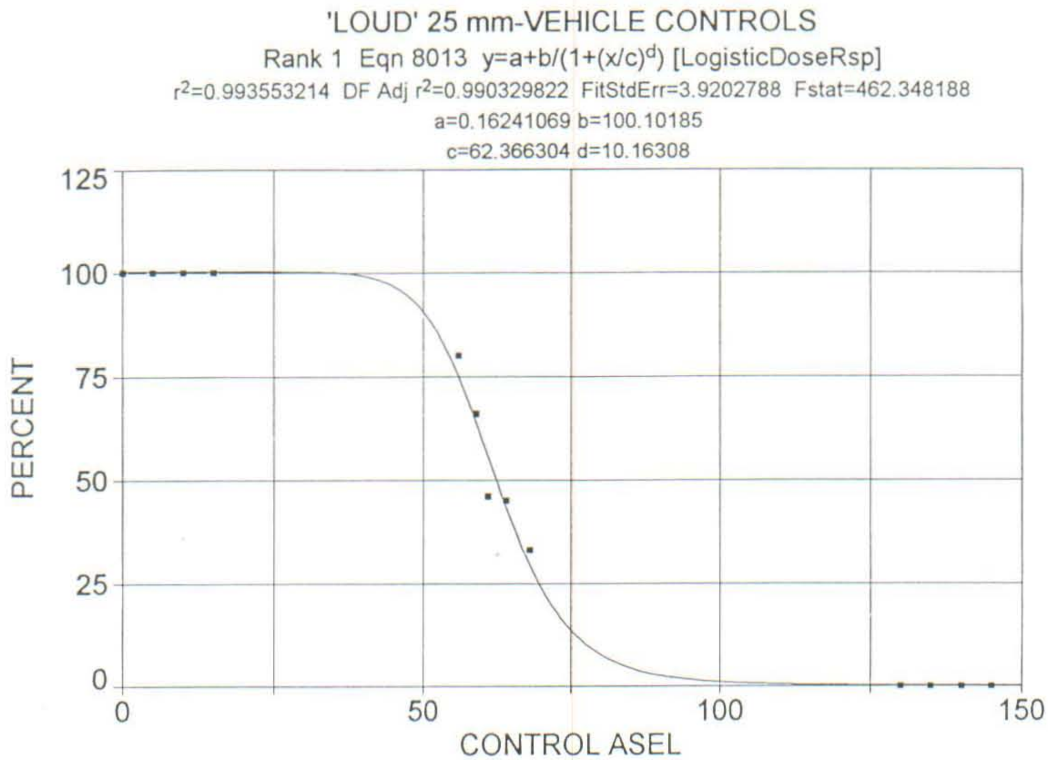
November 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9935532144	0.9903298216	3.9202788014	462.34818788

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.162410695	1.966067266	0.082606886	-4.29847370	4.623295089
b	100.1018465	2.781847258	35.98394780	93.79000802	106.4136850
c	62.36630382	0.613548648	101.6485066	60.97420008	63.75840755
d	10.16307992	1.325606411	7.666740176	7.155361393	13.17079846

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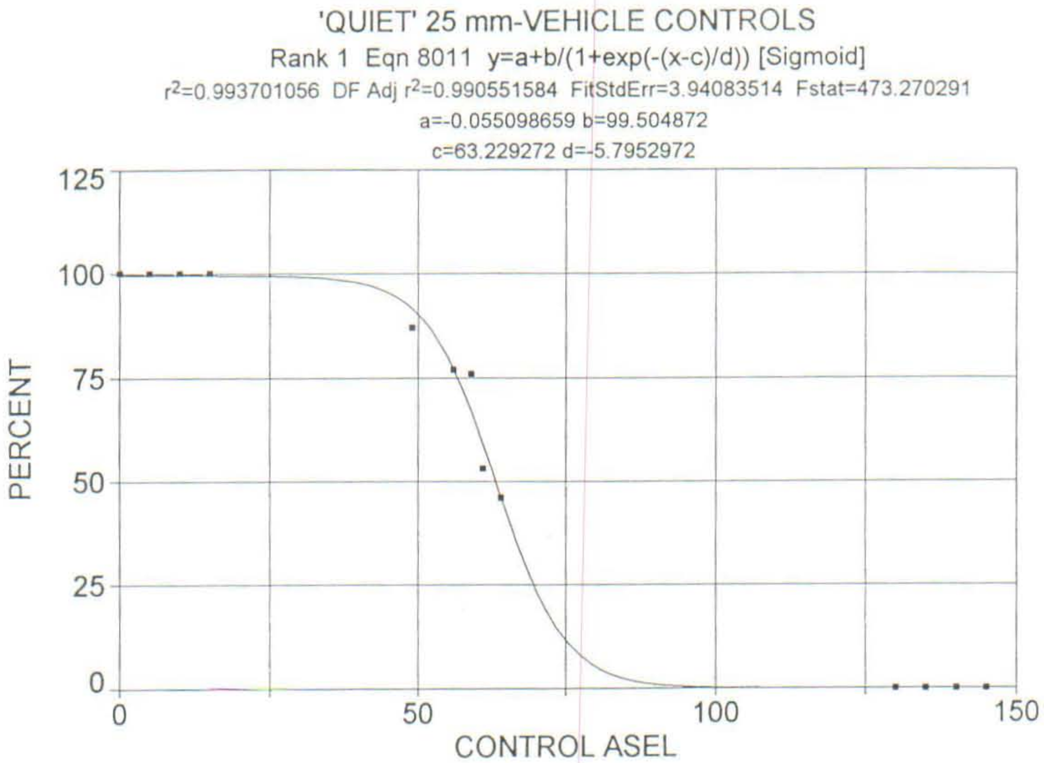

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9937010558	0.9905515837	3.9408351359	473.27029149

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.05509866	1.969910428	-0.02797013	-4.52470295	4.414505631
b	99.50487224	2.771687373	35.90046742	93.21608591	105.7936586
c	63.22927162	0.732360697	86.33624369	61.56759073	64.89095251
d	-5.79529716	0.956784609	-6.05705516	-7.96618195	-3.62441236

Date	Time	File Source
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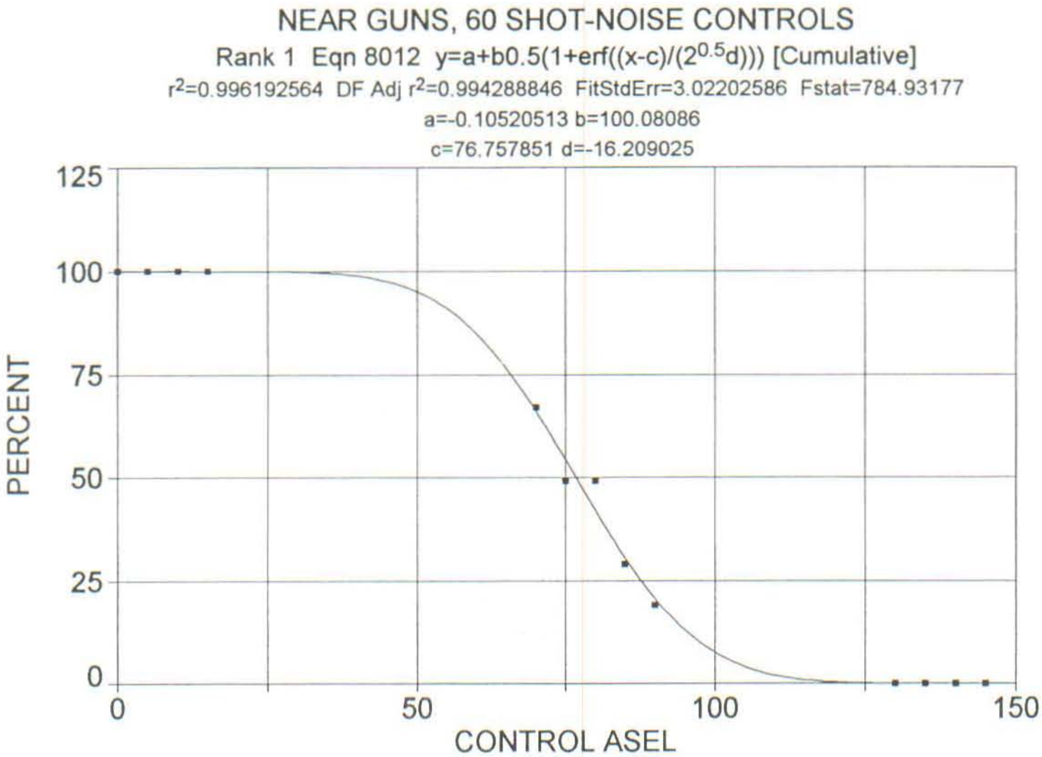

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9961925637	0.9942888456	3.0220258592	784.93177048

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.10520513	1.514986337	-0.06944296	-3.54261494	3.332204680
b	100.0808601	2.143551556	46.68927130	95.21727490	104.9444453
c	76.75785130	0.791175512	97.01747602	74.96272325	78.55297935
d	-16.2090246	1.563871480	-10.3646781	-19.7573517	-12.6606974

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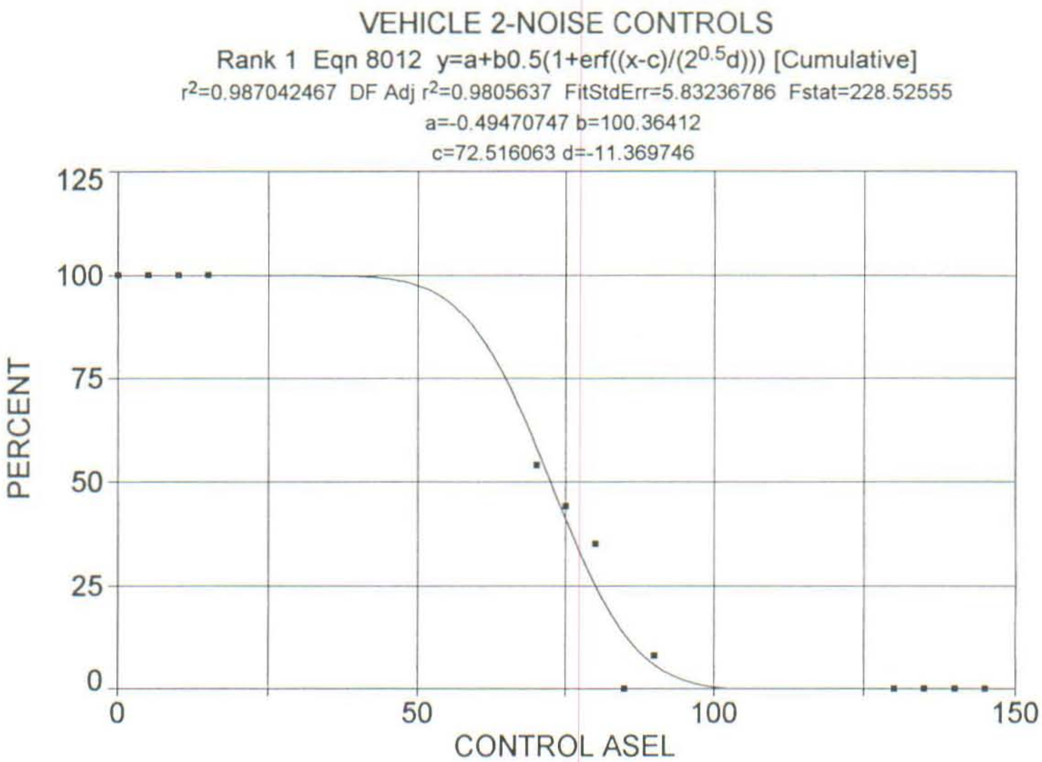

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9870424668	0.9805637002	5.8323678599	228.52554992

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.49470747	2.857527117	-0.17312433	-6.97825884	5.988843904
b	100.3641157	4.092106838	24.52626963	91.07937968	109.6488517
c	72.51606301	1.280440455	56.63368627	69.61082323	75.42130280
d	-11.3697460	2.172698621	-5.23300649	-16.2994641	-6.44002790

Date	Time	File Source
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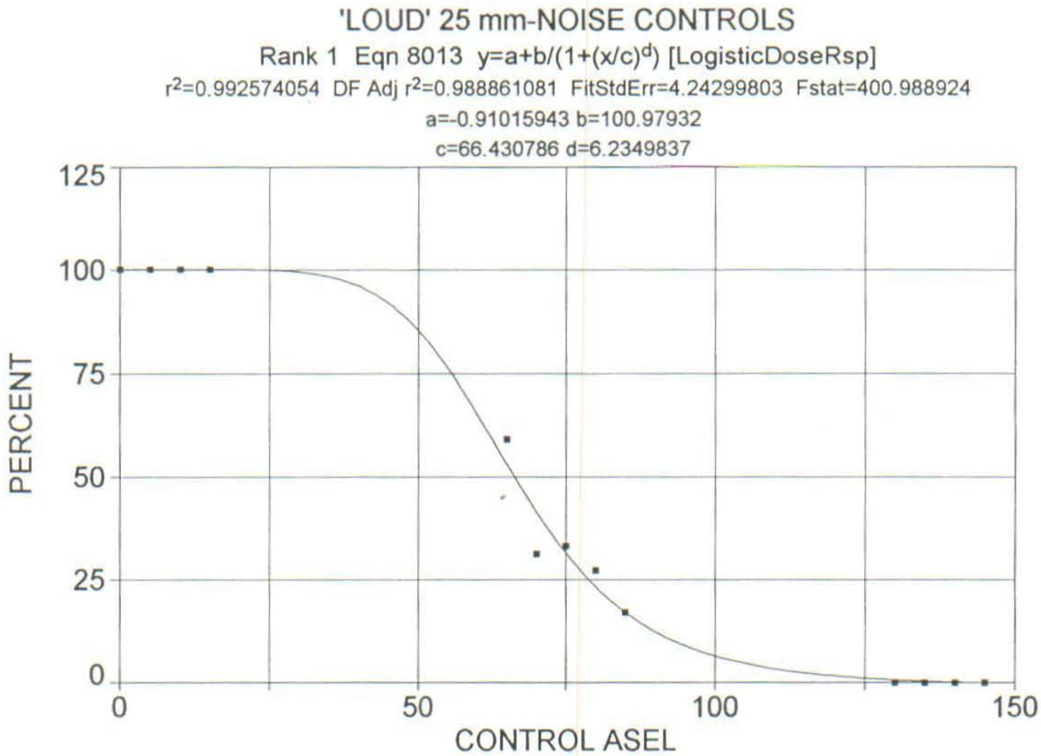

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9925740538	0.9888610808	4.2429980288	400.98892426

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.91015943	2.561605096	-0.35530825	-6.72228214	4.901963275
b	100.9793185	3.357861378	30.07250959	93.36053980	108.5980972
c	66.43078585	1.392148924	47.71816053	63.27208649	69.58948521
d	6.234983694	1.154905987	5.398693714	3.614573810	8.855393578

Date	Time	File Source
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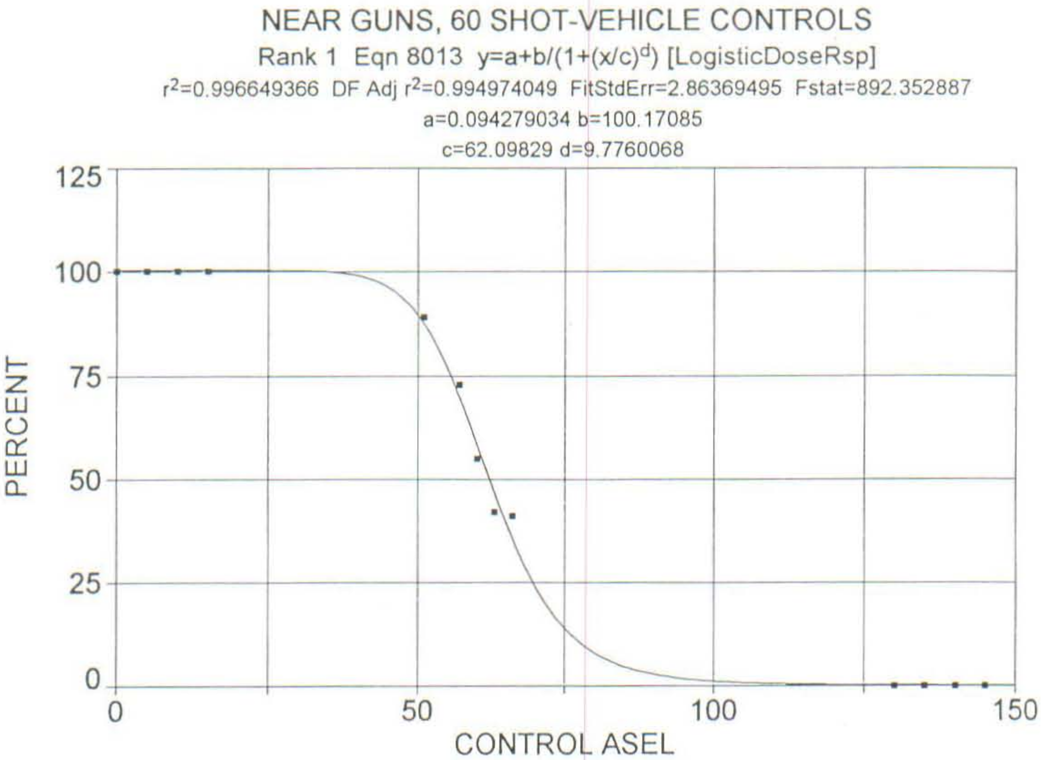
November 1992 Test Period
Indoor Measured Acoustical Data



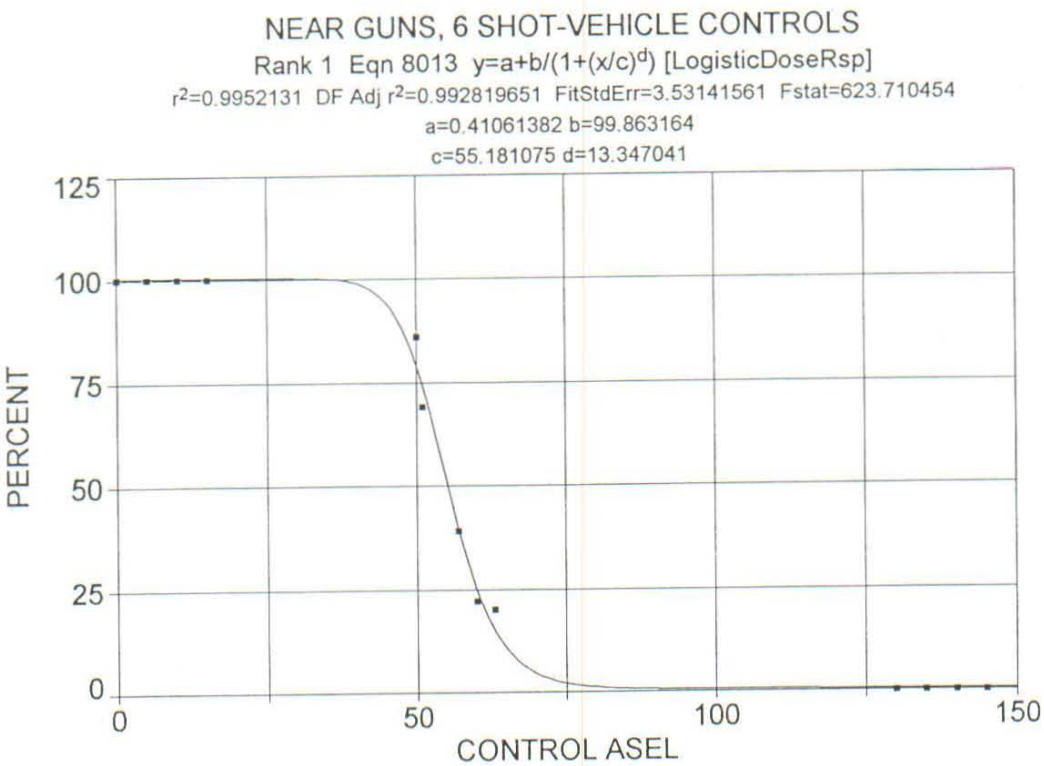
Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9966493658	0.9949740487	2.8636949541	892.35288672

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.094279034	1.436851513	0.065615015	-3.16584772	3.354405786
b	100.1708505	2.030417003	49.33511214	95.56396060	104.7777405
c	62.09828971	0.480198482	129.3179634	61.00874921	63.18783022
d	9.776006826	0.950204027	10.28832392	7.620052963	11.93196069

Date	Time	File Source
May 18, 1994	3:28:48 PM	c:\tcwin\noise.prn

January 1993 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9952131004	0.9928196507	3.5314156091	623.71045431

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.410613822	1.747837401	0.234926785	-3.55512058	4.376348220
b	99.86316430	2.493679681	40.04650840	94.20516014	105.5211685
c	55.18107489	0.445061069	123.9854004	54.17125899	56.19089078
d	13.34704105	1.170549900	11.40236828	10.69113610	16.00294600

Date	Time	File Source
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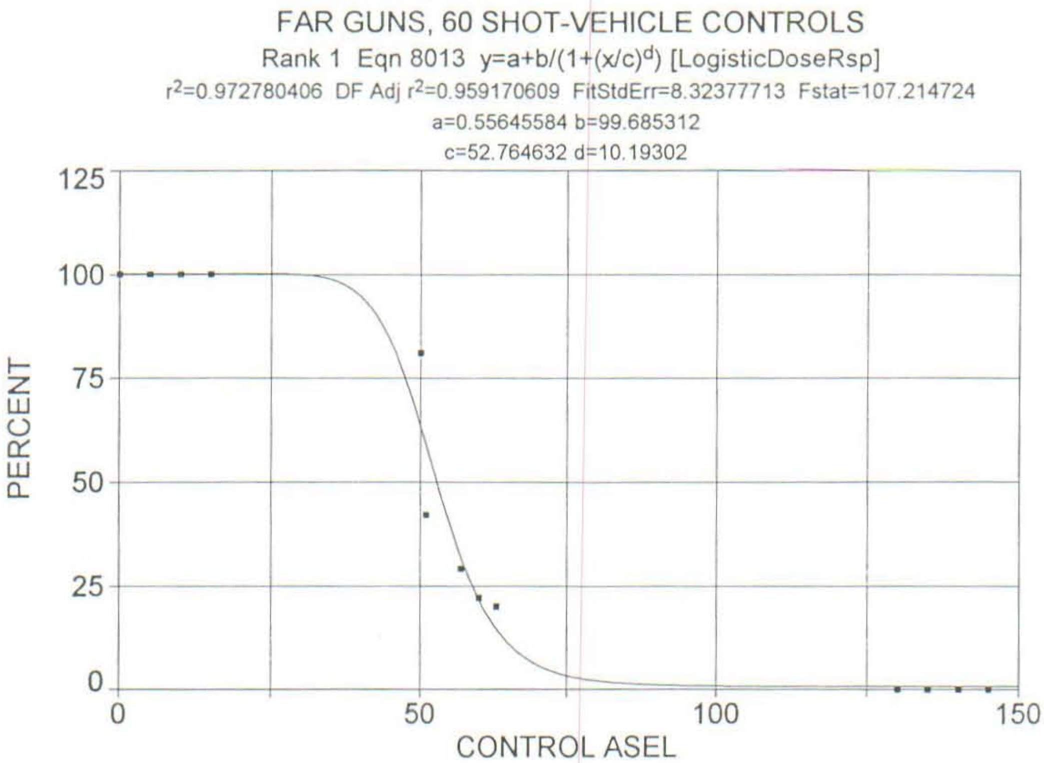
January 1993 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9727804063	0.9591706094	8.3237771310	107.21472358

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.556455842	4.142220259	0.134337579	-8.84198440	9.954896085
b	99.68531198	5.880739988	16.95115108	86.34227856	113.0283454
c	52.76463244	1.222007413	43.17865168	49.99197359	55.53729129
d	10.19302036	2.467464811	4.130968885	4.594496108	15.79154461

Date	Time	File Source
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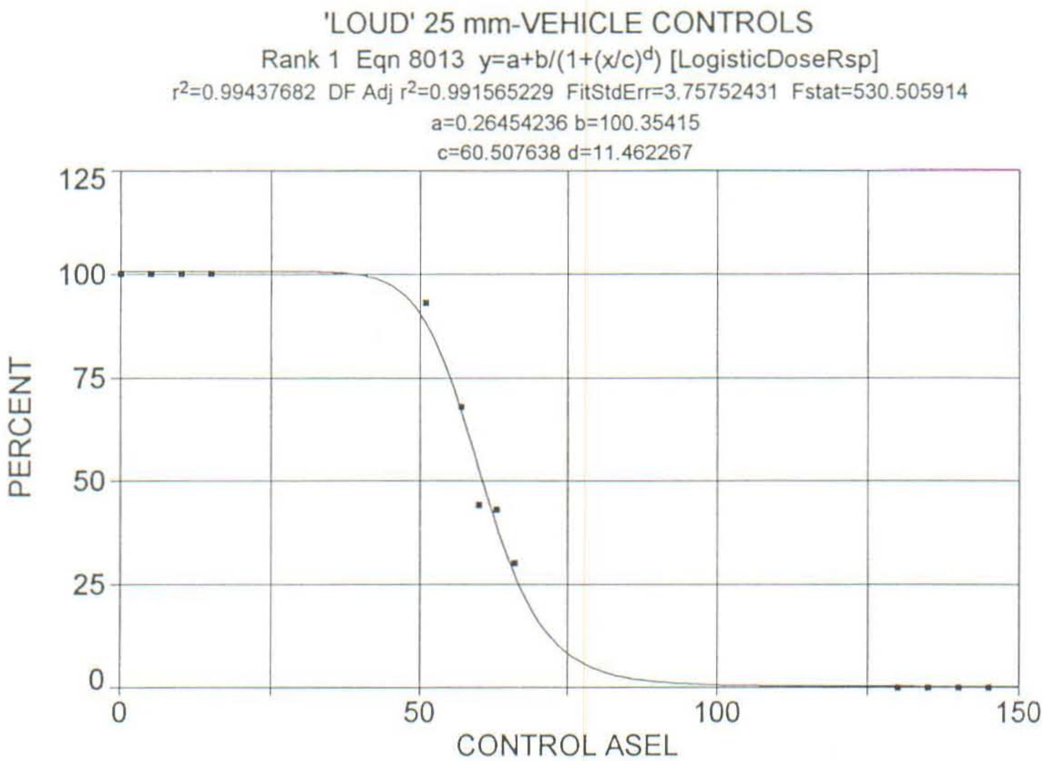

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9943768196	0.9915652294	3.7575243111	530.50591393

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.264542356	1.876018331	0.141012671	-3.99202660	4.521111316
b	100.3541530	2.652932013	37.82763844	94.33481521	106.3734908
c	60.50763781	0.530472824	114.0635958	59.30402796	61.71124767
d	11.46226690	1.315057898	8.716169010	8.478482285	14.44605151

Date	Time	File Source
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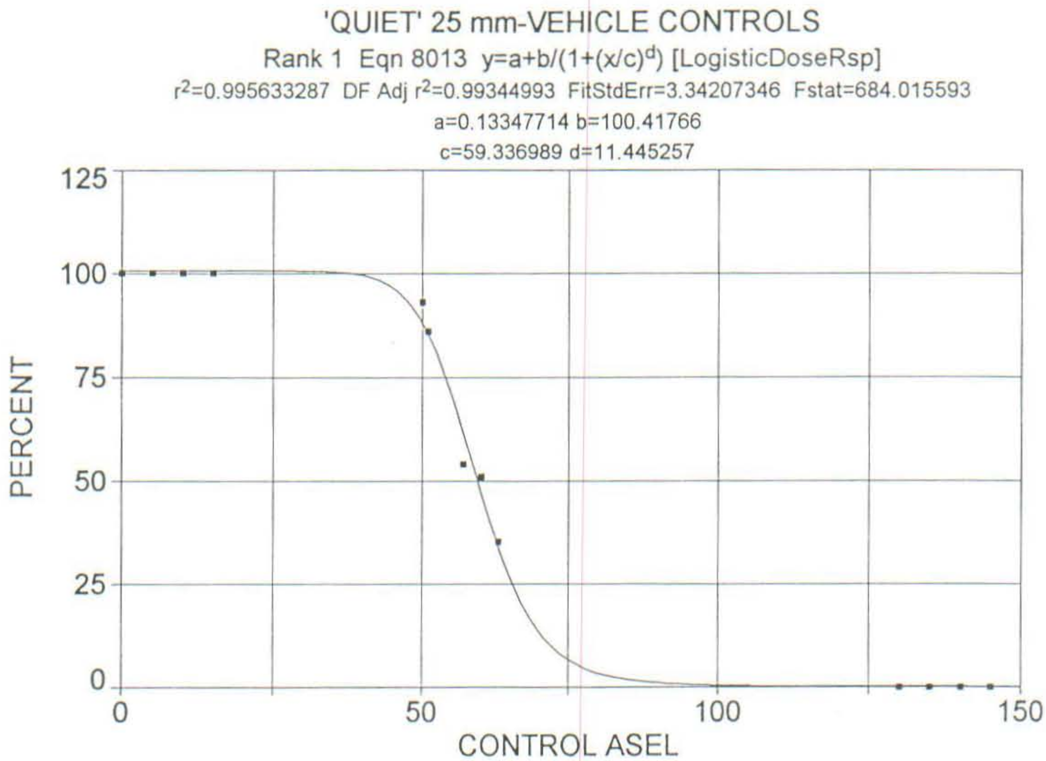


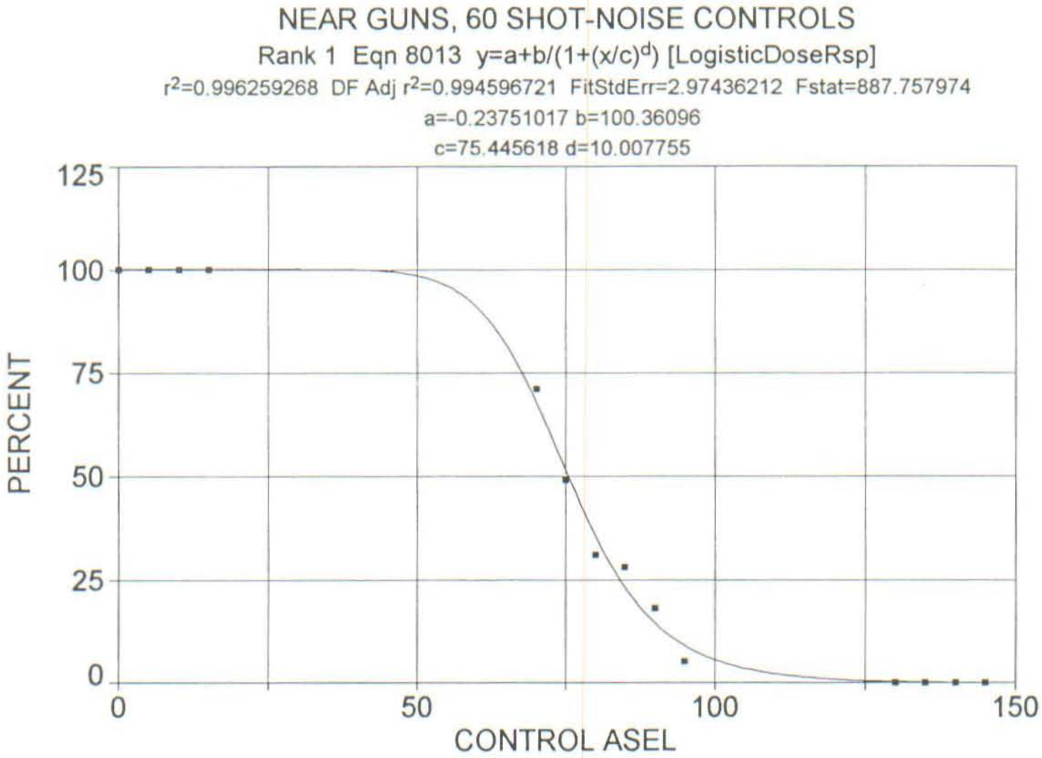
Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9956332869	0.9934499303	3.3420734559	684.01559335

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.133477137	1.670029151	0.079925034	-3.65571518	3.922669454
b	100.4176647	2.360348589	42.54357394	95.06218054	105.7731489
c	59.33698896	0.485229307	122.2864903	58.23603383	60.43794409
d	11.44525713	1.171062754	9.773393521	8.788188547	14.10232571

Date	Time	File Source
May 18, 1994	3:17:03 PM	c:\tcwin\noise.prn

January 1993 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9962592685	0.9945967211	2.9743621213	887.75797369

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.23751017	1.521935870	-0.15605794	-3.63714000	3.162119657
b	100.3609616	2.146834174	46.74835292	95.56546292	105.1564603
c	75.44561826	0.624816133	120.7485119	74.04993293	76.84130359
d	10.00775533	0.863788160	11.58589083	8.078265357	11.93724529

Date	Time	File Source
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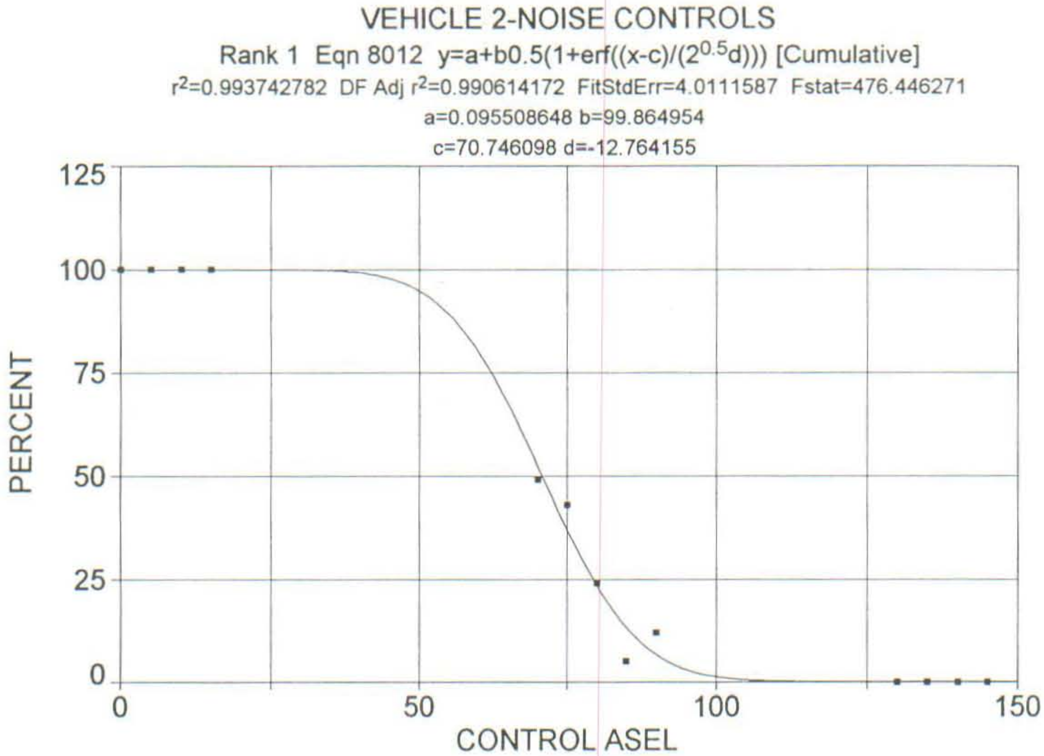

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9937427817	0.9906141725	4.0111586989	476.44627052

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.095508648	1.974296684	0.048376036	-4.38404778	4.575065079
b	99.86495430	2.818566121	35.43111994	93.46980300	106.2601056
c	70.74609833	1.103338485	64.12003145	68.24269191	73.24950476
d	-12.7641551	1.873112226	-6.81441023	-17.0141303	-8.51417993

Date	Time	File Source
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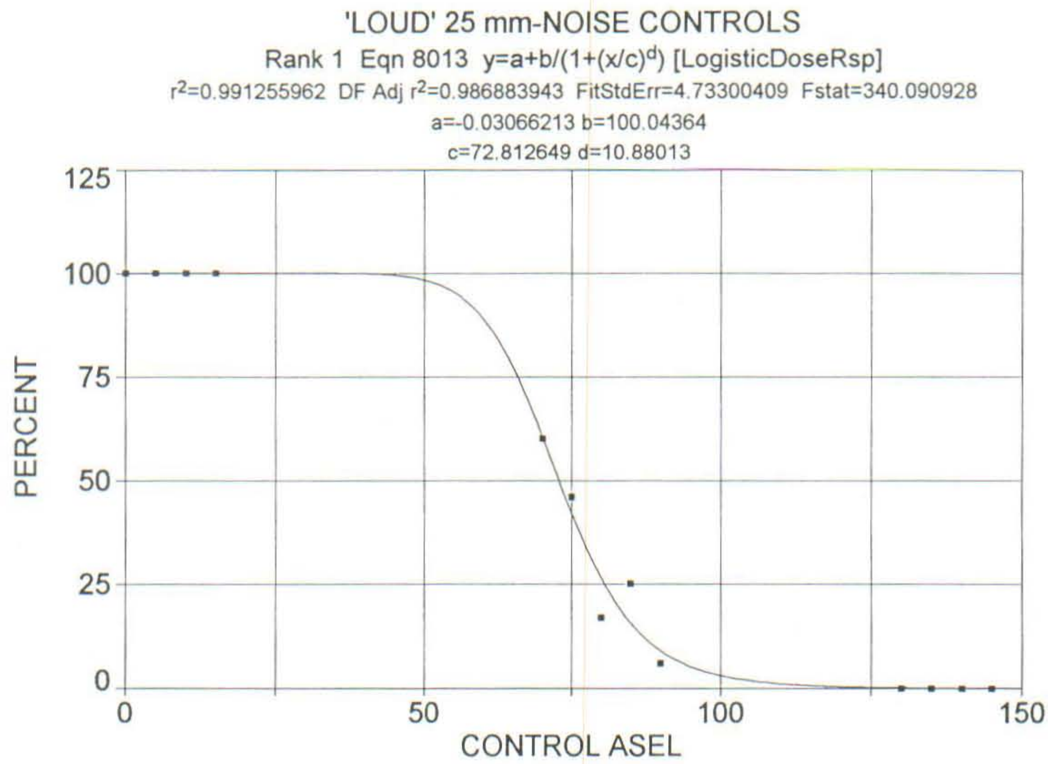

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9912559623	0.9868839435	4.7330040867	340.09092817

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.03066213	2.378976796	-0.01288879	-5.42841258	5.367088317
b	100.0436357	3.370387169	29.68312859	92.39643678	107.6908347
c	72.81264898	0.975796230	74.61870286	70.59862800	75.02666996
d	10.88013017	1.726381293	6.302275295	6.963078350	14.79718200

Date	Time	File Source
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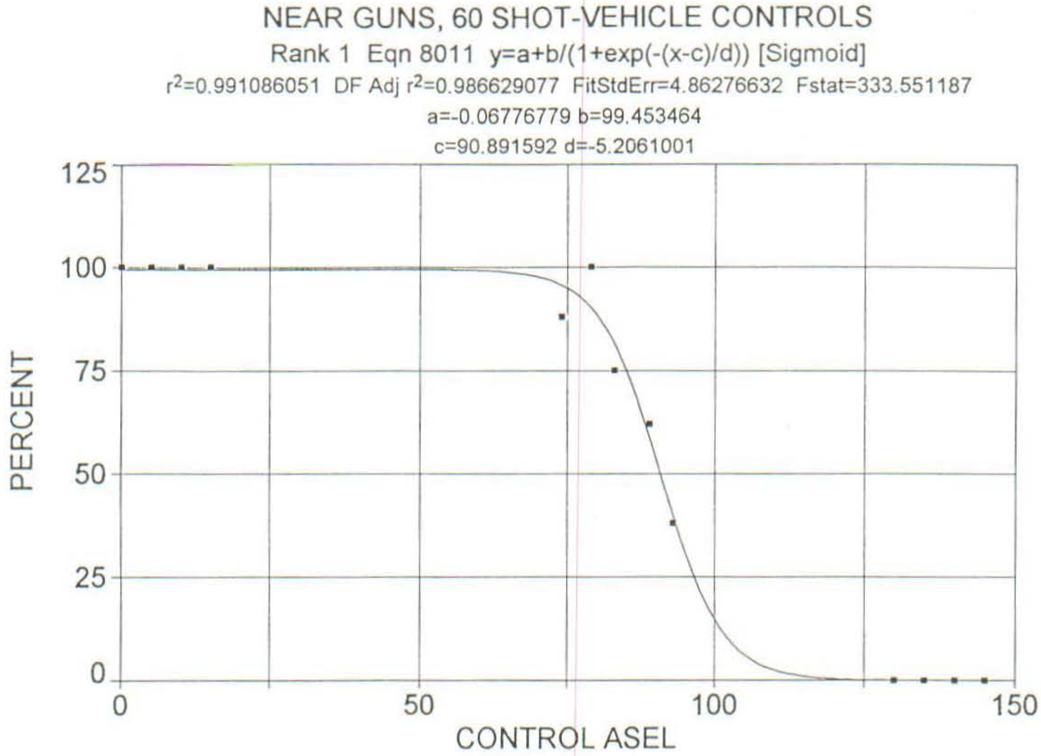


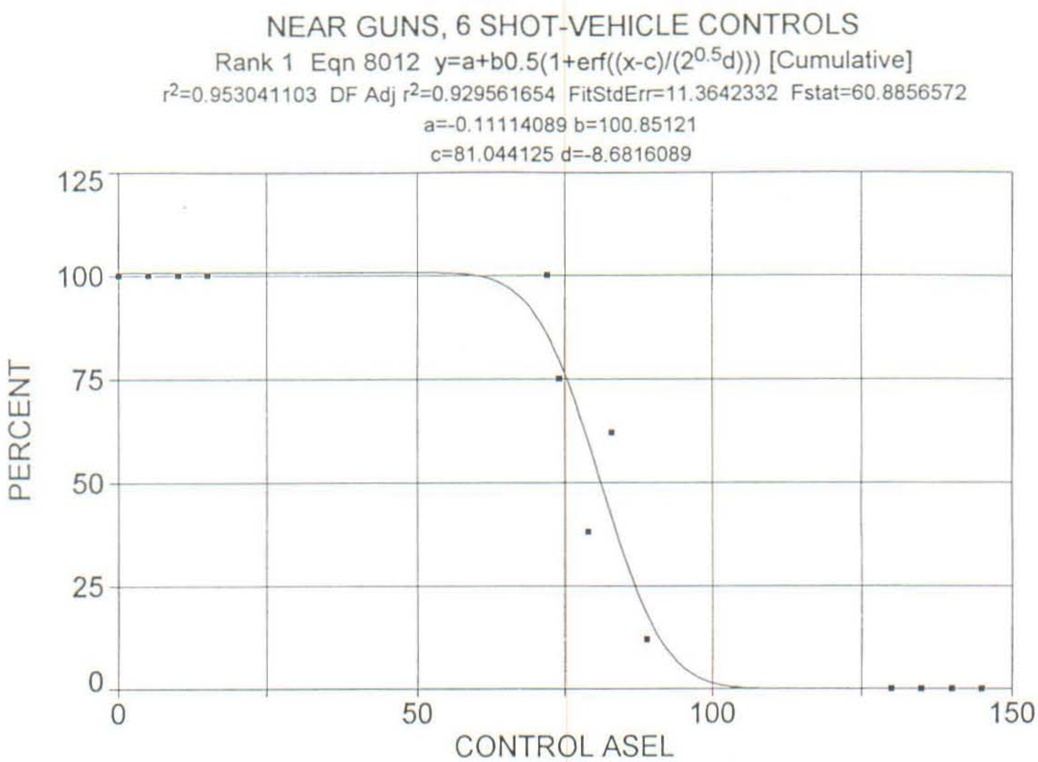
Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9910860514	0.9866290770	4.8627663244	333.55118715

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.06776779	2.434210935	-0.02783974	-5.59084107	5.455305485
b	99.45346363	3.384229160	29.38733133	91.77485807	107.1320692
c	90.89159235	0.812533650	111.8619424	89.04800401	92.73518068
d	-5.20610011	0.898341535	-5.79523478	-7.24438120	-3.16781902

Date	Time	File Source
Sep 1, 1994	4:34:56 PM	c:\tcwin\augh.prn

June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Tent Microphone



Rank 1 Eqn 8012 $y=a+b0.5(1+\text{erf}((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9530411029	0.9295616544	11.364233226	60.885657185

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.11114089	5.650980723	-0.01966754	-12.9328648	12.71058305
b	100.8512130	8.030177466	12.55902668	82.63123960	119.0711865
c	81.04412501	1.745490099	46.43058419	77.08371649	85.00453352
d	-8.68160894	2.487675543	-3.48984777	-14.3259901	-3.03722779

Date	Time	File Source
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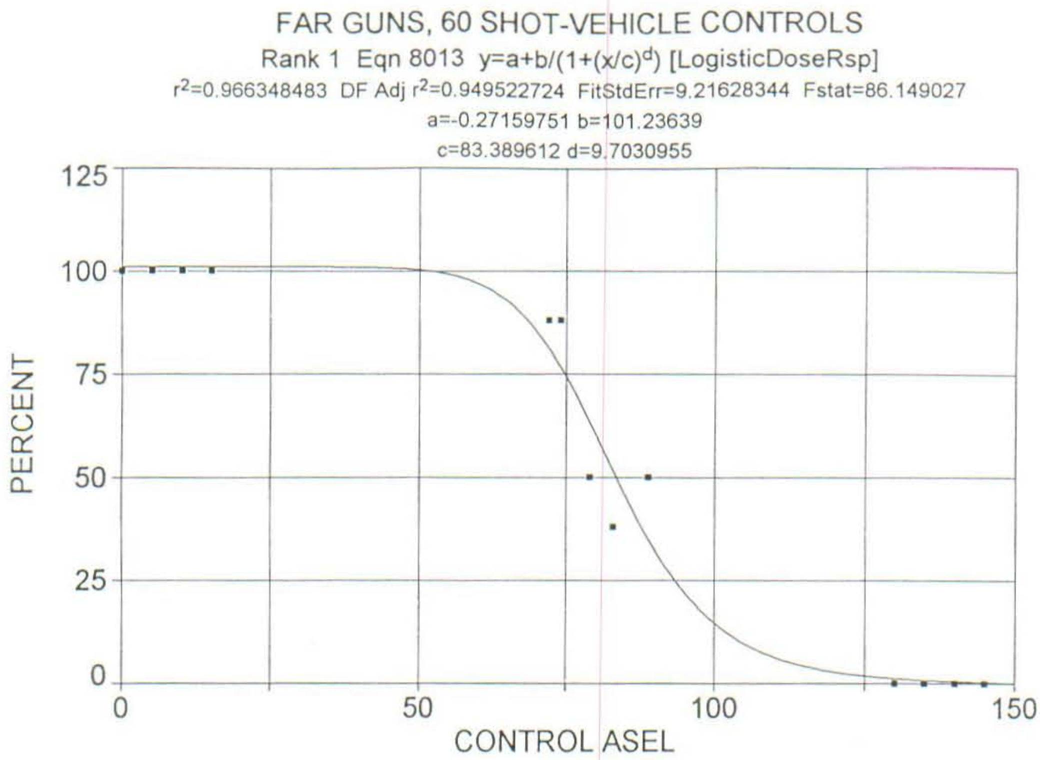
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Tent Microphone



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9663484830	0.9495227245	9.2162834363	86.149027037

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.27159751	5.052078724	-0.05375956	-11.7344500	11.19125502
b	101.2363870	7.013416562	14.43467475	85.32338084	117.1493931
c	83.38961163	2.292140573	36.38067082	78.18888718	88.59033609
d	9.703095491	2.914608404	3.329124927	3.090030226	16.31616076

Date	Time	File Source
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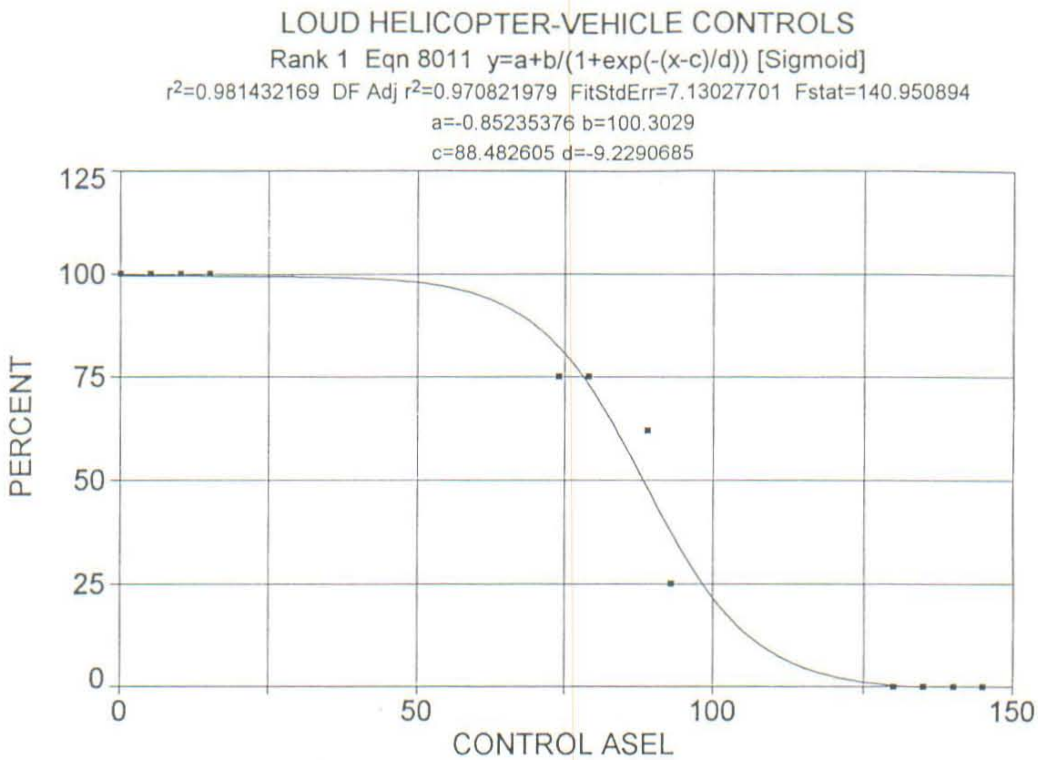
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Tent Microphone



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9814321685	0.9708219791	7.1302770058	140.95089408

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.85235376	3.781604142	-0.22539476	-9.60319379	7.898486273
b	100.3028981	5.324766817	18.83704987	87.98109473	112.6247014
c	88.48260468	1.982799433	44.62509077	83.89429771	93.07091166
d	-9.22906853	2.277847498	-4.05166217	-14.5001330	-3.95800410

Date	Time	File Source
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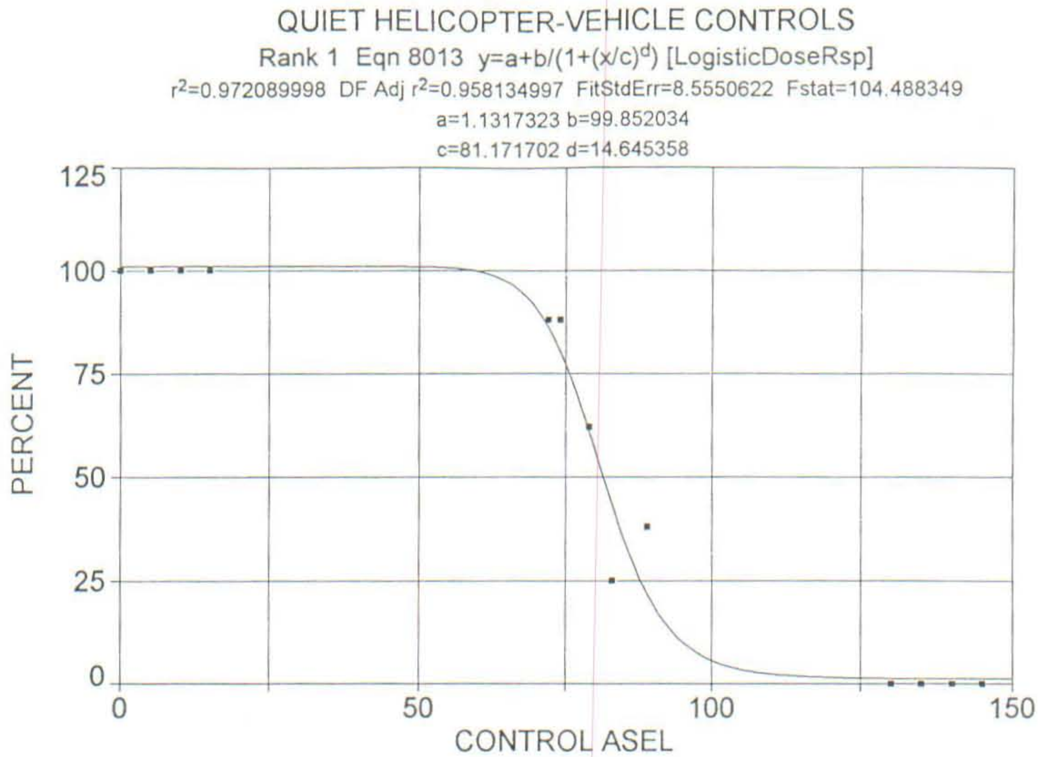
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Tent Microphone



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9720899983	0.9581349975	8.5550621996	104.48834889

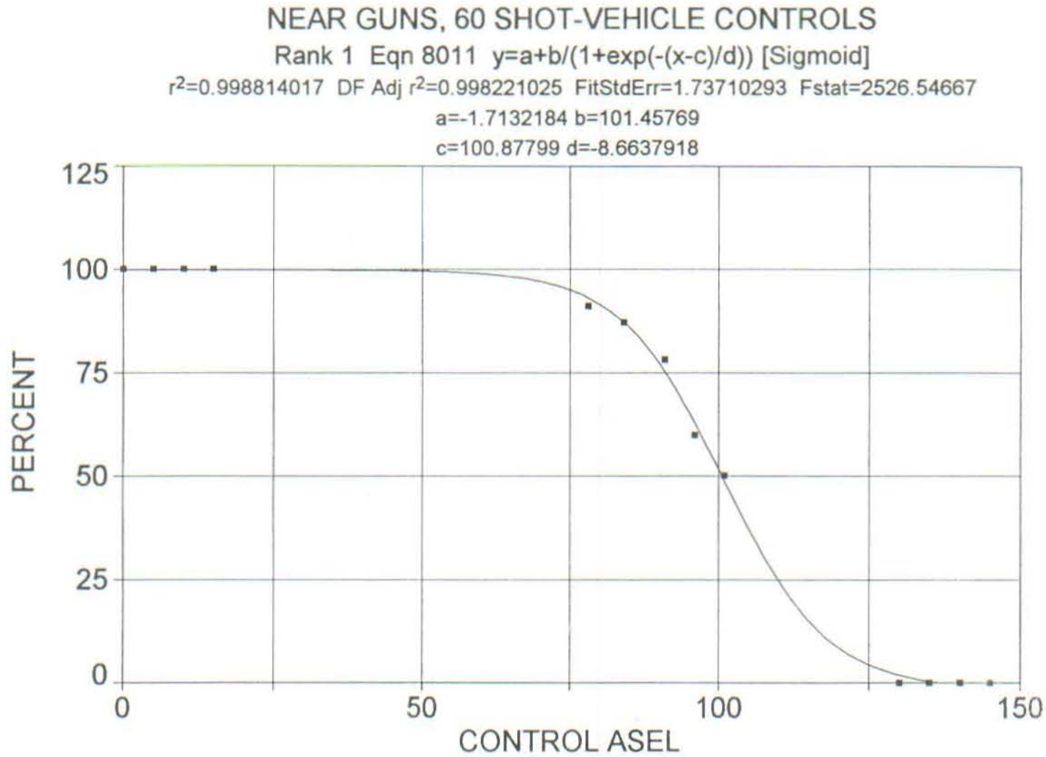
Parm	Value	Std Error	t-value	95% Confidence Limits	
a	1.131732272	4.279779171	0.264437072	-8.57882059	10.84228513
b	99.85203449	6.079609766	16.42408614	86.05777791	113.6462911
c	81.17170178	1.388242381	58.47084264	78.02186613	84.32153743
d	14.64535769	3.423307641	4.278130751	6.878085483	22.41262990

Date	Time	File Source
Sep 1, 1994	4:58:43 PM	c:\tcwin\augh.prn

June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Tent Microphone

Appendix D: Nonblast Sound Transition Curves—Free-field Measurements

This appendix contains the transition curves for the nonblast sound data for subjects indoors and outdoors with the **acoustical measurements made outdoors with the free-field microphone.** Each curve represents an entire test period, so there are two sets of curves for the two test periods that included outdoor subjects.



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9988140167	0.9982210251	1.7371029337	2526.5466670

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.71321844	1.085632010	-1.57808394	-4.17644997	0.750013098
b	101.4576867	1.484513392	68.34406967	98.08941808	104.8259553
c	100.8779860	0.578711673	174.3147593	99.56492518	102.1910468
d	-8.66379177	0.601341776	-14.4074337	-10.0281989	-7.29938466

Date	Time	File Source
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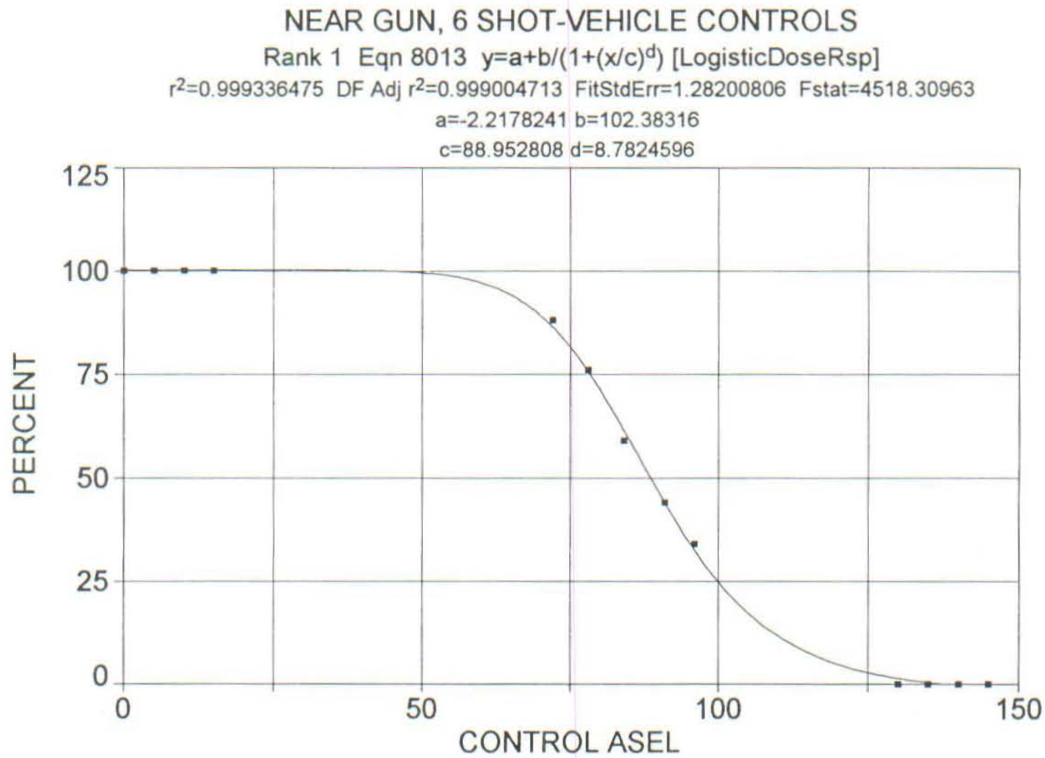

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9993364754	0.9990047132	1.2820080635	4518.3096256

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-2.21782414	0.832008440	-2.66562698	-4.10559956	-0.33004872
b	102.3831589	1.103243877	92.80192803	99.87996710	104.8863506
c	88.95280821	0.385413468	230.7983907	88.07832901	89.82728741
d	8.782459625	0.357978751	24.53346627	7.970228094	9.594691156

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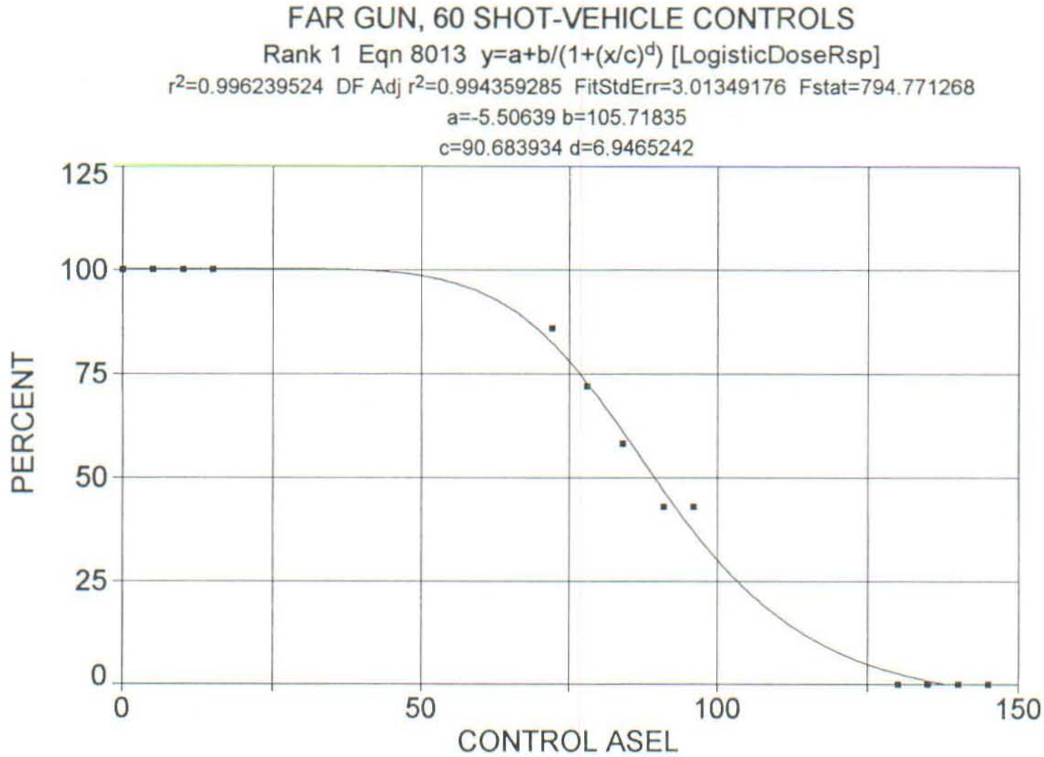

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9962395236	0.9943592855	3.0134917607	794.77126845

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-5.50639002	2.960445727	-1.85998681	-12.2234573	1.210677284
b	105.7183543	3.505268312	30.15984653	97.76511847	113.6715902
c	90.68393388	1.394982754	65.00720788	87.51880474	93.84906302
d	6.946524201	0.761577554	9.121230223	5.218552079	8.674496323

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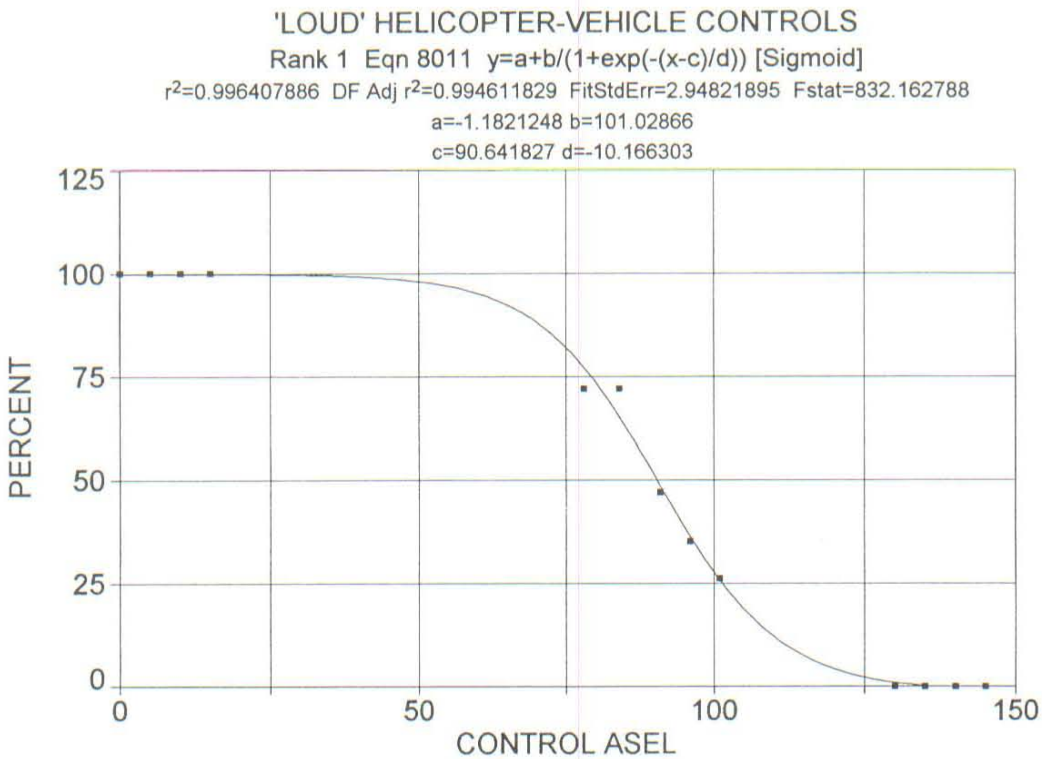

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9964078859	0.9946118289	2.9482189523	832.16278793

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.18212477	1.673421870	-0.70641169	-4.97901496	2.614765411
b	101.0286647	2.293523589	44.04954245	95.82480229	106.2325272
c	90.64182725	0.801194297	113.1333905	88.82396720	92.45968729
d	-10.1663035	0.928001881	-10.9550462	-12.2718821	-8.06072492

Date	Time	File Source
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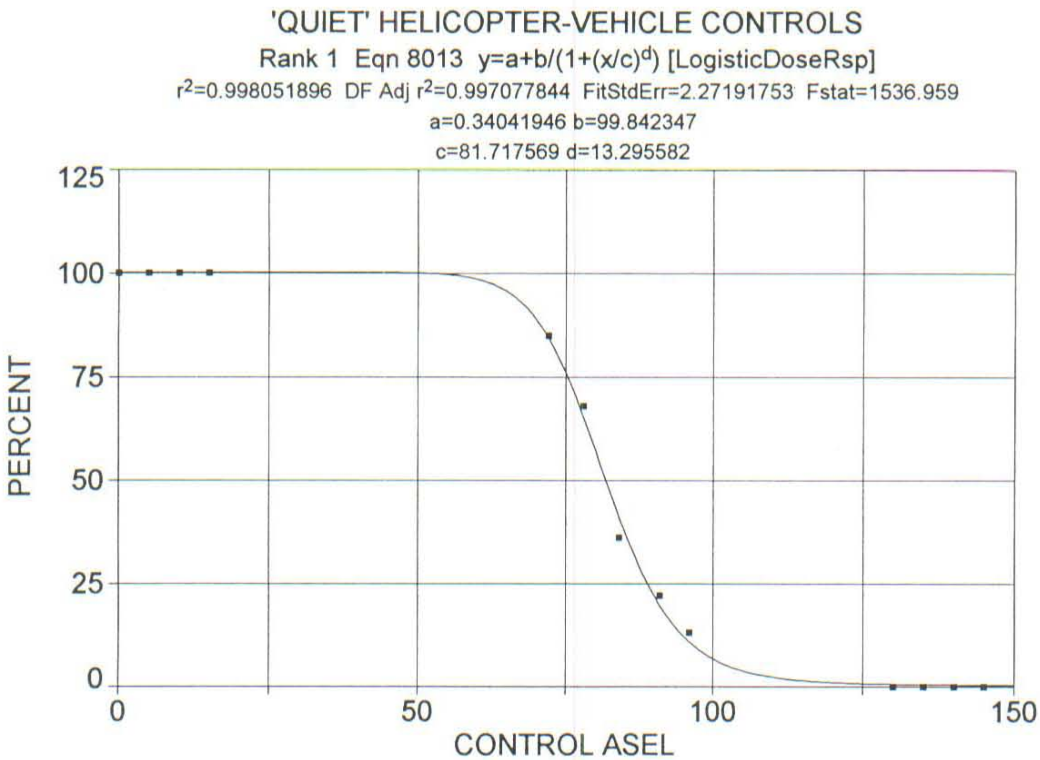

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9980518962	0.9970778443	2.2719175329	1536.9590014

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.340419464	1.133398250	0.300352912	-2.23119070	2.912029630
b	99.84234726	1.621524571	61.57313251	96.16320882	103.5214857
c	81.71756858	0.432839261	188.7942616	80.73548321	82.69965396
d	13.29558238	0.820905441	16.19624101	11.43299897	15.15816579

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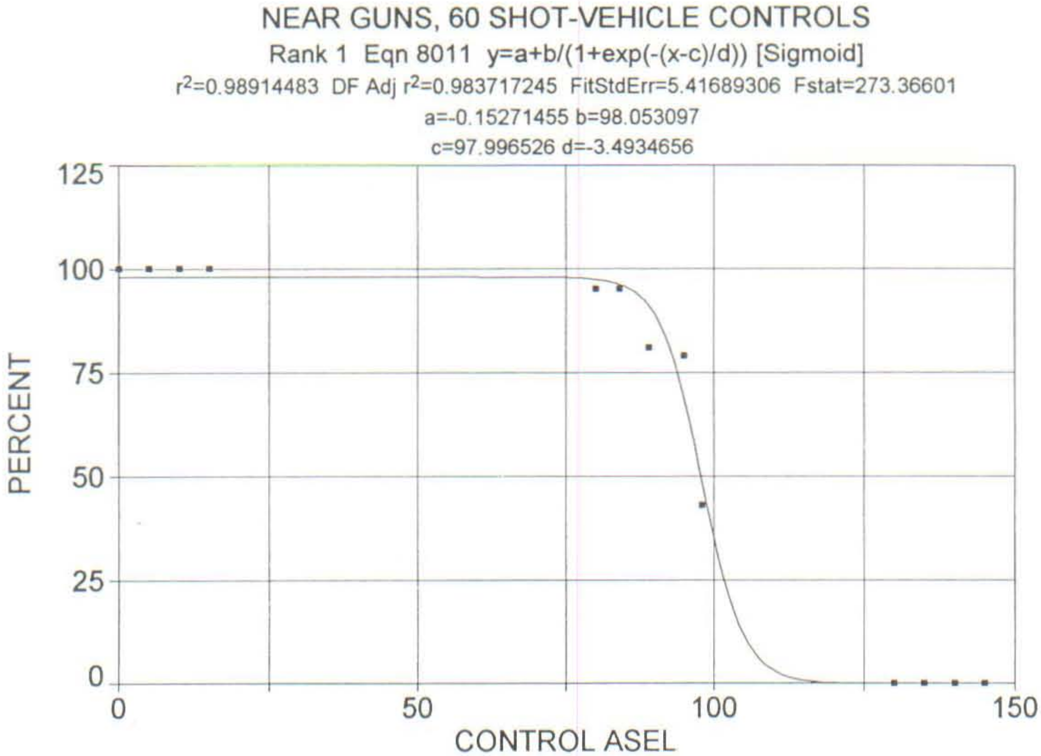

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9891448301	0.9837172451	5.4168930621	273.36600991

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.15271455	2.708674457	-0.05637981	-6.29852849	5.993099395
b	98.05309711	3.601196214	27.22792408	89.88220679	106.2239874
c	97.99652563	0.740936648	132.2603301	96.31538644	99.67766482
d	-3.49346561	1.011360399	-3.45422424	-5.78817948	-1.19875174

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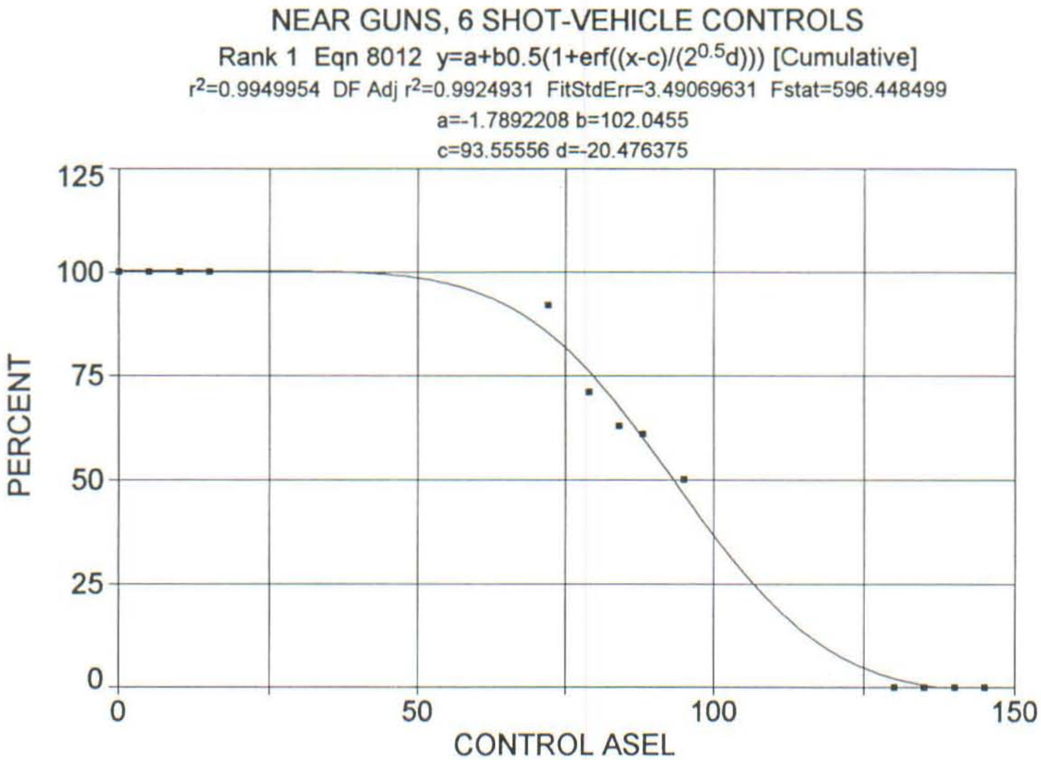

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9949953999	0.9924930999	3.4906963085	596.44849878

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.78922076	2.496256268	-0.71676165	-7.45307104	3.874629514
b	102.0455035	3.182915505	32.06038720	94.82366612	109.2673409
c	93.55556023	1.682449414	55.60675969	89.73818711	97.37293335
d	-20.4763751	2.741014601	-7.47036339	-26.6955669	-14.2571834

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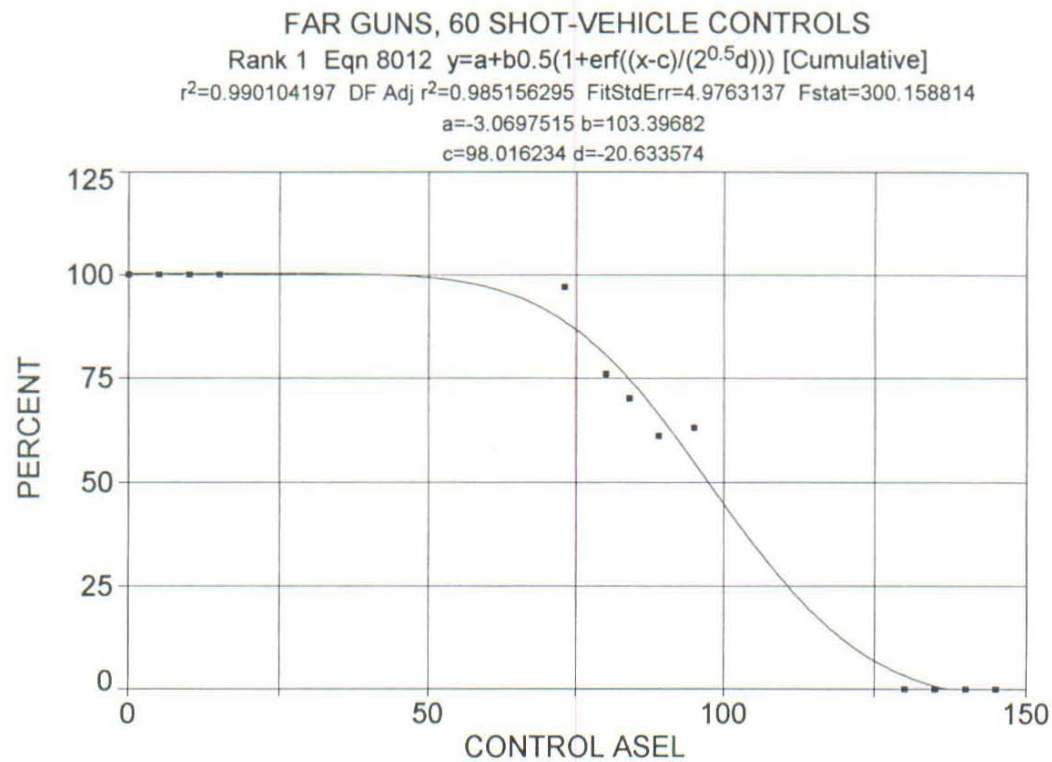

Rank 1 Eqn 8012 $y=a+b0.5(1+\mathrm{erf}((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9901041967	0.9851562950	4.9763136978	300.15881448

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-3.06975145	4.591971097	-0.66850409	-13.4886484	7.349145482
b	103.3968191	5.492075865	18.82654603	90.93564038	115.8579978
c	98.01623376	3.094740315	31.67187673	90.99446039	105.0380071
d	-20.6335738	4.125637939	-5.00130504	-29.9943898	-11.2727578

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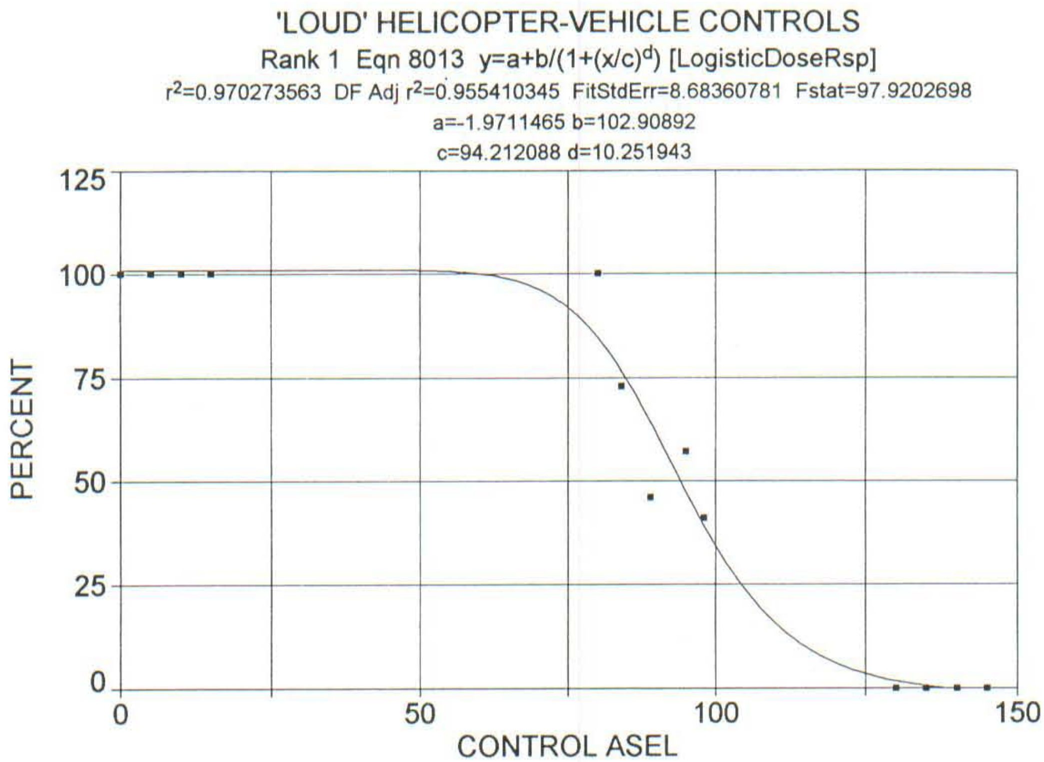

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9702735634	0.9554103451	8.6836078052	97.920269789

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.97114654	5.639728021	-0.34951092	-14.7673388	10.82504572
b	102.9089225	7.478673830	13.76031698	85.94027653	119.8775685
c	94.21208792	2.420447162	38.92342266	88.72024379	99.70393205
d	10.25194331	3.005608653	3.410937517	3.432404142	17.07148249

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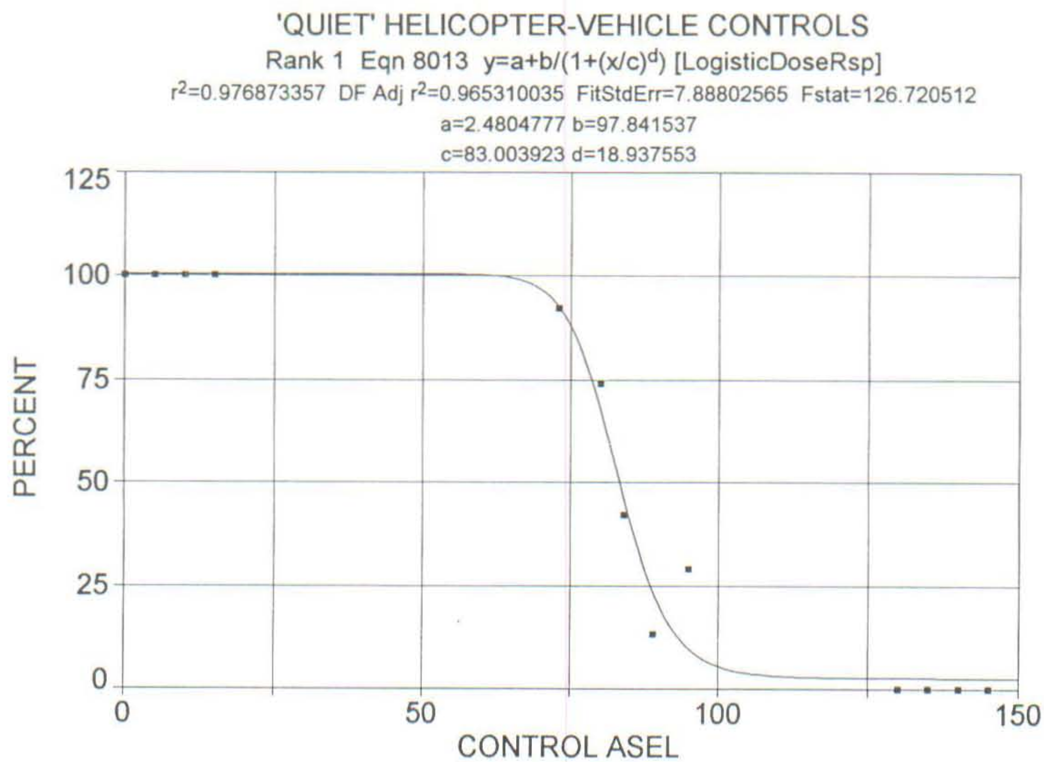

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9768733568	0.9653100353	7.8880256476	126.72051235

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	2.480477685	3.823148055	0.648805029	-6.19400756	11.15496293
b	97.84153717	5.519653823	17.72602781	85.31778581	110.3652885
c	83.00392282	1.111701140	74.66388209	80.48154205	85.52630359
d	18.93755279	4.559122884	4.153771082	8.593186415	29.28191917

Date	Time	File Source
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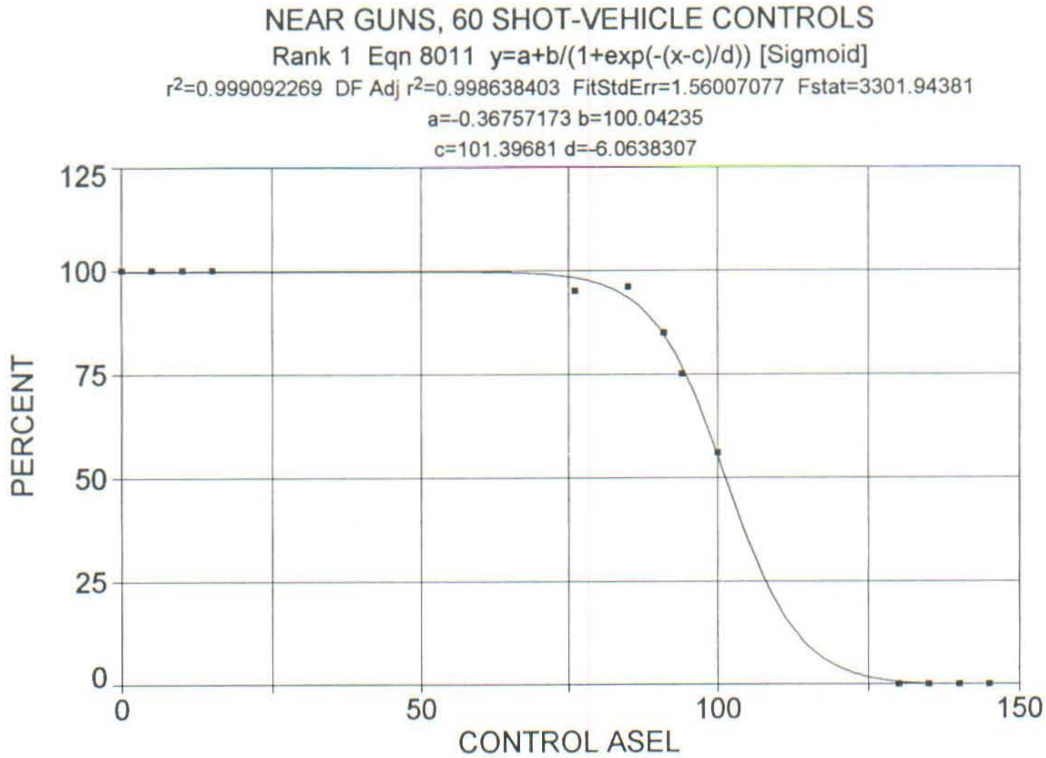

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9990922690	0.9986384035	1.5600707716	3301.9438088

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.36757173	0.811908208	-0.45272572	-2.20974098	1.474597518
b	100.0423521	1.127053151	88.76453786	97.48513860	102.5995657
c	101.3968106	0.453692106	223.4925607	100.3674115	102.4262098
d	-6.06383068	0.445530510	-13.6103601	-7.07471170	-5.05294965

Date	Time	File Source
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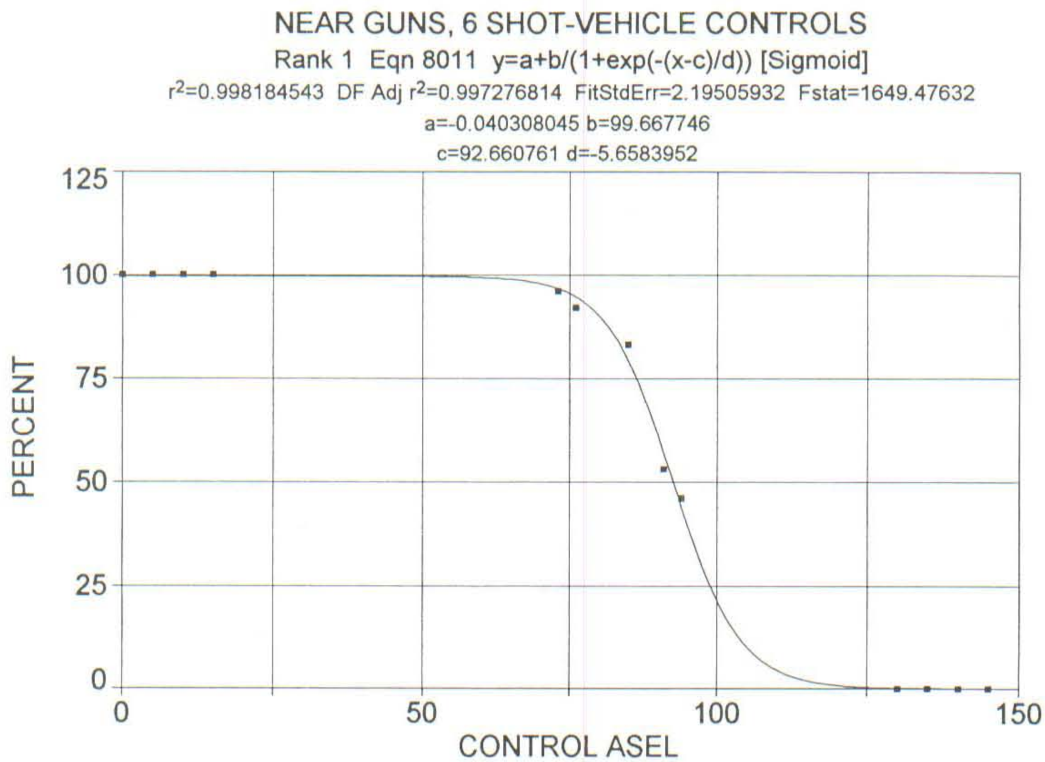

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9981845428	0.9972768142	2.1950593202	1649.4763212

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.04030805	1.102069191	-0.03657488	-2.54083452	2.460218432
b	99.66774644	1.522585218	65.45955211	96.21309524	103.1223976
c	92.66076098	0.391833659	236.4798402	91.77171477	93.54980719
d	-5.65839521	0.520205430	-10.8772321	-6.83870899	-4.47808143

Date	Time	File Source
May 12, 1994	3:56:03 PM	c:\tcwin\ngf.prn

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9973639119	0.9960458679	2.5489897494	1135.0499932

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.09960074	1.554613479	-0.70731455	-4.62692207	2.427720595
b	101.1811321	2.102179316	48.13154202	96.41141791	105.9508463
c	93.66718102	1.021847341	91.66455423	91.34867293	95.98568911
d	-18.5161690	1.729089428	-10.7086243	-22.4393654	-14.5929726

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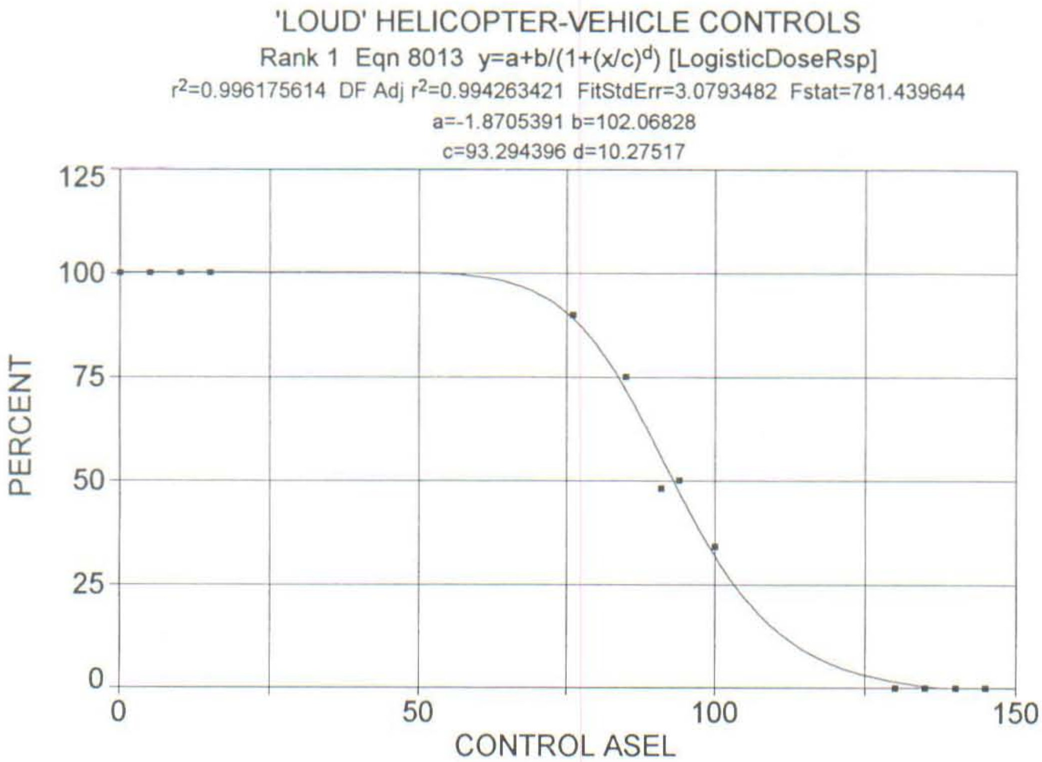

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9961756140	0.9942634210	3.0793481994	781.43964391

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.87053910	1.949944134	-0.95927830	-6.29484111	2.553762911
b	102.0682778	2.608995894	39.12167051	96.14862827	107.9879272
c	93.29439634	0.794992031	117.3526183	91.49060885	95.09818384
d	10.27516982	1.083509522	9.483229832	7.816754080	12.73358557

Date	Time	File Source
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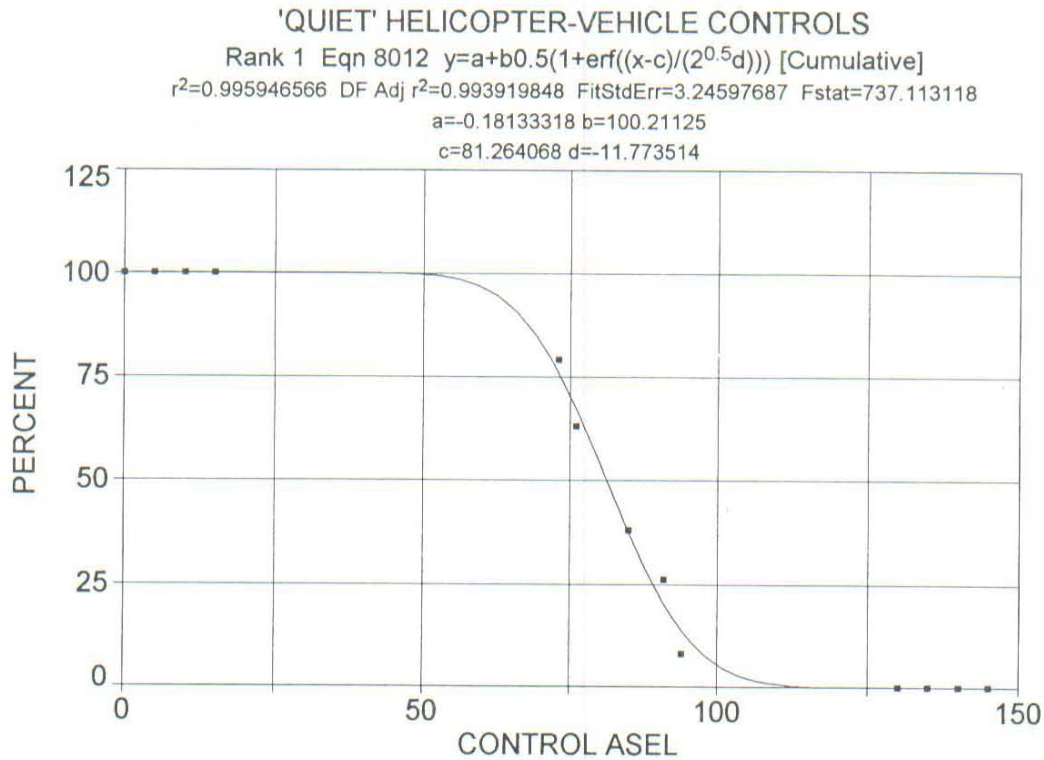

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9959465656	0.9939198483	3.2459768689	737.11311750

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.18133318	1.612827002	-0.11243188	-3.84073738	3.478071018
b	100.2112533	2.292956547	43.70394784	95.00867749	105.4138292
c	81.26406800	0.681055080	119.3208456	79.71879636	82.80933963
d	-11.7735135	0.923939127	-12.7427373	-13.8698740	-9.67715310

Date	Time	File Source
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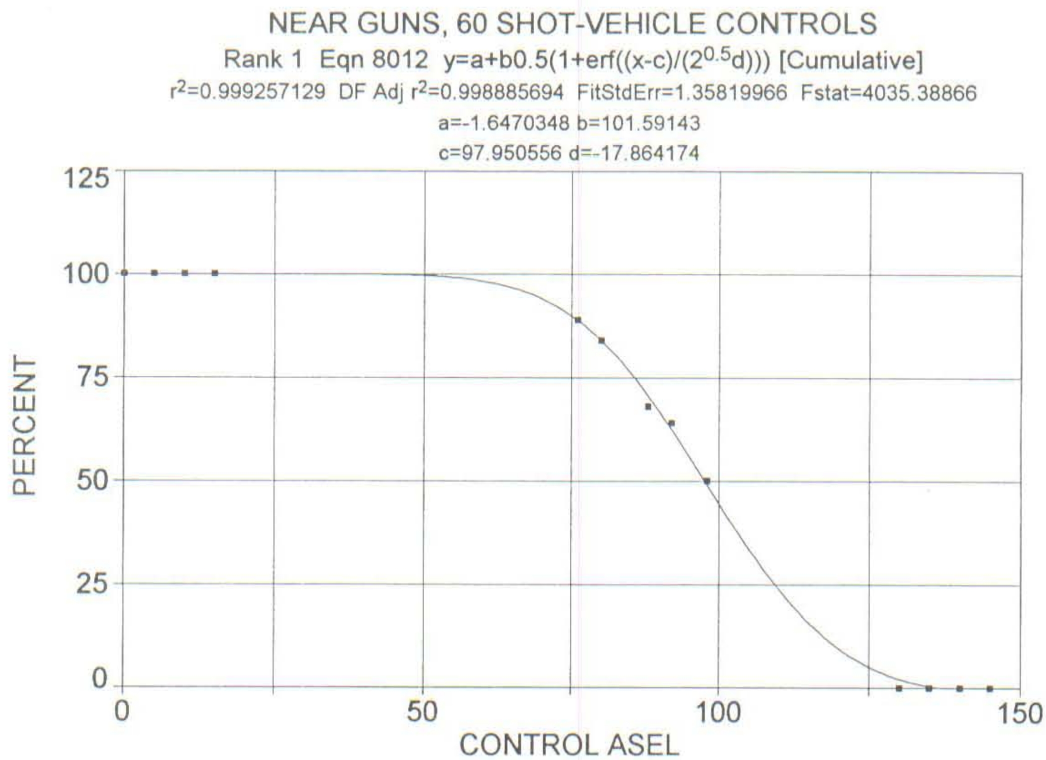

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9992571295	0.9988856942	1.3581996564	4035.3886577

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.64703480	0.918101037	-1.79395811	-3.73014898	0.436079369
b	101.5914326	1.203215271	84.43329724	98.86141198	104.3214533
c	97.95055569	0.587650410	166.6816767	96.61721344	99.28389793
d	-17.8641744	0.897891238	-19.8956996	-19.9014338	-15.8269150

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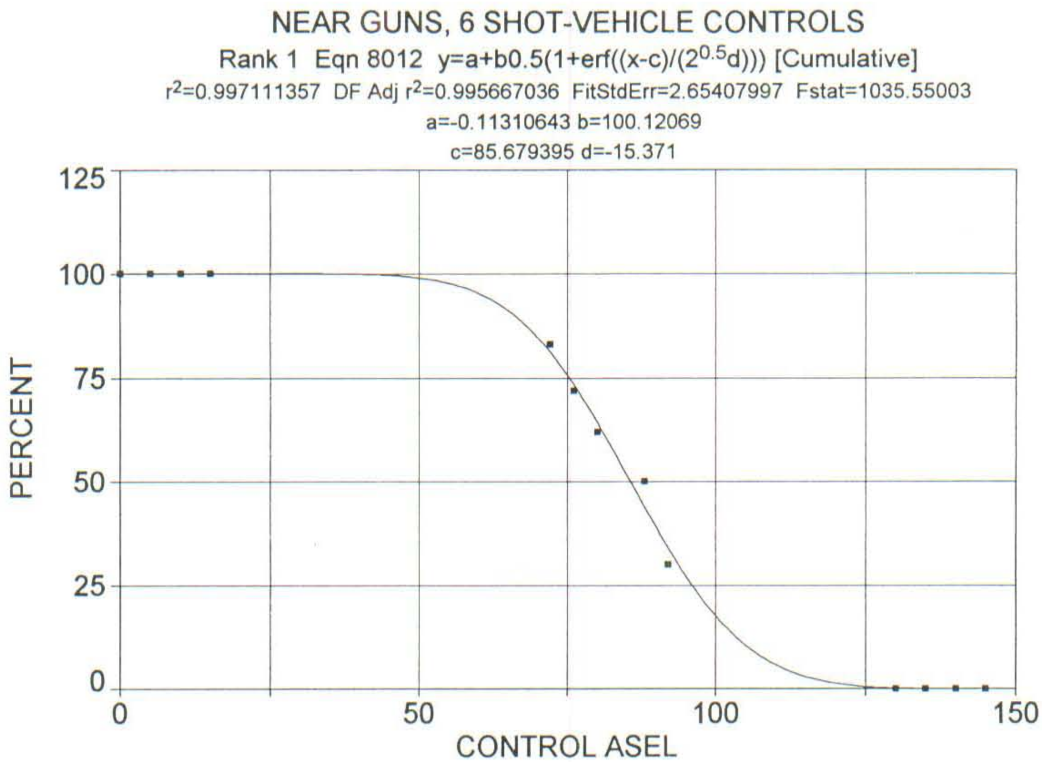

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9971113573	0.9956670359	2.6540799674	1035.5500311

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.11310643	1.341445430	-0.08431683	-3.15676271	2.930549850
b	100.1206854	1.894115270	52.85881329	95.82305562	104.4183152
c	85.67939478	0.688174950	124.5023446	84.11796860	87.24082096
d	-15.3709999	1.202078315	-12.7870204	-18.0984409	-12.6435590

Date	Time	File Source
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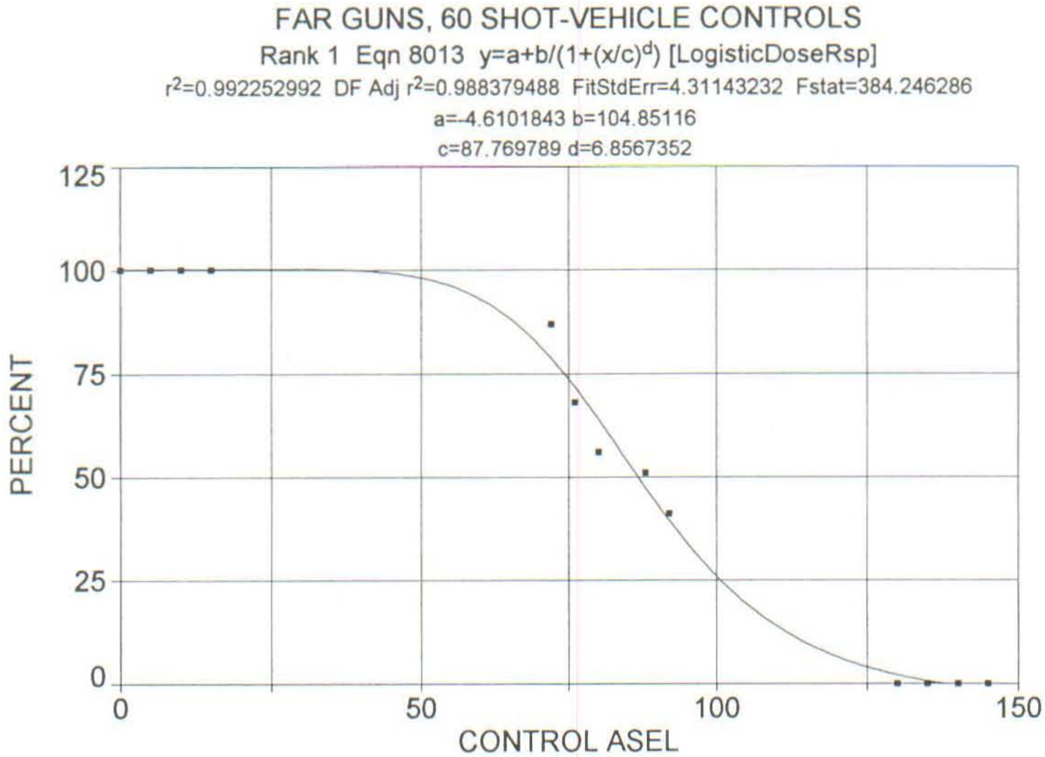
November 1992 Test Period
Outdoor Measured Acoustical Data



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9922529922	0.9883794883	4.3114323181	384.24628580

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-4.61018426	3.950284962	-1.16705106	-13.5731352	4.352766728
b	104.8511620	4.719991156	22.21427085	94.14179549	115.5605285
c	87.76978914	1.966192232	44.63947509	83.30862121	92.23095708
d	6.856735238	1.117422233	6.136207994	4.321373663	9.392096813

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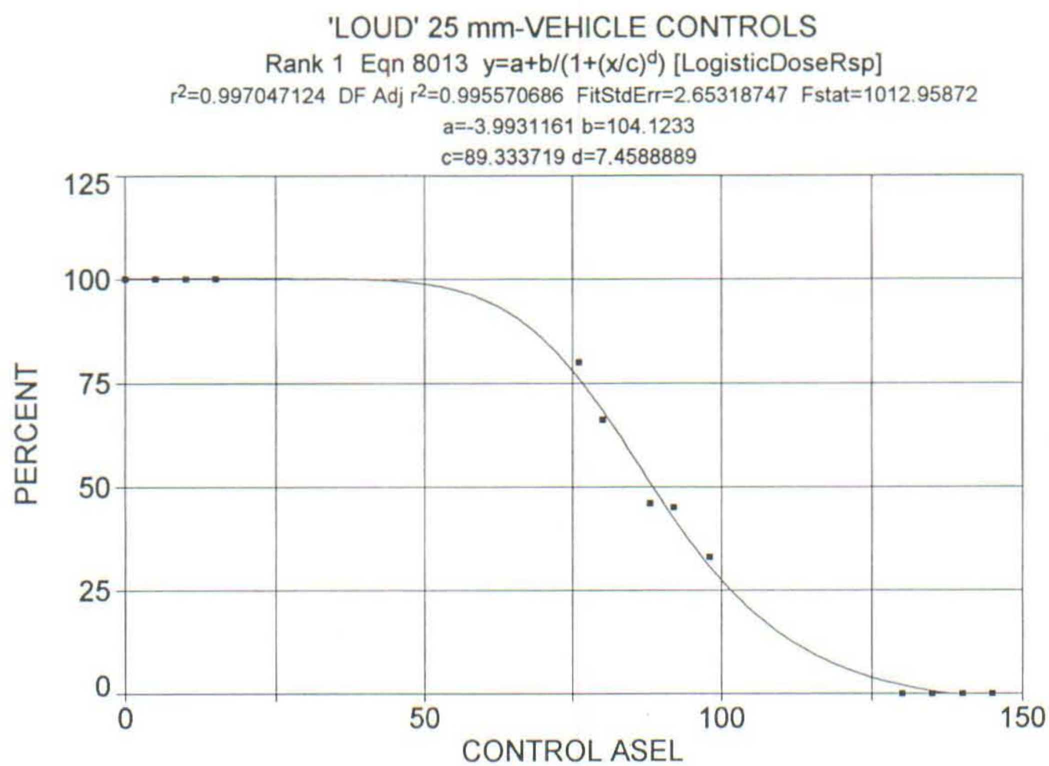

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9970471241	0.9955706862	2.6531874673	1012.9587172

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-3.99311609	2.192689108	-1.82110454	-8.96819135	0.981959178
b	104.1232969	2.671747961	38.97197582	98.06126693	110.1853270
c	89.33371873	0.961212991	92.93852615	87.15278621	91.51465125
d	7.458888919	0.699883739	10.65732564	5.870896227	9.046881610

Date	Time	File Source
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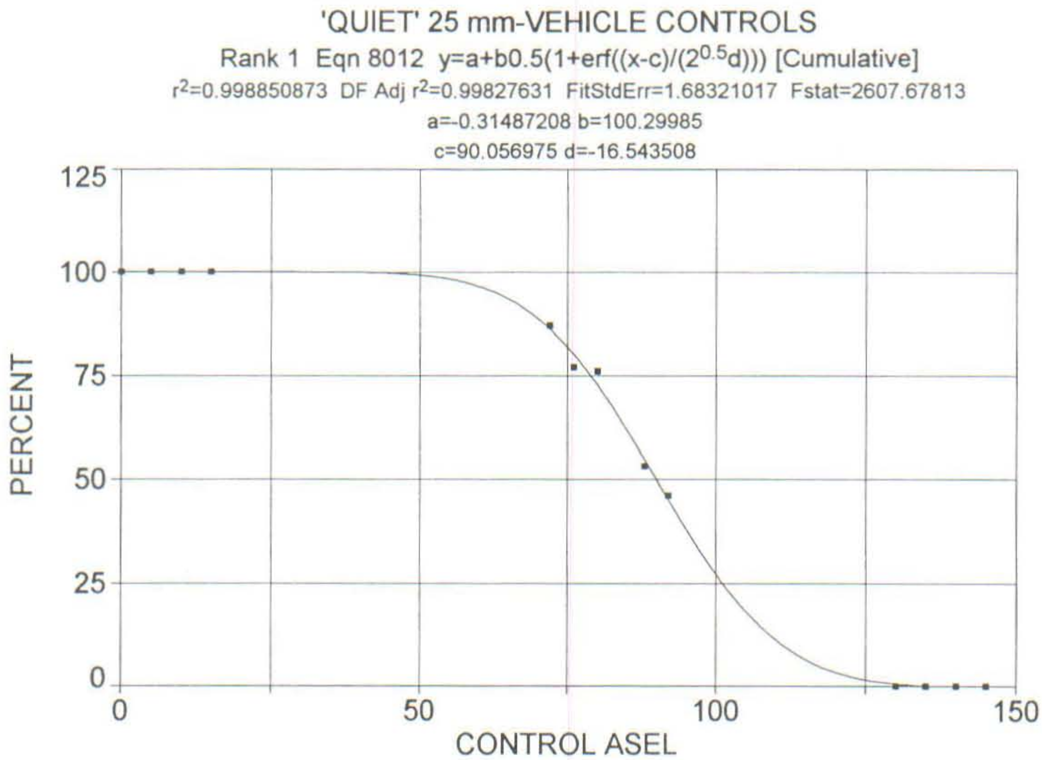

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9988508733	0.9982763099	1.6832101734	2607.6781277

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.31487208	0.881841763	-0.35706188	-2.31571621	1.685972057
b	100.2998502	1.241007023	80.82133969	97.48408241	103.1156180
c	90.05697500	0.559809516	160.8707470	88.78680202	91.32714799
d	-16.5435075	0.953291307	-17.3540946	-18.7064663	-14.3805488

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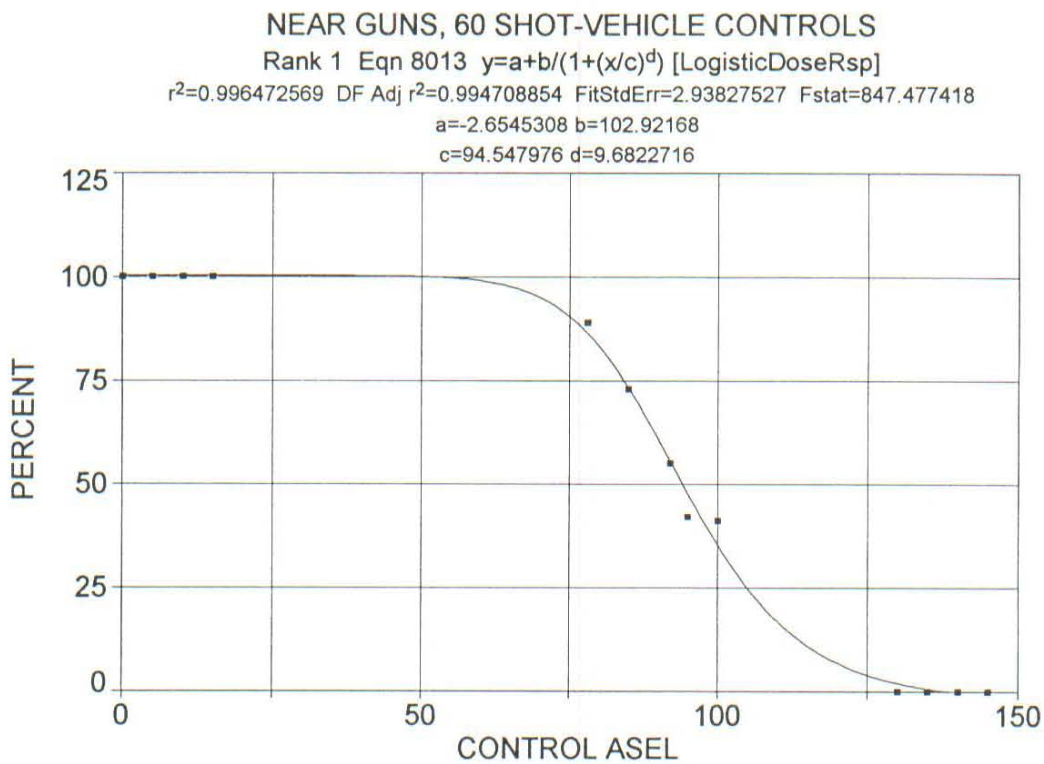

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9964725695	0.9947088542	2.9382752714	847.47741775

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-2.65453078	2.058128495	-1.28977894	-7.32429638	2.015234816
b	102.9216847	2.674179726	38.48719803	96.85413714	108.9892322
c	94.54797609	0.849235065	111.3331043	92.62111452	96.47483765
d	9.682271648	0.990328833	9.776824950	7.435277094	11.92926620

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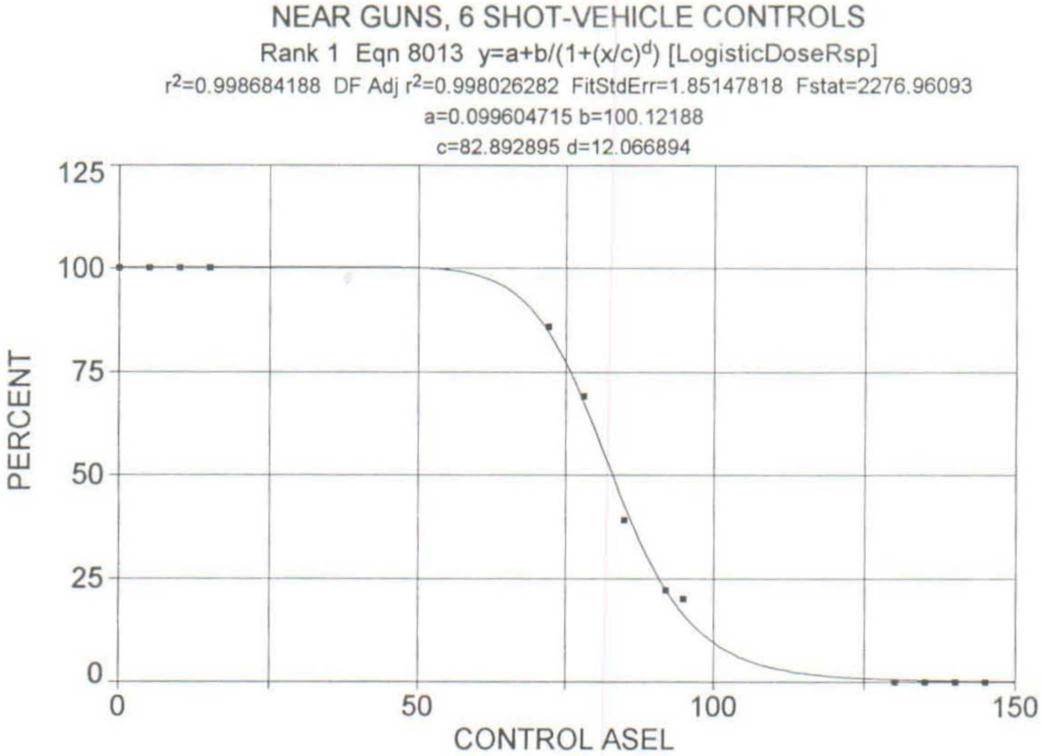

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9986841880	0.9980262820	1.8514781845	2276.9609329

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.099604715	0.948218170	0.105044090	-2.05184336	2.251052792
b	100.1218793	1.339857997	74.72573928	97.08182483	103.1619338
c	82.89289498	0.385701873	214.9144217	82.01776141	83.76802855
d	12.06689450	0.589364435	20.47441917	10.72966324	13.40412576

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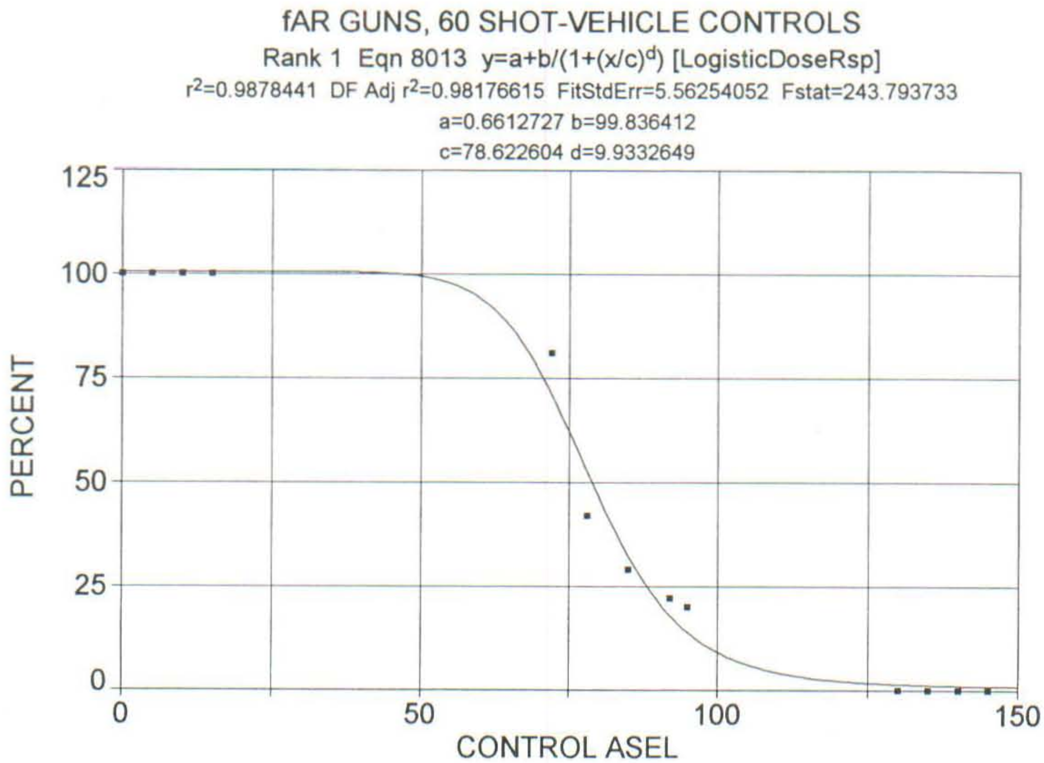
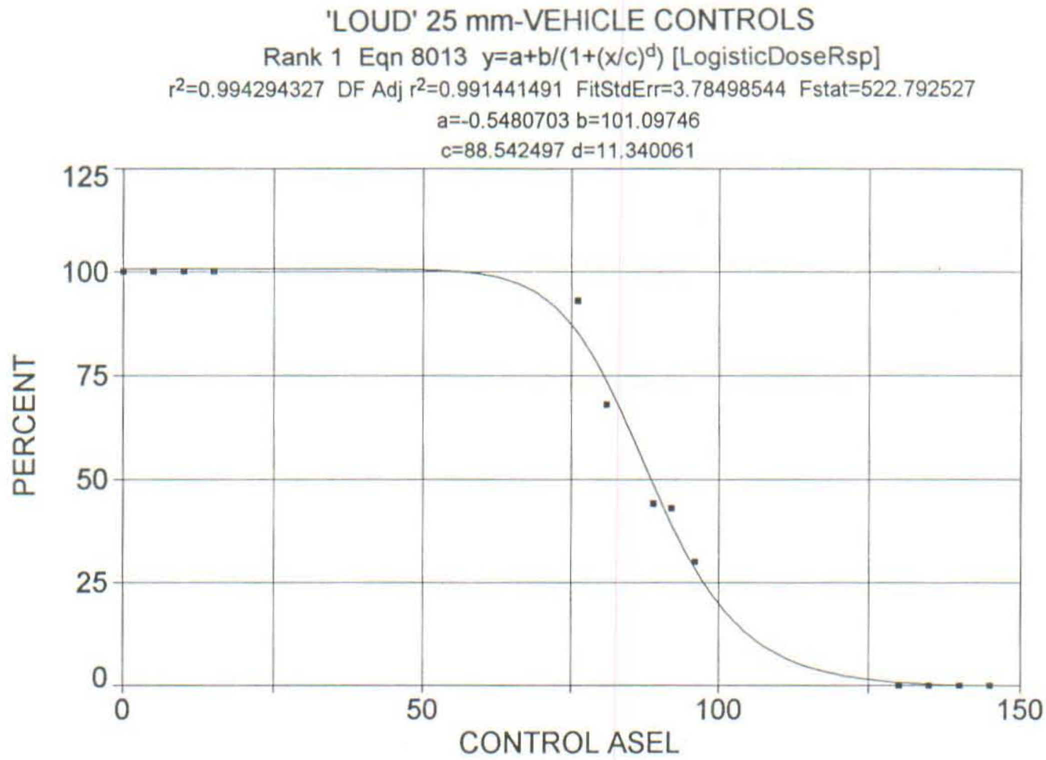


Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9878440997	0.9817661496	5.5625405235	243.79373289

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.661272700	2.934705404	0.225328477	-5.99739141	7.319936808
b	99.83641198	4.084164798	24.44475600	90.56969597	109.1031280
c	78.62260432	1.300087262	60.47486705	75.67278715	81.57242149
d	9.933264919	1.633166910	6.082210494	6.227710735	13.63881910

Date	Time	File Source
May 17, 1994	2:34:27 PM	c:\tcwin\noise.prn



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9942943274	0.9914414911	3.7849854442	522.79252650

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.54807030	2.041556784	-0.26845705	-5.18023572	4.084095114
b	101.0974610	2.851188182	35.45801068	94.62829228	107.5666297
c	88.54249677	0.806415443	109.7976205	86.71279026	90.37220327
d	11.34006095	1.268175664	8.942026940	8.462649211	14.21747268

Date	Time	File Source
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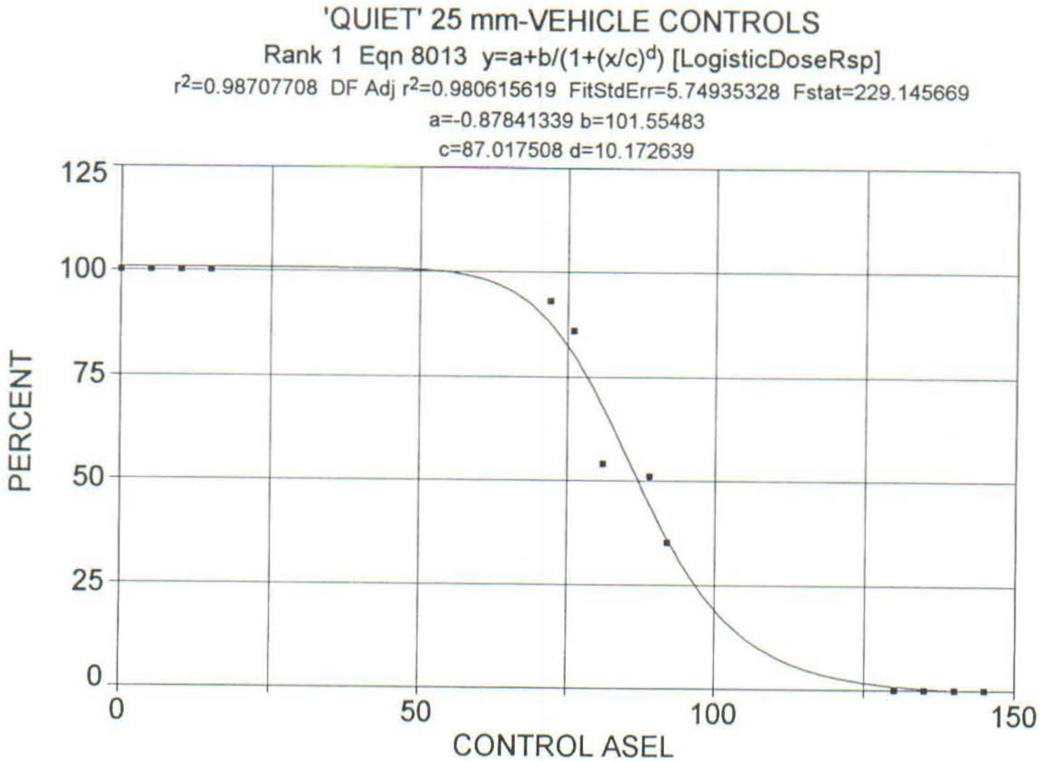

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9870770796	0.9806156194	5.7493532810	229.14566885

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.87841339	3.192812806	-0.27512211	-8.12270715	6.365880364
b	101.5548272	4.443558346	22.85439264	91.47266954	111.6369848
c	87.01750840	1.429638396	60.86679586	83.77374776	90.26126903
d	10.17263858	1.776520220	5.726159752	6.141824650	14.20345251

Date	Time	File Source
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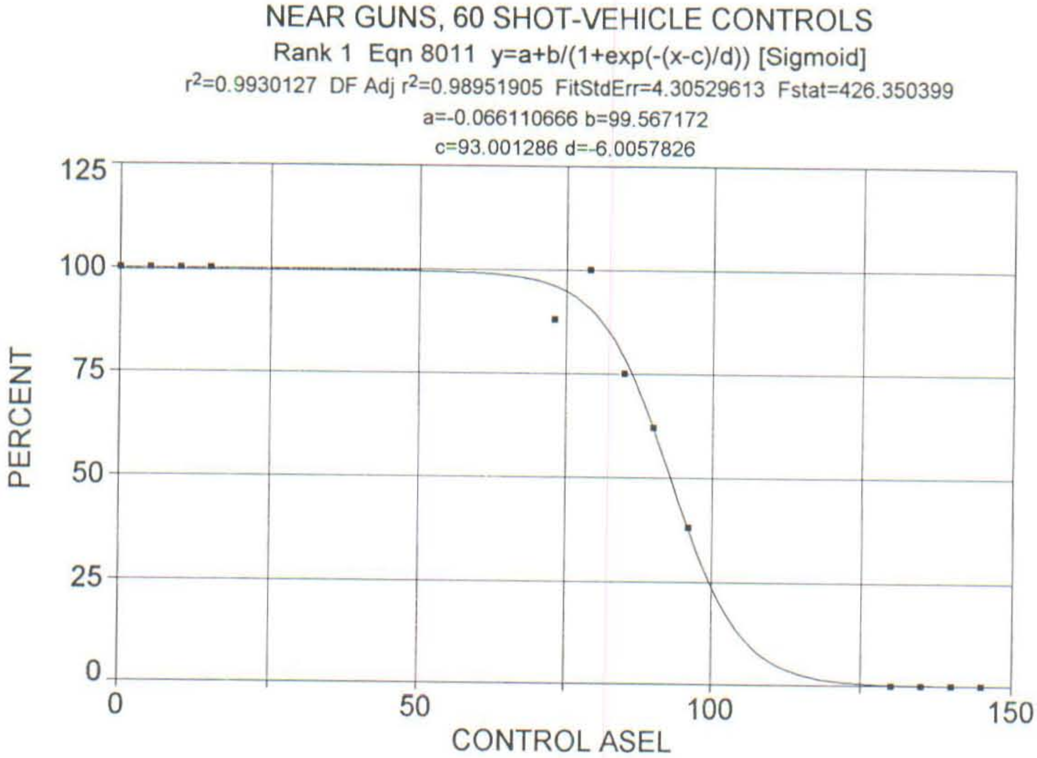


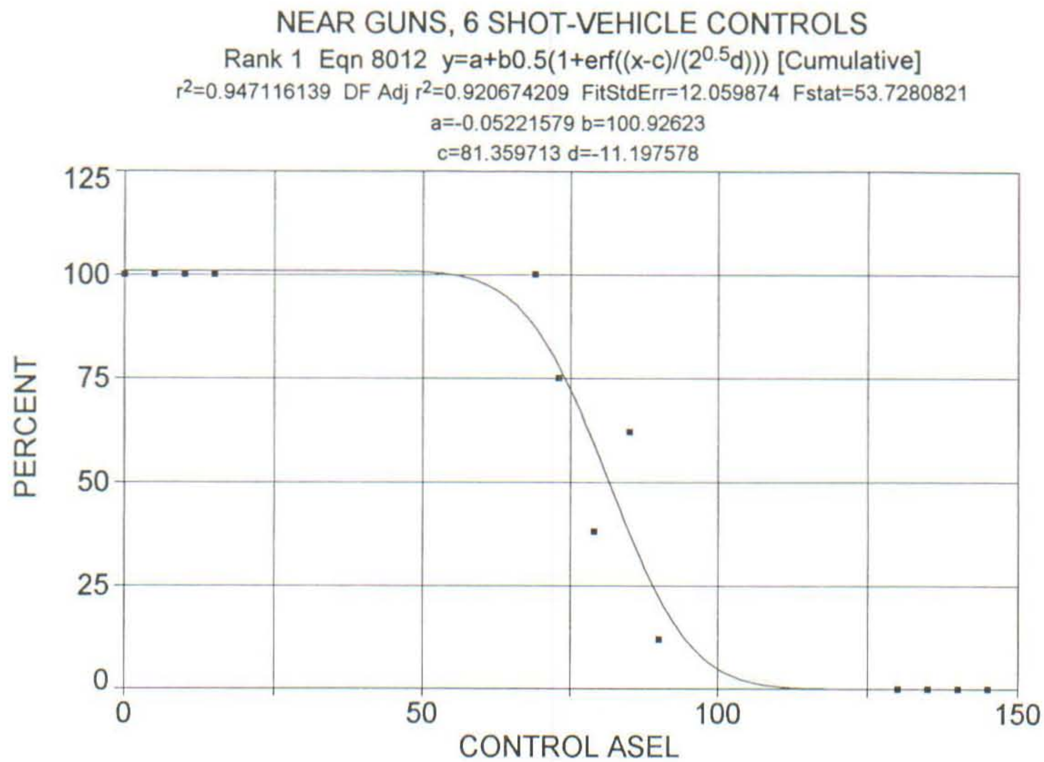
Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9930127001	0.9895190502	4.3052961260	426.35039917

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.06611067	2.167949774	-0.03049456	-4.98505392	4.852832588
b	99.56717221	3.009795679	33.08104032	92.73813293	106.3962115
c	93.00128619	0.843048768	110.3154287	91.08846095	94.91411143
d	-6.00578263	0.894685205	-6.71273270	-8.03576774	-3.97579753

Date	Time	File Source
Sep 21, 1994	11:30:55 AM	c:\tcwin\augl.prn

June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone



Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9471161391	0.9206742087	12.059874019	53.728082084

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.05221579	6.012349162	-0.00868476	-13.6938622	13.58943067
b	100.9262315	8.517885593	11.84874233	81.59967869	120.2527844
c	81.35971260	2.338612048	34.78974321	76.05354725	86.66587794
d	-11.1975783	3.389627698	-3.30348324	-18.8884328	-3.50672377

Date	Time	File Source
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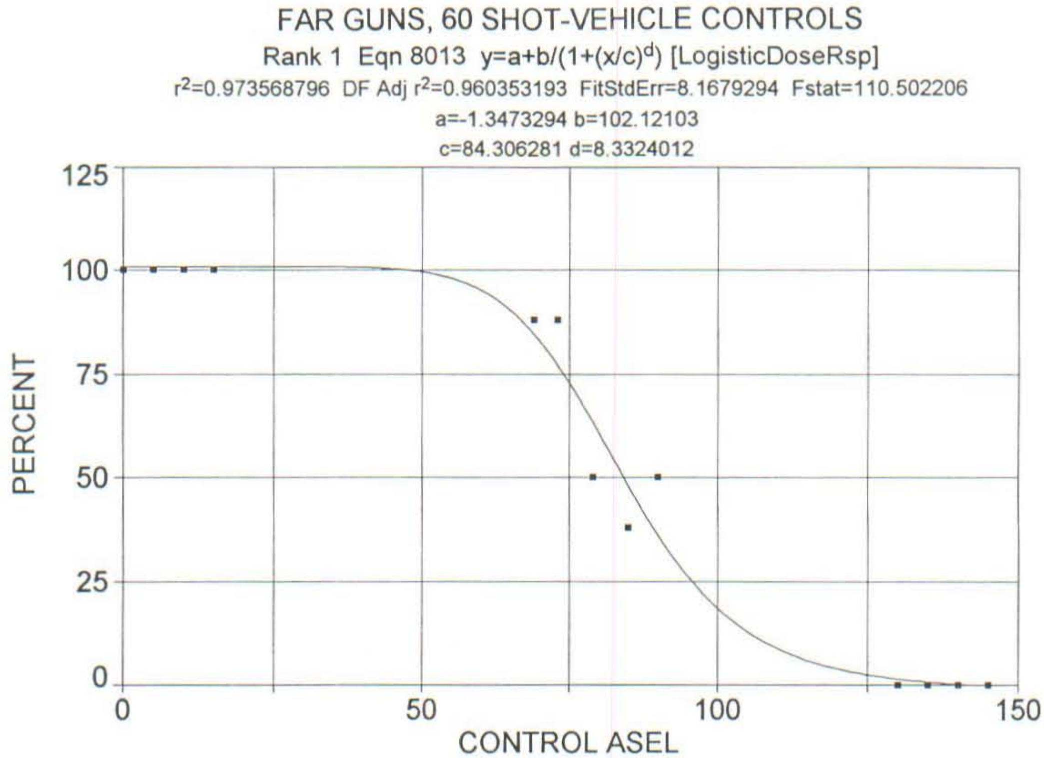
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9735687956	0.9603531934	8.1679294028	110.50220587

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.34732936	5.015212377	-0.26864852	-12.7265344	10.03187573
b	102.1210258	6.760799961	15.10487316	86.78119105	117.4608606
c	84.30628101	2.454514786	34.34743254	78.73713956	89.87542246
d	8.332401198	2.233810329	3.730129228	3.264024440	13.40077796

Date	Time	File Source
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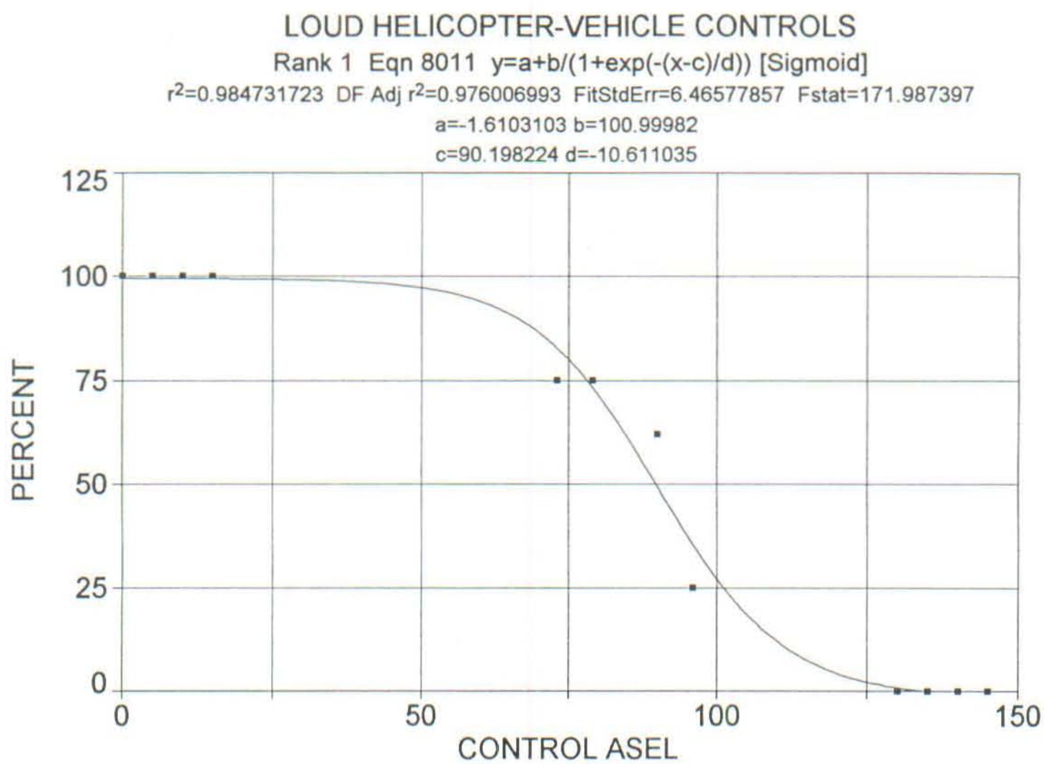
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9847317228	0.9760069929	6.4657785743	171.98739710

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.61031027	3.746190030	-0.42985280	-10.2792001	7.058579560
b	100.9998244	5.170365257	19.53436930	89.03531472	112.9643340
c	90.19822399	2.143079555	42.08813610	85.23902000	95.15742798
d	-10.6110348	2.371035632	-4.47527428	-16.0977417	-5.12432789

Date	Time	File Source
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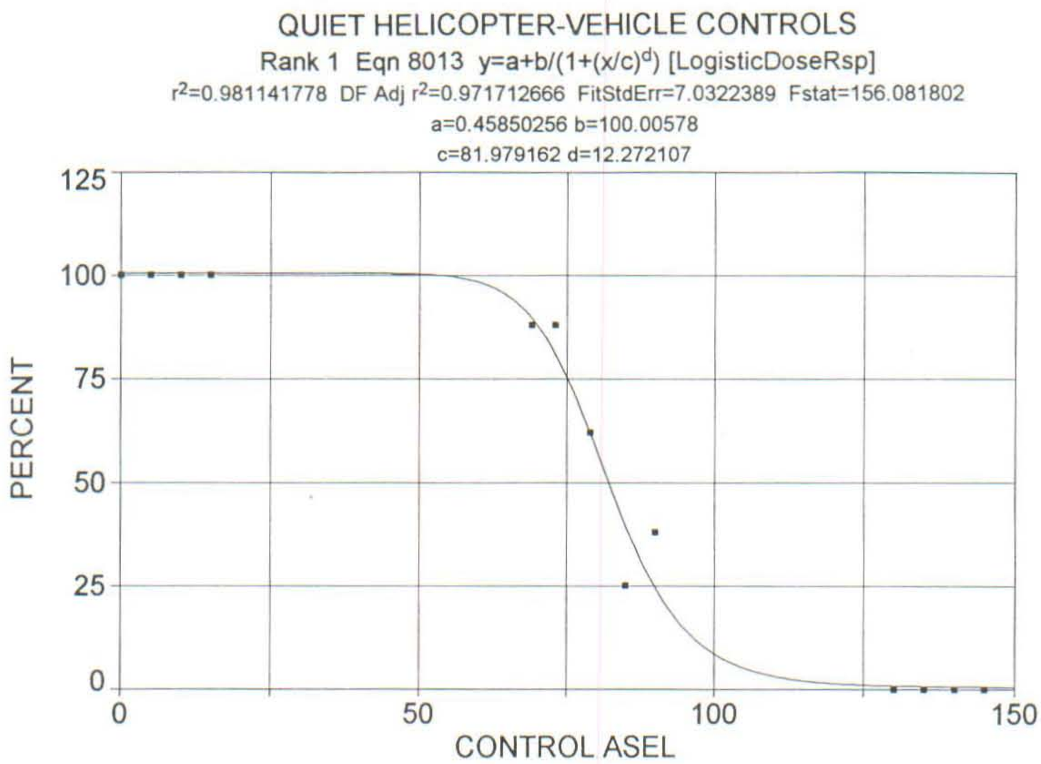
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9811417776	0.9717126664	7.0322389049	156.08180193

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.458502561	3.578236620	0.128136457	-7.66029387	8.577298990
b	100.0057811	5.056718914	19.77681235	88.53240024	111.4791619
c	81.97916242	1.383846987	59.24004835	78.83929964	85.11902520
d	12.27210728	2.390737437	5.133189070	6.847672672	17.69654189

Date	Time	File Source
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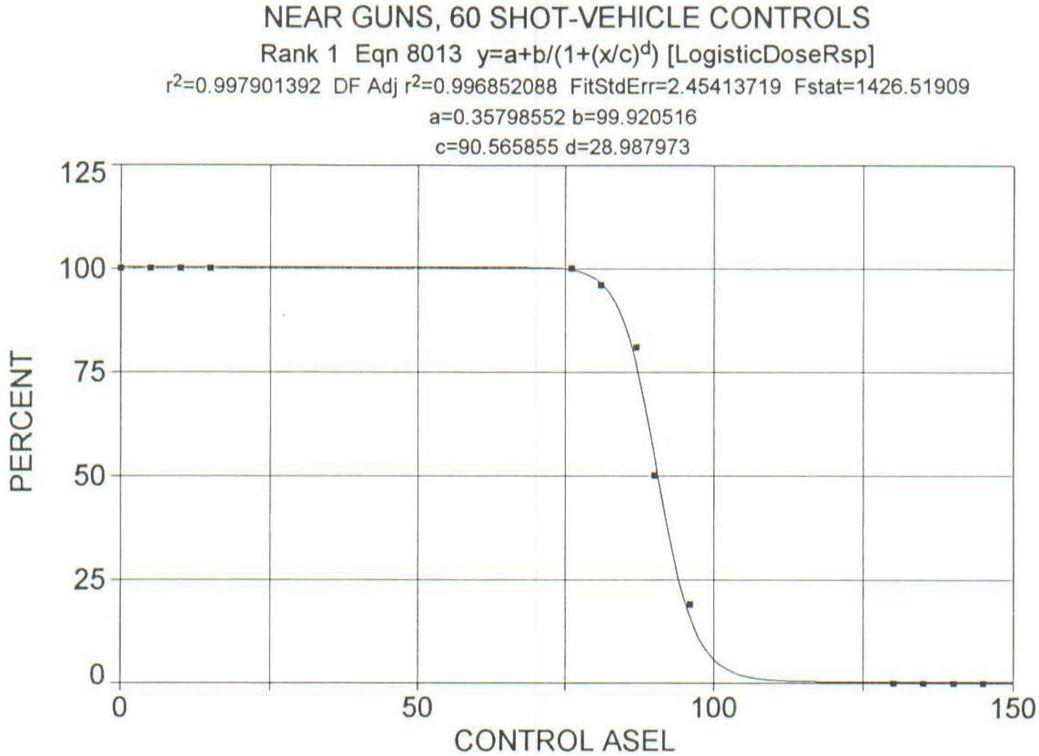
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9979013921	0.9968520882	2.4541371862	1426.5190879

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.357985524	1.218530447	0.293784636	-2.40678430	3.122755352
b	99.92051607	1.644453434	60.76214382	96.18935346	103.6516787
c	90.56585455	0.268055637	337.8621528	89.95765297	91.17405612
d	28.98797345	2.362905504	12.26793598	23.62668776	34.34925913

Date	Time	File Source
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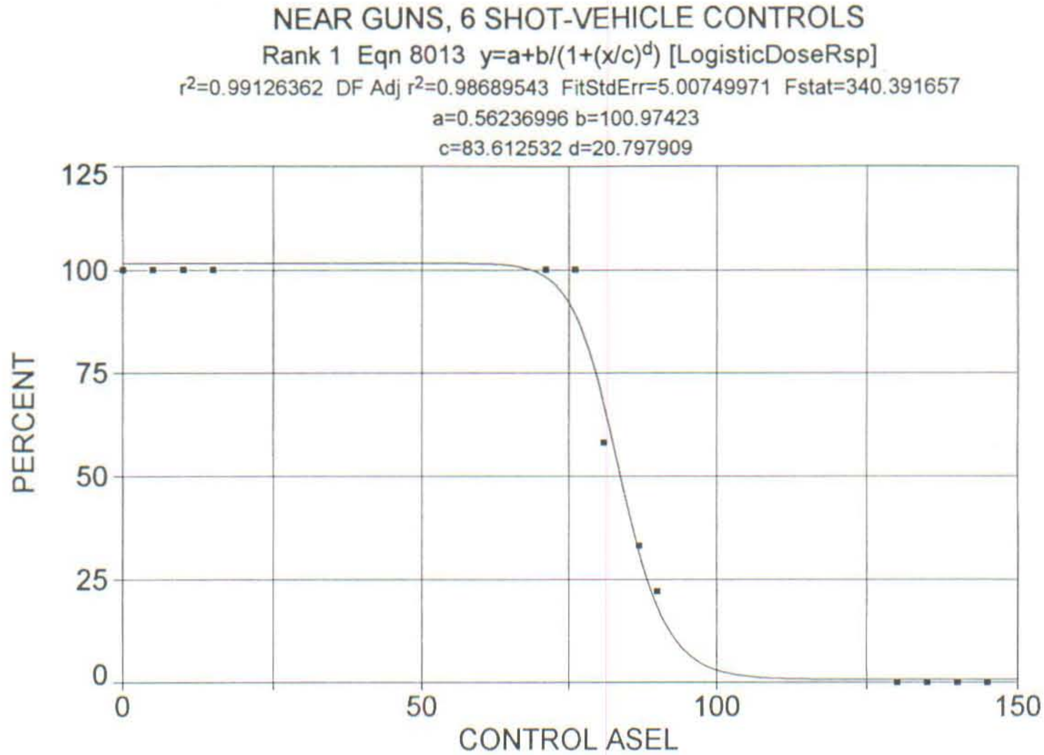
August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9912636200	0.9868954300	5.0074997085	340.39165660

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.562369964	2.490027138	0.225848930	-5.08734681	6.212086733
b	100.9742319	3.463499178	29.15382009	93.11576760	108.8326962
c	83.61253197	0.673128000	124.2149071	82.08524638	85.13981755
d	20.79790897	2.860380826	7.271027963	14.30788271	27.28793523

Date	Time	File Source
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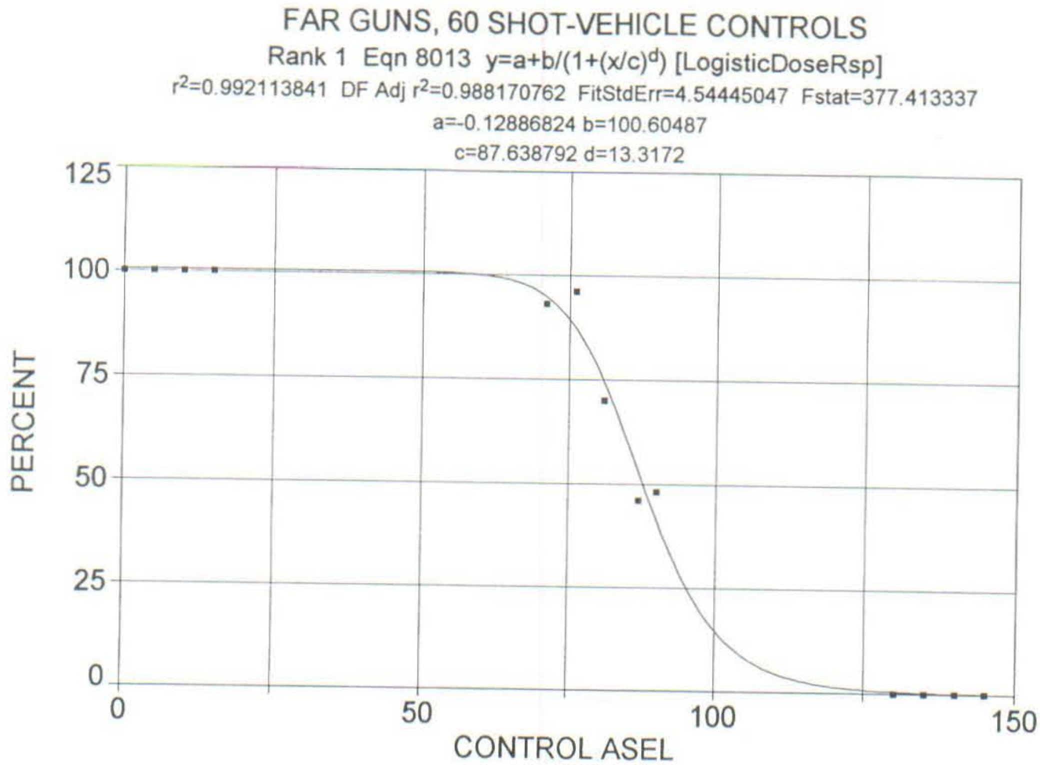
August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9921138412	0.9881707617	4.5444504748	377.41333697

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.12886824	2.330115047	-0.05530553	-5.41575442	5.158017938
b	100.6048691	3.286370340	30.61276078	93.14829907	108.0614390
c	87.63879186	0.900568177	97.31499969	85.59545866	89.68212507
d	13.31719994	2.112672897	6.303484063	8.523676480	18.11072339

Date	Time	File Source
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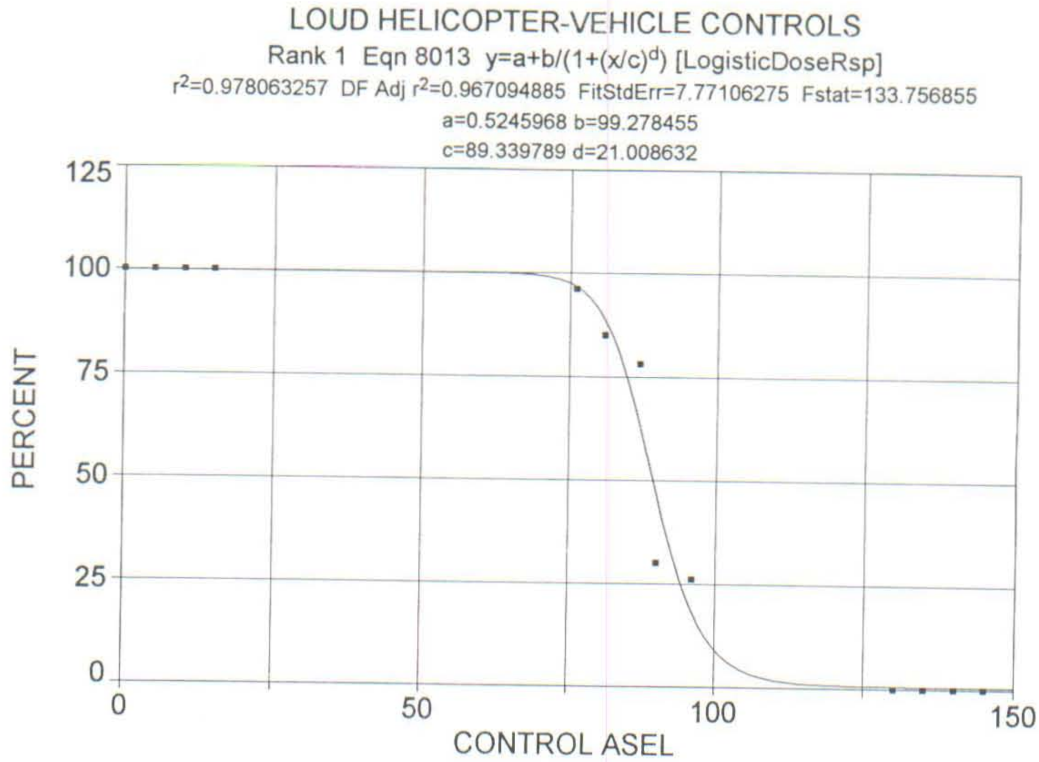
August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9780632569	0.9670948854	7.7710627544	133.75685523

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.524596798	3.863849656	0.135770499	-8.24223785	9.291431449
b	99.27845475	5.396207325	18.39782068	87.03479581	111.5221137
c	89.33978899	1.033160121	86.47235526	86.99561291	91.68396507
d	21.00863195	5.169883952	4.063656389	9.278486683	32.73877723

Date	Time	File Source
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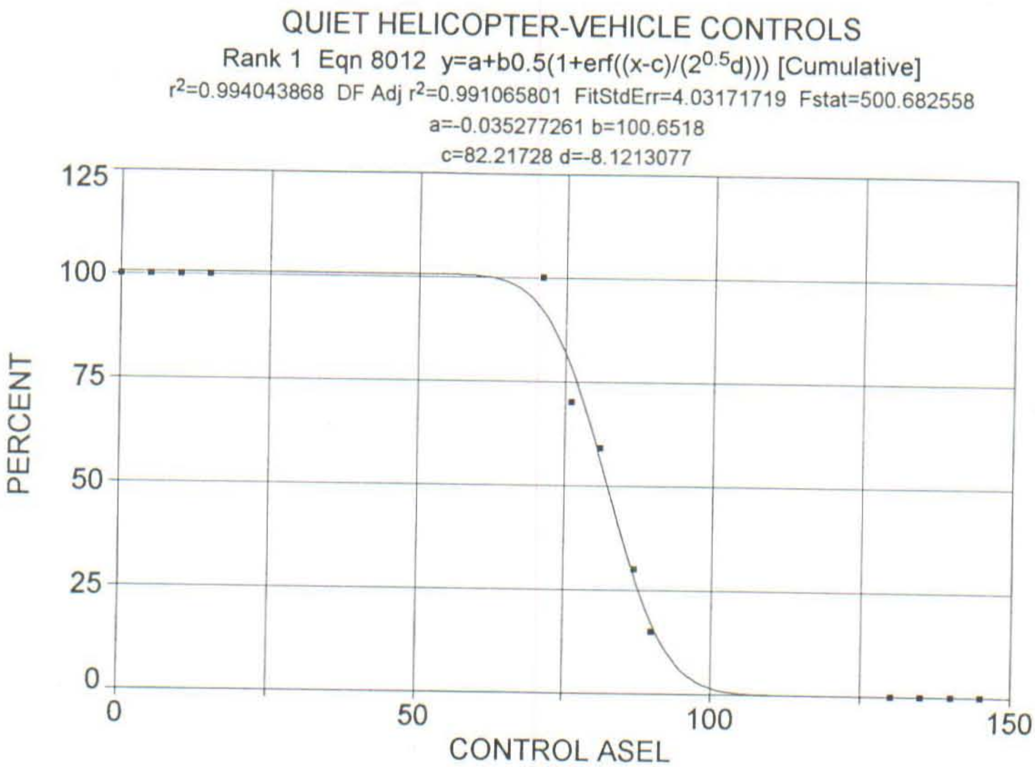
August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone



Rank 1 Eqn 8012 y=a+b0.5(1+erf((x-c)/($2^{0.5}$d))) [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9940438676	0.9910658014	4.0317171857	500.68255805

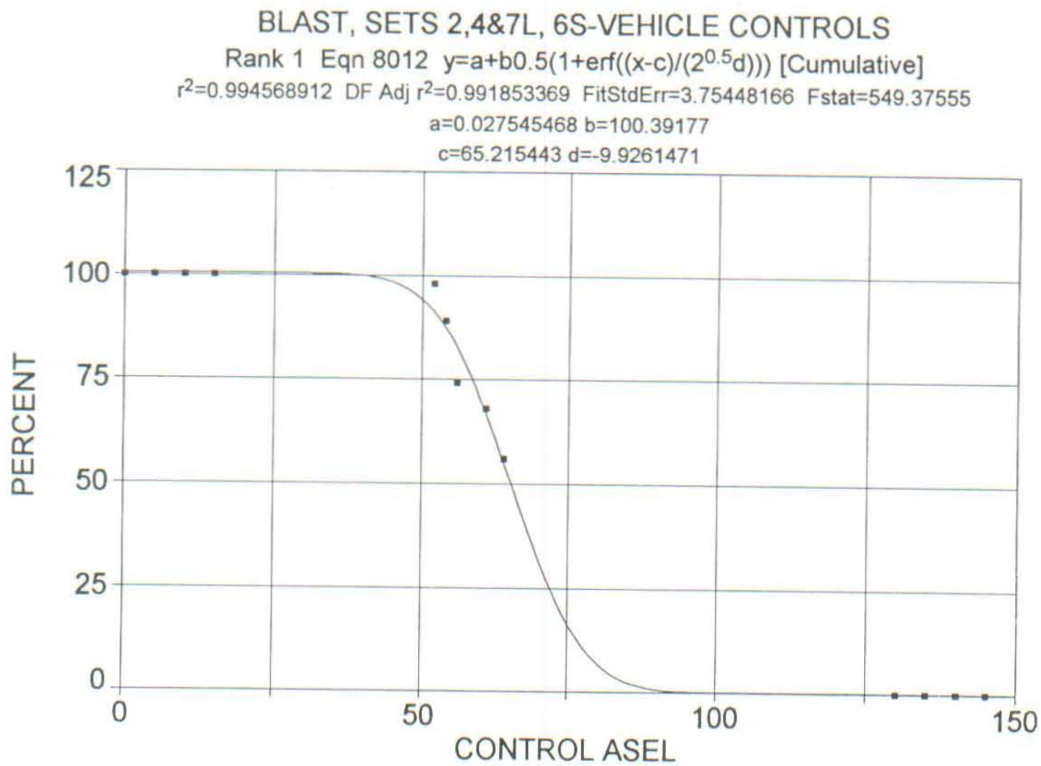
Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.03527726	2.005002810	-0.01759462	-4.58450398	4.513949463
b	100.6517972	2.837885069	35.46718588	94.21281246	107.0907820
c	82.21728009	0.609018094	134.9997329	80.83545590	83.59910429
d	-8.12130767	0.800428681	-10.1461977	-9.93743058	-6.30518475

Date	Time	File Source
Sep 21, 1994	11:12:32 AM	c:\tcwin\augl.prn

August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at Free-Field Microphone

Appendix E: Blast Sound Transition Curves—Acoustical Measurements Near the Subjects

This appendix contains the transition curves for the blast sound data for subjects indoors and outdoors with the **acoustical measurements made near to the subjects.** Each curve represents the grouping of data indicated on the curve. As discussed in the text, only these data include the white-noise control sounds because these could only be heard or measured by the subjects. Because of the problems cited in the text, only indoor measured acoustical data for the windows-closed test periods are included. Each curve represents an entire test period, so there are two sets of curves for the two test periods that included outdoor subjects.



Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9945689124	0.9918533686	3.7544816636	549.37554982

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.027545468	1.877137555	0.014674187	-4.23156294	4.286653878
b	100.3917673	2.649335370	37.89318954	94.38059009	106.4029446
c	65.21544339	0.959570132	67.96318606	63.03823842	67.39264836
d	-9.92614709	1.490959133	-6.65755812	-13.3090407	-6.54325351

Date	Time	File Source
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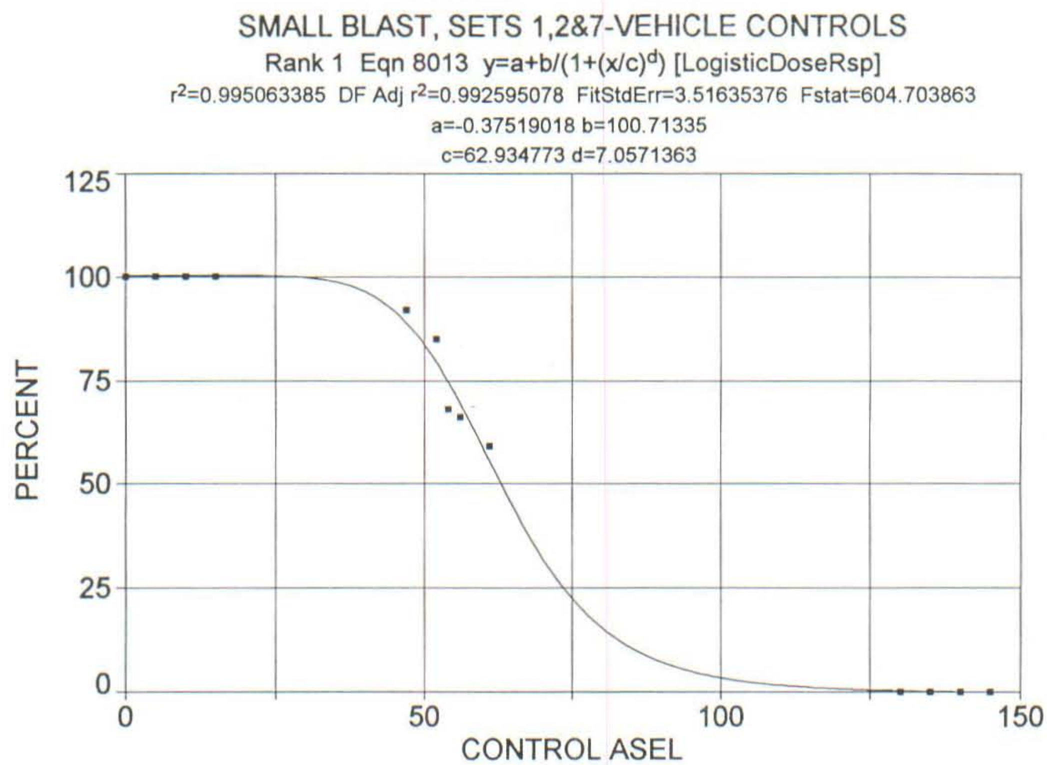

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9950633850	0.9925950775	3.5163537635	604.70386283

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.37519018	1.852062916	-0.20257961	-4.57740579	3.827025434
b	100.7133467	2.625731673	38.35629806	94.75572477	106.6709686
c	62.93477334	1.484674919	42.38959824	59.56613825	66.30340843
d	7.057136285	1.199715143	5.882343260	4.335057213	9.779215357

Date	Time	File Source
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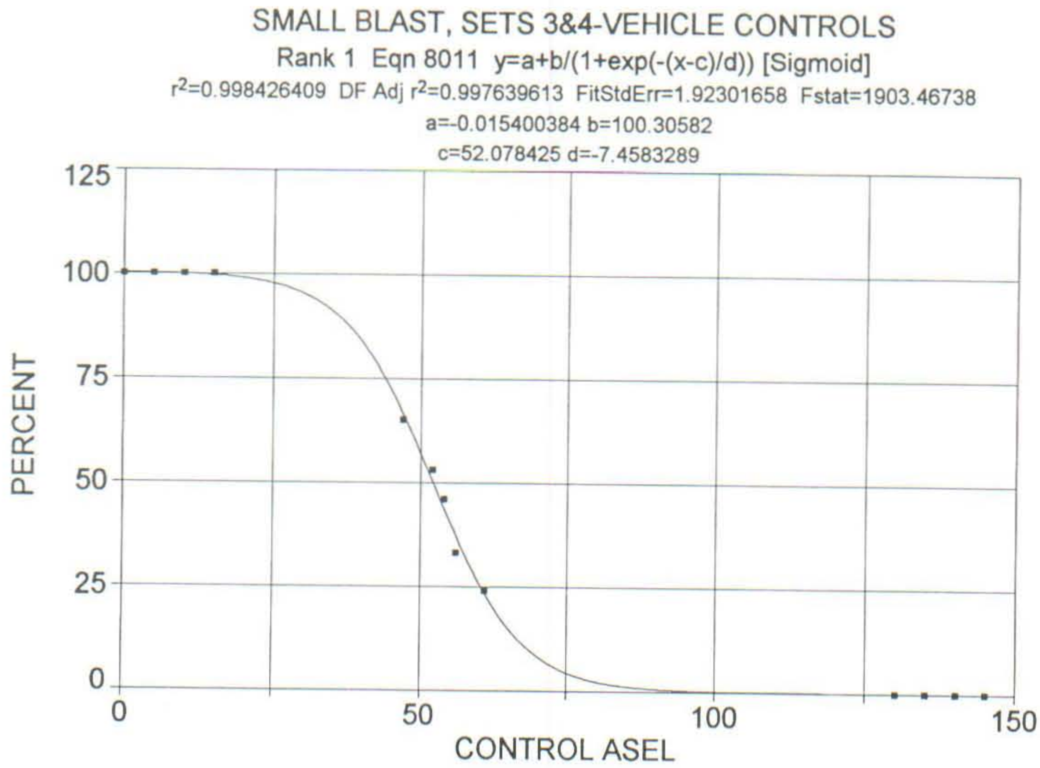

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9984264089	0.9976396134	1.9230165797	1903.4673759

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.01540038	0.959539546	-0.01604976	-2.19253596	2.161735191
b	100.3058173	1.399155255	71.69026948	97.13122101	103.4804136
c	52.07842544	0.373898707	139.2848504	51.23007252	52.92677836
d	-7.45832886	0.530653110	-14.0549989	-8.66234777	-6.25430994

Date	Time	File Source
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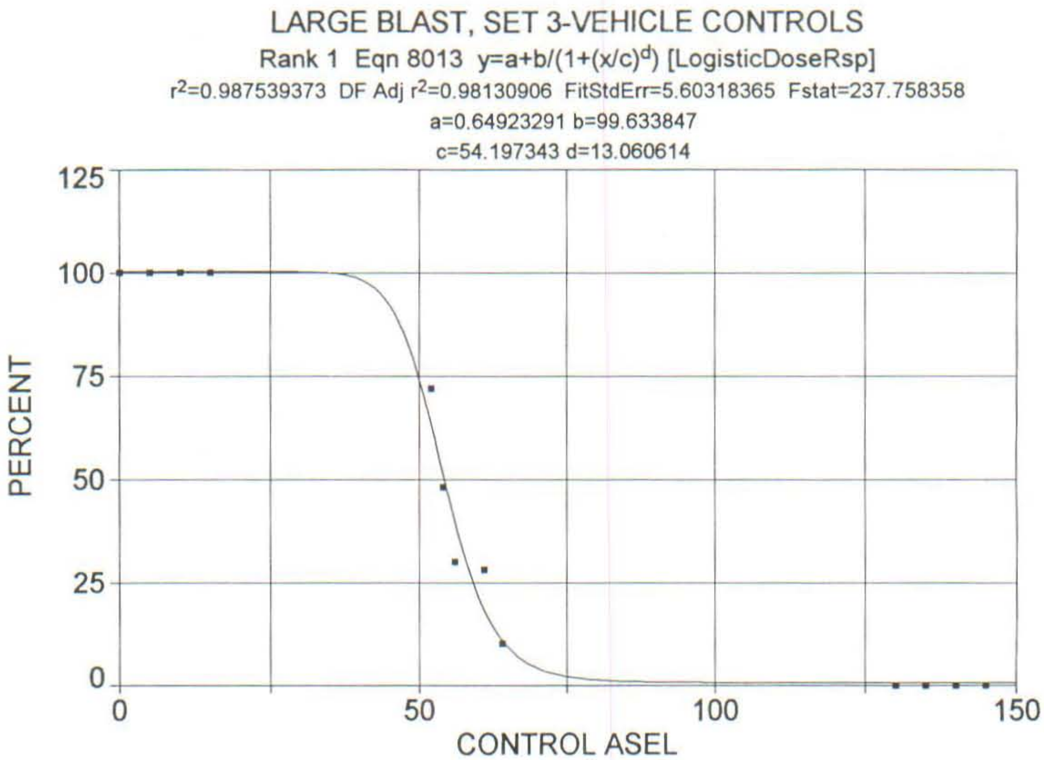

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9875393734	0.9813090601	5.6031836467	237.75835802

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.649232911	2.767329202	0.234606317	-5.62966500	6.928130823
b	99.63384747	3.948238907	25.23500979	90.67553885	108.5921561
c	54.19734256	0.646092083	83.88485781	52.73139979	55.66328533
d	13.06061428	2.417919946	5.401590858	7.574504244	18.54672431

Date	Time	File Source
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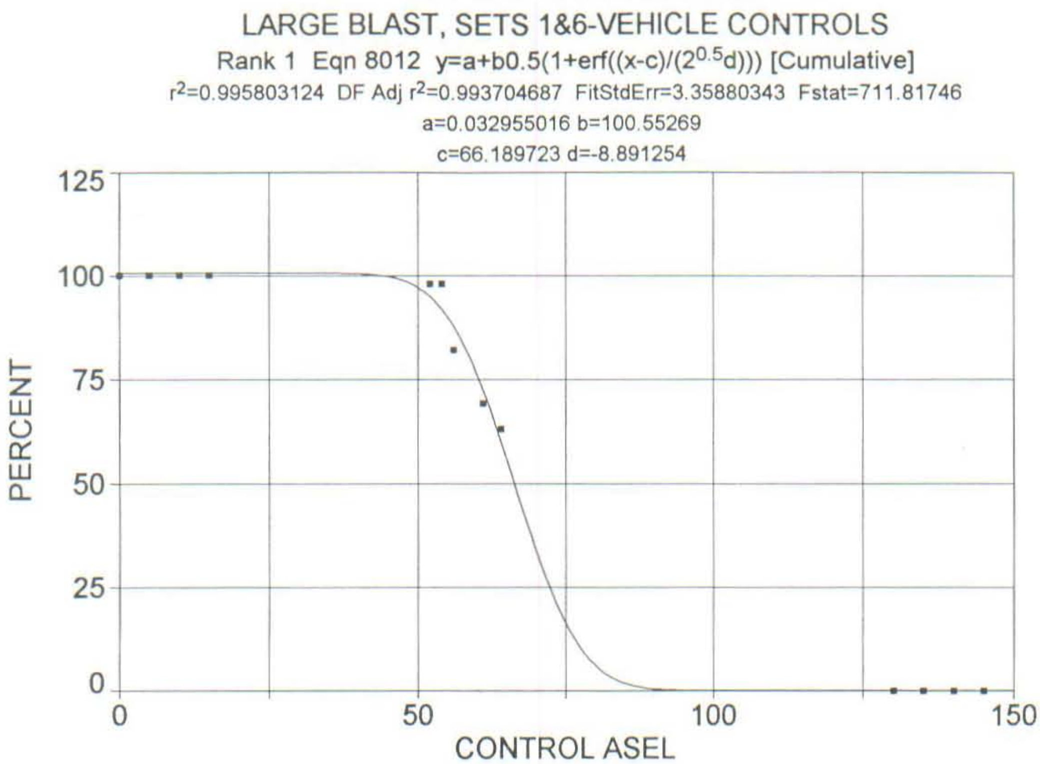

Rank 1 Eqn 8012 y=a+b0.5(1+erf((x-c)/($2^{0.5}$d))) [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9958031243	0.9937046865	3.3588034305	711.81745997

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.032955016	1.679334820	0.019623851	-3.77735128	3.843261316
b	100.5526851	2.362754781	42.55739355	95.19174140	105.9136288
c	66.18972302	0.911003725	72.65582041	64.12271221	68.25673383
d	-8.89125404	1.359406590	-6.54054063	-11.9756631	-5.80684500

Date	Time	File Source
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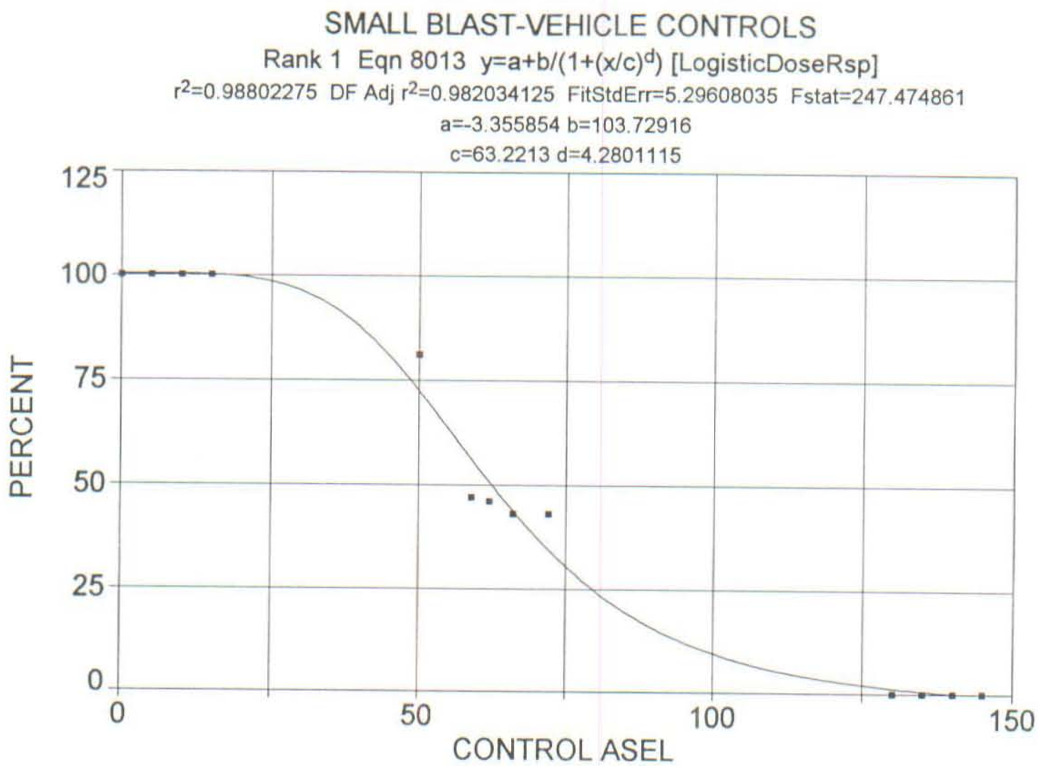

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9880227501	0.9820341252	5.2960803482	247.47486138

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-3.35585400	4.541762510	-0.73888804	-13.6608308	6.949122770
b	103.7291620	5.516728635	18.80265804	91.21204772	116.2462763
c	63.22129993	2.257724685	28.00221849	58.09866298	68.34393687
d	4.280111535	1.007265980	4.249236666	1.994687649	6.565535421

Date	Time	File Source
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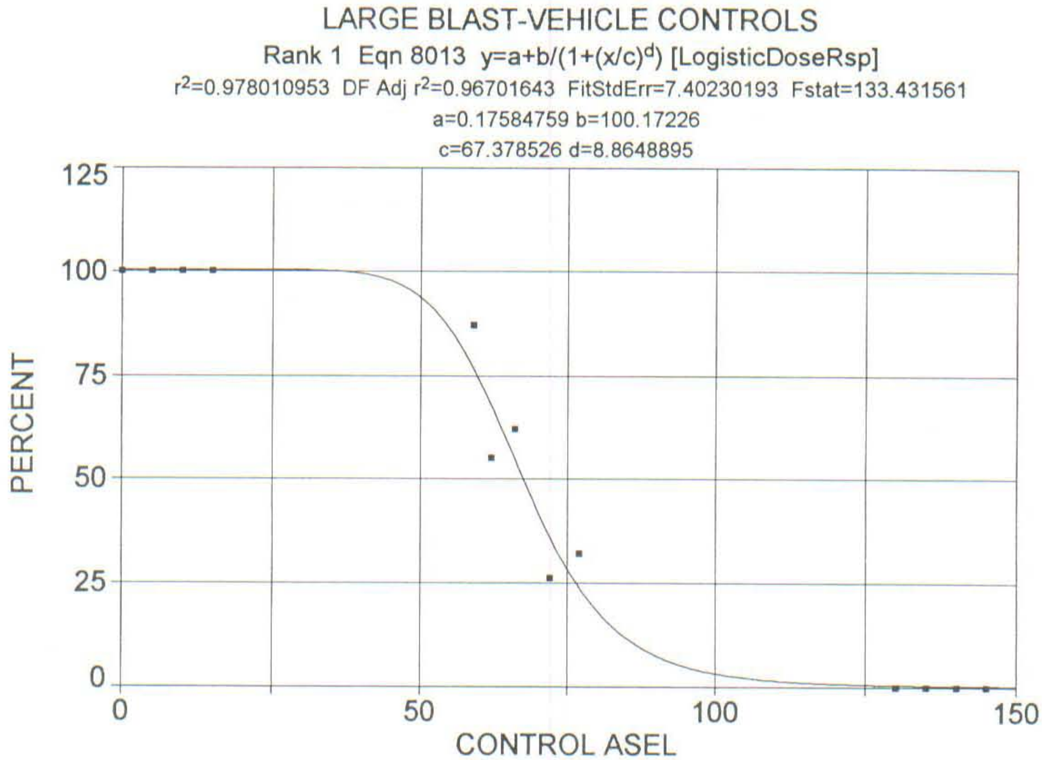
June 1992 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9780109530	0.9670164296	7.4023019304	133.43156089

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	0.175847589	3.777154292	0.046555575	-8.39428067	8.745975849
b	100.1722581	5.324602601	18.81309566	88.09106580	112.2534503
c	67.37852602	1.510363982	44.61078709	63.95160405	70.80544800
d	8.864889480	1.891500923	4.686695824	4.573191481	13.15658748

Date	Time	File Source
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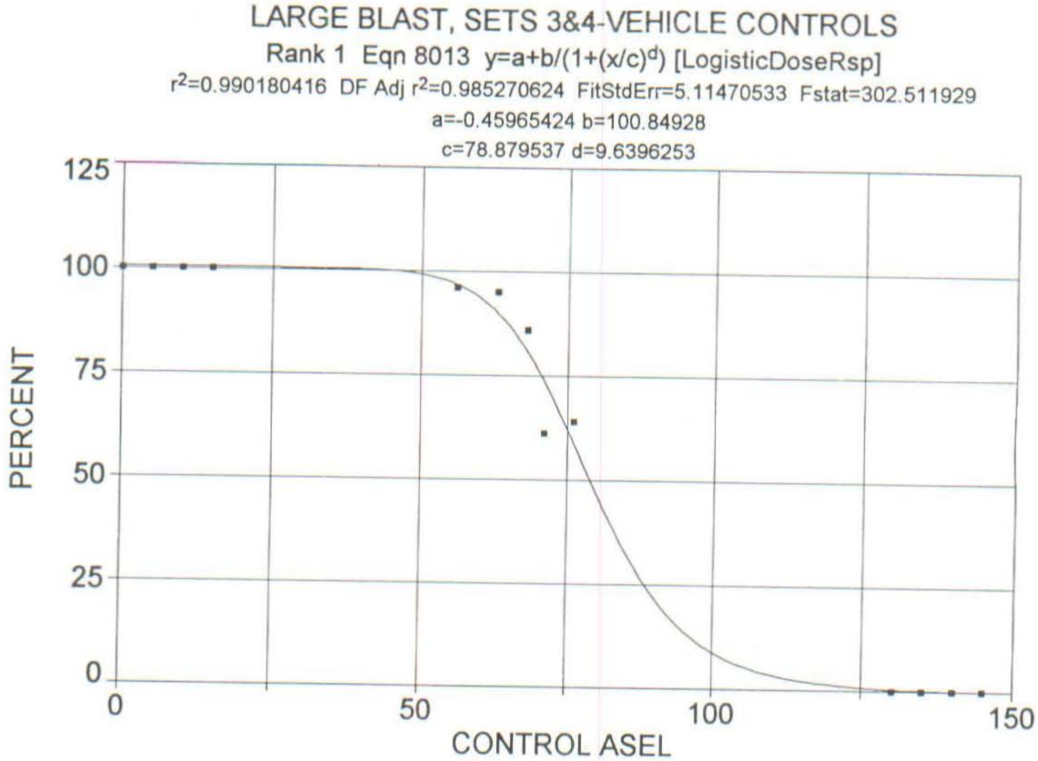

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9901804162	0.9852706242	5.1147053319	302.51192888

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.45965424	2.743315050	-0.16755430	-6.68406554	5.764757050
b	100.8492831	3.883440286	25.96905724	92.03799850	109.6605676
c	78.87953744	2.214407870	35.62105180	73.85518366	83.90389123
d	9.639625338	2.536868454	3.799812845	3.883628535	15.39562214

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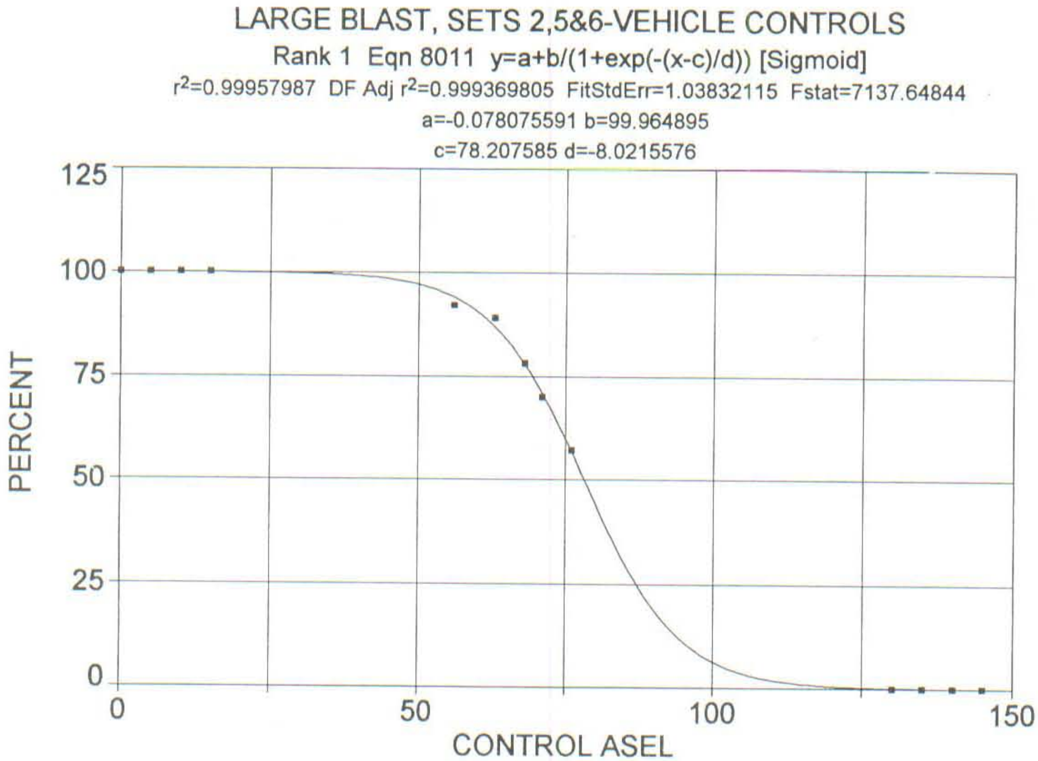

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9995798701	0.9993698051	1.0383211487	7137.6484387

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.07807559	0.522209368	-0.14951013	-1.26293618	1.106784999
b	99.96489501	0.739759745	135.1315690	98.28642614	101.6433639
c	78.20758521	0.391980090	199.5192795	77.31820676	79.09696367
d	-8.02155756	0.403708148	-19.8696945	-8.93754625	-7.10556887

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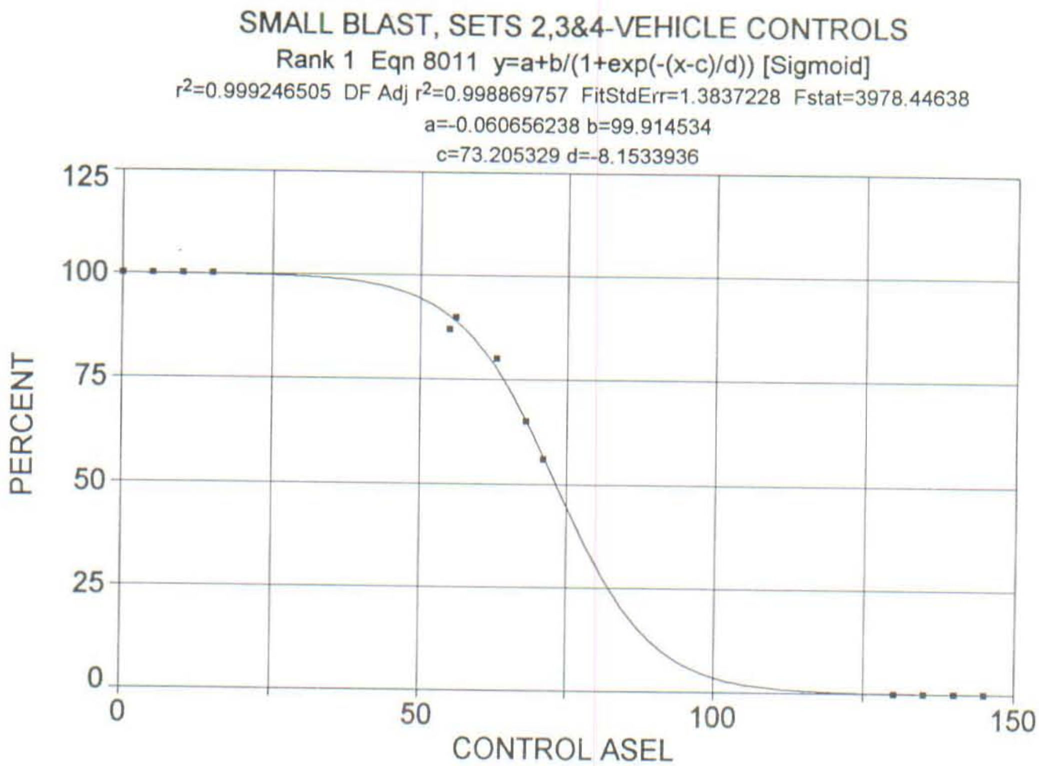

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9992465050	0.9988697575	1.3837228029	3978.4463781

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.06065624	0.694066937	-0.08739249	-1.63545097	1.514138490
b	99.91453387	0.989730036	100.9513001	97.66889795	102.1601698
c	73.20532916	0.482899410	151.5953998	72.10966042	74.30099790
d	-8.15339358	0.524839188	-15.5350320	-9.34422107	-6.96256609

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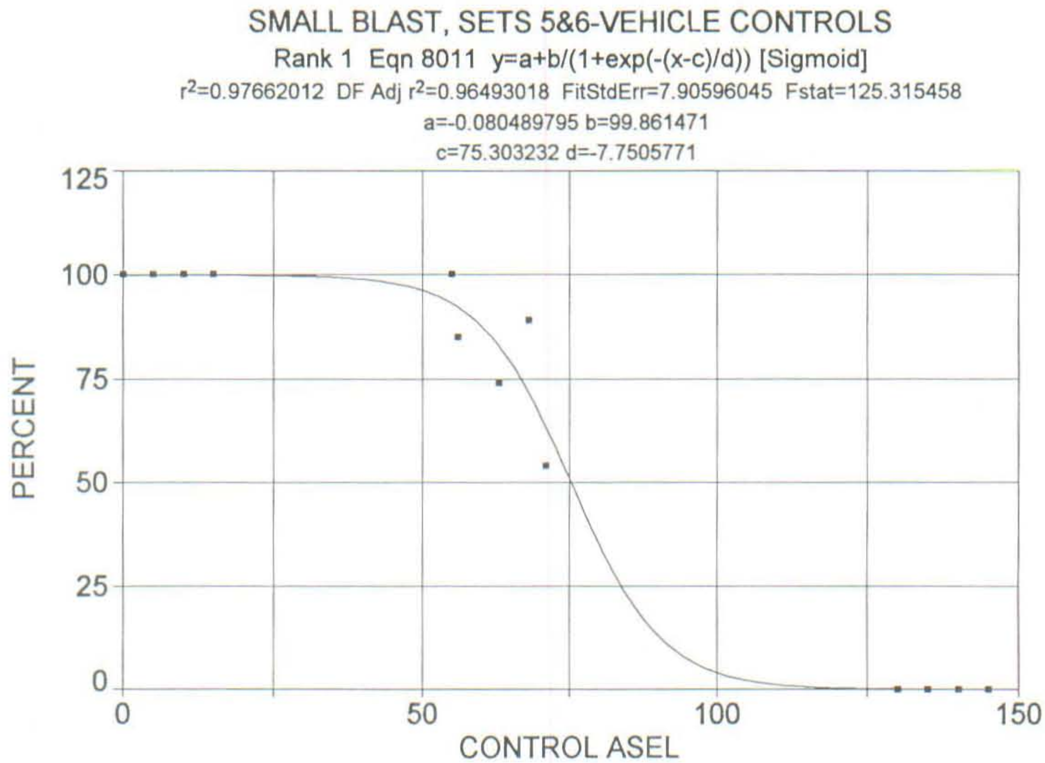

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9766201201	0.9649301801	7.9059604503	125.31545792

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.08048979	3.964007356	-0.02030516	-9.07457604	8.913596451
b	99.86147094	5.637401840	17.71409486	87.07055665	112.6523852
c	75.30323228	3.603797329	20.89552364	67.12644019	83.48002437
d	-7.75057708	3.459332013	-2.24048373	-15.5995863	0.098432189

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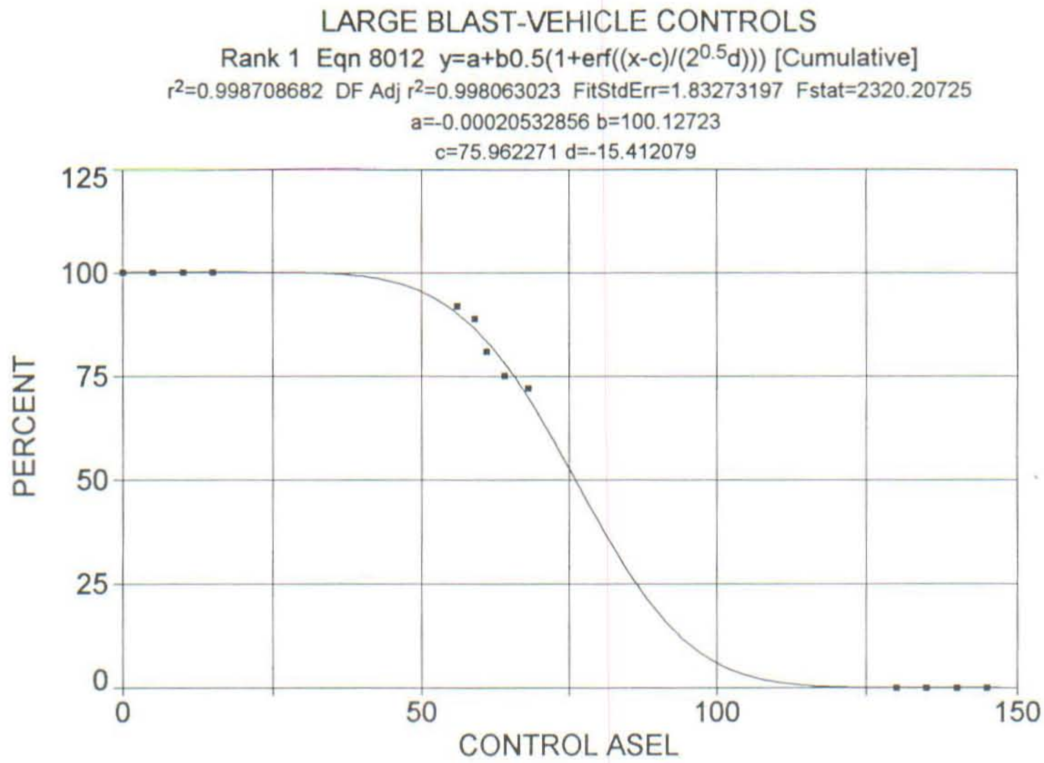

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9987086817	0.9980630226	1.8327319737	2320.2072481

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.00020533	0.917282509	-0.00022384	-2.08146231	2.081051657
b	100.1272314	1.298781179	77.09322636	97.18037766	103.0740852
c	75.96227098	1.581558923	48.02999742	72.37381212	79.55072985
d	-15.4120793	1.927134452	-7.99740741	-19.7846276	-11.0395311

Date	Time	File Source
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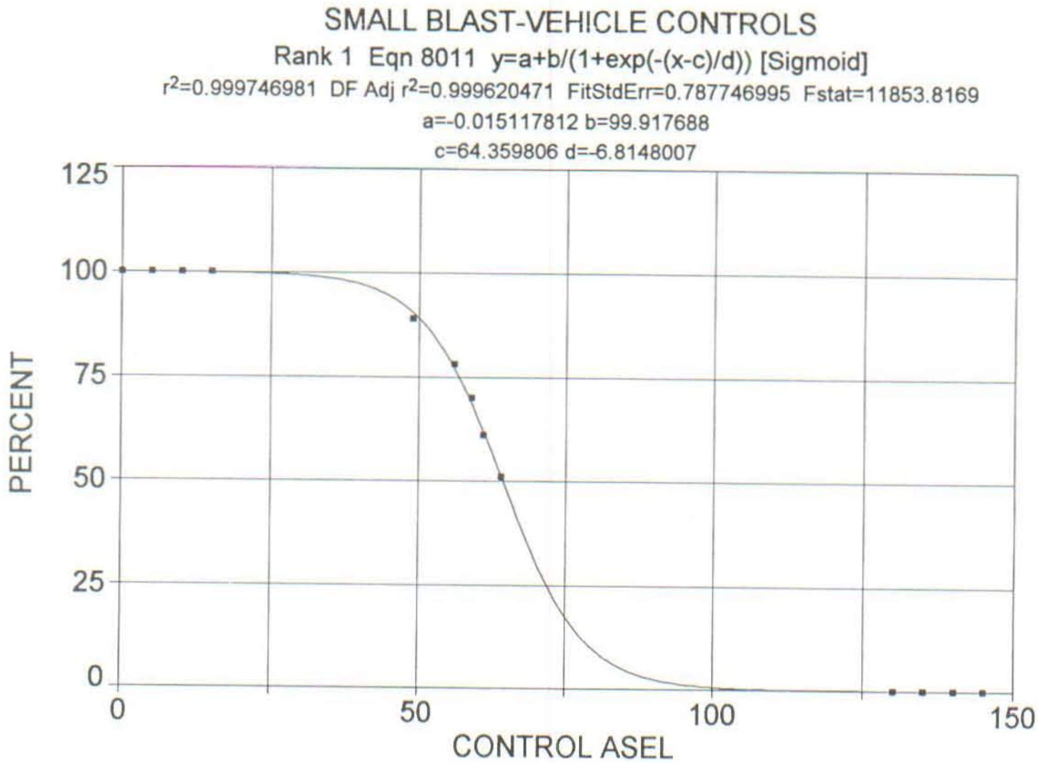

Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9997469810	0.9996204715	0.7877469945	11853.816873

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.01511781	0.393904135	-0.03837942	-0.90886180	0.878626181
b	99.91768765	0.557525273	179.2164276	98.65269747	101.1826778
c	64.35980642	0.193973524	331.7968608	63.91969255	64.79992028
d	-6.81480074	0.247472369	-27.5376227	-7.37630016	-6.25330132

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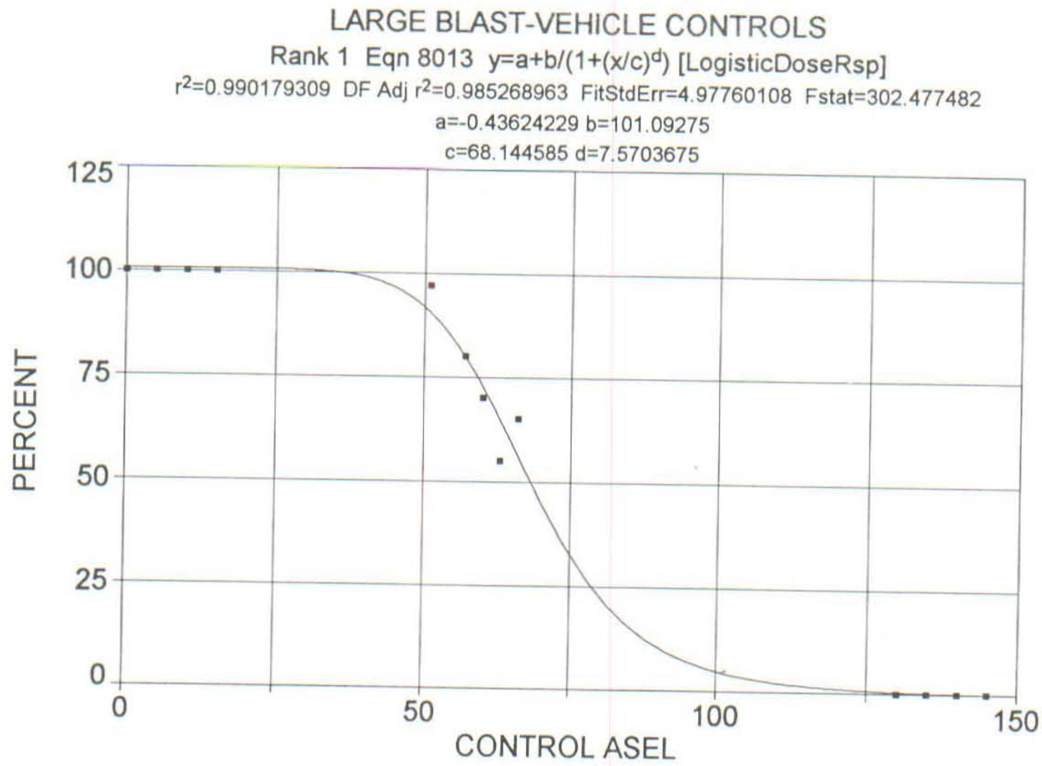

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9901793089	0.9852689633	4.9776010826	302.47748216

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.43624229	2.665042203	-0.16369058	-6.48305736	5.610572776
b	101.0927521	3.776755175	26.76709171	92.52352945	109.6619748
c	68.14458475	1.997452376	34.11574943	63.61248949	72.67668000
d	7.570367513	1.863701668	4.062006083	3.341744295	11.79899073

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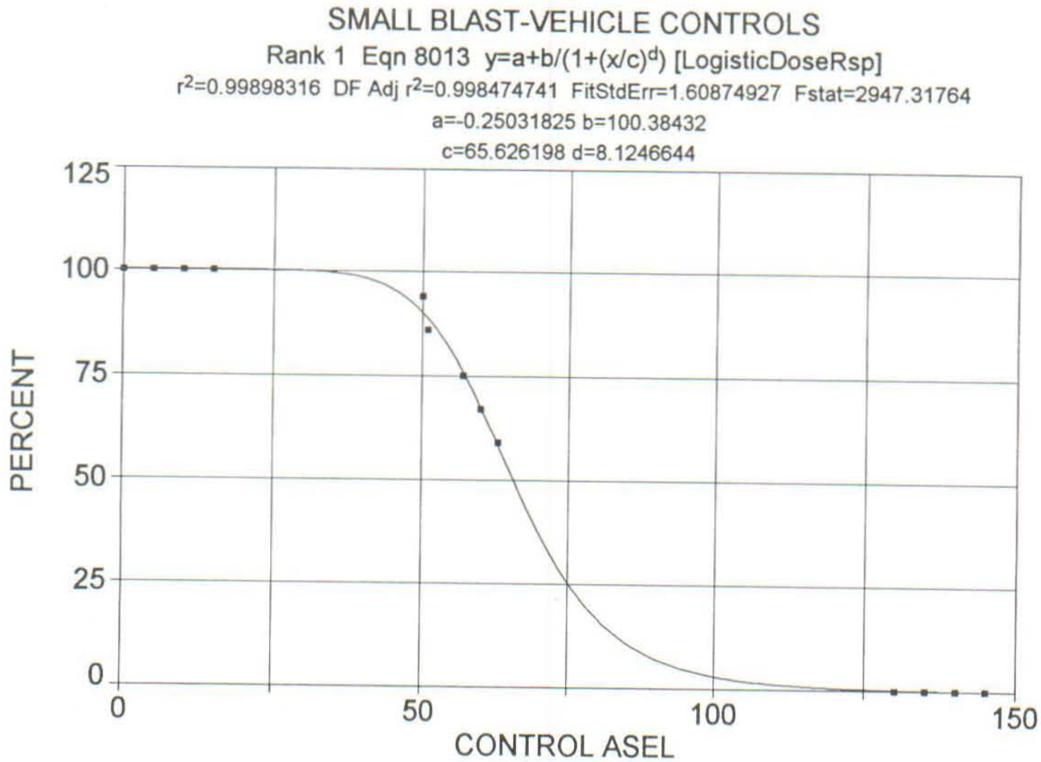

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9989831603	0.9984747405	1.6087492727	2947.3176374

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.25031825	0.826051341	-0.30302989	-2.12457739	1.623940887
b	100.3843213	1.181585536	84.95730375	97.70337714	103.0652654
c	65.62619753	0.611781545	107.2706394	64.23810324	67.01429182
d	8.124664382	0.639203162	12.71061356	6.674352147	9.574976617

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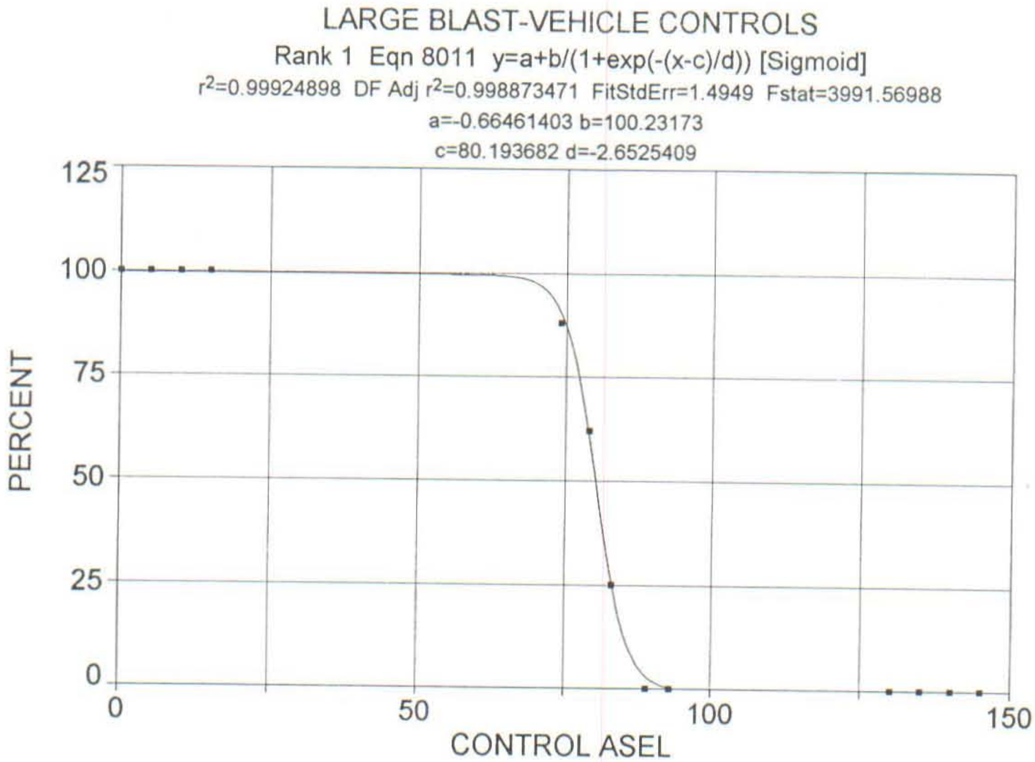
January 1993 Test Period
Indoor Measured Acoustical Data



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9992489805	0.9988734707	1.4949000012	3991.5698832

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.66461403	0.649441567	-1.02336232	-2.13815657	0.808928508
b	100.2317285	0.999008878	100.3311689	97.96503946	102.4984175
c	80.19368221	0.142365257	563.2953157	79.87066429	80.51670012
d	-2.65254092	0.135334900	-19.5998291	-2.95960739	-2.34547444

Date	Time	File Source
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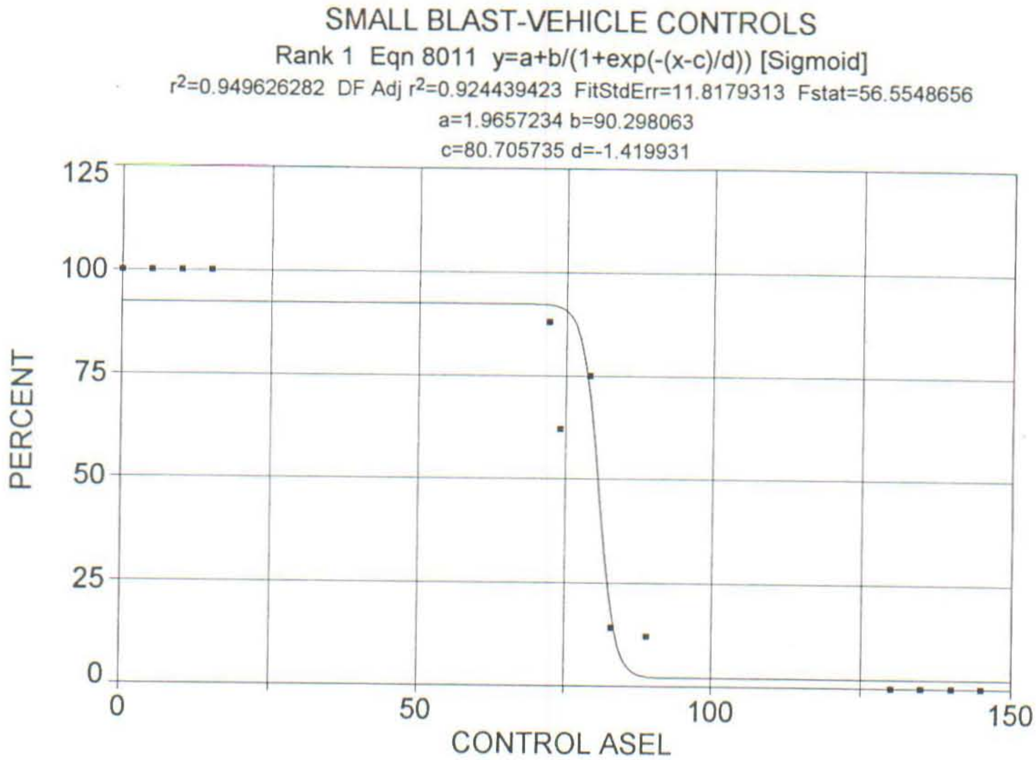
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Tent Microphone



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9496262821	0.9244394231	11.817931330	56.554865596

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	1.965723436	5.328337012	0.368918751	-10.1239420	14.05538885
b	90.29806350	7.306980884	12.35778017	73.71897815	106.8771488
c	80.70573457	0.908037969	88.87925098	78.64545287	82.76601627
d	-1.41993101	0.630184921	-2.25319738	-2.84978142	0.009919395

Date	Time	File Source
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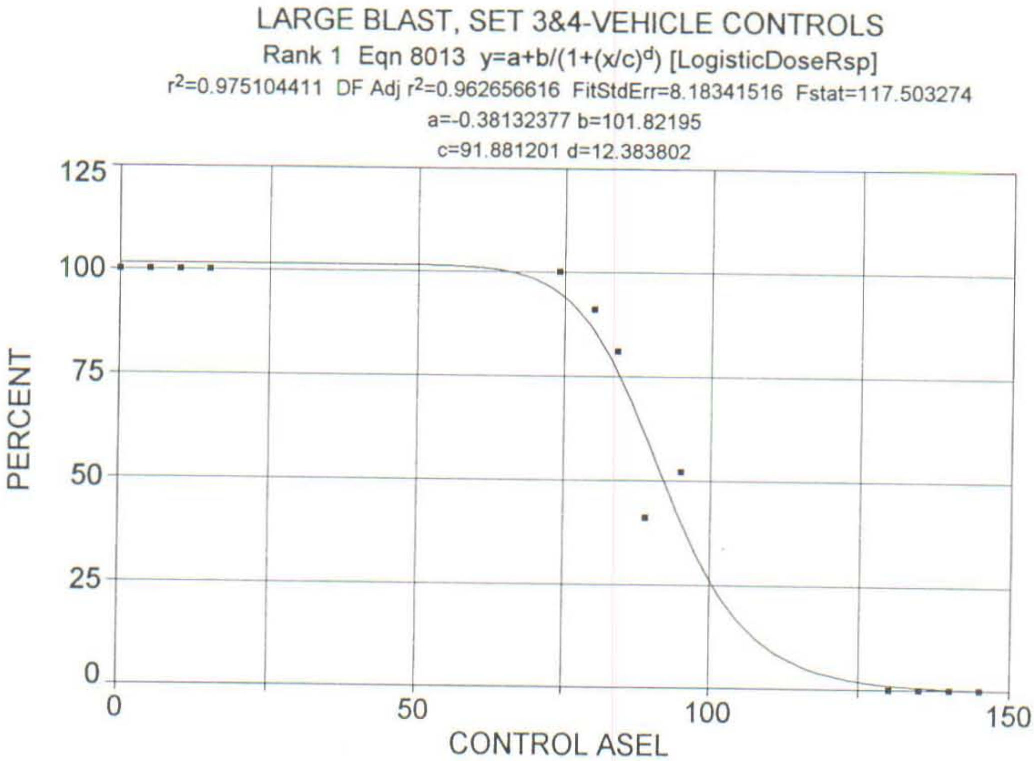
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Tent Microphone



Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9751044109	0.9626566163	8.1834151592	117.50327400

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.38132377	4.431665597	-0.08604525	-10.4364975	9.673849947
b	101.8219535	6.209747832	16.39711568	87.73242178	115.9114853
c	91.88120079	1.959156214	46.89835354	87.43599714	96.32640444
d	12.38380228	3.435108659	3.605068576	4.589754298	20.17785026

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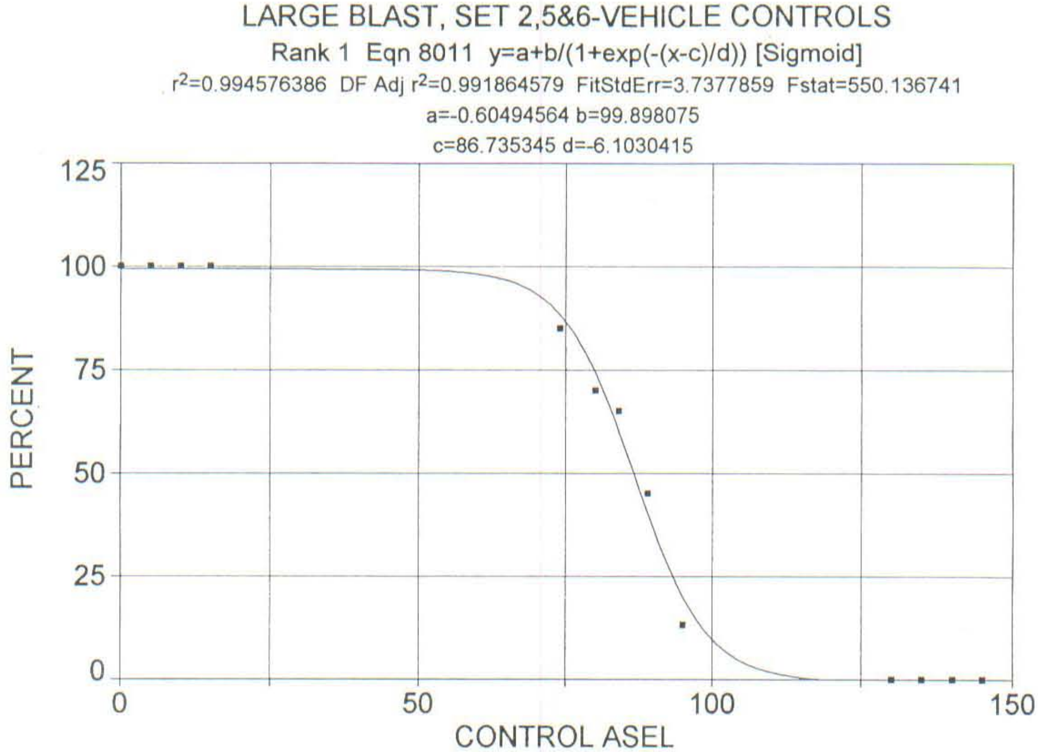
August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Tent Microphone



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9945763863	0.9918645795	3.7377858992	550.13674141

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.60494564	1.866612890	-0.32408736	-4.84017424	3.630282959
b	99.89807510	2.645014575	37.76844031	93.89670147	105.8994487
c	86.73534500	0.662735838	130.8746865	85.23163859	88.23905141
d	-6.10304154	0.637001136	-9.58089586	-7.54835752	-4.65772557

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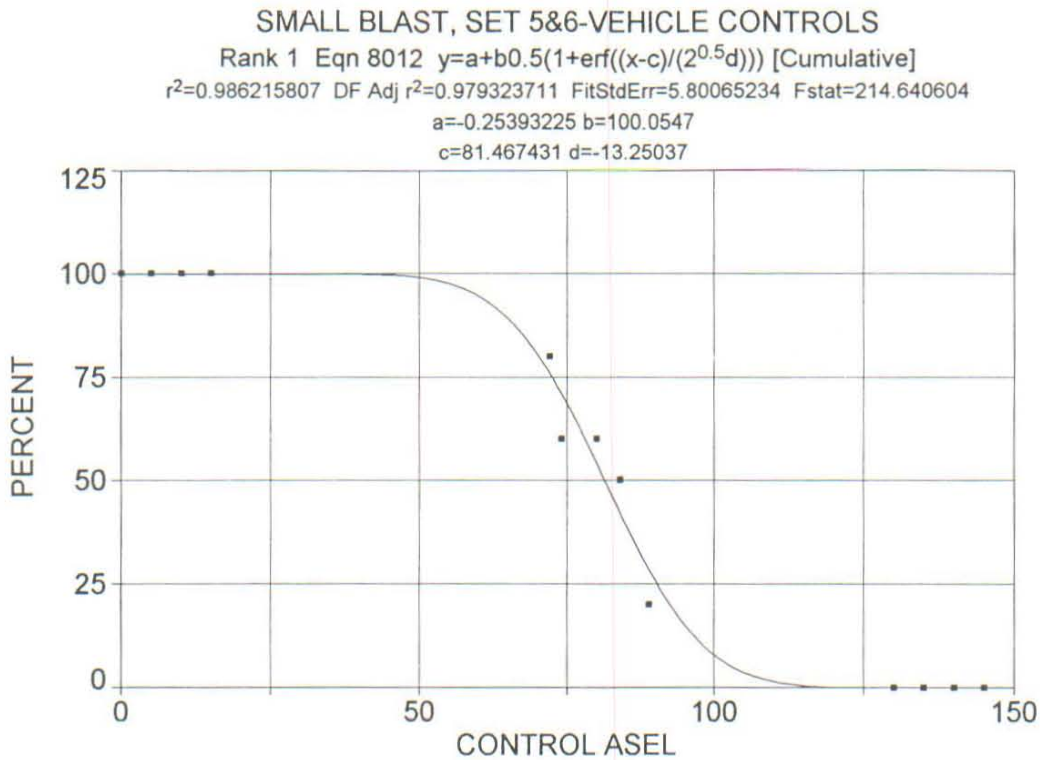
August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Tent Microphone



Rank 1 Eqn 8012 $y=a+b0.5(1+\mathrm{erf}((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9862158074	0.9793237111	5.8006523374	214.64060402

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.25393225	2.899996787	-0.08756294	-6.83384466	6.325980162
b	100.0546965	4.104347093	24.37773762	90.74218813	109.3672049
c	81.46743128	1.235188882	65.95544413	78.66486450	84.26999806
d	-13.2503698	2.257435029	-5.86965719	-18.3723495	-8.12839002

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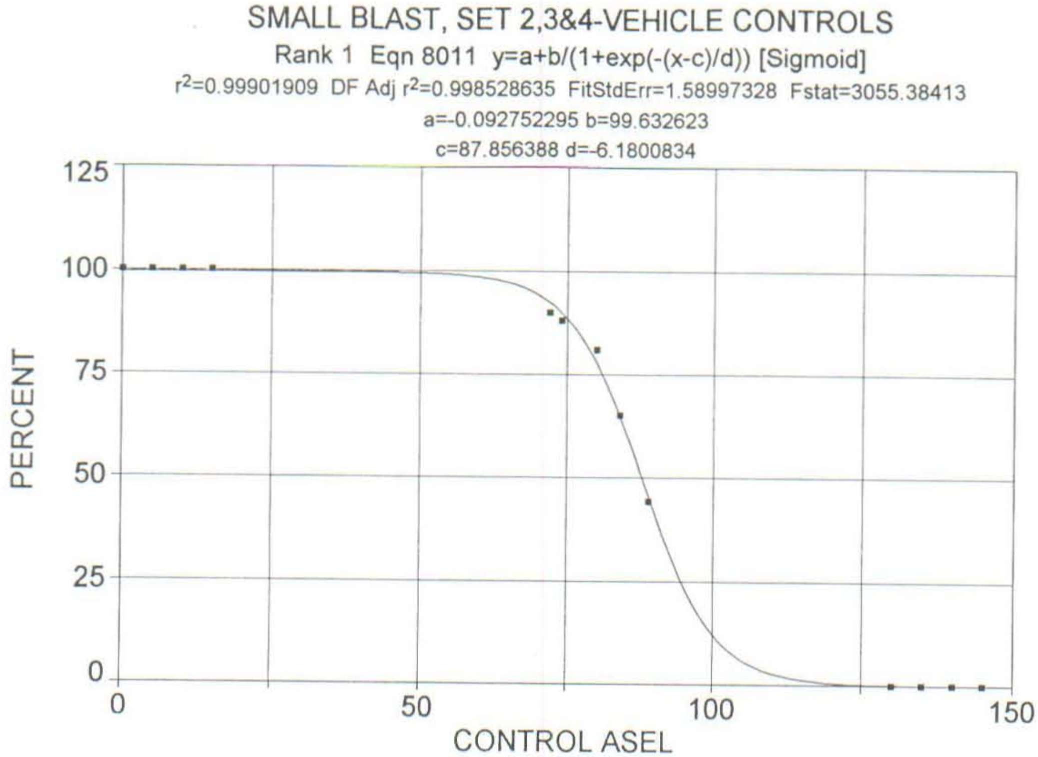
August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Tent Microphone



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9990190899	0.9985286348	1.5899732780	3055.3841276

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.09275230	0.797583300	-0.11629167	-1.90241922	1.716914626
b	99.63262319	1.121561314	88.83386220	97.08787030	102.1773761
c	87.85638802	0.338982635	259.1766628	87.08725750	88.62551855
d	-6.18008343	0.366615160	-16.8571410	-7.01191044	-5.34825643

Date	Time	File Source
Sep 7, 1994	9:57:37 AM	c:\tcwin\augh.prn

August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Tent Microphone

Appendix F: Blast Sound Transition Curves— Pressure-doubled and Free-field Measurements

This appendix contains the transition curves for the blast sound data for subjects indoors and outdoors with the **control sound measured using the outdoor, free-field microphone and the blast sound measured using the outdoor, pressure-doubling microphone**. Each curve represents the grouping of data indicated on the curve. Each curve represents an entire test period, so there are two sets of curves for the two test periods that included outdoor subjects.

Rank 1 Eqn 8012 $y=a+b0.5(1+\mathrm{erf}((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9986285068	0.9979427602	1.8856397122	2184.3969340

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.89387998	1.124819821	-0.79468725	-3.44602622	1.658266268
b	101.2216838	1.546084011	65.46971772	97.71371527	104.7296523
c	99.52538427	0.763454476	130.3619107	97.79315353	101.2576150
d	-15.2588756	1.174092109	-12.9963190	-17.9228176	-12.5949336

Date	Time	File Source
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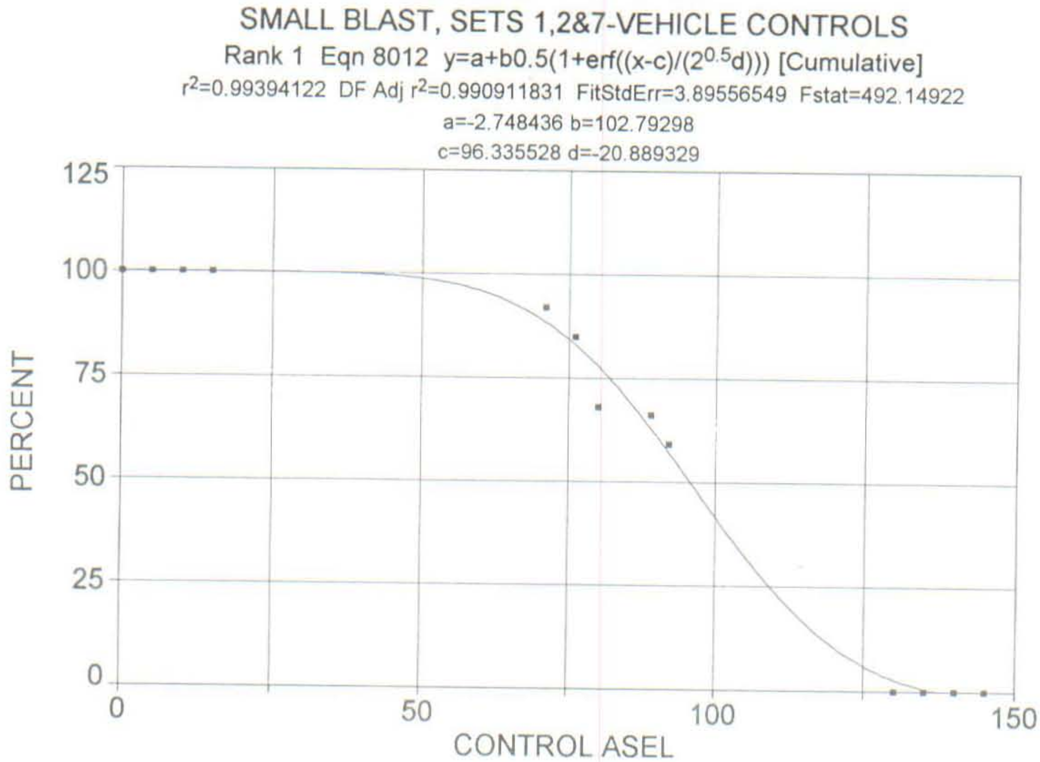

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9939412204	0.9909118306	3.8955654901	492.14921967

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-2.74843595	3.386049236	-0.81169403	-10.4311712	4.934299248
b	102.7929835	4.134322237	24.86332164	93.41246340	112.1735036
c	96.33552784	2.453752405	39.26049248	90.76811618	101.9029395
d	-20.8893286	3.272385161	-6.38351772	-28.3141671	-13.4644902

Date	Time	File Source
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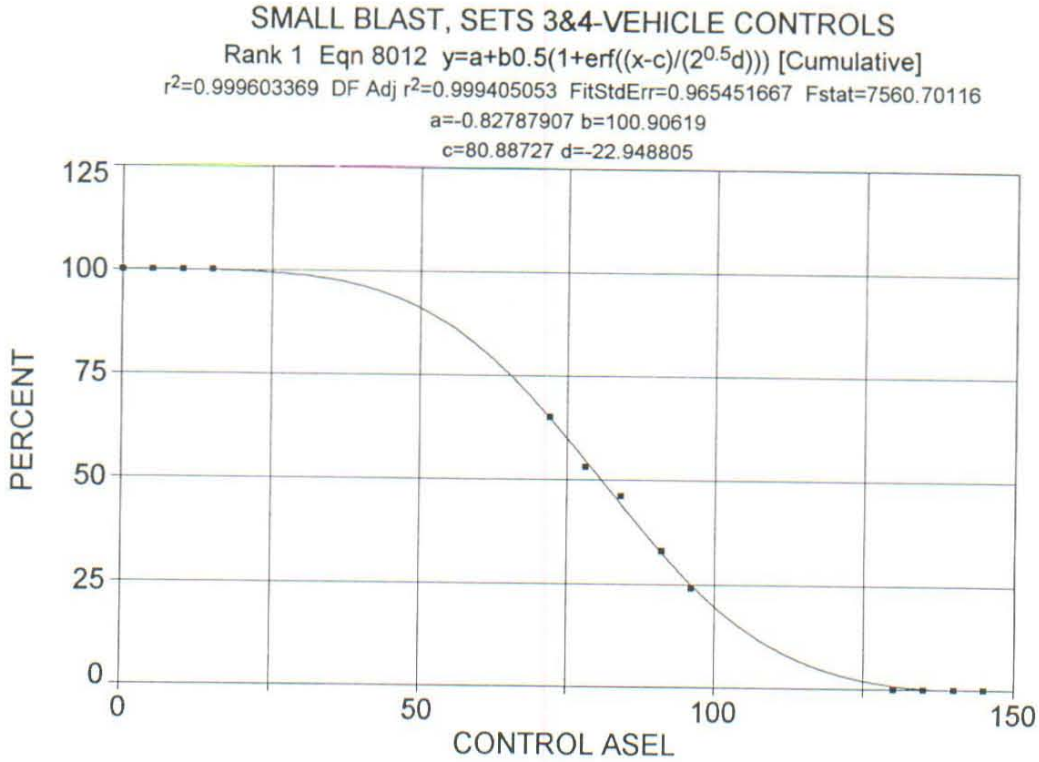

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9996033688	0.9994050532	0.9654516671	7560.7011572

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.82787907	0.563656845	-1.46876434	-2.10678141	0.451023266
b	100.9061858	0.766780559	131.5972147	99.16640837	102.6459632
c	80.88726964	0.351308087	230.2459651	80.09017343	81.68436585
d	-22.9488054	0.806787897	-28.4446575	-24.7793570	-21.1182538

Date	Time	File Source
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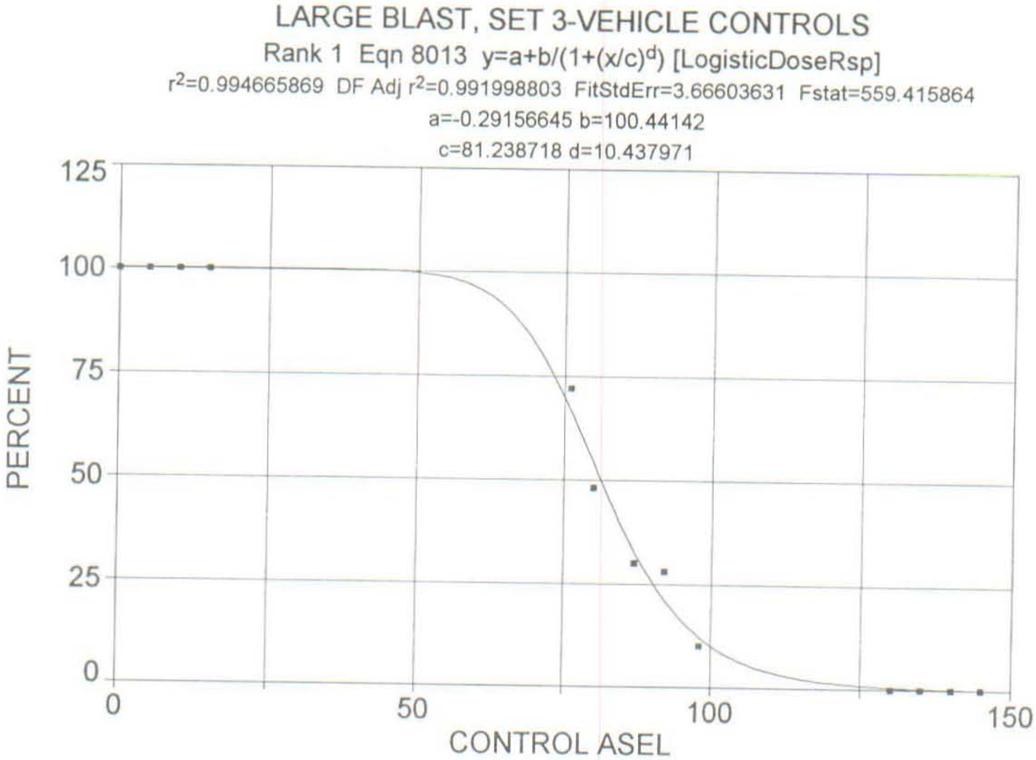

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9946658688	0.9919988032	3.6660363119	559.41586352

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.29156645	1.944321733	-0.14995793	-4.70311159	4.119978680
b	100.4414217	2.696090270	37.25447281	94.32416047	106.5586829
c	81.23871833	0.808557859	100.4735993	79.40415082	83.07328585
d	10.43797139	1.177461723	8.864807393	7.766383944	13.10955884

Date	Time	File Source
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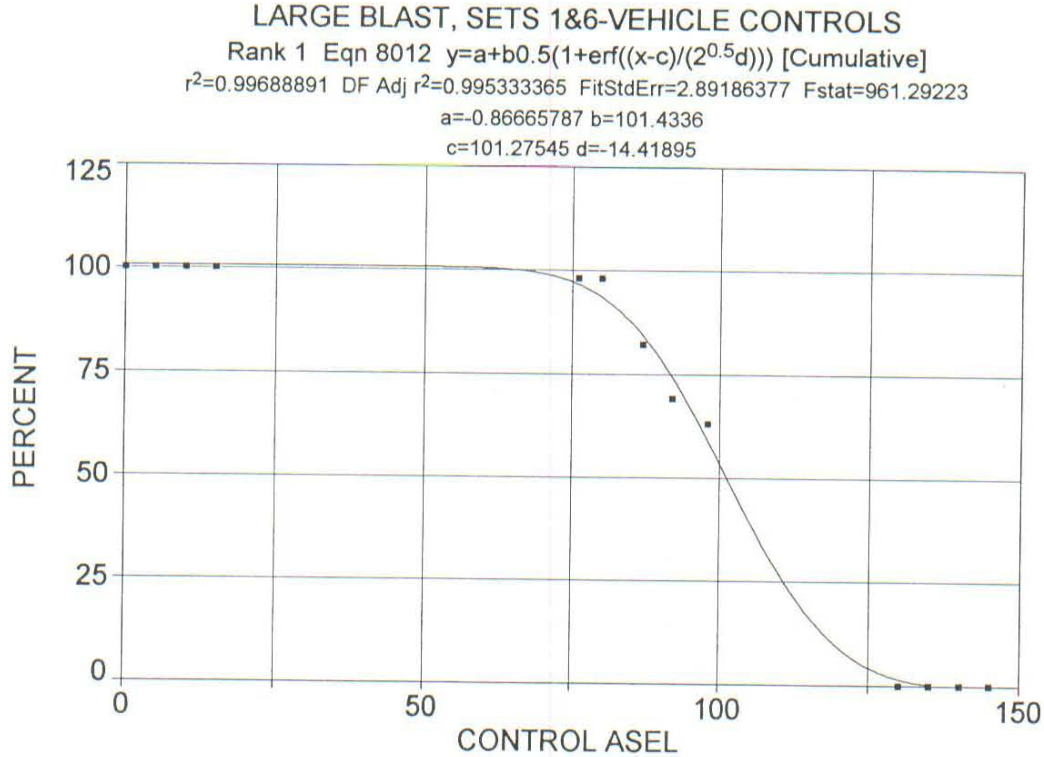

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9968889099	0.9953333649	2.8918637704	961.29222989

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.86665787	1.746213560	-0.49630692	-4.82870787	3.095392134
b	101.4336009	2.396213111	42.33079288	95.99674232	106.8704595
c	101.2754512	1.303859467	77.67359427	98.31707517	104.2338273
d	-14.4189498	1.821840276	-7.91449721	-18.5525921	-10.2853075

Date	Time	File Source
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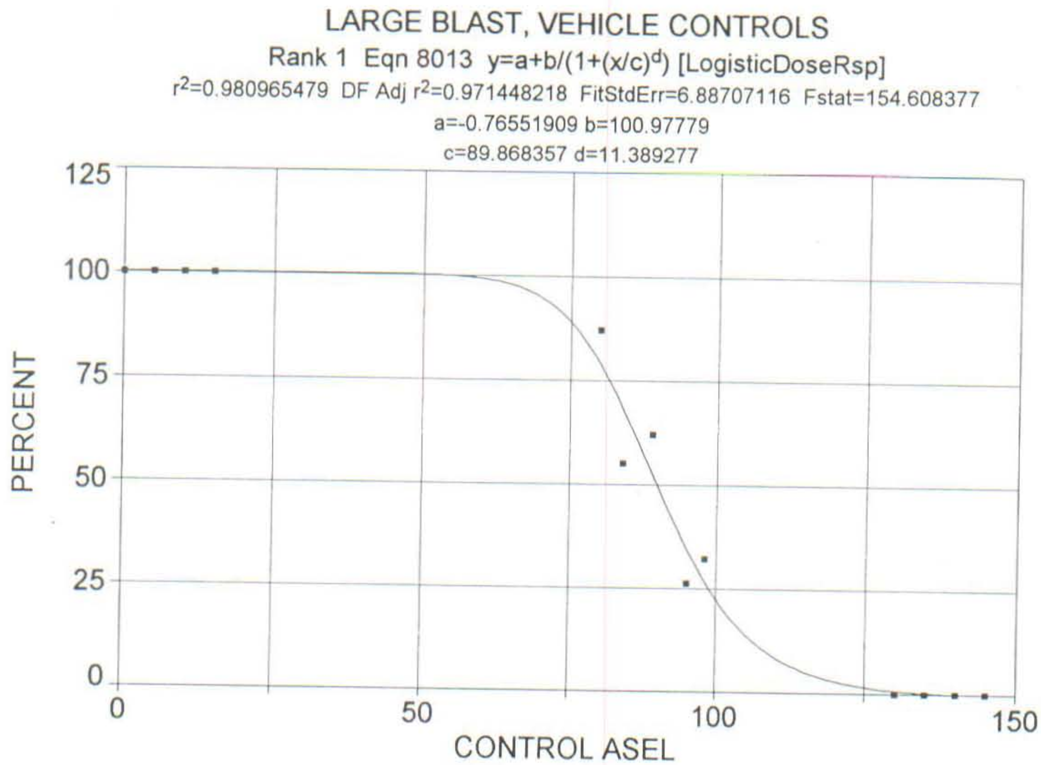

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9809654788	0.9714482182	6.8870711597	154.60837747

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.76551909	3.788876497	-0.20204382	-9.36224430	7.831206126
b	100.9777903	5.224717554	19.32693764	89.12323102	112.8323496
c	89.86835673	1.472200785	61.04354627	86.52802468	93.20868878
d	11.38927672	2.307066690	4.936691589	6.154685837	16.62386761

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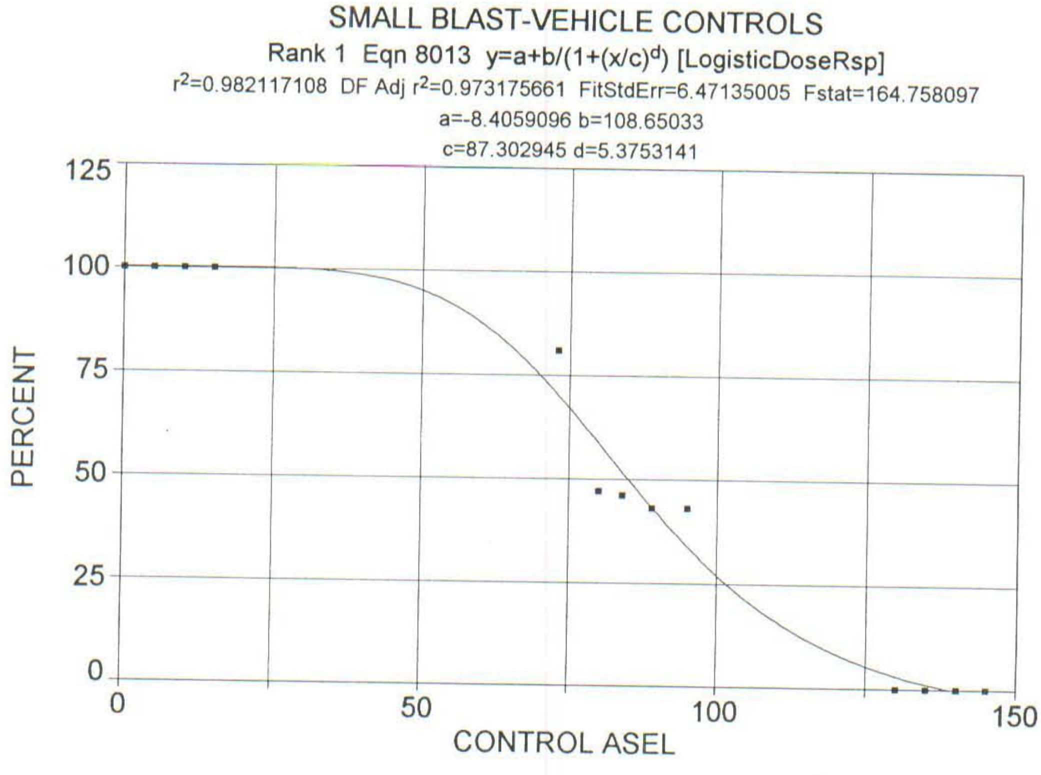

Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9821171076	0.9731756614	6.4713500456	164.75809709

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-8.40590961	9.693772747	-0.86714531	-30.4004773	13.58865808
b	108.6503261	10.48508021	10.36237434	84.86033101	132.4403213
c	87.30294510	4.225948557	20.65878084	77.71453055	96.89135964
d	5.375314135	1.651116733	3.255562753	1.629032920	9.121595350

Date	Time	File Source
Apr 20, 1994	9:09:00 PM	c:\tcwin\augl.prn

Rank 1 Eqn 8012 y=a+b0.5(1+erf((x-c)/($2^{0.5}$d))) [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9891363659	0.9837045488	5.3797444021	273.15068445

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.94757914	3.324317123	-0.28504475	-8.49024802	6.595089736
b	101.0585659	4.473224952	22.59188102	90.90909660	111.2080352
c	103.0515531	2.361975536	43.62939053	97.69237744	108.4107287
d	-13.8562095	3.314231718	-4.18082100	-21.3759953	-6.33642383

Date	Time	File Source
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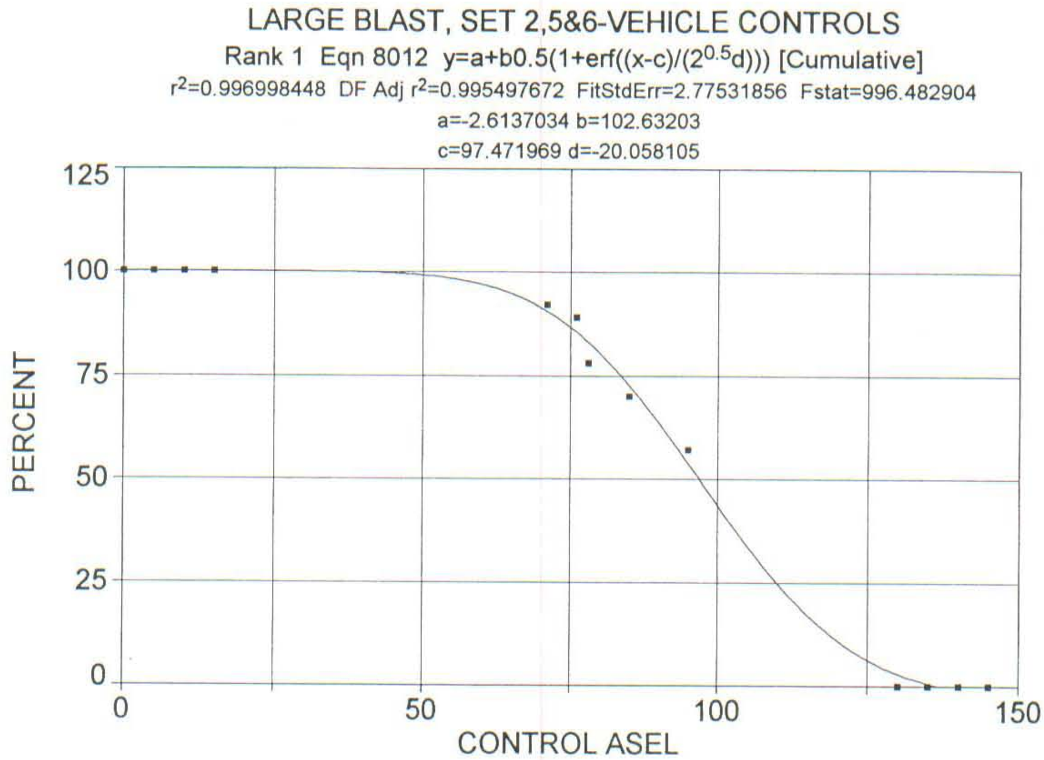

Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9969984479	0.9954976719	2.7753185641	996.48290414

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-2.61370341	2.281573523	-1.14557054	-7.79045189	2.563045065
b	102.6320261	2.833943009	36.21527525	96.20198560	109.0620666
c	97.47196945	1.691943902	57.60945700	93.63305393	101.3108850
d	-20.0581054	2.060173711	-9.73612337	-24.7325115	-15.3836993

Date	Time	File Source
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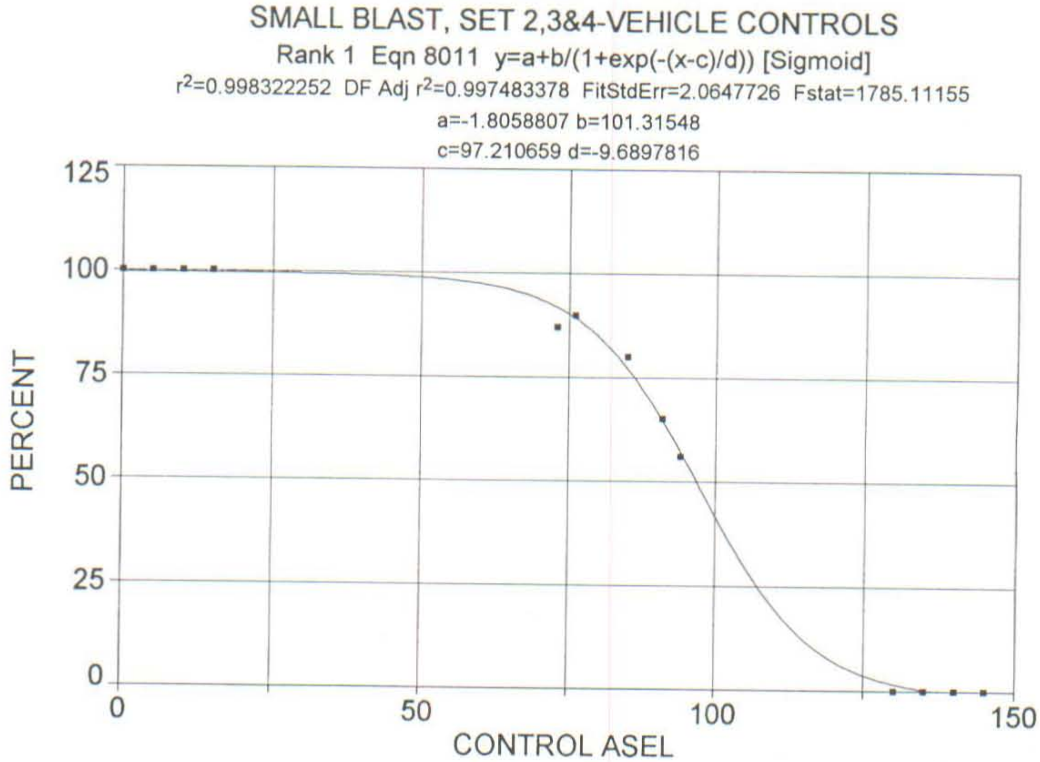
August 1992 Test Period
Outdoor Measured Acoustical Data



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9983222523	0.9974833785	2.0647726017	1785.1115539

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.80588073	1.372851446	-1.31542326	-4.92079531	1.309033850
b	101.3154757	1.870219355	54.17304414	97.07206421	105.5588871
c	97.21065857	0.951144788	102.2038493	95.05257018	99.36874696
d	-9.68978162	0.937430163	-10.3365371	-11.8167524	-7.56281086

Date	Time	File Source
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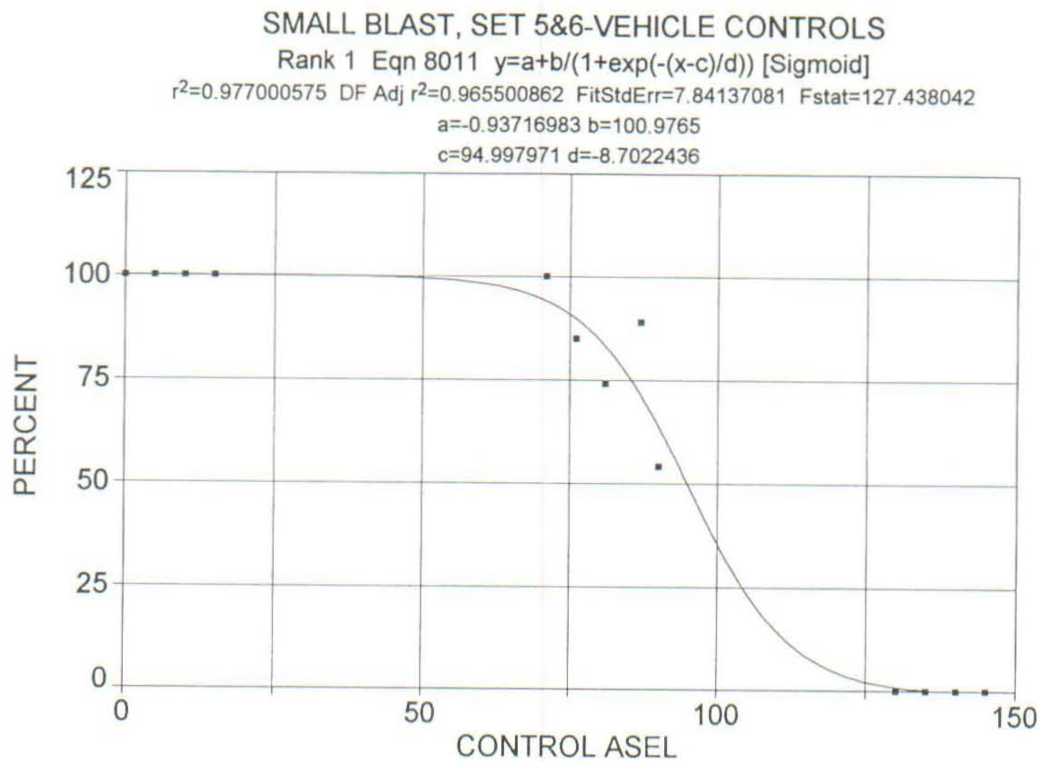
August 1992 Test Period
Outdoor Measured Acoustical Data



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9770005747	0.9655008620	7.8413708055	127.43804177

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.93716983	4.586712621	-0.20432277	-11.3441356	9.469795952
b	100.9764986	6.474508344	15.59601027	86.28624169	115.6667555
c	94.99797129	4.168436405	22.78983342	85.54004824	104.4558943
d	-8.70224364	3.710138157	-2.34553089	-17.1203165	-0.28417082

Date	Time	File Source
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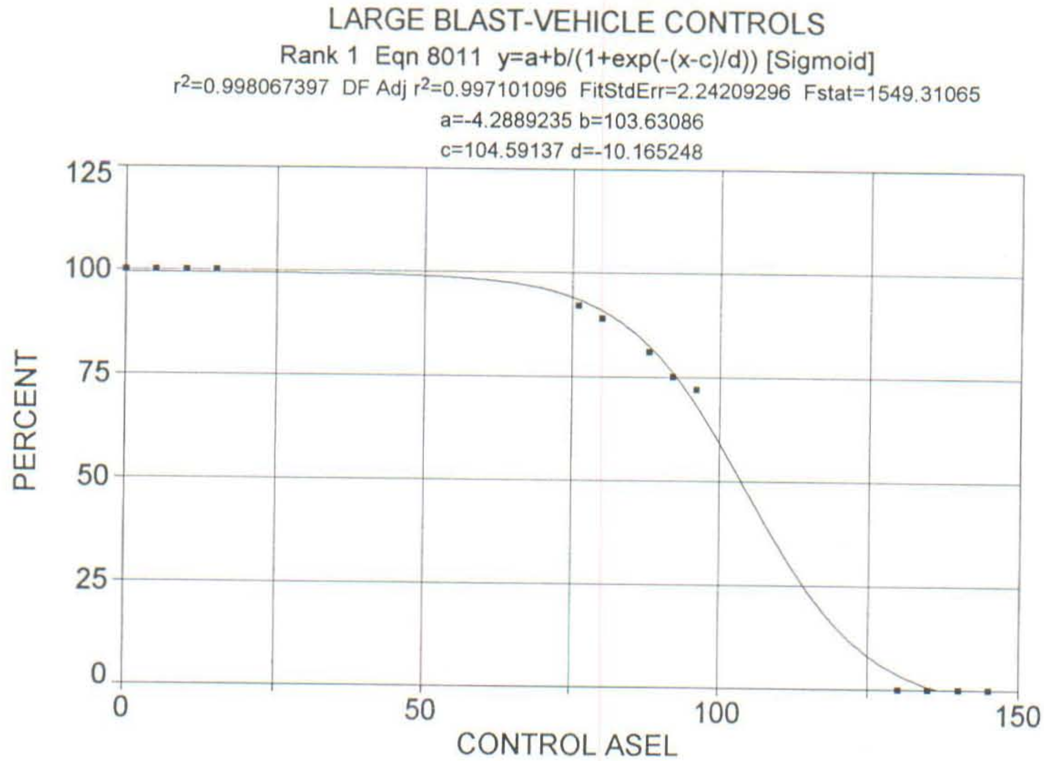
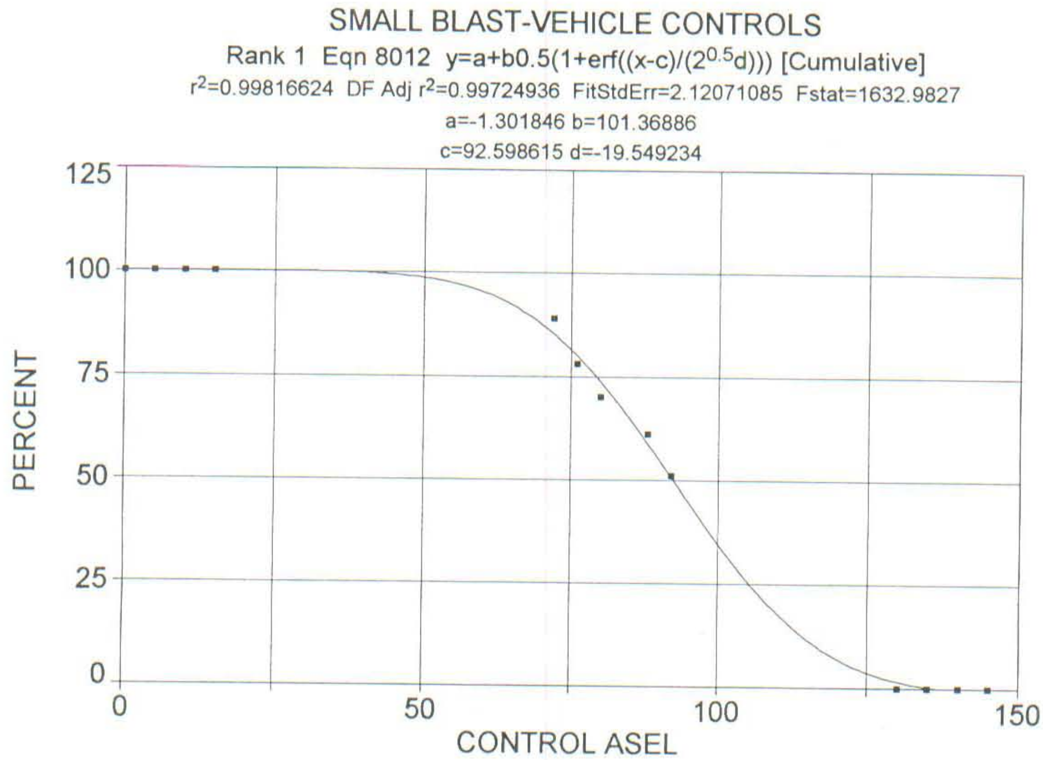


Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9980673971	0.9971010957	2.2420929594	1549.3106509

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-4.28892350	2.437113573	-1.75983735	-9.81858268	1.240735677
b	103.6308632	2.883913160	35.93411363	97.08744352	110.1742828
c	104.5913716	1.691512704	61.83303939	100.7534345	108.4293088
d	-10.1652480	1.133154883	-8.97074898	-12.7363060	-7.59419004

Date	Time	File Source
Apr 20, 1994	10:02:46 PM	c:\tcwin\augh.prn



Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9981662398	0.9972493597	2.1207108482	1632.9826974

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.30184605	1.368087886	-0.95158071	-4.40595240	1.802260314
b	101.3688639	1.808422667	56.05374549	97.26566532	105.4720625
c	92.59861535	1.014948315	91.23480868	90.29576072	94.90146998
d	-19.5492345	1.594971093	-12.2567955	-23.1681247	-15.9303442

Date	Time	File Source
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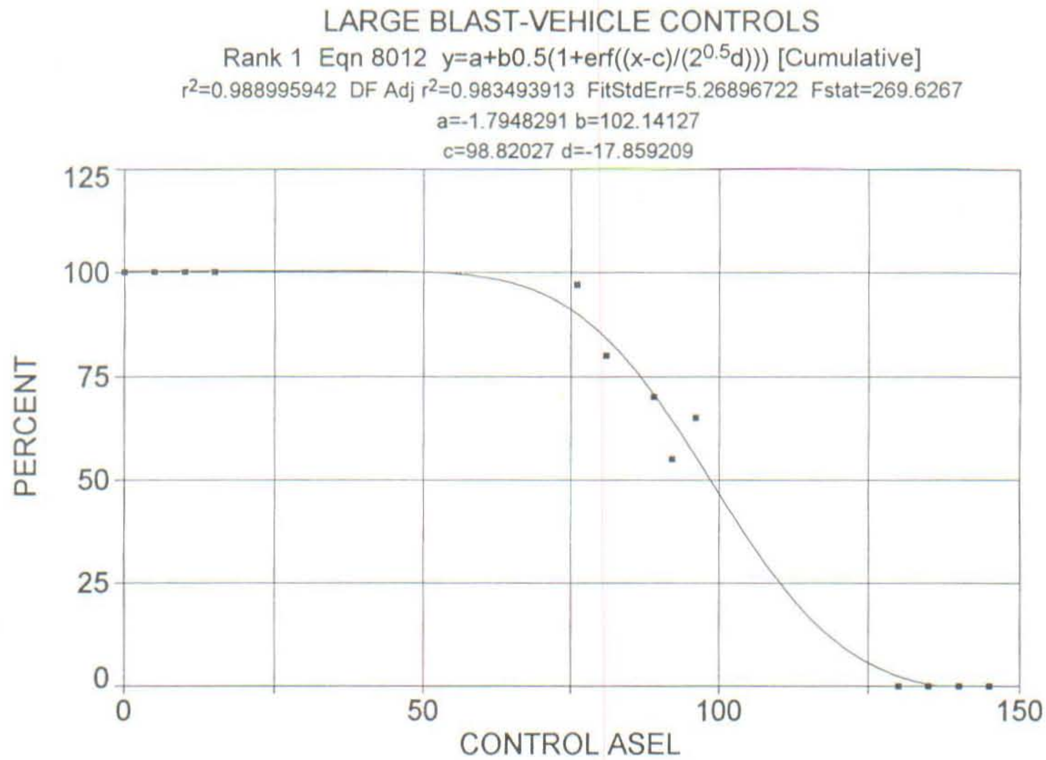
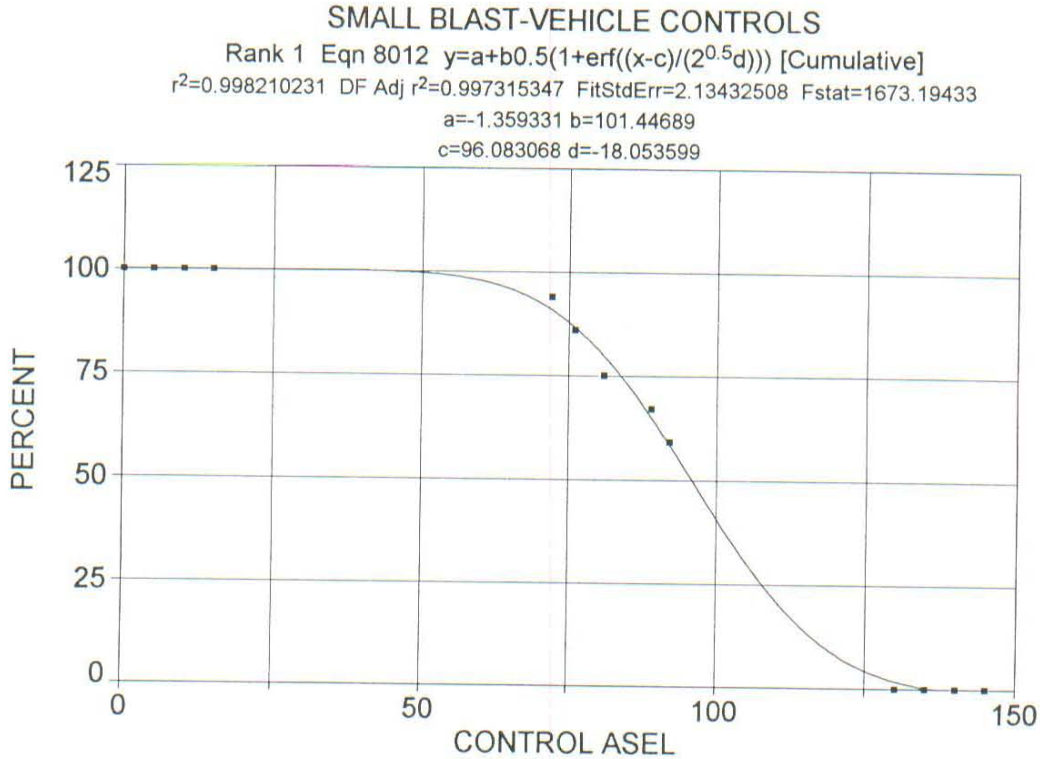


Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9889959421	0.9834939131	5.2689672156	269.62669966

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.79482915	3.853508881	-0.46576489	-10.5382012	6.948542929
b	102.1412677	4.940012266	20.67631865	90.93268702	113.3498484
c	98.82026978	2.597730694	38.04099864	92.92618034	104.7143592
d	-17.8592090	3.865459704	-4.62020313	-26.6296968	-9.08872127

Date	Time	File Source
Apr 20, 1994	10:11:49 PM	c:\tcwin\augh.prn



Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9982102314	0.9973153471	2.1343250812	1673.1943283

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-1.35933101	1.426112702	-0.95317222	-4.59509207	1.876430050
b	101.4468858	1.890482456	53.66190280	97.15749866	105.7362730
c	96.08306802	1.140333689	84.25872967	93.49572178	98.67041426
d	-18.0535987	1.603797871	-11.2567793	-21.6925164	-14.4146810

Date	Time	File Source
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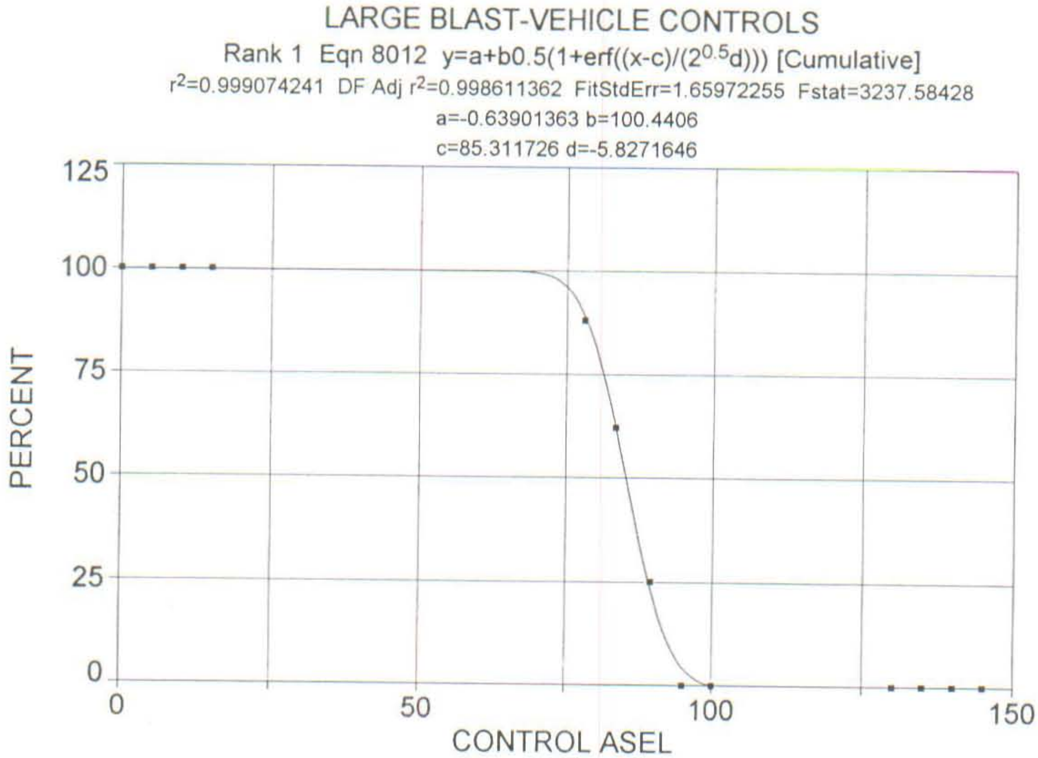


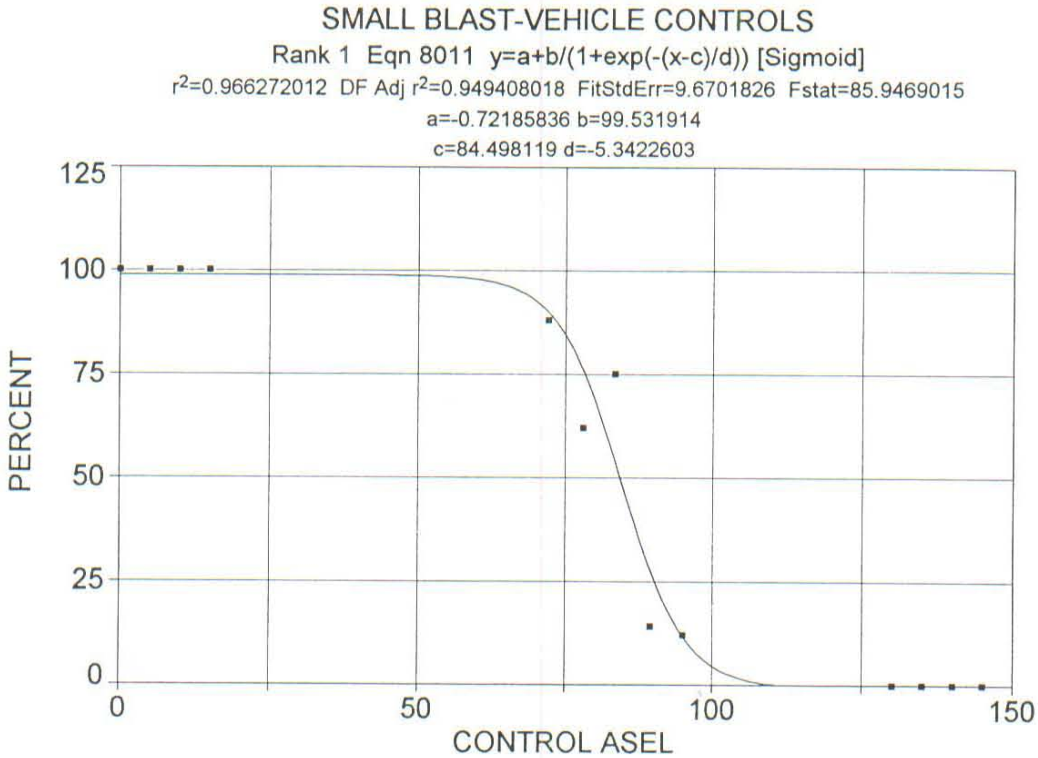
Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9990742410	0.9986113615	1.6597225463	3237.5842771

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.63901363	0.736789367	-0.86729487	-2.31074290	1.032715632
b	100.4406025	1.119077326	89.75304939	97.90148565	102.9797194
c	85.31172636	0.211520479	403.3260825	84.83179954	85.79165318
d	-5.82716462	0.278666970	-20.9108550	-6.45944265	-5.19488659

Date	Time	File Source
Sep 7, 1994	8:50:57 AM	c:\tcwin\augh.prn

June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Pressure Doubling Microphone



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9662720123	0.9494080184	9.6701825966	85.946901460

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.72185836	4.764372573	-0.15151174	-11.5319235	10.08820680
b	99.53191437	6.801090947	14.63469834	84.10066184	114.9631669
c	84.49811901	1.637881052	51.58989959	80.78186873	88.21436929
d	-5.34226032	1.406552434	-3.79812383	-8.53364035	-2.15088030

Date	Time	File Source
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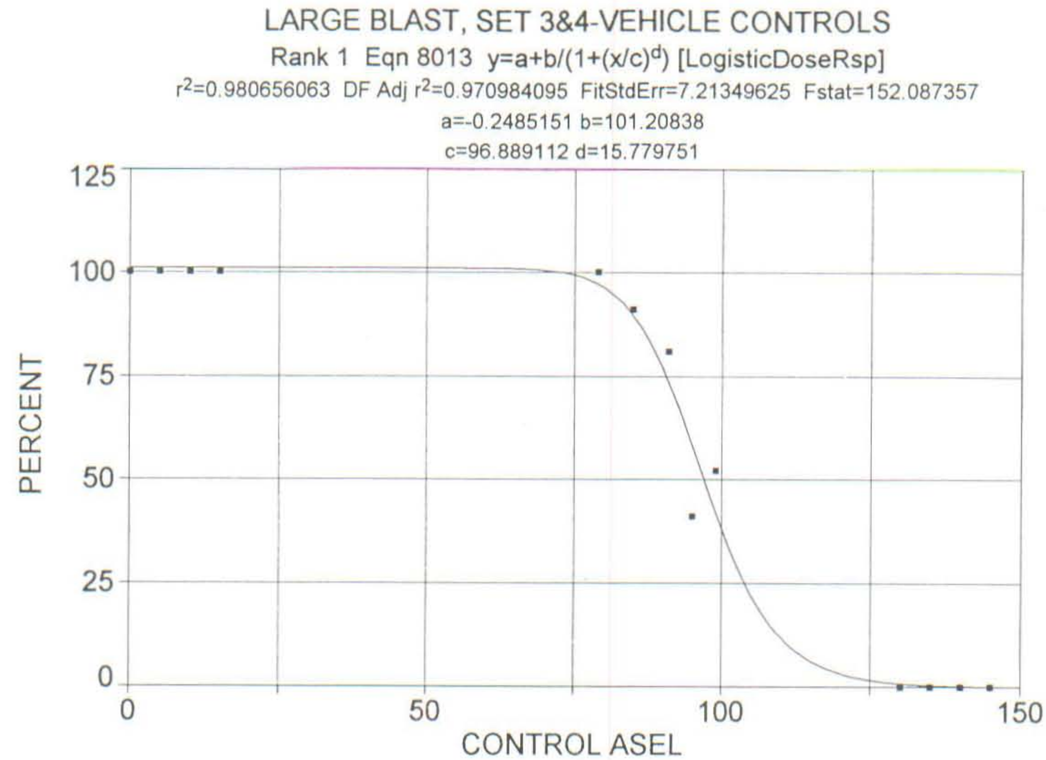
June 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Pressure Doubling Microphone



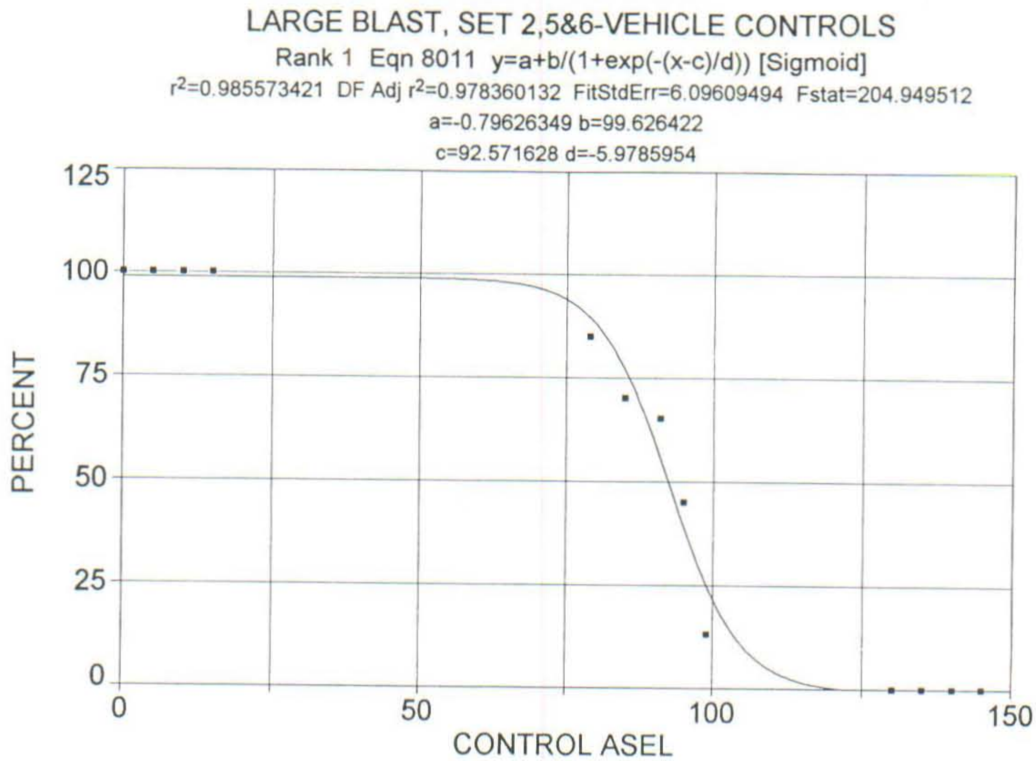
Rank 1 Eqn 8013 $y=a+b/(1+(x/c)^d)$ [LogisticDoseRsp]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9806560634	0.9709840951	7.2134962541	152.08735668

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.24851510	3.786375713	-0.06563403	-8.83956619	8.342535988
b	101.2083796	5.304724197	19.07891453	89.17229018	113.2444690
c	96.88911173	1.378430238	70.28945614	93.76153922	100.0166842
d	15.77975070	4.267778962	3.697415175	6.096425567	25.46307584

Date	Time	File Source
Sep 7, 1994	9:33:04 AM	c:\tcwin\augh.prn

August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Pressure Doubling Mircophone



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9855734213	0.9783601319	6.0960949408	204.94951190

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.79626349	3.063999011	-0.25987720	-7.74828676	6.155759772
b	99.62642174	4.327746373	23.02039287	89.80703428	109.4458092
c	92.57162818	1.042107755	88.83114794	90.20715047	94.93610589
d	-5.97859539	1.061087937	-5.63440143	-8.38613795	-3.57105283

Date	Time	File Source
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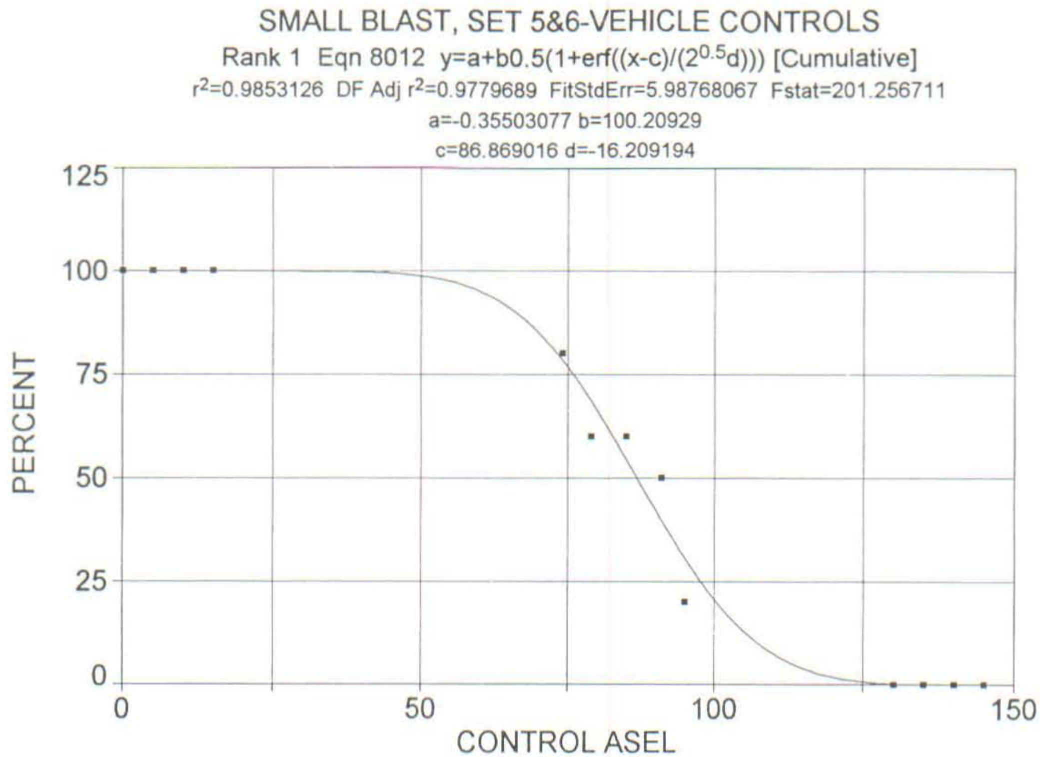
August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Pressure Doubling Mircophone



Rank 1 Eqn 8012 $y=a+b0.5(1+erf((x-c)/(2^{0.5}d)))$ [Cumulative]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9853126001	0.9779689001	5.9876806705	201.25671090

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.35503077	3.064193928	-0.11586433	-7.30749629	6.597434747
b	100.2092875	4.311333994	23.24322070	90.42713875	109.9914363
c	86.86901606	1.561557821	55.62971469	83.32593844	90.41209367
d	-16.2091941	2.908608740	-5.57283416	-22.8086465	-9.60974173

Date	Time	File Source
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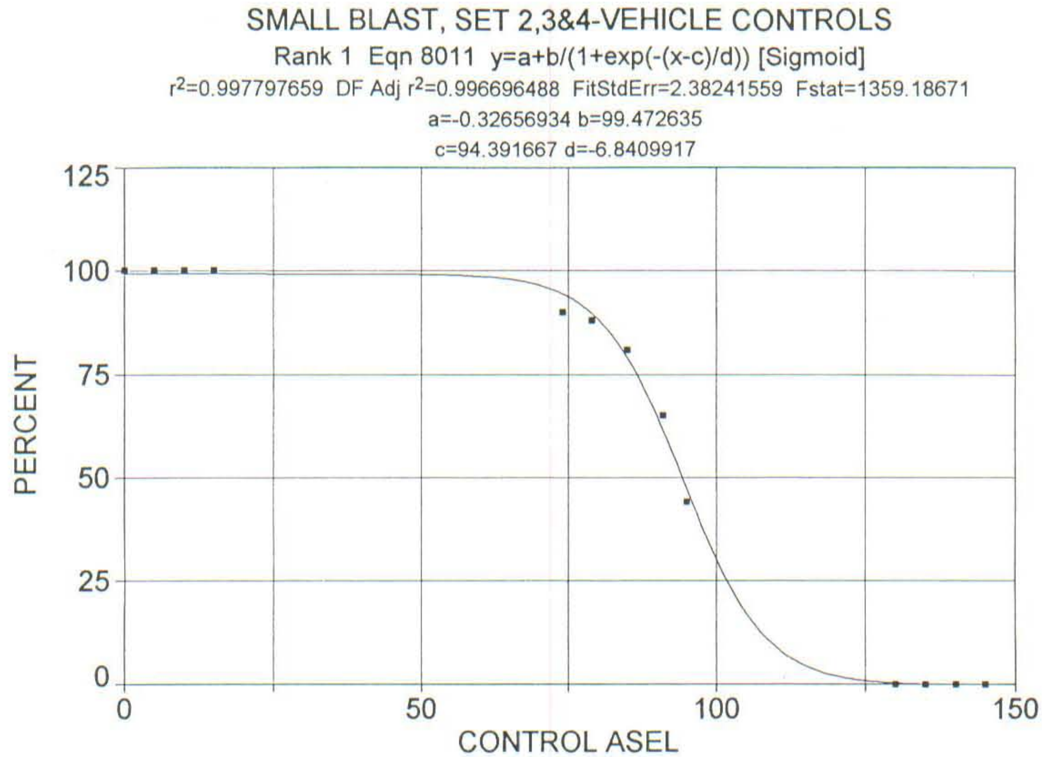
August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Pressure Doubling Mircophone



Rank 1 Eqn 8011 y=a+b/(1+exp(-(x-c)/d)) [Sigmoid]

r^2 Coef Det	DF Adj r^2	Fit Std Err	F-value
0.9977976587	0.9966964881	2.3824155868	1359.1867084

Parm	Value	Std Error	t-value	95% Confidence Limits	
a	-0.32656934	1.216762396	-0.26839204	-3.08732757	2.434188885
b	99.47263489	1.718812468	57.87288417	95.57275626	103.3725135
c	94.39166734	0.568437916	166.0544884	93.10191705	95.68141764
d	-6.84099171	0.657476032	-10.4049294	-8.33276395	-5.34921947

Date	Time	File Source
Sep 7, 1994	10:02:40 AM	c:\tcwin\augh.prn

August 1992 Test Period-Outdoor Subjects
Outdoor Measured Acoustical Data
at the Pressure Doubling Mircophone

Acronyms

ADNL	A-weighted day-night sound level
ANSI	American National Standards Institute
APG	Aberdeen Proving Ground, MD
ASEL	A-weighted sound exposure level
B&K	Brüel and Kjær
CCMS	Command Control and Monitor System
CDNL	C-weighted day-night sound level
CEC	Council of European Communities
CSEL	C-weighted sound exposure level
DoD	Department of Defense
HVAC	heating, ventilating, and air conditioning
NATO	North Atlantic Treaty Organization
SEL	sound exposure level
USACERL	U.S. Army Construction Engineering Research Laboratories