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ENGINEERING DEPARTMENT
LOUVIERS BUILDING

October 10, 1977

Dr. Sergio Piomelli
Director, Pediatric Hematology
New York University Medical Center
550 First Avenue
New York, NY 10016

Dear Dr. Piomelli:

Dr. Jacobs sent me copies of your charts which summarize analyses that you have made of the Azar data. He indicated that you wished for me to review these charts and comment on the results. As you well appreciate, this is difficult to do since you did not provide any written discussion regarding the objectives of your analyses or the assumptions of your model. With these reservations, I will attempt to review your findings.

You point out that the B coefficients in my model show a correlation with air lead and derive the following model.

$$\text{Blood Lead} = 12.1\ (\text{Air Lead} + .62 + .98\ \text{Air Lead})^{0.2669}$$

which can be written as

$$\text{Blood Lead} = 14.5\ (\text{Air Lead} + .32)^{0.2669}$$

In your model you have assigned all the variation in blood lead to air lead and have ignored the fact that the five groups of subjects had different amounts of lead exposure from other non-air sources. In the two analyses which I reported (1972, 1977), significant ($p<0.01$) group-to-group differences were found. I believe that any model which does not take this fact into account is not an appropriate model for the data. In order to draw valid conclusions, the model must be descriptive of the physical situation.

The five groups of subjects in the Azar study differed in many ways (e.g. occupation, diet, socioeconomic, ethnic) besides air lead exposure level. A review of our record shows that the race distribution of the 30 Philadelphia cab drivers was 16 black and 14 white. Some of the Los Angeles cab drivers were Mexican-Americans. As you know, recent studies have shown socioeconomic, environment, diet, occupation, and ethnic variables to have significant effects on blood lead levels. One has to conclude that it is not reasonable to attribute all of the observed blood lead variation to air lead differences. Any attempt to do so is an oversimplification of the true situation.

Additional details and comments are attached. I appreciate the opportunity to comment on your analysis. Please contact me if you feel that further discussion would be useful.

Very truly yours,

ENGINEERING SERVICE DIVISION

Ronald D. Snee

R. D. Snee, Consultant Supervisor
Applied Statistics

chm

Atch

CC: Dr. F. G. Hueter
Dr. V. Hasselblad

Dr. Piomelli's Analysis

Dr. Piomelli observed that the B coefficients in Equation (3) showed a positive correlation with air lead level. He described this correlation with the linear equation

$$B = 0.6249 + 0.9828 \text{ Air Pb} \qquad (5)$$

and rewrote Equation (4) as

$$\text{Blood Pb} = 12.1(\text{Air Pb}+0.6249+0.9828 \text{ Air Pb})^{0.2669}$$

$$= 14.5(\text{Air Pb}+0.32)^{0.2669} \qquad (6)$$

Dr. Piomelli's Equation 6 is similar to Equation 3; however, it assigns all the variation in blood lead to air lead and ignores the fact that the different groups had significantly ($p<.01$) different amounts of lead exposure from other sources. The result of Dr. Piomelli's assumption is shown in Figure 1 which is a plot of Equations 3,4, and 6. The analyses associated with both Equations 1 and 3 indicated that there were significant ($p<.01$) group differences after the effect of air lead was taken into account. It seems reasonable to conclude that any model which does not take this fact into account is not an appropriate model for the data. It is unlikely that valid conclusions can be drawn from a model which isn't descriptive of the physical situation.

TEH 0470657

REFERENCES

1. Azar, A., R. D. Snee, and K. Habibi, "Relationship of Community Levels of Air Lead and Indices of Lead Absorption", Proceedings of the International Symposium Environmental Health Aspects of Lead, Amsterdam, 581-594 (1972).

2. Azar, A., R. D. Snee, and K. Habibi, "An Epidemiological Approach to Community Air Lead Exposure Using Personal Air Samples", Environmental Quality and Safety, Supplement Vol II. Lead, 152-196 (1975).

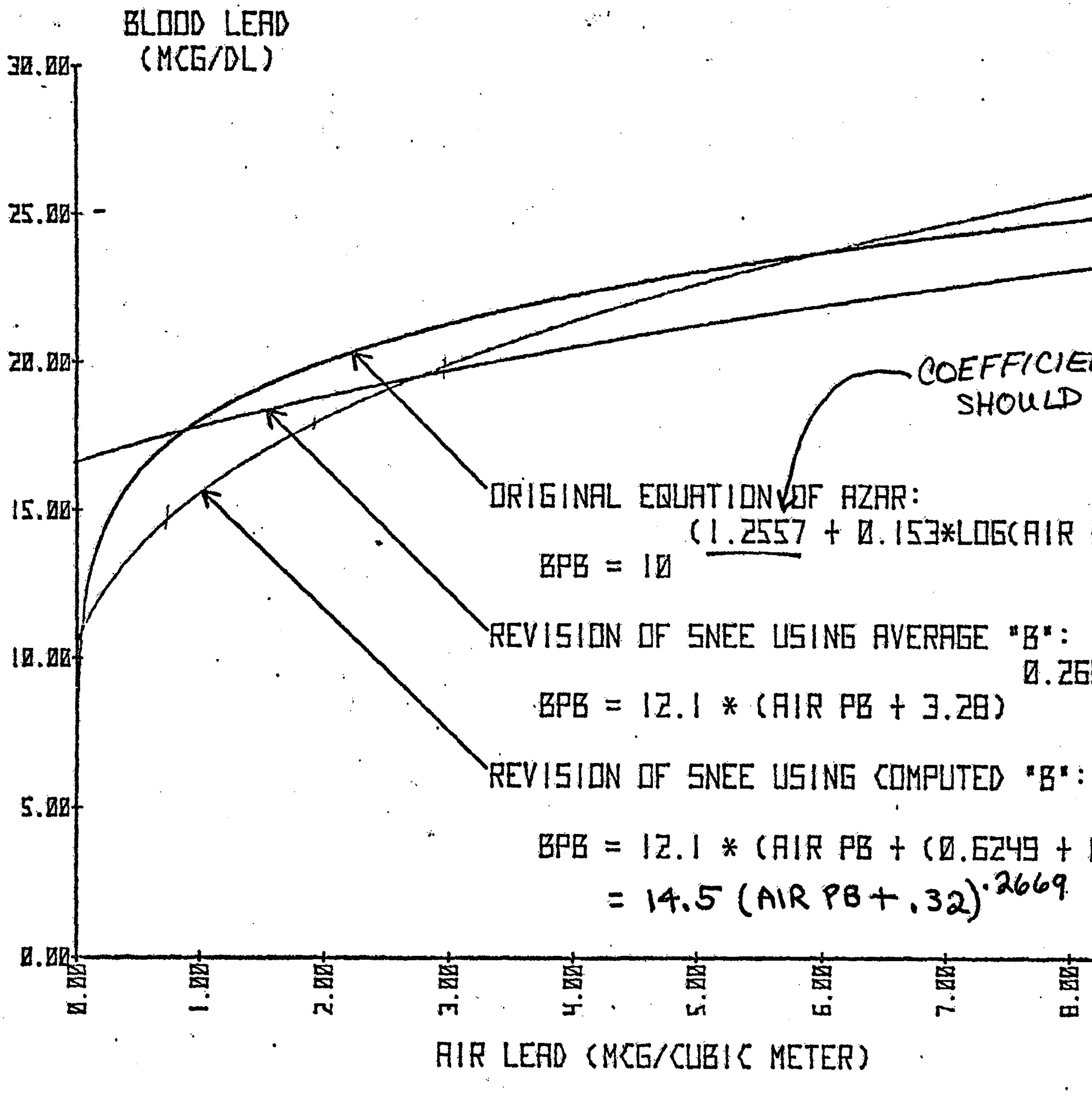
3. McCaughran, D. A., "Air Lead-Blood Lead Models", Presented at the International Conference of Heavy Metals in the Environment, Toronto, Ontario, Canada (1975).

4. Snee, R. D., "Development of An Air Quality Value for Lead from Community Studies", Report No. PLMR-3-77, Petroleum Laboratory, E. I. du Pont de Nemours & Co, Wilmington, Delaware (1/20/77).

5. Snee, R. D., "Evaluation of Studies of the Relationship between Blood Lead and Air Lead, Report No. PLMR-8-77, Petroleum Laboratory, E. I. du Pont de Nemours & Co, Wilmington, Delaware (4/7/77).

APPENDIX

TABLES AND GRAPHS
SUMMARIZING DR. PIOMELLI'S ANALYSIS
OF BLOOD LEAD AND AIR LEAD
DATA REPORTED BY AZAR ET AL.


BLOOD LEAD
(MCG/DL)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
COEFFICIE
SHOULD
ORIGINAL EQUATION OF AZAR:
(1.2557 + 0.153*LOG(AIR
BPB = 10
REVISION OF SNEE USING AVERAGE "B":
0.26
BPB = 12.1 * (AIR PB + 3.28)
REVISION OF SNEE USING COMPUTED "B":
BPB = 12.1 * (AIR PB + (0.6249 +
= 14.5 (AIR PB + .32)^.2669
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
AIR LEAD (MCG/CUBIC METER)

```
10 DEF FNF(X)=10↑(1.2557+0.153*LGT(I))
20 FOR I=0.00000001 TO 10 STEP 0.2
30 A=FNF(I)
35 I=I+1
36 B=FNF(I)
37 I=I-1
50 C=B-A
55 FIXED 1
60 PRINT I,A,C,TAB35,C
70 NEXT I
80 END
```

Original equation Azar paper

RUN

Air Pb	b/Pb	Increase per 1µg/m3
0.0 (0.0000001)	1.1	16.9
0.2	14.1	4.4
0.4	15.7	3.3
0.6	16.7	2.7
0.8	17.4	2.3
1.0	18.0	2.0
1.2	18.5	1.8
1.4	19.0	1.6
1.6	19.4	1.5
1.8	19.7	1.4
2.0	20.0	1.3
2.2	20.3	1.2
2.4	20.6	1.1
2.6	20.9	1.1
2.8	21.1	1.0
3.0	21.3	1.0
3.2	21.5	0.9
3.4	21.7	0.9
3.6	21.9	0.8
3.8	22.1	0.8
4.0	22.3	0.8
4.2	22.4	0.7
4.4	22.6	0.7
4.6	22.8	0.7
4.8	22.9	0.7
5.0	23.0	0.7
5.2	23.2	0.6
5.4	23.3	0.6
5.6	23.5	0.6
5.8	23.6	0.6
6.0	23.7	0.6
6.2	23.8	0.6
6.4	23.9	0.5
6.6	24.0	0.5
6.8	24.2	0.5
7.0	24.3	0.5
7.2	24.4	0.5
7.4	24.5	0.5
7.6	24.6	0.5
7.8	24.7	0.5
8.0	24.8	0.5
8.2	24.9	0.4
8.4	25.0	0.4
8.6	25.0	0.4
8.8	25.1	0.4
9.0	25.2	0.4
9.2	25.3	0.4
9.4	25.4	0.4
9.6	25.5	0.4
9.8	25.5	0.4

```
10 DEF FNF(X)=12.1*(X+(3.28))↑0.2669
20 FOR I=0 TO 10 STEP 0.2
30 A=FNF(I)
40 B=FNF(I+1)
50 C=B-A
55 FIXED 1
60 PRINT I,A;TAB35;C
70 NEXT I
80 END
```

Average "B"
Snee's revision.

Air Pb RUN	Bl Pb	Increase for 1 µg/m³
0.0	16.6	1.2
0.2	16.9	1.2
0.4	17.1	1.1
0.6	17.4	1.1
0.8	17.6	1.1
1.0	17.8	1.0
1.2	18.1	1.0
1.4	18.3	1.0
1.6	18.5	0.9
1.8	18.7	0.9
2.0	18.9	0.9
2.2	19.1	0.9
2.4	19.2	0.9
2.6	19.4	0.8
2.8	19.6	0.8
3.0	19.8	0.8
3.2	19.9	0.8
3.4	20.1	0.8
3.6	20.2	0.7
3.8	20.4	0.7
4.0	20.6	0.7
4.2	20.7	0.7
4.4	20.8	0.7
4.6	21.0	0.7
4.8	21.1	0.7
5.0	21.3	0.7
5.2	21.4	0.6
5.4	21.5	0.6
5.6	21.7	0.6
5.8	21.8	0.6
6.0	21.9	0.6
6.2	22.1	0.6
6.4	22.2	0.6
6.6	22.3	0.6
6.8	22.4	0.6
7.0	22.5	0.6
7.2	22.7	0.6
7.4	22.8	0.6
7.6	22.9	0.5
7.8	23.0	0.5
8.0	23.1	0.5
8.2	23.2	0.5
8.4	23.3	0.5
8.6	23.4	0.5
8.8	23.5	0.5
9.0	23.6	0.5
9.2	23.7	0.5
9.4	23.8	0.5
9.6	23.9	0.5

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Computed "B"
Snee's revision

```
LIST

10 DEF FNF(X)=12.1*(X+(0.6249+(0.9828*X)))↑0.2669
20 FOR I=0 TO 10 STEP 0.2
30 A=FNF(I)
40 B=FNF(I+1)
50 C=B-A
55 FIXED 1
60 PRINT I,A,TAB35,C
70 NEXT I
80 END
```

Air Pb | bl Pb | Increase for 1 µg/m3

```
RUN
 0.0          10.7          5.0
 0.2          12.2          4.1
 0.4          13.3          3.5
 0.6          14.2          3.1
 0.8          15.0          2.8
 1.0          15.6          2.5
 1.2          16.2          2.4
 1.4          16.8          2.2
 1.6          17.3          2.0
 1.8          17.7          1.9
 2.0          18.2          1.8
 2.2          18.6          1.7
 2.4          19.0          1.7
 2.6          19.3          1.6
 2.8          19.7          1.5
 3.0          20.0          1.5
 3.2          20.3          1.4
 3.4          20.6          1.4
 3.6          20.9          1.3
 3.8          21.2          1.3
 4.0          21.5          1.2
 4.2          21.7          1.2
 4.4          22.0          1.2
 4.6          22.2          1.1
 4.8          22.5          1.1
 5.0          22.7          1.1
 5.2          22.9          1.0
 5.4          23.1          1.0
 5.6          23.3          1.0
 5.8          23.6          1.0
 6.0          23.8          1.0
 6.2          24.0          0.9
 6.4          24.1          0.9
 6.6          24.3          0.9
 6.8          24.5          0.9
 7.0          24.7          0.9
 7.2          24.9          0.8
 7.4          25.1          0.8
 7.6          25.2          0.8
 7.8          25.4          0.8
 8.0          25.6          0.8
 8.2          25.7          0.8
 8.4          25.9          0.8
 8.6          26.0          0.7
 8.8          26.2          0.7
 9.0          26.4          0.7
 9.2          26.5          0.7
 9.4          26.6          0.7
 9.6          26.8          0.7
 9.8          26.9          0.7
 10.0         27.1          0.7
STOP
```

Estimates from Azar, Snee, Habibi Study

	Original equation(1)		Average "B"(2)		"B" from regression(3)	
Air Pb	Blood Pb	Increase for 1μg/m³ increase	Blood Pb	Increase for 1μg/m³ increase	Blood Pb	Increase for 1μg/m³ increase
0.2	14.1	4.4	16.9	1.2	12.2	4.1
1.2	18.5	1.8	18.1	1.0	16.2	2.4
2.2	20.3	1.2	19.1	0.9	18.6	1.7
3.2	21.5	0.9	19.9	0.8	20.3	1.4
4.2	22.4	0.7	20.7	0.7	21.7	1.2
5.2	23.2	0.6	21.4	0.6	22.9	1.0
6.2	23.8	0.6	22.1	0.6	24.0	0.9
7.2	24.4	0.5	22.7	0.6	24.9	0.8
8.2	24.9	0.4	23.2	0.5	25.7	0.8
9.2	25.3	0.4	23.7	0.5	26.5	0.7

COEFFICIENT IN ERROR - SHOULD BE 1.2257

1) From original paper
   Blood Pb = antilog (1.2557 + 0.153 log Air Pb)
   Estimate of blood Pb at air Pb=0 is not possible

   at air Pb=1×10^{-8} blood Pb = 1.1

2) From Snee April 1977
   Blood Pb = 12.1 (Air Pb + 3.28)$^{0.2669}$
   At air Pb=0, blood Pb = 16.6

3) From Snee April 1977, considering that "B" is a function of Air Pb.
   B = 0.6249 + 0.9828 Air Pb
   This formula is derived by linear regression from "B" values of Snee April 1977 and Air Pb of original study.
   Blood Pb = 12.1 [Air Pb + (0.6249 + 0.9828 Air Pb)]$^{0.2669}$
   At Air Pb = 0, blood Pb = 10.7

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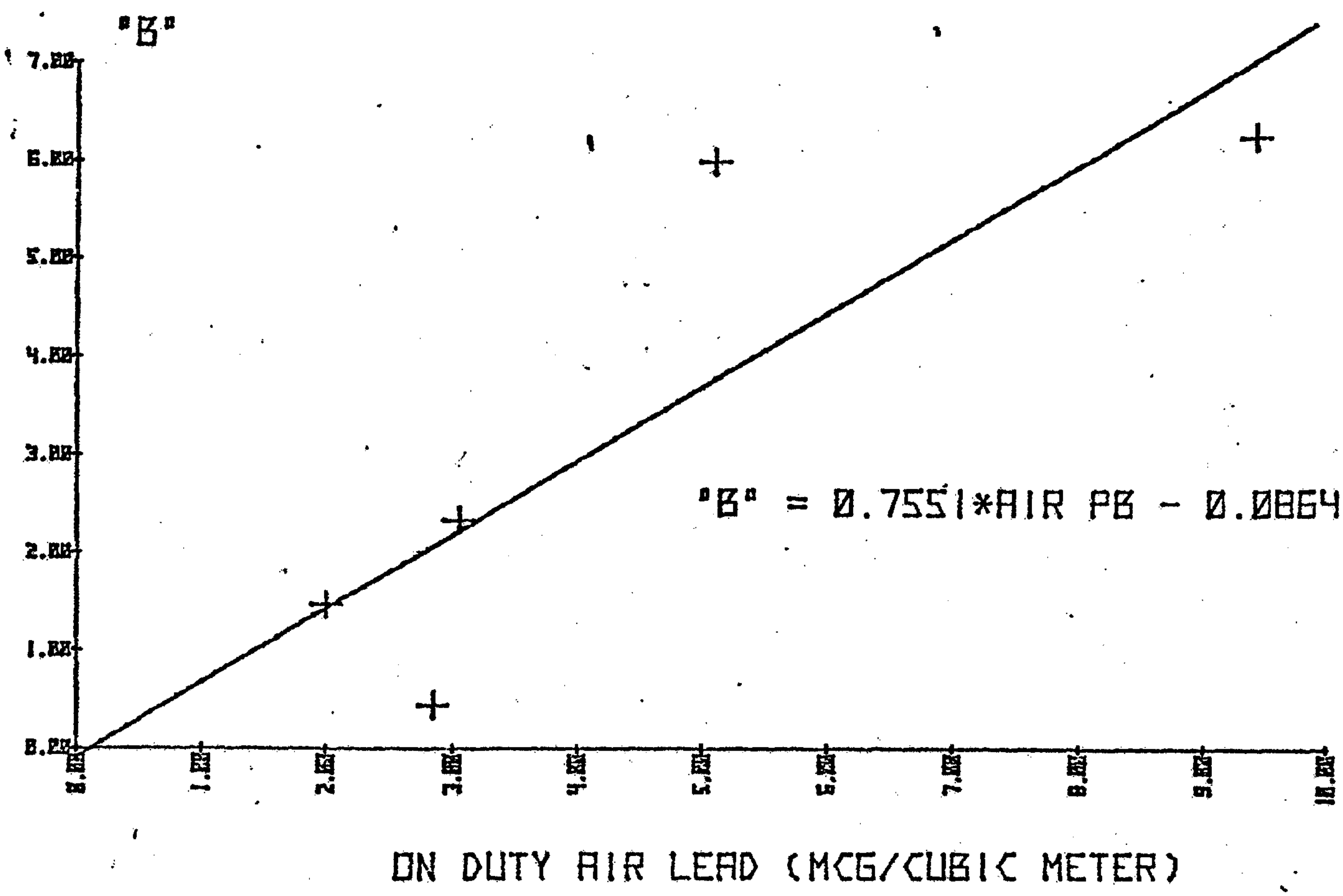
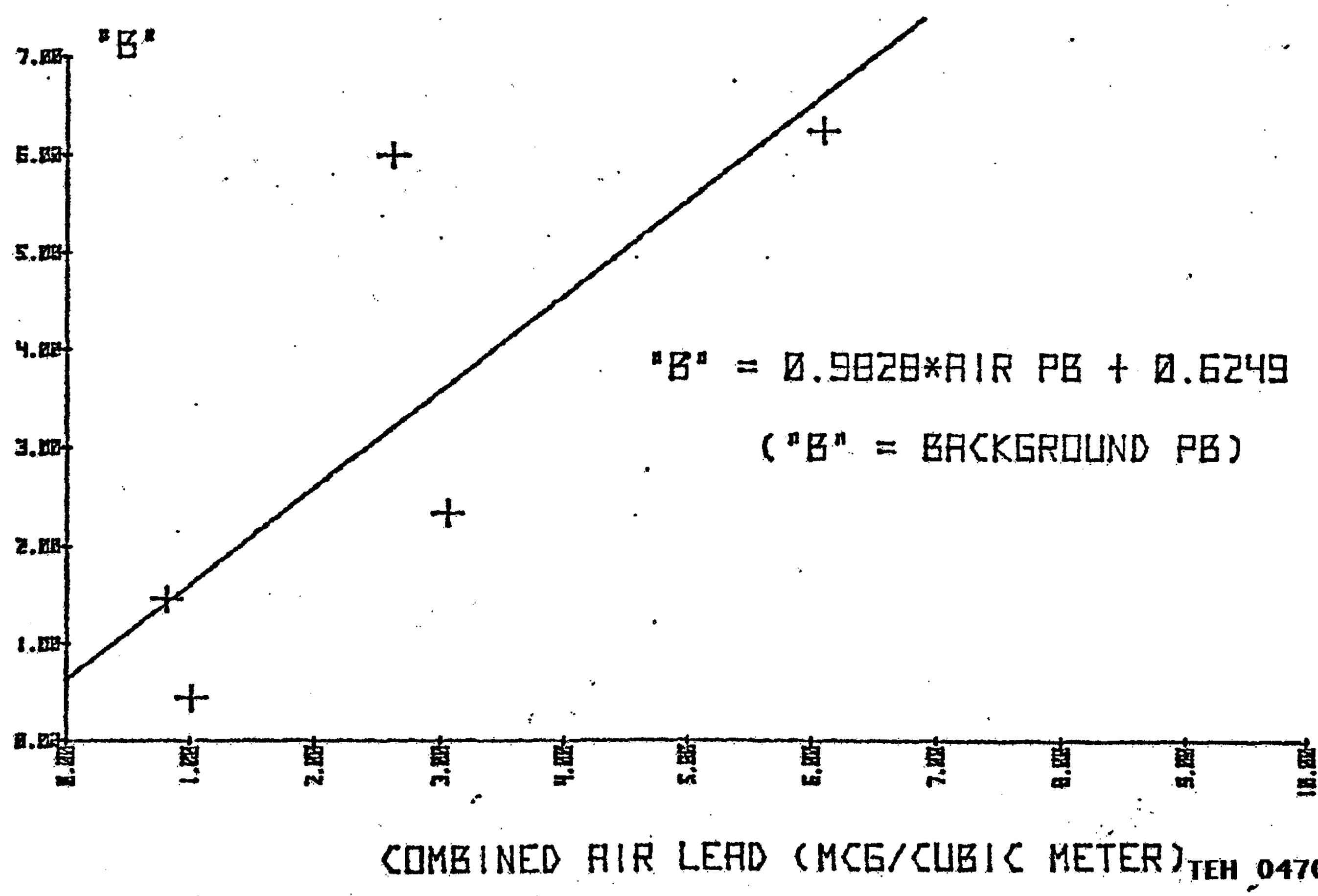




TEH 0470665

DUP050083482

PT.NO.	X	Y
1	1.0100	0.4400
2	0.8100	1.4600
3	3.0600	2.3300
4	2.6200	6.0000
5	6.1000	6.2600

NO. POINTS = 5

X: MEAN= 2.72 ST.DEV.= 2.128588868
Y: MEAN= 3.298 ST.DEV.= 2.671969311

Combined Air Pb = x
"B" = y

CORR.COEFF.= 0.782883245

COEFFICIENTS

B(0)= 0.6249
B(1)= 0.9828

"B" = .9828 * AIR PB + 0.6249

R SQUARE = 0.612906175

PT.NO.	X	Y
1	2.8400	0.4400
2	2.0000	1.4600
3	3.0500	2.3300
4	5.1000	6.0000
5	9.4200	6.2600

NO. POINTS = 5

X: MEAN= 4.482 ST.DEV.= 2.986338896
Y: MEAN= 3.298 ST.DEV.= 2.671969311

On Duty Air Pb = x
"B" = y

CORR.COEFF.= 0.843957570

COEFFICIENTS

B(0)= -0.0864
B(1)= 0.7551

"B" = .7551 * AIR PB − .0864

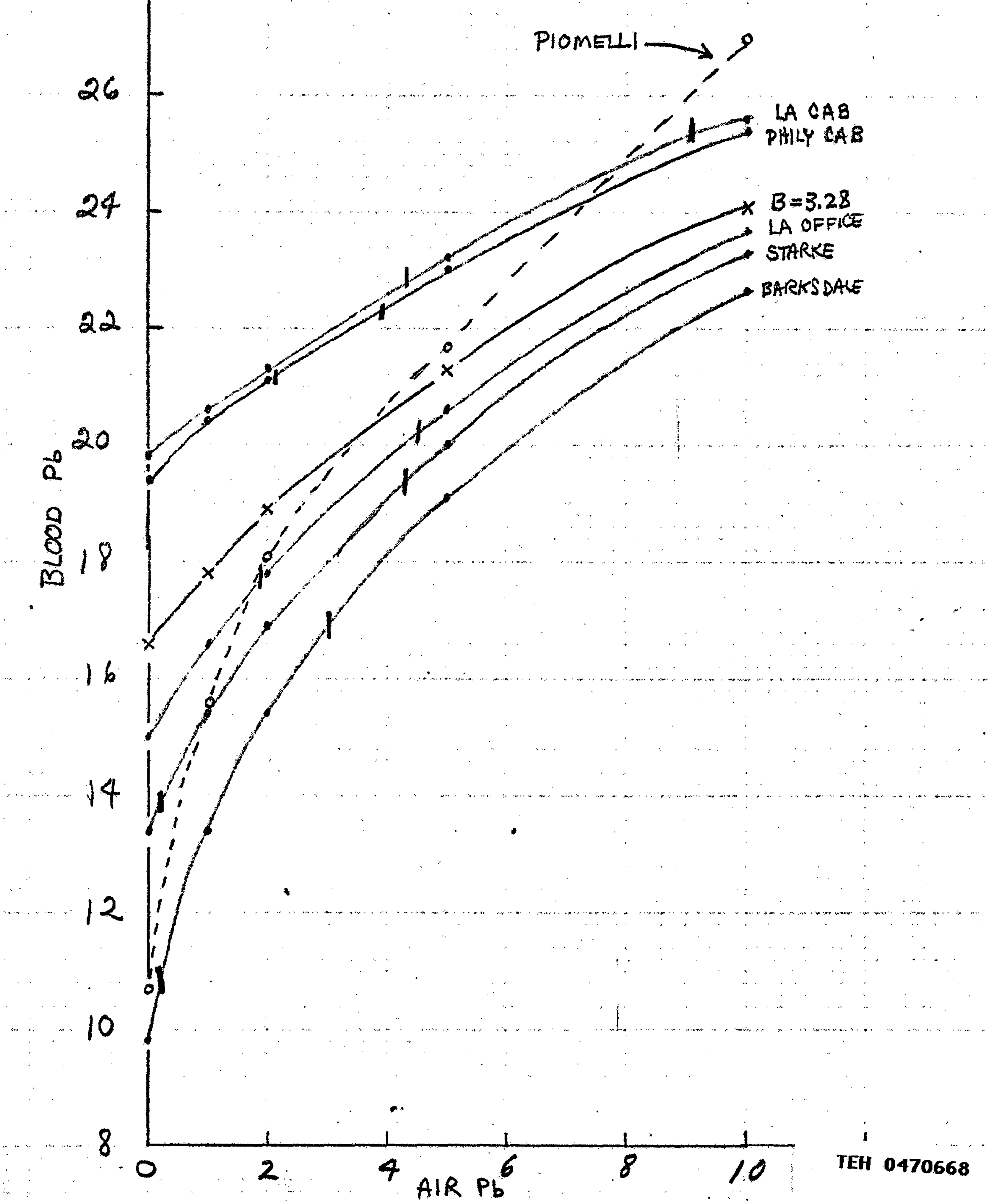
R SQUARE = 0.712264380

TEH 0470666

DUP050083483

```
R= 0.782893245    AND N= 5

T=      2.1795,DF=        3

BY ONE-TAILED T TEST:
PROB T GREATER THAN        2.1795=   0.0587

BY TWO-TAILED T TEST:
PROB T GREATER THAN        2.1795=   0.1174


R= 0.84395757    AND N= 5

T=      2.7251,DF=        3

BY ONE-TAILED T TEST:
PROB T GREATER THAN        2.7251=   0.0361

BY TWO-TAILED T TEST:
PROB T GREATER THAN        2.7251=   0.0722
```

FIGURE 1



TEH 0470668

DUP050083485