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TO: R. D. SNEE

FROM: C. G. PFEIFER CGP

COMMENTS REGARDING APPROPRIATENESS OF THE AIR-LEAD STANDARD

In response to your request, I have reviewed the memo of August 21, 1981, from E. S. Jacobs to A. J. Pahnke which outlined Jerry Cole's argument to convince the EPA to reconsider the air quality standard of lead. I first discuss another argument which I feel may be more compelling than Cole's and then comment on Cole's argument. I would appreciate your comments.

Below is a summary of the assumptions used by the EPA in setting the air-lead standard.

- BPb is distributed lognormally.
- Geometric Mean wo/air-lead exposure = 12
- Geometric Standard Deviation = 1.3
- $\alpha = \frac{dBPb}{dAPb} = 2$
- Standard should keep 99.5% of population below safe BPb level.

Fig. 1 summarizes these computations. The lower line reflects the geometric mean (or 50th percentile) blood-lead value, B_{50}, as a function of air lead. Note $\alpha = 2$ represents the slope of this line. Under the lognormal assumption, the upper line expresses the 99.5th percentile of the blood-lead distributions as a function of air lead. (The general equation for the pth percentile can be shown to be $B_p = 12(1.3)^{z_p} + 2(1.3)^{z_p}(APb)$ where z_p is the pth percentile of the standard normal distribution.) The important thing to note about the $B_{99.5}$-line is that the slope of 3.9 is greater than 2, as will be all slopes for B_i, $i>50$.

What the slope of 3.9 implies is that an individual with a blood lead of 23.6 under no air-lead exposure will increase 3.9 μg/dl for every unit increment of air lead (μg/m^3). If $\alpha = 2$ is supposed to apply to all blood-lead values (and not just the geometric mean value), then this observation contradicts EPA's assumptions. If $\alpha = 2$, in fact, applies to all blood-lead values (and I assume the EPA intended it to for otherwise they would have to justify that α is an increasing function of blood lead for small air-lead increments above zero), then EPA's standard setting procedure can be applied to any blood-lead percentile. For example, under the very conservative assumption that

$\alpha = 2$, a blood-lead value of 23.6 could increase to 30.0 under air-lead exposure. Thus the appropriate air-lead exposure is $(30.0-23.6)/2 = 3.2\ \mu g/m^3$.

If, on the other hand, $\alpha = 2$ was intended to apply to only the geometric mead blood lead, then Hammond's results clearly demonstrate that EPA's implicit assumption that α increases with increasing blood lead is incorrect.

In my opinion the foregoing argument is more compelling for a reconsideration of the air-lead standard than Jerry Cole's because

- it demonstrates inconsistencies in the EPA procedure.
- for "better or worse" it uses the EPA procedure.
- the air-lead standard is underestimated by more than a factor of 2 even if $\alpha = 2$.
- if Hammond's results are pertinent, it depends only on the qualitative result that α is a decreasing function of blood level and not the quantitative value of α (although it still may be argued that an $\alpha<2$ for a blood lead at 23.6 is appropriate).
- it is more straightforward.

While on the surface Cole's argument may not seem unlike the one presented above, his apparently depends on more assumptions and at this point it is not entirely clear what these assumptions are. For example, Cole's argument uses values from Hammond's Fig. 4 which depends on the functional relationship established between blood lead and air lead using the Box-Cox transformation on the Azar, et al data. It is not clear how the blood lead value from this relationship relates to any blood lead percentiles at a given air-lead value. This is important because Cole presumes the Figure 4 relationships apply to 99.5th percentile of the blood-lead distribution. This may be far from correct. (Recall, from above an α value of 2 at 50th percentile (12 $\mu g/dl$) changed to an α value of 3.9 at the 99.5th percentile. Furthermore, the functional relationship does not express either the mean or geometric mean blood lead at a given air lead. This is because of the transformation used. To illustrate how a transformation can affect the interpretation of a regression line, suppose a variable Y has lognormal distribution at each X. Usually, then, one regresses LnY on X and then exponentiates the resulting equation to express Y (alone) as a function of X. The resulting equation expresses the geometric Y-mean relationship as a function of X - not the arithmetic mean as first thought might suggest. Thus, using the Box-Cox transformation, we can't presume that Hammond's equation 1 relates a geometric mean blood lead to air lead.

CGP/gb

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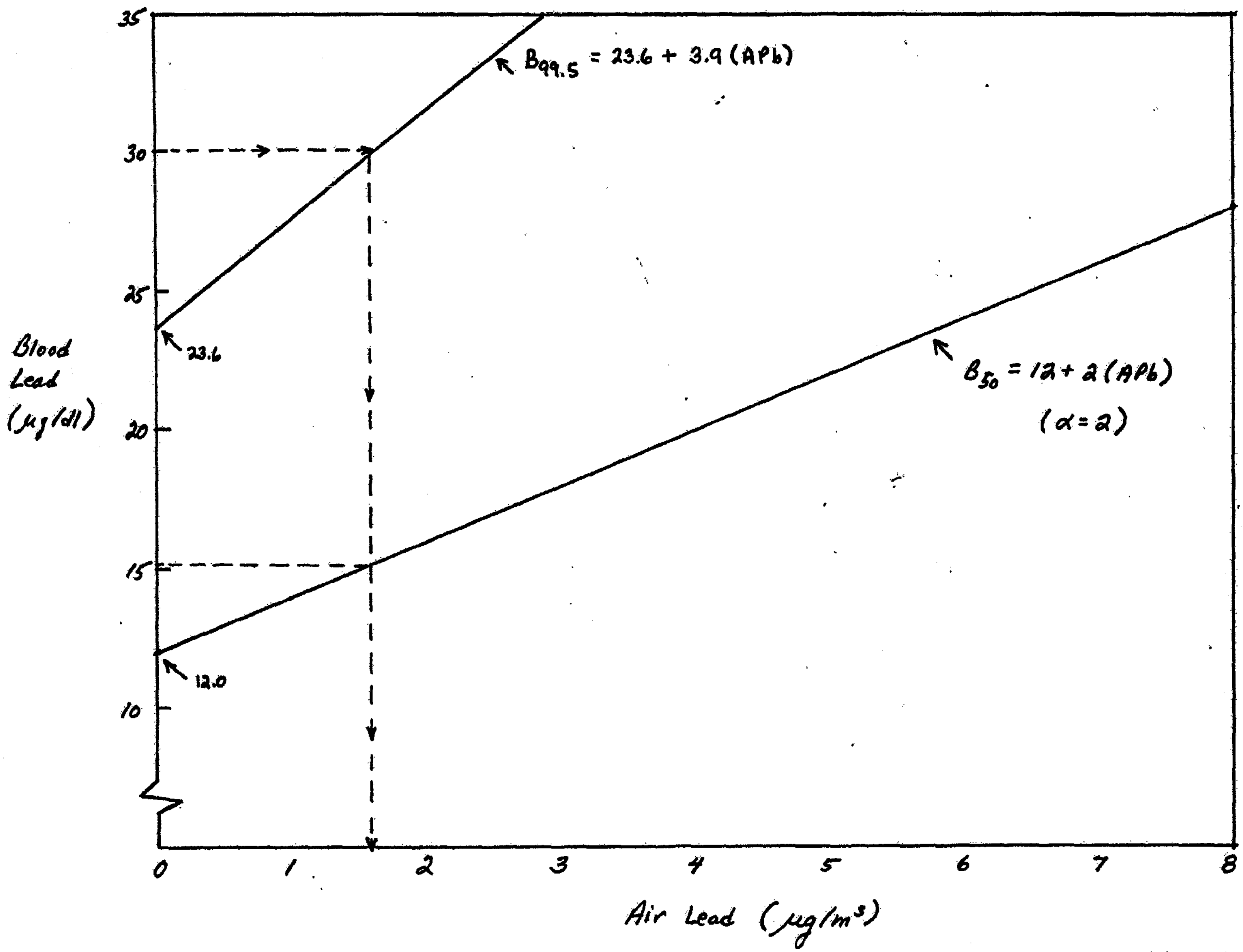
Fig. 7

EPA's Procedure for Determining Air Lead Standard



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Effect of assumed Standard Geometric Deviation on EPA AQS For Pb

Sg		CALCULATED MEDIAN	AQS
1.30	(IDAHO)	15.3	1.6
1.16	(AZAR)	20.4	4.2
1.11	(7 CITIES)	23.2	5.6

need to verify

1. Is the lognormal distribution appropriate
2. what is the proper Sg

DATA BASES

Idaho 1974, 1975
Johnson S. Calif
Azar
Japanese
McIntire & Engle ?
Seven Cities
DuPont 5-Year Pb Study

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