Transactions of the

TWENTY-EIGHTH ANNUAL MEETING

OF THE

AMERICAN CONFERENCE

OF

GOVERNMENTAL INDUSTRIAL HYGIENISTS

PITTSBURG·PENNSYLVANIA

MAY·15·17·1966

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Pittsburgh, Pennsylvania

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ANNUAL MEETINGS AND OFFICERS

Annual Meetings				Secretary-
No.	Date	Place	Chairman	Treasurer
1	June 27-28, 1938	Washington, D.C.	A.S. Gray, M.D.	J.J. Bloomfield
2	Apr. 26-28, 1939	Washington, D. C.	W.S. Johnson	J.J. Bloomfield
3	Apr. 30-May 2, 1940	Bethesda, Md.	M.H. Kronenberg,M.D.	J.J. Bloomfield
4	Feb. 17-18, 1941	Washington, D.C.	C.L. Pool	J.J. Bloomfield
5	Apr. 9-10, 1942	Washington, D.C.	C.A. Nau, M.D.	J.J. Bloomfield
6	May 24, 1943	Rochester, N.Y.	M.F. Trice	J.J. Bloomfield
7	May 9, 1944	St. Louis, Mo.	P.A. Brehm, M.D.	J.J. Bloomfield
8	Apr. 7-13, 1946	Chicago, Ill.	P.A. Brehm, M.D.	J.J. Bloomfield
9	Apr. 26-29, 1947	Buffalo, N. Y.	K. M. Morse	J.J. Bloomfield
10	May 27-30, 1948	Boston, Mass.	L. W. Spolyar,M. D.	J.J. Bloomfield
11	Apr. 2-5, 1949	Detroit, Mich.	H. G. Dyktor	J.J. Bloomfield
12	Apr. 22-25, 1950	Chicago, Ill.	K.E. Markuson, M.D.	L.J.Cralley, Ph.
13	Apr. 21-25, 1951	Atlantic City, N.J.	J. J. Bloomfield	J.E. Flanagan, Jr
14	Apr. 19-22, 1952	Cincinnati, Ohio	L.M. Petrie, M.D.	J.E. Flanagan, Jr
15	Apr. 18-21, 1953	Los Angeles, Cal.	J. C. Soet	J.E. Flanagan, Jr
16	Apr. 24-27, 1954	Chicago, Ill.	J. Shilen, M.D.	J.E. Flanagan, Jr
17	Apr. 23-26, 1955	Buffalo, N. Y.	H. B. Ashe	J.E. Flanagan, Jr
18	Apr. 21-24, 1956	Philadelphia, Pa.	R.R. Sullivan, M.D.	C. D. Yaffe
19	Apr. 20-23, 1957	St. Louis, Mo.	W.G. Fredrick, D. Sc.	C. D. Yaffe
20	Apr. 19-22, 1958	Atlantic City, N.J.	T.F. Mancuso, M. D.	C. D. Yaffe
21	Apr. 25-28, 1959	Chicago, Ill.	C. E. Couchman	C. D. Yaffe
22	Apr. 23-26, 1960	Rochester, N. Y.	A. L. Coleman	C. D. Yaffe
23	Apr. 9-12, 1961	Detroit, Mich.	A. L. Coleman	C. D. Yaffe
24	May 12-15, 1962	Washington, D. C.	W.L. Wilson, M.D.	A. D. Hosey
25	May 5-7, 1963	Cincinnati, Ohio	E. L. Schall	A. D. Hosey
26	Apr. 25-28, 1964	Philadelphia, Pa.	C. Einert, M. D.	A. D. Hosey
27	May 1-5, 1965	Houston, Texas	L.J. Cralley, Ph. D.	A. D. Hosey
28	May 14-17, 1966	Pittsburgh, Pa.	B.D. Bloomfield	A. D. Hosey

Note: No meeting held in 1945.

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ENGINEERS' ROUND-TABLE SESSIONS

May 15, 1966

Irving H. Davis and Howard E. Ayer
(Co-chairmen)

(Editor's Note: This year, for the first time, four technical papers were presented during the engineers' round-table discussions. Since the central theme concerned mineral dusts and the various problems involved in evaluating occupational exposures to dusts, the Executive Committee of A.C.G.I.H. agreed to publish these papers in the Transactions. It was their hope that the information presented would be of interest and value to those members and others not able to attend these sessions. Futhermore the material presented on the following several pages will serve as an excellent reference source for those having an interest in this subject.)

PANEL ON EVALUATION OF EXPOSURES TO MINERAL DUSTS

Moderator: Robert L. Harris, Jr.*

Introduction

In the United States atmospheric concentrations of the types of mineral dusts that may cause pneumoconioses are ordinarily determined by impinger sampling in a liquid medium and microscopic counting of the collected dust. The free silica content of siliceous dusts, or the composition of other dusts, are used to determine the concentration indices by which the hygienic significance of exposures to the mineral dusts are to be judged. The Threshold Limit Values used to judge the degree of hazard for exposures to pneumoconioses-producing mineral dusts are based on these methods. Although an investigator may prefer some other method to measure exposures, he must use the impinger and the composition of the dust if he wishes to interpret his results with the Threshold Limit Value.

Professor Theodore Hatch has suggested that our long continued use of the microscopic method for assessing dust exposures may have trapped us into the idea that the technique has inherently in it some very profound built-in truth. While speaking in June 1964 in Cincinnati to a group of industrial hygienists concerned with the problems of dust counting, Professor Hatch recounted the origin of using the microscope for count dust. About 1910 Professor G. C. Whipple was retained to advise on the feasibility of recirculating air in a college gymnasium. He was concerned about the buildup of carbon dioxide, bacteria, and dusts. Professor Whipple was an authority on marine organisms and was accustomed to examining water specimens by low-power, light field microscopy. It was quite natural for him to apply this same microscopic technique to dust counting, and he did so.

Various methods were used for sampling dust for counting or weighing in the years that followed. In 1922 a comparative study of various samplers was made; the impinger was developed during this study. It was used in this country in most major studies in the dusty industries after that time and in 1942 was adopted as the standard instrument by the National Conference of Government Industrial Hygienists.

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The impinger sampling-microscopic counting method has served well in the past as a tool in reducing exposures to pneumoconiosis-producing dusts. Now we seldom have the continued massive exposures of earlier days, and the prevalence of pneumoconiosis in many of our dusty occupations may be less than 5 percent when it once was more than 50 percent. As exposures become less and the prevalence of disease decreases, we need to improve the precision and sensitivity of our assessment methods if we are to detect those differences in exposures that are significant in the production of disease.

Variability in results yielded by the impinger sampling-microscopic counting method was explored in experiments in Cincinnati in June of 1964 and in Pittsburgh in February of 1965. Substantial differences in results of counts were obtained. The concentration ranged from 100 to 1000. These experiments will be discussed in greater detail later in this panel.

The A.C.G.I.H. Committee on Environmental Factors in the Pneumoconioses has as its Bill of Particulars, "To recommend methods for assessing airborne dust, and other environmental factors, in the prevention of pneumoconioses." During the past year it has directed its attention particularly toward three areas:

1. Sampling and counting for quantitation.

2. Sampling and analysis for composition.

3. Sampling strategy and statistics.

At its meeting in Houston last year the Executive Committee, A.C.H.I.H., asked that the Environmental Factors Committee undertake critical review of the standard method for counting of impinger samples to reduce or eliminate choices in the method which can lead to differences in results. The Executive Committee asked that representatives of the Committee work with representatives of the A.I.H.A. on the problem. A Joint A.C.G.I.H.-A.I.H.A. Committee on Uniform Methods for Dust Counting was appointed. Messrs. H. E. Ayer, E. J. Baier, J. H. Davis, and Dr. S. A. Roach represent A.C.G.I.H. on the Environmental Factors in the Pneumoconioses; Dr. D. M. Anderson, Messrs. H. E. Bumsted and W. M. Smith, and Mrs. Kathleen Kumler represent the A.I.H.A. I serve as Chairman of the Joint Committee. The Joint Committee has met twice in the past year, both times in working sessions for 2 days. Its agreed Bill of Particulars is "To define the method for optical microscopic counting of impinger dust samples for the evaluation of exposures in terms of the A.C.G.I.H. Threshold Limit Value". Work of this Joint Committee continues; it is not yet ready to report. One of the difficulties it faces is relating counting practice to the sampling and counting practices of the past upon which present Threshold Limit Values are based.

This panel today will explore the three areas of special concern this year to the Committee on Environmental Factors in the Pneumoconioses: Counting, Composition, and Sampling strategy.

I. Problems of Dust Counting, by Howard E. Ayer

II. Procedures for Free Silica Analysis, by Edward J. Baier

III. Testing Compliance with the A.C.G.I.H. Threshold Limit Values for Mineral Dusts, by Dr. S. A. Roach.

PROBLEMS OF DUST COUNTING

Howard E. Ayer*

Introduction

As Dalla Valle[1] and others have pointed out, the impinger dust count is an index of dustiness rather than an absolute measure. Evaluation of relative hazard of a dusty operation requires the consideration of exposure time and dust composition as well as dustiness in a particular part of the operational cycle. The first two factors will be considered by other speakers at this session. The problems of dust counting as considered here, are those of determining the "count" of mineral dust particles in an impinger sample after it is brought into the laboratory, using the "standard" techniqu As Halley[2] pointed out some 20 years ago, even the "standard method" allows considerable variation in technique; and, in fact, there is disagreement as to what constitutes the standard method. For today's discussion, the "standard method" will be considered that adopted by this body in 1942.[3]

This method includes requirements of:

(1) A counting cell 1.0 mm deep, or down to 0.1 mm deep provided liquid depth is reported with results;

(2) Microscope with 16 mm (10X) objective, 7.5 or 10X ocular;

(3) Water with or without ethyl or isopropyl alchol admixed;

(4) Counting within 36 hours; and

(5) 30 minute settling time.

Halley in his survey of 45 laboratories in 1946 found variations in each of these points, suggesting that dust counts from different laboratories were not, indeed, "comparable."

Chapman and Ruhf,[4] have discussed statistical variation to be expected in dust counts. Harris[5] has pointed out the effect on particle settling time of composition of media and suggested a method of determining whether pairs of counts are within the limits of variation to be expected from random distribution of particles on the floor of a counting cell. In addition to these random and media variables there are several others which are less readily defined. A principal factor is probably the limit of visibility for small particles, which is a function of particle size, contrast, background field brightness, and physiological and psychological characterristics of the person doing the counting. The varying counts on the same field by any particular individual suggest that one's limit of visibility varies from time to time; this might be called an "intra-observer variance." A systematic difference in count of the same field between individuals (inter-observer difference) suggests that this "limit of visibility" varies between individuals. The fact that the limit of visibil

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varies with brightness and contrast makes evident the possible variation of counts with illumination. Experience of the dust counter has been mentioned as a variable, and optical differences between microscopes of the same nominal characteristics have been suggested as another source of variation in dust counts.

Representative Data on Dust Counting Variability

Many studies have been made over the years to attempt to define and reduce some of these variables. Some of these will be summarized here to suggest the precision and reliability to be expected in dust counts.

Three general types of data were available for this presentation:

(1) counts on fixed, semi-permanent slides

(2) repeated counts on the same impinger samples, and

(3) counts on simultaneous, adjacent impinger samples

Examples of each of these will be presented.

In attempting to compare results of different studies with one another, some index of variation must be used. Perhaps the most convenient is coefficient of variation, which is the standard deviation divided by the mean x 100; i.e., $\frac{S}{\bar{x}}$ x 100. For a normal distribution with a coefficient of variation of 10%, 2/3 of the values will fall within ± 10%, and 95% will fall within ± 20%. Many of the comparisons are of paired samples; for each pair the coefficient of variation is the range divided by the mean, and the estimate used will be the median of the series.

Fixed Slide Experiments. Paulus[6] conducted experiments using 11 fixed slides and eight observers. He was able to demonstrate statistically significant differences between observers, between microscopes and in sequence of observations. It was also observed that, in general, counts increased when an ocular of higher magnification was used (an average of 14% increase when a 15X was substituted for a 10X), and became more uniform when the defined field was subdivided by crosshairs. In Paulus' experiments, a pooled estimate of the coefficient of variation (with 10X ocular, no crosshairs) was 17%.

Edwards, et al.[7] have reported another fixed slide experiment, using 30 fields and 8 observers. In this experiment a Porton graticule was used to delineate the field. The coefficient of variation between observers for fields with more than 30 particles per Porton field was about 20%, as shown in Figure 1. These two fixed slide experiments suggest that coefficients of variation even on repeated counts of the same dust particles will be on the order of 15 - 20%.

Repeated Counts of Impinger Samples. Somewhat more relevant are duplicate counts of the same impinger sample, either by two individuals each counting one cell, or by two completely independent evaluations of the sample. These data are available from several sources.

First, it is a general practice to prepare two counting cells from a sample and have them counted by different counters. Where this is done as a check, it is used to prevent wide systematic disparities in dust counts within the same organization. When done routinely, the two counts are averaged, and a recount is generally made if the difference is too great. From one such routine procedure,[8] counts involving

13 counters on a total of 534 samples are reported.

The number of pairs of counts per pair of individuals in this series varied from 1 to 77. Comparing the means and standard deviations (ignoring the recounts made on those counts which were quite different) we find that differences in average counts between pairs of counters varied from 1% to 30%; of the 17 pairs, 9 averaged within 10% of one another.

If, however, rather than considering average counts we look at individual pairs, not allowing recounts, we find that a weighted average coefficient of variation of 29%, a median is about 25%. Although one might expect a much larger coefficient of variation for those counters with a systematic difference, in fact, the average coefficient of variation was 32% for those pairs with averages more than 20% apart, and 27% for those averaging within 5%. It should be pointed out that these counts were almost all low, and the random variation is considerably higher on low counts.

A second type of situation is that in which the same sample is counted twice, with a time interval of days or weeks. One such set of 181 counts was available. The first count was made in the field within 24 hours; the second count was made in the laboratory by the same individual some 2 to 3 weeks later. The principal variable here is thus sample age. Again comparing pairs of counts, with at least two cells for each count the pooled coefficient of variation is estimated as 13%.

A third set of data available is a series of 19 samples to be reported by Reno[9]. In this instance, there were four independent counts performed by three individuals. Within 24 hours of each sample, a count was made using two Dunn cells, and another using a haemocytometer by a second individual. This second individual also performed Dunn cell counts within one week. A third individual performed Dunn cell counts on the same 19 samples some three weeks later back in the laboratory. Mean concentrations from the four sets ranged from 2.2 to 2.7 million particles per cubic foot (mppcf), a difference which was not statistically significant. Coefficients of variation for the four counts of each of the 19 samples ranged from 6 to 50%, with a mediam of 18%. For paired counts, as in the previous examples, median estimates of coefficient of variation are shown in Table I.

TABLE I

Coefficients of Variation for Paired Counts
19 Samples, 2 Cells, 3 Observers, Time

Cell-observer	Cell-observer	Time difference	Variables	Coefficient of variation
Dunn (obs. A)	Hmctr (obs. B)	24 hours	cell-observer	25%
Dunn (obs. A)	Dunn (obs. B)	one week	time-observer	29%
Hmctr (obs. B)	Dunn (obs. B)	one week	cell-time	25%
Dunn (obs. A)	Dunn (obs. C)	three weeks	time-observer	27%
Dunn (obs. B)	Dunn (obs. C)	three weeks	time-observer	22%
Hmctr (obs. B)	Dunn (obs. C)	three weeks	cell-time-obs.	13%
All pairs				25%

A final example of this type of data is an experiment conducted among a group of individuals from different organizations engaged in routine dust counting[9] (this group was not necessarily those individuals who routinely counted dust).

Experiment	Coefficient of variation
Quartz dust in water, 8 counters	53%
Quartz dust, same concentration in three different alcohols	51%
Coal dust, same concentration in water and alcohol	24%
Second sample, coal dust in alcohol	24%

Simultaneous, Adjacent Impinger Samples. The third type of data, that most relevant to the sum of problems in dust counting is presented by a series of simultaneous samples, each counted by the individual taking the sample. To be useful for comparison, these samples must be taken immediately adjacent to one another and be simultaneous, or the variability of the environment will far overshadow the counting variability. Three sets of such data are available.

The first is that reported by Bianconi and Thomas.[11] For two groups of 24 impinger samples of limestone dust they found coefficients of variation of 22.2 and 21.8% respectively. This spread apparently included intra-observer variance and the differences in replicate samples.

A second was a group of experiments conducted in Cincinnati in 1962,[10] where a number of persons from different organizations counted two sets of air samples from a dust chamber. For the two sets, each of which included both water and alcohol, coefficients of variation were 47% for silica dust and 53% for coal dust, respectively.

A final set was obtained from two industrial hygiene organizations with overlapping interests in two manufacturing plants. In one of these there were 87 and in the other 71 simultaneous adjacent samples taken. The samples were usually taken with both midget impingers held in one hand. One group used alcohol, the other used water. For the two plants results were as follows:

TABLE II

Comparison of "Duplicate" Field Samples in Two Plants

		Group 1	Group 2
Plant 1	Number of samples	87	87
	Mean count (mppcf)	19.4	17.6
	Standard Deviation	25.4	25.4
	Ratio, Group 2: Group 1	.91	
	Coeff. of correlation	0.41	

Plant 2	Number of samples	70*	70*
	Mean count (mppcf)	11.9	9.7
	Standard Deviation	11.3	12.8
	Ratio, Group 2: Group 1	.81	
	Coeff. of correlation	0.65	

*One sample of 71 excluded from calculations

Group 2 sampled in an alcohol which because of high viscosity and consequent longer settling times can be calculated to produce from 5-20% fewer visible particles on the floor of the cell than samples in water. (The calculated reductions depend upon assumptions as to size distribution in the impinger and limit of visibility.) Group 2's count did 9% less in one plant and 19% in the other. However, the coeffecients of correlation, 0.4 and 0.65, suggest that there may have been greater disagreement on individual samples. And, indeed, we find that the pooled estimates of coefficients of variation were 50% in Plant 1 and 40% in Plant 2. Or, the dust counts from the two organizations may each be classed in one of seven groups with concentration limits differing by a factor of 2; that is 2, 2-4, 4-8, 8-16, 16-32, 32-64, and 64 mppcf. Considering the samples in this way, we find that 41% of the paired samples fall into the same group, 41% differ by one group, and only 6% differ by more than 2 groups. These results are similar to those of Lynch[12] which compare impinger counts with fiber counts on simultaneously collected membrane filters, but exhibit slightly more scatter.

(continued on page 17)

TABLE III

Dust ›unting Variation, Selected Data

	Type of Data	Investig ›or	Variables	Coefficient of Variation Group	Pairs
1.	Fixed Slide, 7 counters	Paulus	Observer, Microscope	17	
2.	Fixed Slide, 8 counters	Edwards, ›t al.	Observer, slide position	20	
3.	Impinger Samples (181)	Harris, ›t al.	Sample age		13
4.	Impinger Samples (19)	Reno, et ›l.	Observer, Cell, Sample Age, Microscope	18	25
5.	Impinger Samples (534)	Lynch, e al.	Observer		25
6.	Impinger Samples	Sutton	Observer, Microscope, Illumination, Details of method	25-53	
7.	Duplicate impinger lab samples	Bianconi & Thomas	Replicate samples	22	
8.	Duplicate impinger lab samples	Sutton	Observer, Microscope, Media, Details of method	50	
9.	Duplicate impinger field samples (151)	P. Comm	Observer, Media, Sampler Microscope, Details of method, Sample Age		45

Discussion

The foregoing data are summarized in Table III. From lines 1 and 2, it appears that with trained but unselected observers, a coefficient of variation (v) between observers of about 20% may be expected on repeated counts of the same field. This v is partly a systematic error, for on the fixed slides some of the counters were consistently higher or lower than the mean.

Line 3 represents probably a practical minimum achievable coefficient of varation for completely independent counts of the same sample. The counts were made by the same observers with recounts when the counts from two cells markedly disagreed. Certainly this variation is so much less than the typical environmental variation as to be completely insignificant.

Line 4 is probably more typical of the kind of variations which might be expected. Of the three counters, all were experienced, but only one counted dust regularly. For paired counts, the coefficient of variation is almost twice that of line 3.

Line 5 gives what should be almost a maximum for counters within the same organization, for all available counters were used, each counted only one cell, counts were typically low, and recounts were not included in the calculations. Because all counts were on the same samples, there were no media or sampling variations included.

Line 6 shows considerably greater variation than any of the lines above. Among the factors which may be involved are the larger number of observers, the different microscopic set-ups, and the fact that only a very few cells were counted, without the usual "warm-up" period for the counters.

Line 7 gives the results of replicate samples counted by the same observers. It there for includes intra-observer variation and any variation between replicate samples. In presenting the data, the author estimated that field samples would vary to a greater degree, perhaps with $v \approx 35\%$.

Line 8 shows much the same degree of variation, for another laboratory experiment involving many of the same counters as line 6. In this case the counts were on air samples from a chamber using water and alcohols as sampling media. There appeared, in the sampling for coal dust, to be a systematic difference favoring the alcohols in collection efficiency, in addition to the variation between samples in the same media.

Line 9 represents dust counting in practice; two organizations taking simultaneous adjacent samples in different media, counted by different persons, at different times, with, probably, slight variations in microscopic technique. On the basis of other data in the table, this variation in practice may not be extreme. A practical goal might be to reduce, by standardization of media and miscroscopic techniques, this coefficient of variation to the 35% predicted by Bianconi.

Conclusions

In carefully controlled experiments, systematic differences between dust counts may be detected. These include differences which may be attributed to:

(1) inter-observer difference

(2) media difference

(3) illumination difference

(4) microscope difference

(5) cell difference

In any series of counts, however, more or less random differences occur which are in excess of the systematic differences, and usually far in excess of the difference which would be predicted from the Poisson distribution of particles in counting cells. As a minimum, a coefficient of variation of 15% or so in paired counts may be expected, and a coefficient of variation of up to 50% can and does occur between counts performed by conscientious, experienced dust counters on presumably identical samples. For a given operation, the coefficient of variation of environmental dust concentrations was usually 60-80%, and in an entire plant v is usually greater than 100%. For this reason, the same judgment will usually be reached on the hazard from dust at a given operation by two groups, as long as each bases his judgment on an average of several samples. Likewise, the value of a particular control measure will generally be judged the same by different groups in before-and-after tests, for most control measures are expected to produce large differences. Where, however, a judgment of a particular operation must be based on one or two samples, disagreement by a factor of two to four would not be uncommon. If one is attempting to stay within a particular limit at each operation, a considerable margin below the limit is necessary for compliance to be demonstrated by a small number of samples.(13)

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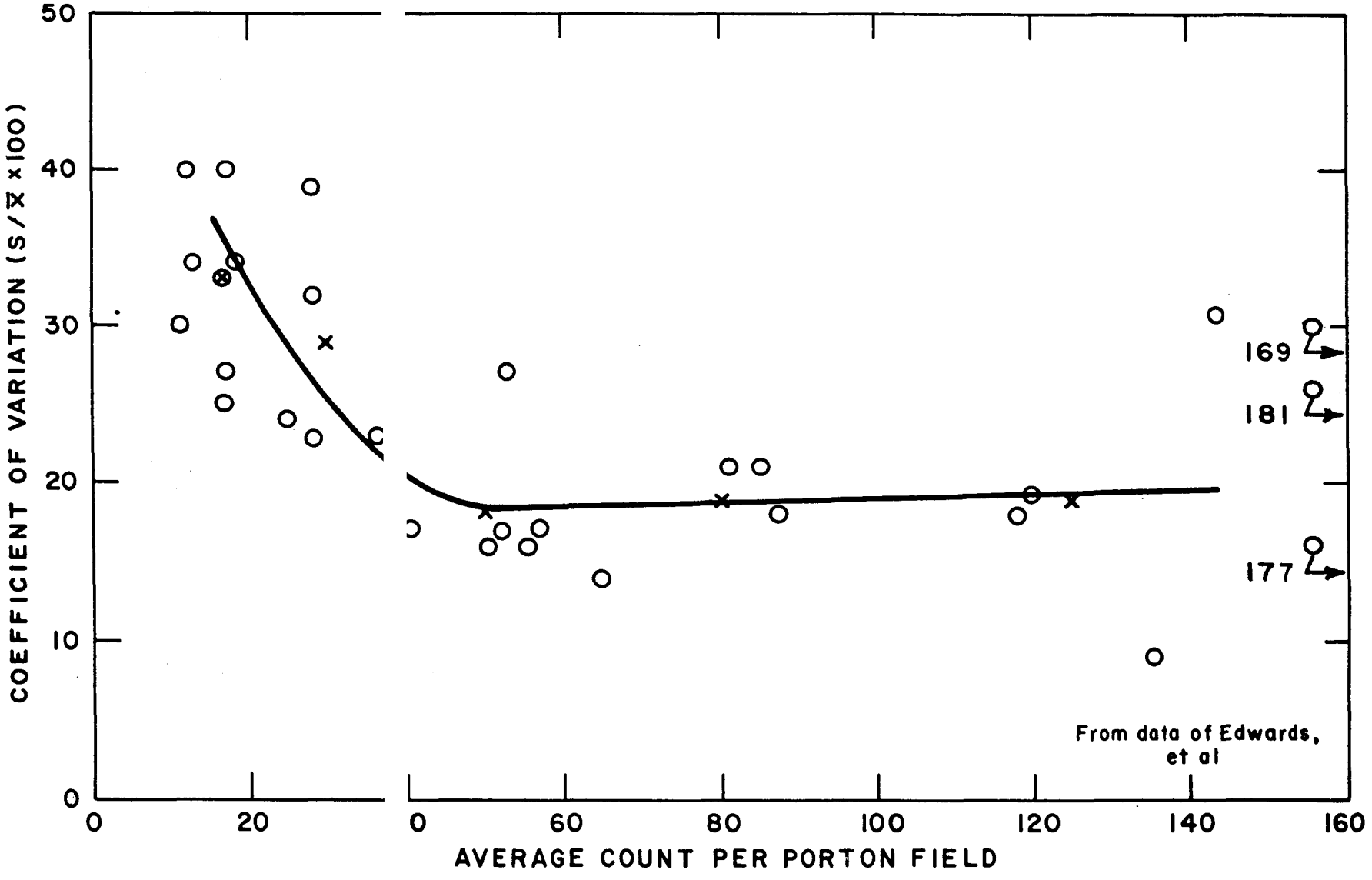
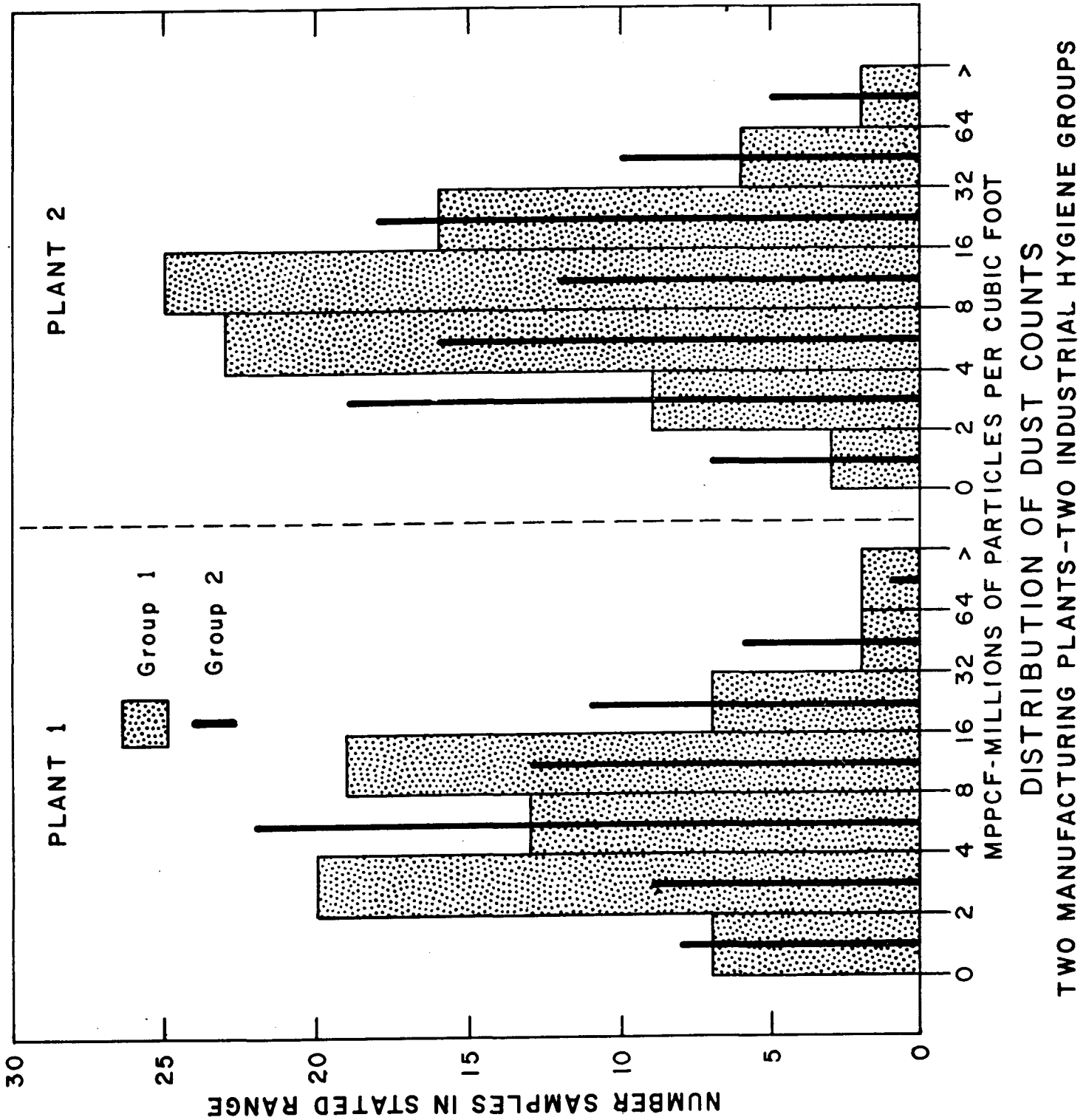


COEFFICIE TS OF VARIATION FOR COUNTS OF 8 PERSONS
30 S LECTED FIELDS, 2 COUNTS PER PERSON



DISTRIBUTION OF DUST COUNTS

TWO MANUFACTURING PLANTS-TWO INDUSTRIAL HYGIENE GROUPS

PROCEDURES FOR FREE SILICA ANALYSIS

E. J. Baier*

Introduction

For many years the Threshold Limit Value (formerly maximum allowable concentration) for quartz-containing (SiO_2) dust was based on the percentage of free silica present in the mixture in three discreet ranges: less than 5%, between 5 and 50%, and greater than 50%. The limits were 50, 20 and 5 million particles per cubic foot of air (mppcf) respectively.(1) Analytical precision was not essential because small variations in SiO_2 percentage as determined by different analytical procedures did not significantly affect the application of these limits to the occupational environment.

Although many investigators recognized that the hazard potential for dust was ill-defined, assuming that 49% SiO_2 exposure had the same effect as a 6% SiO_2 exposure at the same dust concentration, these air standards held until 1962(2) when the Threshold Limits Committee of the American Conference of Governmental Industrial Hygienists recommended the use of a formula for calculating the Threshold Limit Value, and the recommendation was adopted. The formula:

$$\text{Threshold Limit Value (in mppcf)} = \frac{250}{\%SiO_2 + 5}$$

recognized SiO_2 to be the causative agent for lung pathology and provided a sliding scale to use as a guide for estimating the degree of hazard.

Application of the formula created problems in several areas of industrial hygiene practice, especially in analytical technique. Although there are many methods for analyzing quartz, the microscopic, wet chemical and x-ray diffraction procedures have been in vogue in the United States. These basic techniques are modified by practically all laboratories, however. Other procedures include differential thermal analysis,(3) infra-red spectrography(4) and sedimentation.(5)

Microscopic analysis includes various techniques for identifying quartz by its optical properties. A general method is petrographic analysis in which polarizing screens or prisms in combination with immersion oils of known refractive indices classify minerals according to index of refraction, birefringence or interferrence color, or change in color of the particle. A modification of miscroscopic technique is an immersion method(7) in which particles are counted in two separate media, one of which has the same index of refraction as the mineral sought, and dispersion staining(8) (9) in which the mineral in question is quantitated because of its change in color in a staining media.

Wet chemical methods(10) for quartz determination, with modifications(11), are techniques in which a weighed sample of material is washed with hot phosphoric acid to remove silicates, the residue treated with hydrofluoric acid to remove quartz and the weight of the final residue determined. The difference in weight between hydrofluoric acid treatment divided by the total weight of the sample is an estimate of

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the quartz content of the material in percent by weight.

X-ray diffraction technique for free silica determination utilizes the principle that different crystalline minerals refract a beam of monochromatic x-rays in a characteristic pattern.(12-17) These methods generally make use of an internal standard, such as beryl or calcium fluoride, in order to quantitate the SiO_2 component in a mixture.

Study Design

A number of studies have been undertaken(18-19) to determine differences between methods of quartz analysis and between parent, airborne and settled dust or rafter samples. These studies pointed out that parent material generally contains more quartz than airborne or rafter samples, although Sheinbaum(18) states that within six feet of a dust-generating operation, the quartz content remains relatively the same. Many analysts believe that small particles of SiO_2 are lost in analytical procedures, and Talvitie(11) has modified wet chemical methods to account for this loss.

In order to resolve the validity of various methods of analysis the Committee on Environmental Factors in the Pneumoconioses decided to poll governmental units in an effort to learn how quartz was determined in their laboratories. Letters were sent to 45 units asking for sampling and analytical procedures and whether or not the agency would participate in the analysis of "referee" samples. Reduction of the information of the 25 agencies who replied and do their own SiO_2 analyses showed the following procedures in use:

X-ray	4
Wet Chemistry	14
X-Ray and Wet Chemistry	5
X-Ray, Wet Chemistry and Microscopic	1
Wet Chemistry and Microscopic	1

Most expressed strong preferential order for the type of sample they collect for SiO_2 analysis. Most (60 percent) collected air, rafter or settled dust and parent material for testing the quartz content of the dust. Many preferred only one type of sample, stating they collected the other types only as "a last resort." The distribution of type of sample collected was:

Rafter, air and parent material	15
Rafter and parent material	5
Air and rafter	3
Air	2

Specific sampling methods for composition of dust vary considerably between agencies. For air samples high volume samplers using glass fiber, membrane and plain and pleated paper filters are used. Some agencies use electrostatic samplers and impinger and one formerly used a venturi scrubber. Settled dust from rafters is obtained by using a brush, a spatula or a knife. Practically everyone tries to collect only the most recent deposit. One agency cleans a particular section of rafter and collects a sample from the "cleaned" area at a later time when fresh dust has accumulated. Many specified that they preferred to collect dust from sloping surfaces in order to obtain a more representative sample. Parent material is generally

ground in entirety, mixed or blended, cut or quartered and screened. In general, rafter and parent material is screened through 200-mesh for chemical analysis and 325-mesh for x-ray analysis, although certain agencies use 325-mesh screens exclusively.

Analytical methods vary considerably within a general classification. Using wet chemical techniques, samples are leached when amorphous silica is present, pre-acid digested when heavy metals are suspected in quantity and, on occasion, treated with aqua regia, boiled, filtered and ashed prior to the usual analytical method. X-ray procedures include many different grinding and mixing techniques, a shift of orientation of the sample holder in the x-ray beam, a rerunning of the sample by removing it from the holder and refilling the holder with the same material and various techniques of pressing the sample into the holder or forming pellets of the material.

Since particle size of the material seemed to be a limiting factor for analytical methods, three "referee" samples were prepared. Sand, which had been thoroughly tested and found to be 100 percent SiO_2 (some tests showed greater than 100 percent SiO_2) was ground by a commercial grinding company. The sand, with a median particle size of 28.4 microns, was fed into a grinder using heated air at 110 pounds per square inch and 300°F at a rate of 5 pounds per hour. After grinding, median size of the sand was 4.7 microns with a standard deviation of 2.02. Portions of this material was used for samples designated as Group 1. The remaining material was reground at a rate of 4 pounds per hour, producing samples with a median size of 4.3 microns and a standard deviation of 3.35. These samples were designated as Group 2. Samples in Group 3 were collected from a bag house filter of a high-silica refractory plant. The "true" quartz content of this material was unknown, but the particle size of this material had a median of 0.84 micron with a standard deviation of 2.85. The sample material in each group was thoroughly blended, and a portion of each sent to the 22 agencies who had agreed to test the samples for SiO_2 content.

A total of 30 or 31 results were reported for each sample from the 20 agencies reporting, although the true number of analyses is unknown. Several agencies stated that the percentage SiO_2 reported represented "the arithmetic average of several tests" on the same sample. When more than one result for a sample was reported by an agency, these results were also averaged. A few agencies tested the samples by both x-ray and wet chemical methods. When this was done, the data were included in both groups.

The following data were reduced from the results received:

Percent Free Silica

		Range*	Median	Mean	Deviation from Mean
Group 1					
	Chemical	87.6 - 99.5	92.3	92.3	3.4
	X-ray	86.2 - 96.0	91.0	91.3	3.4
Group 2					
	Chemical	88.9 - 97.5	91.7	92.7	2.6
	X-ray	85.0 - 96.0	91.0	91.0	4.1
Group 3					
	Chemical	83.0 - 91.6	88.5	88.3	2.8
	X-ray	87.0 -100.0	90.0	91.8	5.5

*Does not include data from one agency whose results were about 10 percentage points less by wet chemical methods.

An interesting observation from the results of analyses indicate that some of the grinding equipment which prepared the sand samples eroded during processing as evidenc by a reduction of SiO_2 content of the material. A test of the material by use of a strong magnet indicated that the contamination was non-magnetic. No spectrographic tests were run on the samples to identify the contamination.

A review of the deviations from the means indicates that the precision by most methods is very good, with most analyses very near the arithmetic mean of all determinations. It points up that current methods of analysis are adequate for determining airborne quartz if adjustments are made to wet chemical methods to account for loss of SiO_2 by acid digestion. The x-ray method, of course, has the advantage of determining other mineral components in a sample, but is not essential if only quartz is sought.

Summary

In order to determine analytical precision for SiO_2 analysis, "referee" samples were sent to governmental agencies who agreed to participate. With the exception of one State agency, determinations agreed very closely between wet chemical and x-ray diffraction techniques when practically pure quartz of very small particle size was analyzed.

Current analytical procedures in use in the United States for SiO_2 are acceptable for application of the Threshold Limit Value formula.

This study also points up the feasibility of analyzing airborne dust for composition as demonstrated by the close results obtained by different agencies when quantitating samples of very small and respirable particle size. The effects of mixed dusts of small particle size on analytical methods remains unresolved.

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TESTING COMPLIANCE WITH THE ACGIH THRESHOLD LIMIT VALUES FOR RESPIRABLE DUSTS EVALUATED BY COUNT

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Introduction

The respirable dust Threshold Limit Values recommended by the American Conference of Governmental Industrial Hygienists are expressed in terms of measurements made with the impinger. The results from using this instrument can vary widely according to the particular technique used for sampling and evaluating the results.

There has been no general agreement on exactly how samples should be taken and evaluated, nor exactly how the results should be interpreted with respect to the T.L.V. document. Indeed, it is often impossible to decide which of several ways of accomplishing each step is the correct one.

Since it is important that hygienic standards should not be open to widely different interpretations, this paper is concerned with promoting a standard procedure which can be recommended to those who sample the respirable dusts evaluated by count to test compliance with their Threshold Limit Values. It deals with where, when and how many samples should be taken and recommends how results should be interpreted with respect to the T.L.Vs as set out by the ACGIH.

It is not the main object of this paper to consider whether T.L.V. document is an appropriate basis for sampling the respirable dusts, nor whether compliance with it is sufficient to secure safe conditions of work.

The first objective is to derive and specify a standard sampling procedure based strictly on the present T.L.V. document.

The second objective is to specify rules for interpreting the results of a sampling schedule which has not met the optimum requirements. The reason for this latter objective is that sampling with the impinger is often done in confined work-places which are dusty, hot, poorly lit and only reached after an arduous journey. The counting of the samples demands considerable care and concentrated attention to detail for quite long periods. There is, therefore, considerable pressure to keep the sampling and counting to the absolute minimum.

Sampling Location

Where to locate the sampling instrument is a problem which hygienists have to face daily, no matter what the air contaminant being measured.

It is commonplace to state that a sampler inlet was placed in the worker's "breathing zone" although in fact the instrument may have been held 6 inches from the worker's nose, or on his lapel, shoulder or back; or 2 feet away or some considerable distance "upstream". On the other hand, it would be necessary to place the inlet actually inside the worker's nose or mouth for the instrument to sample only the air contaminant which is actually inhaled.

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While this is an impractical requirement the inlet should as far as practicable be placed so as to sample air representative of that inhaled; it is, therefore, desirable to specify the inlet location as precisely as possible. When sampling the mineral dusts with an impinger it is suggested that the inlet should be upstream of the worker's nose and mouth and no more than 2 feet from the worker's nose and mouth.

Representative Sampling

When a number of workers are doing similar jobs the question often arises of deciding which worker(s) to investigate. The problem is how to test the environment of a particular job rather than one particular worker's exposure.

If the environment of the worker whose exposure is the greatest complies with the hygienic standard then the environment of every worker will comply. The hygienist may choose to exercise his own judgement about which workers are representative of those with the highest exposure. These, for example, may be workers in the dustiest location or those who do the job in the dustiest way. The alternative is to use a random sampling procedure, but this has only been done in the past where there has been real uncertainty or where strictly unbiased results were required for research purposes.

The spacing of samples over the sampling period should be planned ahead of time. The samples may be taken at regular intervals or at times chosen at random beforehand. If taken at regular intervals care needs to be taken to see that the interval does not coincide with any other regular cycle of events which might be related to the dustiness.

The TLV Document

A sampling procedure in keeping with the spirit of the TLV document is derived by considering the following relevant quotations from the Preface:

> "The values .... given .... refer to time-weighted average concentrations for a normal workday." For these "... a sufficient number of samples are needed to permit a time-weighted average concentration throughout a complete cycle of operations or throughout the work shift."

The sampling period in mind here is one cycle of operations or at the most one work shift.

> "... the time-weighted average limit requires an explicit limit to the excursions that are permissible above the listed value. The magnitude of these excursions may be pegged to the magnitude of the threshold limit by an appropriate factor ...."

These maxima are further defined by

> "... excursions of concentration above the proposed limit for periods of up to 15 minutes ..."

The Optimum Sampling Procedure

The maximum number of 15-minute samples taken by one instrument in an 8-hour shift is 32. Such a set of 32 samples taken successively, where all 32 results were lower than the Ceiling Limit and whose time-weighted average was lower than the TLV, could be taken as showing that the environment complied with the document on that shift with respect to the air contaminant being determined. This sampling procedure will be referred to as the "optimum" sampling procedure.

How closely does this optimum procedure locate the true average concentration?

Suppose the average of the 32 results came out just equal to the TLV. The standard error of the average of 32 samples is 0.18σ, where σ is the standard deviation representing the dispersion between the individual results (Appendix 2 & 3). In fact, if the measured average equalled the TLV the chances that the true average was above the TLV are about 50/50. Also, if the 32 results may be regarded as samples chosen at random from a population with standard deviation σ the chances are about 1/10 that the true average was at least 0.23σ above the TLV and 1/100 that the true average was at least 0.41σ above the TLV. The likelihood that the true average exceeded the TLV by a given amount is shown in Figure 1.

Missing Samples

One way in which dust sampling procedures differ from the optimum is that often only a few impinger samples are taken, perhaps as few as 4 or 5 samples, each sample lasting about 15 minutes. When fewer than 32 samples are taken it is necessary that the acceptable upper limit of the sample average be made lower than the TLV to compensate for the loss of information.

Suppose, for example, that individual impinger results varied about the shift average with a standard deviation of 35% of the average. The 90% confidence limits work out at ±10% of the average obtained from 32 results. Thus with the optimum sampling procedure, one would be at least 95% sure that the true average did not exceed that TLV by more than 10% since only one side of the distribution is of concern.

When fewer than 32 results are available the confidence limits are further apart, but the same confidence criterion would be obtained by lowering the upper limit of acceptable sample averages to the point where the upper confidence limit is again equal to 1.1 X TLV.

A general formula for this upper limit to the sample average is given in Appendix 4, in terms of the standard deviation. To test compliance take $t = 1.6$, 1 in 20 level of chance, and apply the formula to calculate the upper limit of sample averages for the test conditions.

It should be noted that this upper limit does depend upon knowing the standard deviation of the population. When the standard deviation is not known it has to be estimated from the sampling results. An estimate of the standard deviation from just a few samples has a large standard error. A simple and efficient estimate from a few samples is obtainable from the range[2-3] and the possibility of error can be taken into account by lowering the acceptable upper limit to the average according to the range actually observed.

The upper limit deduced from the range and number of samples is given in Figure 2, which is based on values from Lord(4) and Tippett.(2)

Otherwise the limit may be found more conveniently from Table 1. The limit is

TLV - k.Range

where k is found in the table, from the number of samples taken.

T A B L E I

Number of samples	k
32	0
10-31	0.1
6-9	0.2
5	0.3
4	0.4
3	(0.8)
2	(2.9)

When the limit is less than the observed average the environment cannot safely be said to have complied and when the limit is higher than the observed average it can be stated with some assurance that the environment did comply. Thus, with the aid of the factors given in Table I the hygienist can make a simple confidence test for compliance which is consistent with the optimum procedure and makes due allowance for the number of sample results actually obtained.

Ceiling Limits

The "Ceiling Limits" of the TLV document refer to the results from individual samples and are given by multiplying the TLV expressed in parts per million (ppm) or milligrams per cubic meter (mg/M^3) by a "test TLV factor." It will be noted that the TLVs for respirable dusts evaluated by count are given in millions of particles per cubic foot and the TLV committee has not yet developed test TLV factors for these dusts. A possible basis for considering the consequences of accepting ceiling levels of the kind envisaged in the TLV document is given in Appendix 5.

Time-Weighted Averages

A procedure sometimes used is to measure the concentration in distinct operations and subsequently work out the time-weighted average exposure from a time study. The way to interpret such results in terms of their comparability with TLVs and ceiling values is to treat the system as an exercise in stratified sampling.

Clearly, where the time-weighted average is made up from 32 or more samples, taken at the rate of 4 or more per hour in every distinct operation, the time-weighted average may be compared directly with the TLV.

In other cases, the standard error of the time-weighted average is worked out first and compared alongside the standard error that would have been obtained by sampling at the optimum rate (see Appendix 7). Where S.E. $(\bar{X})$ is the standard error of the time-weighted average and S.E. $(\bar{X})32$ is the optimum standard error, then the environment complies when the time-weighted average is less than

$$TLV + 0.29 \left[S.E. (\bar{X}) - S.E. (\bar{X})32\right]$$

Forecasting

The discussion has so far been about the problems associated with the results of sampling on one shift only. The reason for this is that the TLV document itself does not yet specify how variations in concentration over a longer period might be interpreted.

Whereas it is possible to state that the conditions examined on a particular date complied (or otherwise) with the TLV document, it is not possible to infer from the results of sampling on one shift whether those conditions were representative of any other period.

The hygienist may make a judgement in the choice of the shift to be sampled with the aim of sampling a representative shift or he may make an on-the-spot judgement as to whether the conditions are representative of a longer period. However, it has to be borne in mind that even with careful observation of the processes, cross-questioning of the workers and employers, ventilation measurements and studies of the dust control equipment, the judgement may be little more than intelligent guesswork. It is not possible to calculate from the results of one shift just how accurate such predictions might be.

It would be wrong to consider saying that as long as there are no changes in methods of dust production or control the results are representative of the state of affairs. If indeed methods of dust production and control did remain constant there would be no need to sample more than one cycle of operations.

The average dust concentration will certainly vary from one shift to another, from one week to another and from one year to another. No certain knowledge of a longer period is contained in the sampling results from a single shorter period except in so far as the shorter period contributes to the long period average.

The results of successive visits to a workplace may be plotted on a control chart for prediction purposes. This is a useful means for predicting ahead when an environment is getting out of control, as might happen for example, with an increase in production or with seasonal fluctuations.

The successive averages are plotted by date. The chart is set up by first considering a sample of, say, 20 visits. A "warning" line is drawn 2 standard deviations above the grand average and an "action" line 3 standard deviations above this average. The standard deviation here is that between the average concentrations from the 20 visits. The warning line should, of course, be at or below the TLV at the outset.

Subsequent results should all fall below the warning line. A point falling above this line should be followed by a repeat visit. A repeated point falling above the warning line or a single point falling above the action line indicates that there is good cause for immediate action to be taken to reduce the dustiness.

A supplementary chart may be drawn up for the range. This, in combination with the control chart for averages, will show whether loss of control is due to an increase in average dustiness or due to dust "floods" occurring within each shift. The latter condition will show up as points above the action lines on both charts.

Discussion

The analysis given in the previous sections is one which takes the TLV document as the starting point. Recommended sampling procedures might be rather different if they were based upon our knowledge of the cause and control of pneumoconioses and our knowledge of modern dust sampling instruments, and statistical principles.

In the TLV document the sampling instrument is the impinger. The question is now being taken up of whether another instrument or index of concentration can be recommended. This might lead to an overlapping period of years in which to comply with the new TLV and produce data exactly comparable with the old, it would be necessary to ensure that the concentration is below x mppcf and also below y mg/M3 of certain sizes of dust.

Amongst the air contaminants it is only in the respirable dusts evaluated by count that a particular instrument is specified. It is questionable whether this has really been an advantage.

The specification of a TLV in terms of the result from a particular instrument has the apparent advantage of avoiding the problem of how to reconcile the different results produced by different types of instrument. This advantage is only temporary and it hinders the development of other instruments.

The maximum unit of time specified in the TLV document is one cycle of operations or one shift and the minimum specified is 15 minutes or less. It is questionable whether a worker could get pneumoconiosis in 15 minutes, 8 hours or even 1 week in an industrial environment. Also it is not at all certain that short period fluctuations have any other significant detrimental effects.

The optimum sampling schedule is a fixed number of samples. Ideally, one would prefer the TLV document to specify the upper confidence limit of the estimated average. As it now stands the confidence limits associated with the optimum procedure depend on the variability of the results.

Suppose, for example, that the standard deviation of sample results about the shift average was at one location 35% of the average and at another 10% of the average. Taking the 95% level of confidence to illustrate the point, the standard procedure is equivalent to a requirement that we must be 95% sure that the true average does not exceed the TLV by more than 10% at the first location and 3% at the other.

The TLV document is based upon specifying a single average level which separates those environments which comply from those which do not. The specification of several levels representing different degrees of safety might be more in keeping with our knowledge of the gentle gradation of increasing health risk associated with increasing dust concentration.

Tomlinson(5) took up the problem of making a decision whether a place was above or below a certain average dustiness, and devised a rational sequential procedure for coming to a decision. Wrong decisions were minimised but the remaining few were allowed to err equally either way.

An alternative viewpoint, which is taken in this paper is that while the sampling system should be efficient, decisions should err on the safe side to protect the health of the worker. This view might be more explicitly expressed by saying that in the absence of data to the contrary, assume the worst and act accordingly. That is, assume the concentration is too high unless proved otherwise by dust sampling. From this point of view the purpose of sampling is positive; namely, to save the employer the cost of dust prevention.

Finally, it is sometimes said that the place and time to sample and the interpretation of the results can safely be left to the judgement of the experienced hygienist and there is no need for any discussion or specification of detailed procedure. It should be sufficient to note that the same has also been said about the art of taking and counting impinger samples.

Systematic Errors

Systematic differences are much more important in dust work than the random errors considered in this paper. It is human to assume such errors do not occur or can be neglected. Their measurement is always met with astonishment or frank disbelief.

Examples of bias or systematic error are:

a) Impinger A collects more dust than Impinger B.
b) Observer A counts more particles than Observer B.
c) Hygienist A samples higher concentrations than hygienist B.
d) Liquid A gives rise to higher counts than liquid B.
e) Microscope A resolves more particles than microscope B.

Unfortunately, even when a systematic difference is discovered, measured, investigated and understood it is seldom possible to decide which of several methods is nearer the truth. This does not mean that the choice is arbitrary. The choice may still be made on grounds of consistency, reproducibility and practical convenience. It is believed the methods promoted in this paper are consistent and the results comparable with the values given in the present TLV document and it is on these grounds alone they are to be recommended.

Recommendations

1. The inlet to the impinger should be held upstream of the worker's nose and mouth and no more than 2 feet from the worker's nose and mouth.

2. The samples should be spaced throughout a shift or complete cycle of operations. The samples should be taken at regular intervals or at times chosen at random beforehand. If taken at regular intervals care should be taken to see that the interval does not coincide with any other regular cycle of events which might be related to the dustiness.

3. The environment complies with the TLV document when the estimated average concentration is less than that given by the following formula

$$TLV - k.Range$$

In this formula
TLV = Threshold Limit Value
Range = Difference between maximum and minimum result
k = a constant related to the number of samples taken

Number of samples	k
32	0
10-31	0.1
6-9	0.2
5	0.3
4	0.4
3	(0.8)
2	(2.9)

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A P P E N D I X

1. Random Sampling

The object of random sampling is to obtain unbiased statistics such as the mean and the degree of variability of dust exposure. The results obtained are not necessarily more accurate than those obtained by purposive sampling but it is possible to say just how accurate they are.

Men from a group may be chosen at random by listing all their names and selecting names at random with the aid of random sampling numbers. The statistics of random sampling can then be applied to the results.

The men may be further sub-divided into smaller groups and each group sampled separately. This might be beneficial if, for example, groups of men in different places doing the same job were exposed to markedly different dust concentrations. This subdivision of a population into a number of distinct groups and sampling at random within each group, called "stratified" sampling, may enable more accurate statistics to be obtained than with purely random sampling.

2. Standard Deviation

The standard deviation is the square root of the average of the squares of the deviations of a large number of observations from their average.

Where σ is the standard deviation,
$\bar{x}$ is the average of the observations,
x is a single observation,
n is the number of observations,
and Σ stands for "the sum of all such things as ...."

$$\sigma = \sqrt{\frac{\Sigma (x - \bar{x})^2}{n}} \qquad (1)$$

3. Standard Error

The standard error (S.E.) of an average of n observations is the standard deviation of the average in repeated random samples of size n. It can be shown that,

$$S.E.\ (\bar{x}) = \frac{\sigma}{n} \qquad (2)$$

It can also be shown that the distribution of sample averages is a Normal distribution when the parent distribution is Normal. More important, even if the parent distribution is not Normal, the distribution of sample averages tends rapidly to Normal form as the sample size increases. In most cases it may be assumed for all practical purposes that with samples of four or more the average is distributed Normally.

Consequently, the variability of the average of a sample from almost any distribution can in practice be accurately predicted by reference to a Normal distribution. Tables of a standard Normal distribution are given in most books on Statistics. These show, for example, the relationship between the standard deviation and the chance of the average of a particular random sample of results exceeding the parent average by a specified amount.

4. Maximum Shift Average

The standard error of the average of 32 observations is $\sigma/\sqrt{32}$ (from formula (2)). The probability, P, or occurrence of an observed average lower than the true average by more than t standard errors is found by reference to tables of the Normal distribution. Thus, when the average of 32 observations is equal to the TLV, P is the probability of the corresponding true average being higher than

$$\text{TLV} + \frac{t\sigma}{\sqrt{32}} \qquad (3)$$

Also, when the average of n observations is equal to $\bar{x}$, the probability that the true average exceeds $\bar{x}$ by at least t of its standard errors is also P.

This is the probability that the true average exceeds

$$\bar{x} + \frac{t}{\sqrt{n}}$$

Equating these two expressions:

$$\bar{x} = \text{TLV} - t\left(\frac{1}{\sqrt{n}} - \frac{1}{\sqrt{32}}\right)\sigma \qquad (4)$$

5. Ceiling Limits

The calculation of appropriate limits for sample averages when the sampling procedure is less than the optimum is fairly straightforward.

The comparable limits to the maximum of a set of results cannot be so readily specified. There are reasons for supposing that the assumption of a Normal Law for the distribution of averages is unlikely to be very misleading but there is little reason for supposing that individual measurements of concentration will be distributed according to a common mathematical law at the extremes of the distribution. Consequently, to be as confident about individual measurements not breaking the ceiling requirement as about shift averages not exceeding the TLV an extra safety factor is needed.

One interpretation of the Ceiling Limit is found by the following reasoning. It has been noted that when the average of 32 samples is just equal to the TLV the true average, that is, the average of an infinite number of samples, is equally likely to be greater or smaller than the TLV. Similarly, in an environment where the true average concentration was exactly equal to the TLV the chances are about 50/50 that the average of a finite number of samples will be above or below the

TLV. It might be argued in a like fashion that an environment is at its maximum with respect to acceptable ceiling concentrations when the chances are 50/50 that the environment would be called satisfactory, that is, when the chances are 50/50 that none of 32 results exceeds the ceiling limit. To achieve this probability (0.5) from 32 samples the frequency with which individual samples rise above the ceiling limit is 1 in 47 or 2.14%. (See Appendix 6).

If only 12, 5 or 2 samples are taken the chances are 50/50 that a particular ceiling limit will not be exceeded by any of the impinger results when the frequency with which individual samples exceed the limit is 5.61%, 12.95% or 29.29% respectively. Clearly, it would be inconsistent to have the same admissible ceiling limit as for 32 samples. In these circumstances the working maximum needs to be lower than the ceiling limit if one wishes to be sure that the 2.14% quantile does not exceed the ceiling limit.

Consistent maximum limits are given by noting the relationship between the levels corresponding to the maximum result of a few samples and the level corresponding to the upper 2.14% quantile.

In a Normal distribution the position of the quantiles appears at the points given in columns 2 and 3 of Table 2.

T A B L E 2

No. of Samples	Quantile corresponding to highest result	S.Ds from average		S.Ds from 2.14% quantile
		Normal distribution	Distribution assumed	
32	2.14%	2.03	2.03	0
12	5.61%	1.59	1	1
5	12.95%	1.13	0.5	1.5
2	29.29%	0.55	0	2

Their relative position in the distribution realized in practice can only be determined experimentally. In the absence of such data it would be necessary to make some plausible assumption about the distribution. A distribution which might err on the safe side is suggested in column 4 and the corresponding distances from the 2.14% quantile are given in column 5. This gives the working limits, correcting for number of samples as follows:

TABLE 3

No. of samples	Working Maximum
32	C
12	C - σ
5	C - 1.5σ
2	C - 2σ

It should be emphasised that these factors have been worked out on the basis of a particular interpretation of the meaning of "ceiling limit." To take just 32 samples and consider that the highest result is the highest that is likely ever to be obtained would be a mistake. It may be shown, for example, that to be 95% confident that 99% of the possible results will be at or below the maximum result obtained it would be necessary to take 299 samples and to be equally confident that 99.9% of the possible results will be at or below the maximum result obtained it would be necessary to take 2995 samples. The TLV document does not give explicit guidance about where the "ceiling limit" lies in relation to the frequency distribution of sample results.

6. Combining Probabilities

Where p is the probability that a particular observation will be greater than the ceiling value, the probability that it will be less than this value is

$$1 - p$$

The probability, P, that all of n observations will be less than the ceiling value is, therefore

$$(1 - p)^n$$

and the probability that at least one of the n observations will be greater than the ceiling value is

$$1 - P = 1 - (1 - p)^n$$

$$p = 1 - \sqrt[n]{P} \qquad (5)$$

and when P = 0.5,

$$p = 1 - \sqrt[n]{0.5} \qquad (6)$$

e.g., when n = 32, p = 0.0214

7. Time Weighted Averages

Where $\bar{x}_1$, $\bar{x}_2$ ...., are the average concentrations for distinct operations and a_1, a_2 ...., are the proportions of a worker's time spent in these operations the time-weighted average, $\bar{x}$, is given by

$$\bar{x} = a, \bar{x}, + a_2 \bar{x}_2 + ...$$

(7)

Where $_1$, $_2$ ...., are the standard deviations within the distinct operations and n_1, n_2 ...., are the numbers of samples taken of each operation the standard error of the time-weighted average is given by

$$S.E.\ (\bar{x}) = \sqrt{\left(\frac{a_1^2 \sigma_1^2}{n_1} + \frac{a_2^2 \sigma_2^2}{n_2} + \ldots \right)}$$

(8)

A special result of this is for the case when 32 samples are taken at the rate of 4 per hour in each operation.

$$\text{Then, } n_1 = 32a_1,\ n_2 = 32a_2 \ldots., \text{ etc.}$$

$$\text{and} \quad S.E.\ (\bar{x})_{32} = 0.177 \sqrt{(a_1 \sigma_1^2 + a_2 \sigma_2^2 + \ldots)} \quad (9)$$

SUMMARY OF PANEL

Robert L. Harris

In his paper on Problems of Dust Counting, Mr. Ayer has discussed some of the systematic differences in dust counts and has reviewed a number of experiments with various combinations of variables. When the variables include observers, instruments, media, and details of technique - the variables common in practice of the method - he shows that the coefficient of variation for groups of simultaneous samples in the laboratory and for pairs of duplicate samples in the field is about 50 percent. Some of the individual variables that make up the total variance in these experiments were discussed. This analysis will be of specific value to the Joint ACGIH-AIHA Committee on Uniform Methods for Dust Counting as it continues its efforts to define and reduce variables in the method.

It may be of interest here to consider the Report of the Committee on Dust Counting made by its Chairman, Dr. W. G. Frederick to the ACGIH in 1949.

"Your Committee has critically reviewed the optical counting methods in general use for evaluating atmospheric dustiness. This is a preliminary report of the Committee.

1 Light field counting methods in general use will, under desirable conditions and in the hands of skilled observers, yield order of magnitude estimates of the extent of stmospheric dustiness, e.g., 1 million, 5 million, 20 million, 50 million, 100 million. Variations of considerable magnitude are expectable among evaluations made by experienced observers using similar procedures on

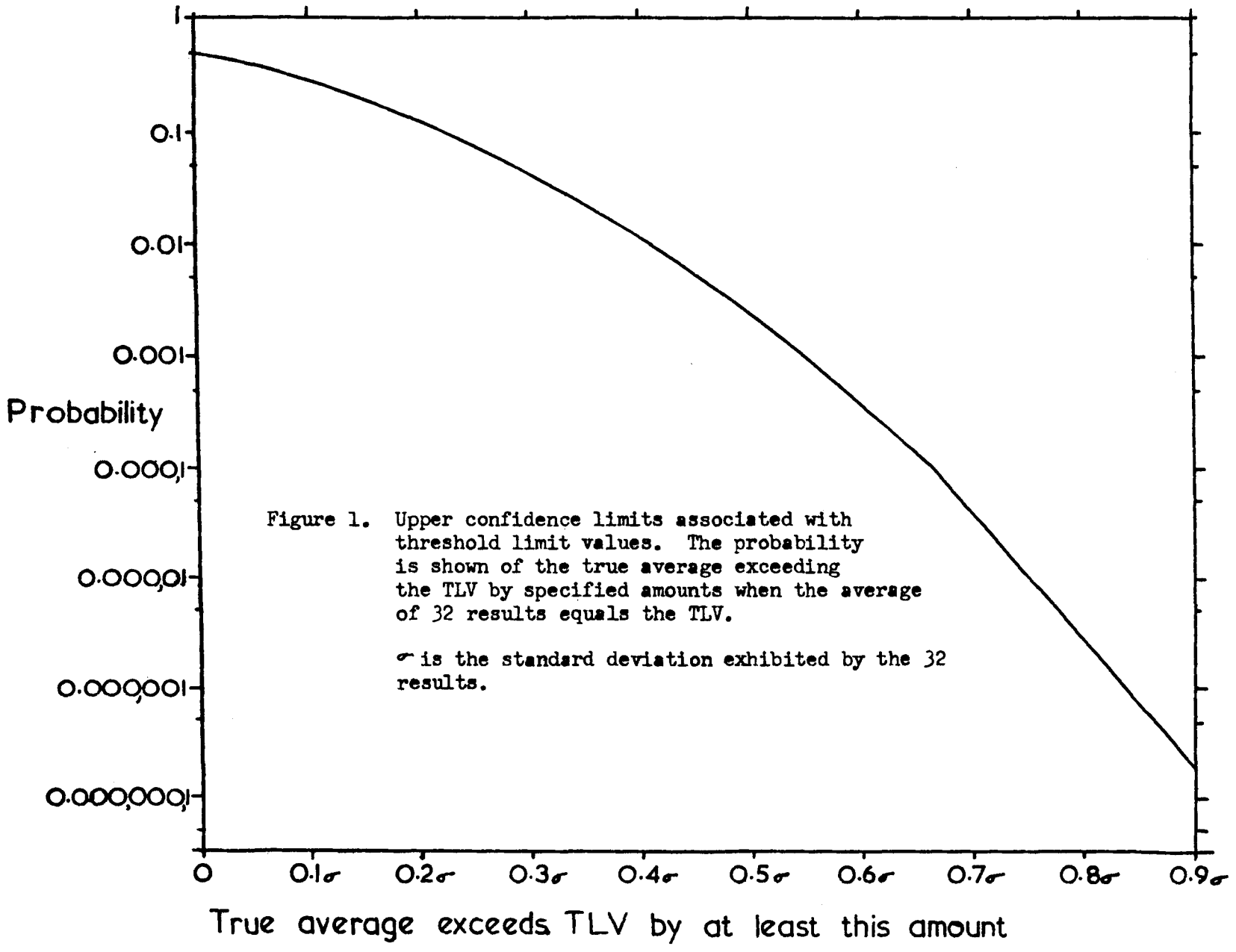

Figure 1. Upper confidence limits associated with threshold limit values. The probability is shown of the true average exceeding the TLV by specified amounts when the average of 32 results equals the TLV.

σ is the standard deviation exhibited by the 32 results.

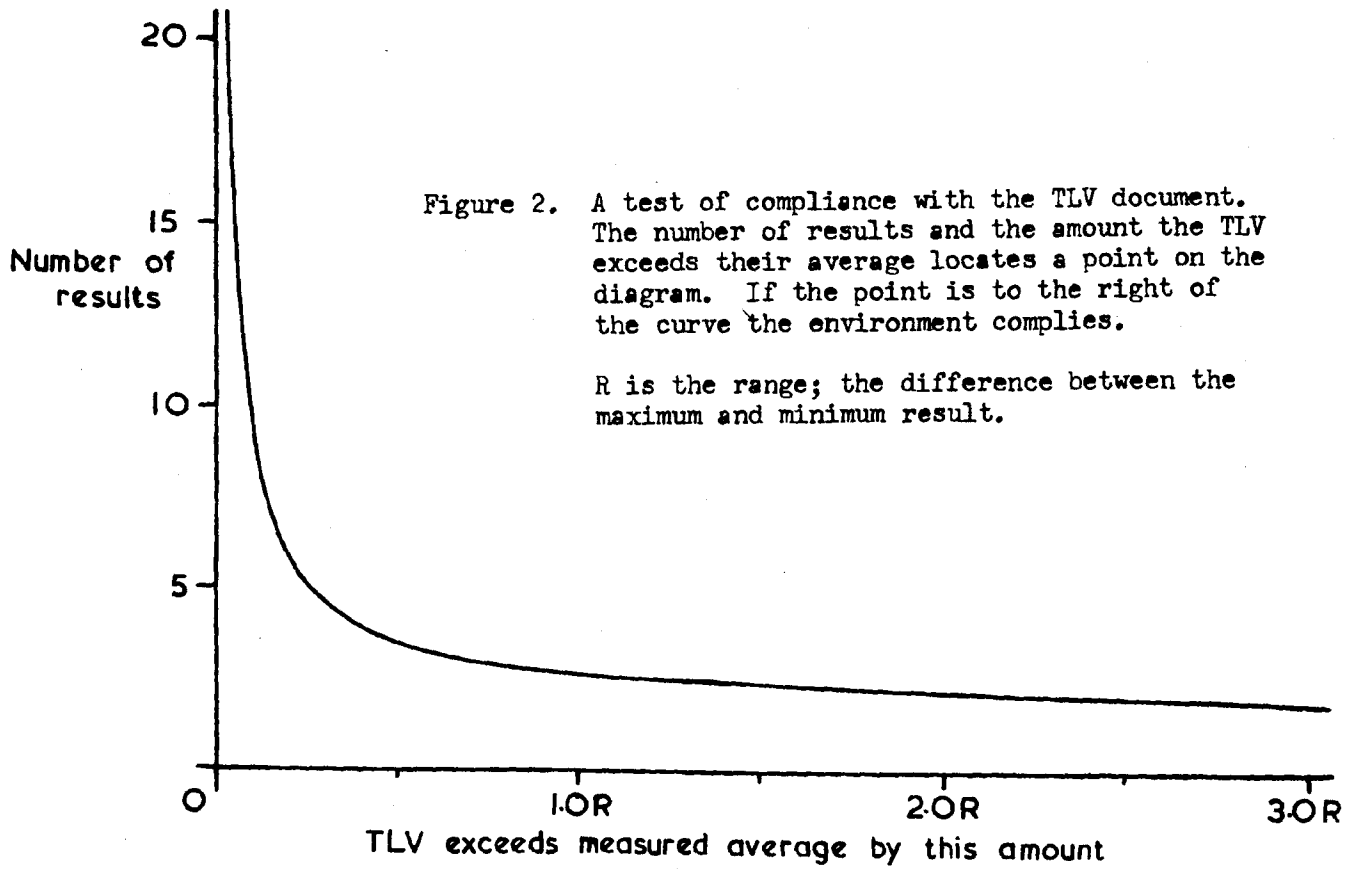

Figure 2. A test of compliance with the TLV document. The number of results and the amount the TLV exceeds their average locates a point on the diagram. If the point is to the right of the curve the environment complies.

R is the range; the difference between the maximum and minimum result.

2. Light field optical methods, using 16 mm. objectives, are of little utility for samples containing a significant percentage of particles below one micron in size. Such samples should be examined by auxiliary methods capable of resolving small particles.

3. Standardization of counting cells, media and similar details produces little improvement of accuracy.

4. The accuracy of optical methods of counting cannot be substantially improved.

5. The present light field optical method should be retained until new methods of evaluation based on particle surface area, electronic counting, etc., are developed or devised.

6. Use of the light field optical counting method should be restricted to evaluating mineral dusts for which suitable chemical methods of analysis are not available.

7. More accurate physiological information concerning the effect of concentration, particle size, surface area and solubility is needed to expedite the development of new evaluation procedures.

8. Methods now available for estimating the silica content of airborne dust samples will be inadequate when more precise total dust evaluation methods are developed.

9. Methods used by industrial hygienists for evaluating particle distribution are for the most part obsolete. Techniques developed for use in other fields of study should be applied to this industrial hygiene problem."

Seventeen years later we have not one, but two Committees, still struggling with the same problems and being able to report more confirmation of variables. Practice, however, has changed little, if any, and many of the discrepancies reported in 1949 by Dr. Frederick's Committee still exist today.

Mr. Baier has reported the results of his poll of governmental industrial hygiene units regarding the collection and analysis of dust samples for determination of quartz content. More than half of those responding use wet chemistry for the analysis, and more than half may use settled dust, airborne dust, or parent material samples, depending upon availability. Results of analyses of referee samples sent to 22 cooperating agencies were in good agreement for chemical and X-ray methods. Referee samples were high in silica; continuation of the experiment with samples of medium - and low - silica content may be in order. Variations in composition with particle size and type of sample have been reported elsewhere. This deserves further attention by the Committee.

Introductory material in the Threshold Limits document states: "Threshold Limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations.", and continues, "The values . . . refer to time-weighted average concentrations for a normal workday." This advice notwithstanding, we know that all too frequently the average value for

a few samples is compared directly with a Threshold Limit Value; and if the average is less than the Threshold Limit Value by any amount, the exposure is judged non-hazardous. In his presentation, Dr. Roach has suggested a rational means for judging the significance of a group of samples based upon their number and variability. Use of such a criterion would be of great benefit in assessing the adequacy of a sampling program and in promoting uniformity in interpretation of results obtained by different investigators. Further, such a statistical criterion can lead to economies in sampling and control by permitting reduction in sampling effort with a calculable degree of confidence and permit a decision on when to initiate correction rather than continue an extensive sampling program. The test for compliance relating the observed average concentration to the Threshold Limit Value, adjusted on the basis of number of samples and their variability, would seem a useful device for routine use.

This panel has limited its discussion to mechanics of the impinger sampling-microscope counting method. It has not explored the adequacy of the method as a means for assessing the hazard of inhalation exposures to mineral dusts. The Committee will continue its efforts to define and reduce variables in the method. This, however, should not inhibit the consideration or exploration of other methods, which may be superior.

The principal concern of the Committee on Environmental Factors in the Pneumoconioses at this time is an orderly conversion from a count to a size selective mass method for measuring exposures. Much excellent work on the respirable dust concept is underway at this time throughout the world. An outstanding review of this topic, entitled "Evaluation of Inhalation Hazards Based Upon the Respirable Dust Concept and the Philosophy and Application of Selective Sampling," by Dr. Paul E. Morrow, University of Rochester, appeared in the AIHA Journal, Vol. 25, May-June 1964. The abstract of this paper states: "The genesis and evolution of the respirable dust and selective sampling concept are described. The background material includes a resume of current ideas on dust deposition and retention in the human respiratory tract and a brief but critical examination of modern dust sampling instruments and methods. Theoretical and practical developments in selective sampling for the respirable or hazardous dust fraction(s) are reviewed." In this concept the deposition of dust particles in the human respiratory system is judged to be related to their aerodynamic properties. In the summary and conclusions of the paper Dr. Morrow states: "The future of dust hazard approaches: (1) The first depends upon an instrument which can quantitatively sample an airborne dust and delineate it according to its aerodynamic properties throughout the size spectrum. As a practical matter some upper and lower limits have to be set above or below which all particles are collected in two classes. It would be possible, without present technology, to set these values as widely apart as $\leq$0.05 and $\geq$50 microns in diameter, respectively. The upper limit will yield to many types of differential sedimentation or centrifugation apparati. The lower end will likely have to depend upon a combination of two instruments if we think in terms of existing equipment, such as the Goetz aerosol centrifuge, molecular filters or diffusion batteries; (2) the second approach is based on the "respirable dust" concept and depends on the utilization of a single or multiple stage selective sampler designed to segregate parts of the airborne dust distributions according to some preconceived plan and in a way which permits analysis of specific aerodynamic size intervals. The selective ranges are based upon specific and general knowledge of the deposition of the dust in the respiratory tract and upon specific knowledge of its clearance, pharmacodynamics and toxicity subsequent to deposition."

You will recall that in his Committee report of 1949, Dr. Frederick encouraged effort to develop new methods and noted that more accurate physiological information concerning the effects of some of the physical properties of dusts was needed to expedite the development of new evaluation procedures. I submit that a great amount of very good information of this type has been developed since 1949. We need, in effect, only an agreement to use it.

Last fall representatives of Great Britain, Belgium, Germany, Holland, South Africa, Sweden, and the United States met in London at the invitation of the British Medical Research Council, Occupational Health Committee, to explore the possibility of agreement for some kind of gravimetric sampling for dust that would yield results comparable between countries. A method selected need not necessarily supplant any national method, but would serve great purpose in being used as a companion to it. Agreement was not concluded at that meeting. The proposal has great merit, and it is hoped that the matter will be pursued with vigor.

I will conclude with one more quotation from the Summary and Conclusions of Dr. Morrow's paper: "We have seen that selective sampling instruments are a reality. They can simulate regional or total dust deposition. They are generally of simple theory, design and operation. They are relatively inexpensive to purchase or to fabricate. No dust samplers in field use today require less support equipment or less training for the operator. There are undoubtedly many dust conditions which could and should be assessed by selective sampling. Pre-existing sampling programs need not be abandoned. The important thing is to begin! The beginning will result from health scientists setting forth tentative criteria for such programs. The implementation phase will follow without difficulty."

GENERAL SESSION

May, 16, 1966 - 9:00 a.m.

Bernard D. Bloomfield, Chairman, Presiding

OPENING REMARKS AND WELCOME

Bernard D. Bloomfield, Assistant Chief
Division of Occupational Health
Michigan Department of Health
Lansing, Michigan

Welcome members, guests, ladies and gentlemen to the start of the A.C.G.I.H. meeting.

Of all organizations which might be directly involved with the workroom environment, or more specifically the prevention of occupational disease, the American Conference of Governmental Industrial Hygienists is the most important organization on the scene today. The organization's members, while in different disciplinary areas--engineers, physicians, chemists, toxicologists, are as an organized group, and individually on their jobs, the most important reason why industrial hygiene as a science is more advanced in the United States than in any other country. A working session with the executive committee is a most enlightening experience. One soon learns that the A.C.G.I.H. has a progressive spirit, has shown a willingness to learn and is relatively up-to-date in terms of this scientific era's prevailing spirit--the drive toward control of what is called man's total environment.

We have recognized the need for control of the workroom environment for fifty years at least. This conference has been a going organization for 28 years. While academicians, consultants and industrial hygienists with private organizations are making significant strides we should not forget that governmental activity has served as the base for much progress. This is where sampling techniques are developed, analytical procedures are developed and improved upon and where toxicological study techniques are being enhanced, and where control comcepts are evolved and transposed into manufacturing technology. This organization has served well as a gathering point for people and ideas. It will continue to do so because this really is its mission with the end result being simply a better workroom environment.

The A.C.G.I.H. is made up of over 900 members, 120 of whom are associate members mainly because of their university affiliations. It sustains a diversified range of committees many of which have been making continues progress in accomplishing their objectives.

We have no exact measuring stick with which we can judge progress. Our accomplishments are summed up as social progress. The other day I visited what will soon be a 1,000-man foundry in Michigan with a production capacity of 2,000 tons of castings per day and something unique was taking place. Being installed with production equipment was local exhaust hooding and ductwork, makeup air supply equipment, and a complete and extensive complement of air cleaning equipment. Admittedly, this is technical progress but from the point of view of the worker on the job, it is also social progress and it represents,

in a large part, the work of members of this organization. It is the grass roots of industrial hygiene activity, the result of knocking on doors, and presenting a convincing argument.

In 1961 at the Detroit annual meeting, our 23rd, one of my associates, Doctor Albert E. Heustis, Commissioner of the Michigan Department of Public Health presented a paper during the opening of the general session entitled "Occupational Needs Today". I would like to borrow a few ideas from that talk. He stated then that the most important occupational health needs of the day were increased effort throughout the country, wise use of the law, continuous consultation, and full use of competencies. On the matter of increased effort he encouraged the practicing of up-to-date public health and not practices used in 1921 or 1931 and affirmed that there is a need to tackle occupational disease problems vigorously and in every state. On wise use of the law, there was mention of the need for a realistic and constructive use of regulatory power in conjunction with the educational process. He quoted a lawyer friend who told him, "The trouble with you folks in public health is that you are afraid to use the law even when it is on your side. You wait around looking for somebody else to do your dirty work." His lawyer friend added that he didn't think working people should end up in a hospital or someplace worse while we waited with baited breath for the long-range results of education. Dr. Heustis made the point, and I agree, that the constructive use of regulatory powers used in conjunction with the educational process will save money, provide the spirit the working staff needs, gain the respect of industry and labor and make the difference between health protection and a lack of it for many working people. On the third item mentioned, the matter of continuous consultation, this is another way of saying that industrial hygiene work cannot be done from the vantage point in back of the desk. The prevention of occupational disease can be done only by getting into industry on a routine basis and making the decisions that are required to bring about a safe workplace. The fourth point made was that there is need for all of us to make full use of our competencies. In this he suggested the breaking of traditional boundary lines and using the taxpayer's dollar most economically. This means that if 2,000 trailers have been marketed and contain a defective propane gas heater which is essentially a carbon monoxide generator, we must do something about it rather than to say this is really not occupational health. The attitude of a limited public health activity with strict boundary lines in a sense spells the doom of any progressive public health organization. Where you have the knowledge, equipment and the trained personnel to cope with the problem, it becomes our responsibility to use these resources wherever and however they are needed to protect people. Let's not be afraid to get out of the traditional setting when our competencies are needed.

This Conference is an orgainization of people with a mission and with objectives which, while directly related to worker protection, are ever expanding. We are not exempt from the increased pressures which will be generated by greater populations and a changing technology. There will be the continuing demands for results and it will continue to require plain, everyday hard work tempered with a progressive spirit.

On behalf of the A.C.G.I.H., I welcome you to this our 28th annual meeting. I thank Mr. Andrew Hosey for his devotion to the job and his exceptional performance as secretary-treasurer. This thanks also extends to Marlene Schmidt, his able assistant.

We also thank Doctor Robert Duguid, our Chairman-Elect, and his program committee for arranging the diversified program which is to be presented. The Conference also expresses its deep appreciation to the many chairman and members of committees, as well as to all others who have worked so hard in carrying out its objectives. We trust that this will be a most rewarding and memorable week for you. Thank you very much for coming.

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PROTECTING THE HEALTH OF EIGHTY MILLION WORKERS

Murray C. Brown, M.D., Chief
Division of Occupational Health
U. S. Public Health Service
Washington, D. C.

It is a pleasure to be here today. I hope to give you a brief rundown on the status of the Frye Report -- what it contains and what it may accomplish.

Over the years, a good many of you have been associated with the Division of Occupational Health in one capacity or another, and are therefore aware of its past achievements.

Unfortunately, however, quite a number of people did not know of its accomplisments. This was due, perhaps, to the failure of the Division, itself, to make its activities more widely known. Whatever the reasons, about two years ago, there were more than mild stirrings which hinted stronly that the Division might cease being an entity, and its responsibilities split up among various other segments of the PHS.

However, at about that time the operations of the Division -- a comparatively small and older program of the Public Health Service -- underwent a thorough review by the National Advisory Environmental Health Committee, a group comprised of health professionals, labor, and industry representatives, and interested private citizens.

Their interest in, and concern over, the Division was the result of the apparent stagnation of the program and its consequent failure to function effectively. Serious questions were raised regarding the need for the program at all, as it was then constituted. Further, whether its functions could be better accomplished were the Division to be fragmented and its various components intergrated into other existing programs of the PHS.

In compliance with the request of the Surgeon General, the Committee gave its consideration to the occupational health program, in June and November of 1964. Its members concluded that the program -- a major and important contributor to the nation's occupational health efforts at an earlier period -- was, at that point in time, in serious need of an overhaul and updating.

The committee suggested that part of the reason, perhaps, for the diminishing effect of the program was the comparatively heavy emphasis being placed on developing newer areas of environmental health. But, they pointed out, it was at least just as true that the program's shortcomings could be found in its failure to adjust itself to the widespread changes in industry, labor, and patterns of public health.

The Committee recommended a full and detailed study of the proper role of the Division in the national program of the PHS. The objectives of this study, in the words of the Committee, were to develop "a revised charter...to be aimed at spelling out first, the responsibilities and mission of the Division appropriate to the current and anticipated state of technology and health resources in the nation, and from this to define the resources required."

No small task, as you can see.

In line with these recommendations, the chairman, Dr. Robert Anderson, appointed a work-committee of four to assist the Staff of the Division in a two-fold mission: first, to

to define the purpose and, second, to establish an estimate of the resources needed for its accomplishment.

The Task Force members, consisting of representatives from labor, management, and industrial medicine, were: Dr. Norton Nelson, Director of the Institute of Environmental Medicine, New York University Medical Center; Mr. George Flaccus, Jr., Vice President of Industrial Relations, Jones & Laughlin Steel Corporation; Mr. George R. Taylor, American Federation of Labor and Congress of Industrial Organizations: and Dr. James Sterner, Medical Director, Eastman Kodak Company.

After nine or ten months of hard study, the Task Force prepared a report to its parent body in which it underscored the need for an occupational health focus -- to be identified as such.

In declaring that considerable urgency was indicated, the Task Force likewise asserted that a new and dynamic program should be outlined at once -- thus insuring that an important chance for effective delivery of health services would not be lost in the wider course of reshaping the national health program.

There was no question, therefore, that there existed a serious and urgent need for a comprehensive study of the nation's occupational health requirements, and of the best methods for meeting them. The Division undertook such a study with the assistance of Dr. William W. Frye, Chancellor of the Medical Center, Louisiana State University.

It was at this juncture that the Frye Report came into being. The Report, in short, is a statement of objectives and goals which some of you have undoubtedly heard about and, perhaps, have even seen--although the Report itself is still, so to speak, under wraps.

The position statement on the Public Health Service Occupational Program as enunciated in January 1965, by the National Advisory Environmental Health Committee Working Group, outlined ten major points which could serve as interim recommendations of issues requiring consideration.

Briefly, the statement embraces the following:

1. To reinforce resources in occupational health in local government units, and to avoid erosion of existing facilities, categoric grant authority for the award of funds to state and local agencies to support occupational health activities is vitally needed.

2. Authority and funds for the support of training grants, applicable to specialty training in occupational health, should be made specfically available to the Division.

3. The Division should explore means for encouraging, on a pilot and demonstration basis, the development of medical services for small plants.

4. Leadership must be provided by the Division to industry in the development of uniform recording and reporting procedures for disease prevalence and mortality in employed groups.

5. The Division should likewise explore means for encouraging studies with industry on chronic exposures to industrial materials and processes. The expectation is that these would be conducted by industry but that the Division should provide aid in working out techniques and methods.

6. Procedures should be found for improving communication between the Division and industrial management, labor groups, and practicing industrial physicians.

7. Every effort should be made to expand studies on the toxicology of new industrial materials. While the majority of this work should be supported through the grant method in universities and elsewhere outside the PHS, it is imperative that the Division have access to a strong intramural laboratory capability. In short, the present unit should be not merely maintained but strengthened.

8. Field studies of occupational disease, on an industry-wide basis of the type which the Division has made in the past, have constituted contributions of major national significance. These endeavors must continue to be vigorously pursued.

9. Occupational health staff representatives should be located in the regional PHS offices.

And lastly, the role of the Division in establishing and enforcing regulations needs a thorough examination.

The Frye Report reflects our efforts in attempting to define a goal and program -- national in scope -- in which each of many diverse elements can play its appropriate role. It would be a partnership of all forces formed -- under the leadership of the Division-- for a vigorous assault on the occupational health problems of American workers.

As background for the study, documents relating to specific subject matter were prepared by senior professional people within the Division and by outstanding authorities outside the Division. For example, discussions were held with the American Medical Association's Council on Occupational Health, the New York Academy of Medicine, the New York Chapter of the Industrial Medical Association, and a number of State health officers.

Dr. Frye visited the Division's installations and talked with industrial physicians, industrial hygienists, and numerous others interested in the field. The Report represents the best thinking of the senior staff of the Division, enhanced and modified by views obtained in all of these processes and by the objective analysis of Dr. Frye.

Actually, the task of assembling the data that makes up the Report, has been referred to as the development of a "new charter for the Division of Occupational Health."

Assuredly, the role and responsibilities of the Division, as the Federal agency most concerned with worker health, should be clearly defined.

It must be remembered, however, that so complex and far-reaching are the implications of occupational health that the Division's role can only be formulated in relation to the activities of many forces in our society.

Among these forces, which also have a direct interest and responsibility in maintaining the health of workers, are other Federal agencies, various state and local jurisdictions, labor, industry, insurance companies, the medical and industrial hygiene professions, and a long roster of organizations working in the field.

The national program in occupational health should have two primary goals: first, eliminating any factor which tends to make the worker pay with his health or his life for the privilege of having a job; and, second, promoting the nation's economy by reducing sick absence and consequent lowered production that are due to correctible health factors connected with the workplace.

Consider, if you will, these statistics:

The average American worker misses five days a year as a result of illness or accidents. On the basis of our current knowledge and experience, a potentially attainable five-year goal in occupational health is a reduction of one day in the yearly average of sick absence.

Together with the comparable reduction of related losses, such as those from temorarily restricted activity while the worker is on the job but below his usual level of health, these improvements--at present rates -- would mean a ten billion dollar annual gain in our gross national product.

Looked at purely in the cold light of dollars and cents, such an achievement is something "devoutly to be wished." And I have not even touched upon the cost in personal suffering as a result of occupationally caused disability -- what it does to the worker involved and his family.

A few more figures may further emphasize the enormity of the problem. Although the nation's work force represents some forty percent of our population, and contributes about sixty percent of the taxes, eighty percent of these citizens work in places where no type of health service is provided. And the protection given the remaining 20 percent runs the gamut from excellent to minimal.

At present, industry is spending $320 million each year to provide in-plant health services to about 15 million workers. However, with proper stimulation and assistance, industry can be encouraged to enlarge and improve these existing services, and to begin new ones. Labor, at the collective bargaining table, and in its own provision of services, likewise is placing increasing emphasis on a healthful workplace.

But the chief element that has up to now been lacking in occupational health is a primary focus of leadership, binding together responsibilities which have long been diffused through different groups -- all of whom, however, have common obligations or interests in the field.

Today, it is eminently clear that there exists an opportunity for a partnership between labor, industry, and government -- a chance to mount a strong tri-partite program, stimulated by Federal leadership and directed toward the elimination of all health hazards at the work site. The plus factor in this effort is the promotion of positive health among a major group of Americans whose health requirements have heretofore been inadequately served.

In launching an effective occupational health program, the Division of Occupational Health, as the major national vehicle for embarking upon so ambitious a project, should be given legislative responsibility and the requisite resources for managing the Federal share of such a program -- a program which would encompass the generating of services by various State and local governments, labor, and industry.

The division has the leadership, the skills, the impetus with which a striking and imaginative national program can be developed. Its achievements in selected fields have been outstanding and are recognized throughout the world. It requires only the legislative authority and funds to extend existing activities for it to assume effective responsibility in areas of need that have long been identified.

Since some occupational health services already exist in various levels of government, as well as in labor and industry, Federal funds would be utilized as seed money, so that the cost of mounting a nationwide program would be comparatively small. Even in those cases where there would be Federal responsibility for direct provision of services programs should be developed to delegate this responsibility to the States, wherever practicable.

Such an approach -- together with leverage gained from the judicious use of Federal monies -- would keep the cost of an effective national occupational program low in relation to the benefits that would accrue.

In addition to about $1 million for services to Federal employees and migrant workers, other annual Federal costs of such a program would be: $15 million for grants to states to develop their own programs and for contracts to carry out delegated Federal responsibilities; $5 million for technical services to provide those services which cannot be delegated; $12.5 million for research and development standards; $2.5 million for measuring and surveillance of the problem; $10 million for research grants; and $2 million for personnel development.

Cost of the proposed program, on an annual basis figures out to approximately 60 cents per worker -- certainly a modest investment in terms of health protection and one which can create considerable economic advantages for the entire Nation.

Keeping in mind the twin goals indicated earlier-- the elimination or control of factors in the work environment harmful to the workers' health, and the promotion of good health, as well as the prevention of illness among workers -- we can readily see that the supplemental benefits to be gained far outweigh the expenditure of money and effort required.

The bed rock of the program can be found in the recommendations embodied in the Report. A summary of each of the pertinent factors reveals the dimensions and scope of the program itself.

The Public Health Service must be given specific legislative responsibility and adequate resources to permit the Division of Occupational Health to launch the program, directing its effort toward the extension of health protection and preventive services to all American workers, plus the development of scientific knowledge regarding occupational health hazards and diseases.

Authority and resources should be allocated to the Division for revitalizing State occupational health programs by the granting, on a matching basis, of Federal funds to the States for this specific purpose. A vital part of this activity should be the development of standards for State programs and model legislation. This method, obviously, would insure that all Federally-supported programs are organized and conducted in accordance with such standards. Additionally, Division advisers should be assigned to States to assist in program development.

The Division should be empowered to develop Federal criteria upon which to base standards for protecting the health of the worker. These criteria -- emerging from consultation with the entire scientific and technical community -- would serve as technical guides in documenting the relationship of specific exposures to health.

They would be made available to States in carrying out their occupational health responsibilities. Included would be criteria for industrial exposure to chemical and

physical hazards, together with methods for measuring and analyzing environmental stresses.

The Division's authority should also encompass the establishment of labeling standards for industrial chemicals transported between States and require compliance with such standards wherever Federal jurisdiction exists. At present, this area of industrial and public health protection lies outside the jurisdiction of any Federal agency.

Assuring the provision of adequate occupational health services to Federal employees, and enforcement of Federal standards within Federal establishments, should likewise come within the purview of the Division.

This responsibility for occupational health services should extend also to beneficiaries of Public Health Service medical services, such as merchant seamen, the Coast Guard, American Indians, Federal prisoners, and migrant workers.

This responsibility would be discharged primarily through the evaluation and certification of programs, technical consultation, and training, with the various departments and agencies assuming chief responsibility for implementing the programs. Division personnel directly assigned would be kept at a minimum. Appropriate legislative or administrative action authorizing the Division to act in these Federal areas is specifically recommended.

Either by negotiation or legislation, the Division should have a clearly defined role in promulgating the health and accident provisions contained in the Walsh-Healey Act -- the law which imposes certain requirements upon Federal contractors. The Division must be in a position, by providing professional skills to develop Federal standards, to insure healthful work conditions for the considerable portion of the work force employed by Federal contractors.

Similarly, changes should be undertaken in regard to the statutory responsibilities of other Federal agencies, such as the Bureau of Mines, relating to health and accident prevention, so that their respective roles vis-a-vis the Division can be clarified and the programs' effectiveness strengthened.

Standards should be developed by the Division to assure that research being done for the Public Health Service, under grants or contract, is conducted under safe and healthful conditions. It is recommended that serious consideration be given to the inclusion of a clause in all U. S. Department of Health, Education and Welfare contracts and grants, requiring certification that such standards are, or will be, met.

Extending this certification to all Federal grants and contracts that do not fall under the Walsh-Healey Act should likewise be given consideration. And if and when such provisions are adopted, they should include authority to delegate, under contract, inspection activities to State programs with demonstrated competence.

Specify authority to enforce Federal health standards in those industries engaged in interstate transportation should be granted the Division.

Although the Federal government has the only jurisdiction covering this segment of industry, it has failed, except in a few cases -- such as airline flight crews -- to exercise its responsibility for occupational health. Currently, no governmental

body, local or state, assumes full responsibility for on-the-job health of railroaders, truckers, or airport workers, for example.

The lack of adequate occupational health protection for workers in small industry and agriculture -- which, incidentally, together employ some 80 percent of American workers -- poses a national problem of such magnitude that dynamic and imaginative Federal action is urgently needed in this wide area.

This action could take the form of support given to short-term demonstration projects by non-profit agencies, medical groups, industry, labor, farmers' organizations, or community groups. A strong federal program of consultative and technical services is most essential.

The Division's in-house and extral-mural research activities should be enlarged to allow further development, and continuous review, of criteria for industrial exposure; expansion of clinical and epidemiological studies; development of new instrumentation and methods for controlling health hazards; improved understanding of the biochemical and physical mechanisms involved in occupational illness; and to provide direct technical services to other agencies. The full range of skills available in the scientific community should be utilized in all of these activities.

The Division' Research and Training Facility in Cincinnati, and its Appalachian Laboratory for Occupational Respiratory Disease, should be expanded, and regional laboratories -- capable of providing rapid technical assistance to States -- established. Resources for research grants, as well as for direct research operations, should be increased to achieve these objectives.

The development of occupational health clinics in hospitals, universities, and community establishments should be supported and aided by the Division. Such clinics will provide clinical-medical services and furnish ample opportunity to utilize accidental human exposures in evaluating toxic hazards. They will also serve to validate indicator systems for subacute toxic exposure, perform other related research, and devote special attention to problems peculiar to the geographic locality served. In addition, such clinics will provide sites for advanced and specialized training of occupational health personnel.

The Division should devise, and put into practice immediately, the most effective methods possible for measuring and anticipating the nature and extent of the national occupational health problem.

Included in its methods should be a substantial expansion of epidemiological studies, sample monitoring of work environments, analysis of technological trends, statistical studies, and development of occupational disease reporting mechanisms through the Workmen's Compensation Commission, the National Health Survey, and the Medical Care for the Aged program.

Leadership should also be provided to employers in developing uniform recording and reporting procedures for disease prevalence and mortality in employed groups.

In those cases where there is evidence of a serious threat to health, coupled with a refusal to cooperate in such studies, the PHS should have right-of-entry to the workplace and authority to examine pertinent work and health records.

In undertaking a broad program to develop the manpower skills requisite for a nationwide effort in occupational health, the Division should be authorized to make training grants to universities and other institutions.

At the same time, it should give special attention to a carefully coordinated program of on-the-job and formal advanced training, together with an expansion of its short-term training program. And, most importantly, as a method of conserving and fully utilizing scarce scientific skills in the many disciplines required, the Division must develop an effectively trained corps of supporting personnel.

The Division's Technical Information Service should be expanded and strengthened to create an effective national resource for the accumulation and dissemination of occupational health knowledge.

Parallel with this should be an increase in its educational and informational activities to provide rapid and effective communication of guidance to industry and labor, and to advance the health education of workers. A National Conference on the Health of the Worker should be arranged at an early date with the purpose of focussing national attention of the need for worker health protection.

A Scientific Advisory Committee, to provide continuous in-depth review of program activities and recommend changes in content and emphasis as required, should be established by the Division.

As outlined in the Report, the program will require a minimum annual budget of $50 million and its fulfillment should proceed with as much rapidity as manpower and the orderly development of its various elements permit.

The budget for Fiscal Year 1967 should be increased to meet the National Advisory Environmental Health Committee interim recommendations as approved by the National Advisory Health Council in March 1965, permitting the Division to prepare for the full-scale national program.

Among the more vital elements required in the preparation of such a program would be: development of legislation, organizational plans, and cost-benefit analysis of the Federal program; detailing model States laws and standards for State occupational health programs; setting forth standards for Federal employee health services; and recruiting an initial cadre of personnel at the Federal and State levels.

It is also recommended that an Inter-Departmental Committee on Occupational Health, plus a similar Intra-Departmental Committee within the U. S. Department of Health, Education, and Welfare, be set up to consider, at their respective levels, appropriate roles of the various governmental agencies in occupational health. These committees should recommend legislation and devise administrative action with a view toward coordinating and expanding Federal efforts in this field.

The foregoing proposals are firmly based upon realities now confronting us. For instance, today there is no such thing as a "national" program in occupational health. The Division, in fact, exists without legislative mandate and with no authority to develop nor enforce any kind of national policy.

Limited resources restrict its activity to highly selective programs and projects. Despite this handicap, however, it has made substantial contributions to worker health over the past 50 years and has repeatedly demonstrated its competency.

Occupational health elements are dispersed throughout other Federal agencies, such as the Departments of the Interior, and Labor. Even within the Public Health Service itself, programs relating directly to worker health are within the precincts of units other than the Division of Occupational Health.

For administrative reasons within the government, an artificial distinction has been made between occupational disease and industrial injury -- a distinction which obscures the total picture and hampers advancement in many areas.

Local and state occupational health resources have never kept pace with the needs and size of the work force. Nine states have no identifiable programs in occupational health; state and local laws vary.

Industry, labor, and insurance companies have an interest in some aspects of occupational health and consequently have made valuable contributions within the limited areas of their interest.

Many organizations, with a membership composed primarily of professionals in the various occupational health disciplines, constantly strive to improve competency and to stimulate activity in the field.

However, what is sorely lacking is a unified core of leadership, with the means and authority to integrate these diffuse -- if not haphazard -- forces, which would create a truly national program of occupational health.

As presently organized and staffed, the Division conducts activities which can very well serve as a nucleus of the dynamic national program envisioned. It performs epidemiological, clinical, and laboratory research; conducts short-term training courses; and has inaugurated a system for rapid storage and retrieval of technical information.

At the same time, it provides technical and consultative services to States, and other Federal agencies, industry, labor, and similar groups. Under its auspices, a broad range of technical and informational materials are disseminated. All of these activities, vital components of a national programs of occupational health, should be expanded and upgraded.

Admittedly, much remains to be done in the field of occupational health. And the Division, once it is given the muscle -- in the form of resources, and the authority, under appropriate legislation -- stands ready to move forward and do the job.

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THE RESEARCH PROGRAM OF THE HEALTH AND SAFETY ACTIVITY OF THE BUREAU OF MINES

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Mr. Chairman, ladies, and gentlemen. It is a pleasure to be here today to tell you something about the research and development program of the Health and Safety Activity of the Bureau of Mines. This program which has its roots in the very creation of the Bureau in 1910 is aimed at reducing accidents, saving lives and property, and improving health in the mineral industries.

Although the original law creating the Bureau in 1910 did not directly call upon it in health matters, the responsibility was clearly implied. And, less than three years later, the Congress amended the Bureau's Organic Act saying, in the revision, that the Bureau of Mines is responsible "....to conduct inquiries and scientific and technologic investigations concerning mining, and the preparation, treatment, and utilization of mineral substances with a view to improving health conditions, and increasing safety, efficiency, economic development, and conserving resources..."

At the outset, the heavy loss of life and high accidental injury rate in the industry received the Bureau's attention. Fires and explosions, especially in coal mines, were then the most serious causes of death and injury. It was at one of the Bureau's Experimental Coal Mines, not more than 15 miles from here, that it was finally demonstrated conclusively to the American coal-mining industry that coal dust suspended in air can form an explosive mixture. Before then, it was generally assumed that explosions occurred only as the result of igniting a mixture of methane coming from the coal measure and air. From this and similar beginnings have developed more sophisticated studies on the nature of gas and dust explosions, and their prevention --studies still being carried on because the dynamically changing conditions in coal mining continually present new explosion hazards.

After what was learned from the earlier work on fires and explosions had been adopted in most of the mining industry, and the frequency and severity of these accidents diminished somewhat, another problem assumed more prominence. Collapse of mine roofs and ribs or walls then became the principle target of our efforts. Substantial progress has been made over the years in our work on roof-fall problems but the greatly increased tempo in coal mining has helped to intensify the roof-fall danger. As a result, this type of accident still accounts for about half the deaths in underground mining. Progress in being made through the adoption of a technique called roof bolting in which rods with expandable upper ends and threaded lower ends are inserted in holes drilled through several strata and drawn tight. The beam-like structure so created when applied in a proper pattern not only provides a stronger roof, but also eliminates timbers or other supports which constrict mine passageways.

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*James Westfield, Assistant Director, Health and Safety, Health and Safety Activity, Bureau of Mines, Department of Interior, Washington, D. C., was co-author of this paper.

Also, in the early days of the Bureau, we undertook work which involved hygienic significance. For example, from 1912 to 1915, we developed processes for extracting and safely handling carnotite and other radium bearing ores from Colorado. When the first world war came along, we studied gas masks and poisonous gases. This work later became the initial effort of the Research Division of the Chemical Warfare Service of the Army. It also was the start of the Bureau's interest in respiratory protective devices and of its testing and approval program.

The present research and development program is subdivided into five major categories. Although some, at first glance, will probably appear to be far from the interests of most of this group, in each there are some parts which may have actual or potential interest.

Under the broad heading of Dust Explosions, we carry on research on methods of preventing such explosions and of minimizing their effect if they occur. The primary research facility for this work is an experimental coal mine, a unique and versatile laboratory. Because research can be conducted under simulated mining conditions, a wide variety of safety problems have been studied. Initially, studies of gas and coal dust explosions were emphasized and the results of this work contributed to the marked reduction in fatalities from explosions. For example, in 1910 when the experimental coal mine was opened, the overall fatality rate from explosions was 500 per year; by the 5-year period, 1958-1962, the average annual fatality rate from this cause decreased to 26 per year. Explosion tests have been made on more than 40 different ranks of coal obtained from all parts of the United States. Numerous parameters affecting the ignition and explosion of coal dust and methane gas have been investigated. These include fuel concentrations, fineness of dust, volatile content, location of dust on mine surfaces, strength and type of igniting source, the effectiveness of dry and wet rock dust, and rock dust and water barriers.

In addition, the members of this group conduct other miscellaneous studies. Recent projects involve the control of mine fires with high-expansion foam, control of mining maching fires, float dust hazards, the use of rigid foam for underground seals and stoppings, and the propagation of flame on coal conveyor belts.

At present, projects are in progress on the factors that affect flame spread along conveyor belts and on urethane foam, on air leakage and rupture strength of typical stoppings (ventilation directing barriers) used in coal mines, on the movement of high concentrations of dust in turbulent air streams, on dust explosion hazards associated with filling coal silos, and on the effectiveness of washer-held vent panels in releasing dust explosion pressures.

Our work with rigid foam for coating the inside of mine openings to protect against the effects of atmospheric moisture, and of gas and water leakage, and as a coating over cloth or expanded metal stretched across mine openings to control ventilation are good examples of how parts of our program are related to and frequently involve hygienic problems.

When rigid foam is applied by a spray gun in the confined configuration of a mine, the usual protection from the fumes of the work comes from dilution by ventilating air. Because the foam contains methylene diphenyl-diisocyanate (MDI) there was concern about possible health hazards. A cooperative study was undertaken by the Anaconda Company, the Public Health Service, and the Bureau of Mines. The result of the study was published over a year ago and many of you may be already acquainted with it.

Suffice it to say that the parties involved concluded that as soon as 30 minutes after application the fresh coating did not emit measurable quantities of diisocyanate vapors; and that although appropriate respiratory protection should be worn by those in the immediate spray area while foam is being applied, no hazardous conditions were found at distances greater than 60 feet from the point of application when ventilating air was passing the same point at 60 linear feet per minute.

In our flame spread studies, experiments have been conducted to determine the effects of ignition source strength, of air velocity, and of the nature of belt cover and belt carcass on flame propagation along conveyor belts; each parameter has been evaluated at three or more levels. Neoprene, polyvinyl chloride, and rubber belts were each ignited by a gas-flame; the total required heat input was 4,200, 700, and 2,500 Btu, respectively. It is probable that the ease of ignition of PVC is due to the plasticizer used in its manufacture. After ignition, ventilation had a marked effect on flame propagation. In general, flame did not propagate when air movement was caused only by heat from the ignition source and from the burning belt. On the other hand, flame propagation did occur in each case when air velocities were about 100 ft./min.; the propagation rate was highest with the rubber belt. Also, the rate of flame propagation was affected by the cross-sectional areas of the gallery and, to a minor extent, by the nature of the belt carcass.

Ignition source strength and location of urethane foam appear to be the primary factors that affect flame spread on foam coating in mine entries. Foam applications on the roofs, in shafts, or on slopes present a hazard because of convective heat transfer. The hazards of ignition and flame spread may be minimized by the use of proper chemical formulations, equipment and application techniques, as well as by control of the amount and location of the surface to be covered.

The importance of mine stoppings in the control of ventilation and in underground fire fighting is immediately apparent. Air leakage rates and rupture strengths have been determined for block stoppings made from cinder, slag, and gravel aggregates and for stoppings made of brattice cloth or nylon, as well as with brattice cloth and expanded metal lath sealed with latex, asphalt emulsion, mortar, or rigid foam. No single stopping was found to be superior to the others for all the conditions encountered in coal mining. Where a stopping may be subjected to relatively high pressure differentials, a rigid foam-coated, mortar-joint block stopping which has the lowest air leakage and highest rupture strength should be selected. Where heaving bottoms and roof-floor convergence occur, the foam-coated brattice cloth stopping shows the least leakage for the greatest convergence and is best. However, if the stopping is expected to offer resistance to convergence, a dry-wall foam-coated stopping is superior.

The nature of airborne coal dust has changed as a result of the adoption of mechanized mining. Samples of dust made airborne during mining operations were obtained in the return airways of 15 operating mines. These were analyzed to determine the proportions of flammable coal and nonflammable or inerts in the dust; the combined particle-size distribution was also determined. The dust particles transported into return airways beyond the last open-cut-through were found to be finer than 44 microns, to have an average particle diameter of 15 microns, and to contain in excess of 85 percent combustible material. The average airborne concentration 200 feet from the mining machine was found to be 1×10^{-6} oz./cu. ft. per ton of coal mined.

Gas accumulations and dust suspensions present an explosion hazard in coal stockpiling and coal reclaiming operations. In the past, coal was generally loaded into

railroad cars the same day it was mined. However, the introduction of the unit train, which affords reduced transportation rates, has made temporary stockpiling at the mine an economic necessity. Instead of loading a few railroad cars daily, a larger predetermined quantity of coal is stored and then loaded in 24 hours or less. Mines have had to construct facilities for storing and reclaiming coal; some safety factors have been neglected. There has been at least one serious explosion.

It is well known that freshly mined coal from a gassy mine continues to liberate methane for several months after mining. It has not been equally recognized by coal mine operators that coal dust, made airborne during the filling of a coal silo, may also indicate that as coal falls in the silo, air is displaced, and fine dust particles are driven toward the perimeter. After coal feeding is stopped, the dust settles at a rate which depends on the particle size, dust concentration, and air turbulence. Explosive concentrations were found to exist within the silo for some time after coal feeding was stopped.

Next, I would like to mention one achievement in another category of our work, Electrical-Mechanical Testing, which is primarily concerned with electrical safety and the prevention of fires and explosions of electrical origin. Ordinarily, in this phase of the Bureau's program the staff is engaged in examining, testing, and passing judgment on electrical equipment to decide if it is worthy of approval for use in the gassy and dusty atmospheres of coal mines. The particular project I want to call to your attention was undertaken because the far greater rate of coal cutting which resulted from the introduction of continuous mining made ignition of gas near the working face an all too common occurrence. In 1960, we undertook an accelerated program to develop a methane monitor which would be rugged, dependable, long-lived, and practical when mounted on the mining machine and used under the very severe operating conditions encountered in coal mines.

During the past two years, development work was completed and a prototype methane monitor constructed and evaluated in the laboratory. Also, we now have ten units in actual mining operations for evaluation. More important is that at least two manufacturers developed competing models and two manufacturers have been given permission to copy any part or all of our detectors. We anticipate others will also want this authority and are prepared to grant it to as many as apply.

Basically the unit uses a detector head consisting of a platinum filament encapsulated in sintered alumina impregnated with platinum black. The electrical components are relatively simple, consisting of an unimpregnated (inactive) duplicate of the sensing head and the other components of a Wheatstone Bridge, a milliameter which reads directly in units of methane, a triggering device and relay to provide power to a warning light when the methane concentration reaches about one-fourth the lower flammable limit, and another relay to interrupt electrical power to the mining machine if the concentration of methane rises to about 40 percent of the same limit.

The field tests have been spectacularly successful in every respect. Although there is little new or novel in principle in the methane monitor, we are proud of it because of its ability to satisfy unique and rigorous operating requirements which include intense vibration of highly irregular frequencies, being struck by falling rock on occasion, high dust loading, rapid response, and electrically permissible (explosion-proof) construction.

The control of mine roof, walls, or ribs, and the protection of miners from rock bursts and rock falls was mentioned earlier. More specifically, I would like to list

for you some of our work in roof bolting:

1. Use of resin-anchored bolts in soft roof; anchorage is generally superior to that obtained with conventional expanded bolts.

2. Use of explosive-anchored bolts in coal mines; these appear to be superior to conventional bolts when proper anchorage is obtained.

3. Development of a simple, rugged, inexpensive hydraulic device for use in measuring changes in tension in roof bolts over relatively long periods.

4. Development of a test procedure to be used in determining the optimum design specifications for roof bolt bearing plates.

In another project, experimental work has been completed to evaluate the effectiveness of resin-rebar supports in repairing fractured rock. Here we use deformed bars similar to the ones used in reinforced concrete and fill the voids between the rock and the bar with resins.

Another experimental project was initiated to obtain information on gas pressure at various elevations in the mine roof. A multiple-seal borehole packer was constructed to permit simultaneous measurements of fluid pressure at several elevations. Data are being obtained at heights to 13 feet above the roof line.

Ventilation has been the backbone of much of the explosion prevention and health work of the Bureau. A Ventilation Group conducts research and tests on ventilation requirements and on methods to control atmospheric contaminants in mines and in industrial establishments. Currently, a study is being made in one of our experimental mines of the performance characteristics of common jute line brattice, the airflow characteristics of auxiliary tubing, airflow and methane concentration patterns in coal mine face areas ventilated by line brattice, and the effect of atmospheric pressure changes on bleeder entry performance. In addition, a compilation is being prepared on heat sources in mines, the physiological effects of heat, and the use of air conditioning underground.

The facilities and personnel of this group are also available to the mining industry to assist in planning, improving and projecting mine ventilation systems.

A series of studies is being conducted on the effectiveness of various systems that can be used to ventilate active mine face areas. These include:

1. Common jute line brattice. Performance charts were prepared for poor, average and good installations using various weights of brattice cloth.

2. Airflow and methane distribution patterns developed by line brattice systems are being studied in the experimental mine using blowing and exhausting systems.

3. Reinforced flexible tubing and flexible fan tubing. Airflow characteristics are being determined for 14-, 18-, and 24-inch diameter reinforced flexible tubing and for flexible fan tubing at elevated pressures.

You are probably best acquainted with and most interested in the work we have lumped together under the title of Health Research. Generally speaking it involves research

and tests on atmospheres and devices of concern to health activities in the mineral industries. Currently, gas chromatographic units are being developed for the rapid analysis of mine air and diesel exhaust. In addition, studies are underway to determine the composition and origin of gases in the atmospheres of operating mines, the applicability of the Coulter Counter to the routine counting of airborne mine dust samples, the effectiveness of foam in suppressing dust generated by continuous mining machines, the performance requirements for gas masks against amines, the performance of respirators at low temperatures, the noise levels associated with supplied-air respirators, carbon dioxide in self-contained breathing apparatus, bacterial action in heating soil, an evaluation of dusts breathed in bituminous coal mines, and a continuation of the study of silicosis in the metal mining industry.

The gas projects utilize a two-stage table-top chromatograph which was assembled and evaluated for use in making routine mine-air analyses. The unit is designed to determine the carbon dioxide content in one column and the fixed gases and methane in the other. Good separations are obtained with mixtures of carbon dioxide, nitrogen, oxygen, carbon monoxide, and methane. This unit also appears to be satisfactory for use in analyzing diesel exhaust gases.

Normal clean, dry air near sea-level consists of nitrogen (78.08%), oxygen (20.95%), argon (0.93%), carbon dioxide (0.03%), and traces of rare gases. When air enters a gassy mine, its composition is altered in two ways -- by the addition of gases such as methane and carbon dioxide, and by loss of oxygen through absorption and chemical reaction which yields carbon dioxide, and, perhaps, carbon monoxide. Mine-air samples collected in producing coal mines in different coal seams are being analyzed to provide information on the source of methane and other hydrocarbon gases, carbon dioxide, and carbon monoxide. The program will be extended to additional mines and localities to encompass a wide variety of coals. Special attention will be given to factors that might relate to migration of strata gases into coal mines such as from nearby oil and natural gas fields.

It is unnecessary to emphasize the importance of airborne dust in preventing explosions and in making working conditions more healthful. All coal mining generates airborne dust in varying concentrations. Water sprays applied as close as possible to the point of dust generation help control the dust; usually the addition of a wetting agent to the spray water makes little or no additional reduction in the dust. Even when water sprays are highly effective there is still considerable dust in the air which may be inhaled by miners.

Protein base foams have been tested in the United States and abroad in place of water sprays. Results have been uniformly discouraging. We are now exploring high expansion foams for the same purpose and are encouraged enough to include the project in our future plans. It is already apparent that the construction and location of the foam nozzles on the mining machines is highly important. Foam nozzles generating 250 to 300 gallons of foam per gallon of solution have been designed and constructed for use on continuous miners and are being used in a study of the effectiveness of foams in allaying the dust generated by such machines.

The interest in respiratory protective devices is growing as rapidly as the need to protect persons from more and more substances. Recently an apparatus was constructed for use in evaluating respiratory protective devices. Both the ingredients and the complete gas mask canisters can be evaluated. Gas masks have been tested against phosphine, sulfuryl fluoride, hydrazine, and unsymmetrical dimethyl hydrazine (UDMH). Commercial canisters have been tested to determine their effectiveness in

removing a series of amines (methyl amine, ethyl amine, ethylene diamine, diethyl amine and n-butyl amine). Throughout we have cooperated with manufacturers seeking to produce effective protective measures.

In another project of recent origin, open-circuit and closed-circuit self-contained breathing aparatus are being evaluated at temperatures to -25°F. The effects of low temperatures and wind on the mechanical parts is one interest and the effect of sub-freezing temperatures on the canister-fill material another. Fire fighters and the AEC have been especially interested in this project.

An experimental program was initiated to develop a method that can be used to determine the average concentration of carbon dioxide in the breathing zone of an individual wearing a self-contained breathing apparatus. A mechanical breather was construc ted to simulate the human breathing cycle. The results of tests conducted with various facepieces indicate that a true measure of the mean carbon dioxide concentration created in the breathing apparatus can be obtained.

Experiments were conducted with natural gas-oxygen mixtures stored over sterilized and unsterilized samples of soil collected near a local residence; heat was being liberated by the upper layers of the soil when it was collected. The gas composition above the sterilized soil did not change but the oxygen concentration above the unsterilized soil dropped from 25 to less than 0.3 mole percent and the carbon dioxide concentration rose to 13 mole percent. The temperature rose from 77° to to 93°F in 24 hours.

In the history of the Bureau of Mines up to the year 1937 one finds an impressive record of scientific accomplishments made by Bureau of Mines employed teams of physicians and engineers, physiologists and toxicologists, and physical scientists. In 1937 it was apparently decided that is was wasteful for the Bureau of Mines and the Public Health Service to maintain similar staffs of medical scientists and similar facilities for conducting animal experiments. At any rate, by agreement between the two agencies, the Bureau terminated this phase of the work and the Public Health Service continued it. There was no lessening of the Bureau's interest, authority and responsibility for health and safety in all phases of the mineral industries, and the Public Health Service agreed to provide medical services as needed by the Bureau.

Since 1937, the agreement has been renewed several times with minor modification. At present, to coordinate the interest and efforts of both agencies in connection with the mineral extractive industries there is an Interagency Committee on Pneumoconiosis in the Mining Industry made up of 6 members, 3 from each agency. It was under the advisory direction of a previous Interagency Technical Committee that the work leading to the report, Silicosis in the Metal Mining Industry, A Revaluation, 1958-1961, was carried out and the report written. In the actual work, the medical study was performed by the Public Health Service and the environmental study was made by the Bureau of Mines.

Sixty-seven underground mines were involved; 14 were iron mines with 4,231 employees; 11 were copper mines with 7,260 employees; 22 were lead-zinc-silver mines with 4,281 employees; 8 were uranium mines with 373 employees; and 12 were a miscellaneous group with 4,365 workers.

In the environmental study a total of 14,480 impinger samples were taken in underground working places and an additional 357 samples were collected elsewhere

underground. Of the grand total 14,837 impinger samples virtually 10% contained excessive amounts of dust. There were 789 full shift weighted average exposures made.

In 1962, the TLV for silica bearing dust was changed. We, therefore, evaluated 789 average exposures on the basis of both the old and new standard. On the old basis, about 6% exceeded the limit; but by the new one, there were approximately 13% over the limit.

The Public Health Service examined 14,076 currently employed metal miners. Overall, they reported that about 3-1/2% of the roentgenograms were classified as consistent with a diagnosis of silicosis. --Earlier studies between 1914 and 1935 revealed prevalence rates as high as 60% and seldom less than 25%.-- Related to the age of the worker, they reported no cases in men under 35; 0.4% between 35 and 39; 2.4% from 40 to 44; moderate increases to about 12% in the 55 to 64 age group and about 1/3 at 65 or older.

When years of work were considered, no cases were found in men with less than 5 years exposure; 0.2% in workers between 5 and 9 years; 1.4% in workers from 10 to 14 years; and 3.0% from 15 to 19 years.

After 20 years of work, the prevalence rate rose rapidly to an average of about 17% for all workers with 30 or more years of exposure. There were other important findings, very lucid conclusions and recommendations. The report is available on request.

Currently, the new Interagency Committee is planning to repeat some of the work on a smaller sample of the mines and miners. This next cycle will otherwise be very much the same as the one just mentioned. It would be valuable to learn if the disease is really disappearing; which dust control measures are working best; and to what levels of dustiness metal miners are now being exposed.

Still another major undertaking involves a similar survey in bituminous coal mines. Also a joint endeavor of the two agencies, the medical phase has progressed far enough especially in the Appalachian Area to permit some preliminary statements. It shows that about 10% of the active miners and 20% of formerly employed miners have roentgenologic evidence of pneumoconiosis. The disease was rarely diagnosed in miners under age 45 and its prevalence could be correlated with years spent underground. Although the study did not attempt to correlate the prevalence of the disease with dust concentrations or other environmental factors, the evidence, based on studies by European investigators, is abundantly clear that there is a relationship between the disease and the quantity of respirable dust inhaled. The significance of the disease as an economic factor is clearly evident from compensation experience. We are told that in one State compensation costs in 1963 amounted to approximately 25 million dollars.

The Bureau of Mines is now preparing to embark on a respirable dust survey in coal mines in the Appalachian Area. The mines are being selected on the basis of the Public Health Service survey in the hope that some relationship between the two surveys will emerge now or in future resurveys.

We are planning the survey in conjunction with the Interagency Committee on Pneumoconiosis with the following purposes in mind:

1. The survey is concerned only with hygienically significant dust as opposed to flammable dusts.

2. Samples will be taken, as best possible, of the hygienically significant dust in the breathing zone of coal mine workers.

3. Simultaneously samples will be taken of the hygienically significant dust in the work area.

4. The realtionship between data obtained from the breathing zone and corresponding information obtained in the work area will be established, if possible.

5. Measurements will be made on a time weighted, full shift basis.

6. The survey should separately identify the dustiness exposure of significantly different mining operations.

7. Compositional analysis, especially for silica and ash, will be made on the samples taken.

There will be both gravimetric and impinger samples taken. One purpose of using both sampling methods is to provide an opportunity to compare results obtained by the two methods. Another is to provide current information on dustiness in coal mines in the same terms that similar information has been gathered in the past.

There are two gravimetric samplers we will use. The first is intended to sample the breathing zone of the wearer and will consist of a 10mm. Dorr-Oliver cyclone, plastic filter, and personal monitor. We have modified commercially produced monitors so that they are intrinsically safe for use in the flammable atmospheres which may exist in coal mines and so that they will operate for a full work shift.

The second which is to sample the general atmosphere in the working place is a battery powered, intrinsically safe instrument developed at the Mining Research Establishment of the National Coal Board at Isleworth, England. This instrument is now being manufactured and sold commercially. Air is sampled at a rate of 2.5 liters per minute. Over a full shift sufficient dust is collected to be well above the lower limit for precision weighing with a balance having a sensitivity of 0.01 milligram. There is a horizontal elutriator designed to cut off at 7 microns, pass 50% of the 5 micron particles and 100% of the particles at a fraction of a micron. The dust is collected on a circle of plastic filter membrane. The air is drawn through the filter by a reciprocating pump driven by a constant speed electric motor.

Because the two aerodynamic particle size selectors, the cyclone and the MRE elutriator, do not have identical selection characteristics, comparisons will be made between them throughout the work so that we will be able to correlate the breathing zone data with that of the working place.

One feature of this survey I want to emphasize is that we will perform compositional analysis, whenever possible, on the respirable fraction of airborne dust.

Questions have been raised regarding the advisability of introducing gravimetric sampling into the picture, even as an adjunct to impinger sampling. We summed up our feelings in the conclusion of a recent paper which also discussed similar work in other countries in these words:

'The administrative reasons for selecting particle count standards in the United Kingdom have largely disappeared, and in their place there are now strong reasons

to adopt gravimetric standards. Among these are that counting is time consuming, requires special training, and is subject to considerable personal bias whereas the gravimetric methods are cheaper, quicker, and more objective. They also gather a sample large enough to permit compositional analysis of the dust.

"The principal goal of the cooperative effort by the Bureau of Mines and the Public Health Service is to conduct a meaningful integrated survey of the medical and environmental aspects of chest diseases in bituminous coal miners due to the inhalation of dusts. The study should lead to rational recommendations of maximum dustiness for hygienic reasons which would provide adequate protection under economically feasible conditions.

"Another purpose of the survey is to develop a simple, economical method of determining dust levels in terms of what mine workers breathe."

My last task this morning is a pleasant one. It is to invite any of you interested in any part of our research program to visit our laboratories in the Pittsburgh area and become better acquainted with us and with what we are doing.

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INDUSTRIAL HYGIENE SURVEY OF METROPOLITAN DENVER 1965-1966

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(Note: This paper was given by Drs. Kendrick and Hendricks)

INTRODUCTION

Although the Occupational Health Sections of the Colorado State Department of Public Health, Denver Department of Health and Hospitals, Tri-County Health Department and Jefferson County Health Department, have been engaged in occupational health activities for several years, no concentrated effort has ever been directed toward the establishment of guide lines or goals for these occupational health activities. Activities had been directed towards special studies, fulfilling request and abating complaints of an occupational health nature in various industries.

The Denver Metropolitan area, faced with accelerating industrialization, was under necessity to strengthen its occupational health resources to more adequately meet the needs. A scientific statistical approach was undertaken to define the problems from which further activities could be projected.

Objectives

The primary objective of the survey was to gather significant data whereby occupational health problems could be defined with respect to industrial groups involved and with respect to the priorities pertaining to each. The analysis of the survey data would pinpoint specific occupational health problems in relationship to specific industrial groups, ascertain need for program expansion, define personnel needs, and establish budgetary requirements.

Groups Involved

The metropolitan Denver area is made up of four counties with three health agencies: The Denver Department of Health and Hospitals, Jefferson County Health Department, and the Tri-County Health Department, serving Adams and Arapahoe Counties. The occupational health personnel of the three agencies receive guidance and technical assistance from the Occupational Health Section of the Colorado State Health Department.

The counties comprising the metropolitan area of Denver have the following areas:

Adams	1246 mi^2
Arapahoe	812 mi^2
Denver	96 mi^2
Jefferson	785 mi^2

*U.S. Department of Health, Education, and Welfare
Public Health Service
Division of Occupational Health
Washington, D.C.

Statistical Design

When the available resources were assessed it was determined that some 500 establishments could be surveyed in approximately two weeks. In order to meet this time schedule, however, a plant-size restriction of 250 or more employees was imposed; in order to inspect situations involving as many workers as possible in this time span the self-employed and places of business with no more than 3 workers were also excluded. The next step was to select the 500 establishments to be surveyed.

In each state there is an official agency to which all businesses fitting specified criteria, must file quarterly reports of their operations. The initial filing is an application which describes its chief activities. Any fundamental changes must be reported. This business, or establishment, is then assigned a numerical code based on the Bureau of the Budget's Standard Industrial Classification.(1) Subsequently, each of these establishments files a quarterly report which furnishes, among other data, the number of employees for the given quarter. It was from this source that selections of industries was made.

It might be noted that privately owned, i.e., family owned and run, farms do not file applications under this legislation; nor do Railroad enterprises. Except for these two large groups, however, other industries are represented in the files of that agency.

For administrative reasons, certain other industrial groups were excluded. These were:

1) Banking, Insurance, and Real Estate
2) Government Services
3) Part of the Services category, primarily comprised of non-profit organizations.

Except for these specified categories, within the employment-size stipulations all establishments were eligible for selection in the sample of places to be surveyed. These industries were considered in 5 broad groups as follows:

1)	Contract Construction	(SIC Nos. 15-17)
2)	Manufacturing	(SIC Nos. 19-39)
3)	Wholesale and Retail Trade	(SIC Nos. 50-59)
4)	Selected Services	(SIC Nos. 70-80, 82, 84, 88)
5)	All others	(SIC Nos. all others exc. 60-67, 81, 86, 89)

Note: The first 3 of these are complete Major Groups in the classification; the fourth is a partial Major Group; the fifth is the residual group.

Within the size limitations mentioned above, the number of employees per establishment were subdivided as follows:

1) 4-7 employees per establishment
2) 8-19 employees per establishment
3) 20-49 employees per establishment
4) 50-99 employees per establishment
5) 100-249 employees per establishment

The number of establishments and the corresponding number of employees were then obtained for these twenty-five categories, i.e., for each of five size groups within each of the five industrial groups.

Using the total number of workers in these five industrial groups, a ratio value was calculated for each of the twenty-five individual industry-size groups of employees. Each of these ratio values was applied to the number of establishments to be surveyed, that is, to the number of establishments in the sample. The resulting figures represented the number of industries in each sub-group necessary to provide the proper employee representation. This technique is termed a proportionate probability sample of employees. It is described by Hanson, Horwitz, and Madow.(2)

From the total number of establishments within each Industry-size group the particular establishments to be surveyed were chosen, using a random selection technique. It was assumed that some of the selected establishments would be out of business by the time the Survey was actually begun. A group of replacements was, therefore, selected at the time. It is impossible, of course, ot obtain an absolutely up-to-date list of establishments. The findings here, then, must be considered in terms of being a random sample of the establishments in operation as of the date represented by the listing used in selecting the sample. In most instances, this will not be a serious deficiency; on the other hand, it is possible to envision situations where it would be a deficiency.

The technique described here allows for the data in the sample to be projected to the entire universe from which the sample was selected. Also built into the scheme was a random allocation of establishments to the individual surveyor which would provide for the assessment of variation among the findings of the individuals conducting the surveys. The procedures for this will be described later.

HEALTH SERVICES IN INDUSTRY

In addition to the evaluation of hazards in the actual work place it was considered desirable to try to assess the presence or absence of certain types of services provided by industries of the size selected here, services which relate to the health of the employee. A questionaire was developed representing the interests of the various groups involved with planning the survey. The type of information desired was framed in questions which were then pre-tested. Necessary changes were made and finally, instructions were written for reference purposes. Prior to the beginning of the Survey a training session was held with the surveyors. After the first day's work, another session was held to discuss problems which arose with regard to the questions and/or to the use of the questionnaire itself.

BASIS OF INDUSTRIAL HYGIENE JUDGMENTS

Occupational health surveys were made of 462 plants in the Denver metropolitan area by about 12 surveyors during a two-week period. Assigned to the survey by the local county health departments, the State Health Department and the PHS Occupational Health Field Station at Salt Lake City, these industrial hygienists observed and evaluated exposures of over 25,000 workers to toxic chemicals or harmful physical conditions, the use or non-use of the necessary control procedures, and the adequacy of the existing controls.

Staff members available for this survey varied considerably with regard to length of experience and to academic training. In order to evaluate the consequences of these factors, if any, specific assignments were given to five men who would be free to work during the entire two-week period. All five were considered as highly competent both with regard to experience and to training.

The sample of 500 establishments was divided in half, on a random basis, within each size-industry category. One of the sets of 250 establishments was further randomly divided, within size-industry groups, into 5 subgroups of 50 each. The 5 full-time men were assigned these subgroups and were not free to make any exchanges whatsoever. The remaining 250 establishments were also randomly subdivided into 5 sub-groups but in some instances 2 or 3 men might have worked on a given group of 50. Likewise, all other workers were free to make exchanges to accommodate to specific situations. For example, if a local man drew a plant with which he was very familiar, he was instructed to swap for one not known to him. If a man had only one establishment at one extreme of the county, he was free to make an exchange.

INTERVIEW RESULTS

In general the interviews confirmed the previous impression that few small and medium-sized employers had an awareness or understanding of health hazards at work, had taken suitable preventive measures to protect the health of their workers, or were aware of the resources and services of the various governmental occupational health agencies.

The major conclusions resulting from the interviews are:

1. Knowledge of Health Hazards in the Workplace Was Slight

Although hazards were observed in all but one-fourth of the establishments surveyed, two-thirds of the persons interviewed "thought" that they had no hazards. In one-half of the establishments, hazards were observed of which the interviewees "said" they were not aware.

Moreover, from the answers given to various survey questions it seemed evident that few of the employers had ever heard of, or even thought about, occupational health and illness. In short, few were able to recognize a health hazard in the work-place, or to foresee its possible consequences. Only one in four said that, in introducing a new process or material at work, he had or would have consulted some-one in advance about possible health hazards.

2. Prevention of Illness and Disability through Health Promotion Was Infrequent

The use of professional medical and related help was relatively rare in the industries represented in this sample. For example, only 28% of those interviewed said that a doctor "advises or assists" them "in any way." This included those who had only an informal arrangement for emergency service.

A safety committee among the workers was reported in 25% of establishments with 50 or more employees. Small establishments were not asked this question.

Only one establishment in four offered employees any health education material. But over half said that such material--or more of it--would be useful to them. Interest in receiving it was greatest among those currently distributing health material.

3. Arrangements for Early Detection and Prompt Treatment were Generally Inadequate

Regular records of all employee absences due to illness were reported as being kept by about half of the establishments.

Arrangements for employees to secure chest X-rays--used in many communities as a valuable screening device for tuberculosis, emphysema and other cardio-pulmonary conditions--were reported by about one employer in three.

Although most establishments (82%) have some sort of first-aid equipment or supplies, some had "a bottle of aspirin and a package of band-aids." Only one-third had an employee with any first-aid training. Thus, even though first aid supplies were usually on hand, they were most often administered by an untrained person; moreover, in more than half of the plants the equipment was rated as "poor."

INSPECTION RESULTS

The inspections of the plants demonstrated that exposures to hazardous agents and materials were not uncommon, averaging almost 30 exposures per plant or establishment. Secondly the industrial hygiene controls were absent or inadequate for more than one-third of these exposures. Slightly less than 25% of the plants were rated as High Priority and one-fourth of these establishments had serious hazards which the industrial hygienist judged to merit immediate attention.

The major conclusions on the plant inspections are:

4. The Estimated Population at Risk was Sizable

About 30% of the study population, or almost 43,000 workers were employed in establishments receiving a rating of HIGH PRIORITY, i.e., the surveyor judged the composite hazard picture as requiring a revisit to the establishment within one year. This would lead to an estimate of over 1400 plants of the size range studied which would require industrial hygiene services within the next year. The existing health department staff could be expected to provide limited services to only about half of this aggregate. About three-fourths of these HIGH PRIORITY employees worked in either manufacturing or trade establishments.

5. Multiple, Mixed, and Unidentified Chemical Exposures were Frequent

All of the HIGH PRIORITY establishments had a chemical hazard, and three-fourths also had a physical hazard present. Over nine out of ten HIGH PRIORITY establishments had exposures to inhalant hazards, excluding dusts. Noxious and pneumoconiosis-producing dusts and significant skin contactants were found somewhat less frequently: 42% and 66%, respectively. Over half of the HIGH PRIORITY manufacturing plants had exposures to chemicals which could not be identified by the labels found on any containers or dispensers. More than two-thirds of HIGH PRIORITY establishments exhibited six or more different exposure agents.

6. Inadequately Controlled Exposures were Frequent

There was an average of 32 inadequately controlled exposures in each of the HIGH PRIORITY establishments. Since the average number of employees for these establishments was 58, the "inadequacy ratio" was about 55 inadequate exposures per 100 employees. The corresponding ratio was 14/100 for LOW PRIORITY establishments.

About one-third of all exposures were rated as inadequate. The average number of exposures per plant approached 40; of these, 11 would be inadequately controlled chemical agent exposures, and two would be inadequately controlled physical agent exposures.

7. Potential Health Hazards were Frequent

The frequency of each type of potential health hazard was listed as the percent of all establishments where the hazard was found: carbon monoxide 37% of plants, oxides of nitrogen 21%, ozone 16%, stoddard's solvent 16%, unidentified solvent 8%, lead 5%, silicosis-producing dust 4%, and epozy resin 3%.

8. Plant Ratings by Industrial Hygienists were Generally Consistent

The frequency of the HIGH PRIORITY rating was examined to compare the performance of each surveyor. As shown below, only one of the five full-time workers appeared to deviate from the general pattern of plant ratings. It is noted that this one surveyor was the most inexperienced hygienist of the group.

SURVEYOR VARIATION IN PLANT RATING

Surveyor Code	% High Priority Rating for Manufacturing Plants	% High Priority Rating for all Plants
No. 1	90*	35
No. 2	50	22
No. 3	78	35
No. 4	22*	4**
No. 5	63	30
Aggregate of all other surveyors	49	23
All	54	25

*P < .05
**P < .01

METROPOLITAN DENVER INDUSTRIAL HYGIENE PERSONNEL REQUIREMENT

Industry by Hazard Category and Man Hours per Assignment

	S.I.C. Code	No. of Plants
I. Manufacturing		
A. High Risk Plants All plants in this category should be inspected annually.		
1. Plants requiring 4 man-hours per visit		
Industrial organic chemicals	2818	3
Industrial inorganic chemicals	2819	2
Clay refractories	3255	1
Gray iron foundries	3321	4
Brass, bronze, copper, copper base alloy castings	3362	5
Fabricated structural steel	3441	12
2. Plants requiring 2 man-hours per visit		
Small arms	1951	1
Grease and tallow	2094	4
Work clothing	2328	1
Millwork plants	2431	9
Wood products	2499	3
Wood household furniture (except upholst.)	2511	3
Wood household furniture, upholst.	2512	6
Mattresses and bed springs	2515	7
Corrugated and solid fiber bases	2653	3
Commercial printing except lithograph	2751	47
Blank books, looseleaf binders and devices	2782	2
Specialty cleaning, polishing and sanitation preparation, except soap and detergents	2842	5
Paints, varnishes, lacquers, and enamels	2851	9
Concrete products, except block and brick	3272	8
Oil field machinery and equipment	3533	1
Farm machinery and equipment	3522	3
Mining machinery and equipment	3532	4
Machine tools, metal cutting types	3541	1
Food products machinery	3551	2
Photographic equipment and supplies	3861	3
Signs and advertising displays	3993	15
		137

3. Plants requiring 1 man-hours per visit		
Bottled and canned soft drinks and carbonated water	2086	5
Biological products	2831	3
Leather goods	3199	7
Ready mixed concrete	3273	10
Hardware	3429	2
Metal stampings	3461	1
Misc. fabricated wire products	3481	4
Fabricated metal products	3499	8
Electrical measuring instruments and equipment	3611	1
Automatic temperature controls	3822	1
Surgical and medical instruments and apparatus	3841	3
Orthopedic, prosthetic and surgical appliances and supplies	3842	3
Sporting and athletic goods	3949	6
		62

B. Intermediate Risk Plants
Plants in this group should be inspected every two years.

1. Plants requiring 2 man-hours per visit		
Commercial printing, lithographic	2752	11
Chemicals and Chemical preparations	2899	6
Primary smelting and refining	3339	1
Primary metal industries	3399	1
		19

2. Plants requiring 1 man-hour per visit		
Meat packing plants	2011	14
Fluid milk	2026	6
Pickled fruits and vegetables, vegetable sauces and seasoning; salad dressings	2035	5
Bread and other bakery products	2051	24
Beet sugar	2063	2
Candy and other confectionery products	2071	3
Food preparations	2099	10
Wood products	2499	3
Wood household furniture, upholst.	2512	6
Wood partitions, shelving, lockers office and store fixtures	2541	8
Engraving and plate printing	2753	3
Petroleum refining	2911	5
Paving mixtures and blocks	2951	3
Asphalt felts and coatings	2952	3
Concrete products	3272	7
Machinery and parts, except electrical	3599	25

Engineering, Laboratory and scientific and research instruments and associated equipment	3811	2
Costume jewelry and costume novelties	3961	3
Needles, pins, hooks and eyes and similar notions	3964	1
Manufacturing material not elsewhere classified	3999	8
		141

C. Low Risk Plants
Plants in this group should be inspected every four years.

1. Manufacturing--require 1 man-hour per visit.

Fluid milk	2026	12
Bottled and canned soft drinks, carbonated waters	2086	5
Food preparations	2099	6
Men's clothing; youth's and boy's	2329	5
Women's, misses', children's and infant's underwear and nightwear	2339	4
Fabricated textile products	2399	5
Periodicals, publishing,printing	2721	7
Manifold business forms manufacturing	2761	2
Ready mixed concrete	3273	5
Phonograph records	3652	1
		52

II. Wholesale and Retail Trades

This division includes establishments primarily engaged in selling merchandise. Because exposures are generally occasional and intermittent the entire division is considered as a group.

All establishments in this division are to be inspected every 2 years. Two man-hours per visit.

Wholesale Trade	Major group	50	730
Retail Trade	Major group	52-59	2058
			2788

III. Construction

Since the majority of establishments fall within the intermediate or low risk categories, all varieties of construction are considered as a group.

Establishments within this division should be visited every two years. Two man-hours per visit.

Building construction	Major Groups	15	291
Construction - other than building	Major Groups	16	73
Construction - special trade contractors	Major Groups	17	522
			886

IV. Services

Exposure within service establishments are generally infrequent and unpredictable. In some, however, well recognized industrial hygiene hazards do occur more frequently and, although exposures are usually occasional and intermittent, should be evaluated routinely.

Laundries, Laundry services and cleaning and dyeing plants	7210	104
Beauty shops	7230	85
Automobile repair shops	7530	107
Reupholstery and furniture repair	7640	11
Miscellaneous repair shops and related services	7690	32
		339

DISCUSSION

Manufacturing plants, wholesale, and retail trade establishments and construction firms were assessed from an industrial hygiene viewpoint and the resulting information used in formulating an industrial hygiene program. Service and transportation establishments were also included in the survey but, because of the nature of operations, exposures were generally found to be infrequent and unpredictable. For this reason a routine evaluation of these establishments (with the exception of selected service groups) may not be warranted.

Plants were divided into risk groups (high, intermediate, and low) depending on the extent of hazard. Firms with a "high" risk rating contained, according to the observer, one or more industrial hygiene hazards requiring immediate attention and annual survey. Plants labeled "intermediate" contained potential health hazards which during the investigation appeared to be under control. It is felt that such establishments should be visited bi-annually. "Low" risk plants were observed to include possible hazards of a lower order of magnitude and may require an occasional appraisal.

Exposures in the wholesale and retail trades were usually infrequent and intermittent while in construction the majority of firms fell within the intermediate or low risk classifications. This being the case, all firms within these SIC categories were considered as a group and were not categorized according to risk. Using this approach, a specific number of man-hours per visit required to conduct a comprehensive industrial hygiene evaluation was assigned.

METROPOLITAN DENVER INDUSTRIAL HYGIENE REQUIREMENTS MAN-HOURS PER YEAR BY TYPE INDUSTRY

Type Industry	Firms Needing Routine Survey	Firms To be Visited Annually	Man-Hours Per Assignment	Man-Hours Per Year
Total	4794	2497		4563.5
Manufacturing	27	27	4	108
High risk plants	137	137	2	274
	62	62	1	62
	226	226		444
Intermediate risk plants	19	9.5	2	19
	141	70.5	1	70.5
	160	80.0		89.5
Low risk plants	52	13	1	13
Wholesale and retail trades	1073	536.5	2	1073
	2058	1029	2	2058
	3131	1565.5		3131
Construction	291	145.5	2	291
	73	36.5	2	73
	522	261.0	2	522
	886	443.0		886
*Services	104	52.0	2	104
	85	42.5	1	42.5
	107	53.5	2	107
	11	5.5	1	5.5
	32	16.0	1	16
	339	169.5		275.0

*Only those service establishments considered as being of industrial hygiene significance are included.

The preceding table showed that approximately 4563 man-hours per year will be necessary to complete a total of 2,497 plant visits. With a maximum of 220 available man-days per year, 6 industrial hygienists employing about 50 percent field time will be required. The supporting staff should include two chemists, a stenographer, and a clerk-typist.

The calculations do not lead to an estimate of total staff needed for a total program - only staff requirements for monitoring workers in plants of a certain industry size and excludes unscheduled surveys in these plants, e.g., followup

studies and consultations, occupational disease investigations, emergency visits in response to requests, visiting nursing consultations, and many other facets of occupational health services to these 5,700 small plants. The plants of less than four employees and the plants of greater than 250 employees, plus the 15% annual attrition within the group, would also add some workload for surveillance and unscheduled services. The survey does not provide an estimate to cover these additional considerations.

CONCLUSION

State or local governmental occupational health units operate in the Metropolitan Denver area. However, limitations of staff and budget have forced these groups to restrict their efforts to investigating high risk situations, and to responding to requests for assistance. The findings of this survey point out the large amount of work that needs to be done to correct the numerous hazardous and unsatisfactory conditions which were found in many plants.

The programs of the official occupational health units must be expanded and strengthened if the benefits of known procedures for controlling exposures to toxic materials are to be made generally available to workers in the metropolitan Denver area. It was estimated that over 2,497 plant visits per year would be necessary to provide minimum industrial hygiene services to the 5,700 plants.

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THE FEDERAL CLEAN AIR ACT
BACKGROUND AND REVIEW OF ACT AND AMENDMENTS

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Eighteen years ago several individuals presently at this meeting, including myself, were members of the Public Health Service's Division of Industrial Hygiene who were in Boston attending the Annual Meeting of the American Public Health Association. One evening, while there, we received word to assemble immediately in the room of Dr. James Towsend, Chief of our Division. When we got there we were told that many cases of illness and some deaths, presumably from air pollution, were being reported in a place called Donora, Pennsylvania, and that the Division had been requested to investigate the problem.

This dramatic event and the comprehensive report of the study which was undertaken on such short notice, brought public realization that under certain circumstances our aerial enviornment could be treacherous. This episode and a gradually increasing awareness of a different type of air pollution problem in the Los Angeles area were largely responsible for the passage in 1955 by the 84th Congress of Public Law 159 establishing for the first time an identifiable Federal air pollution program. It was entitled "An act to provide research and technical assistance relating to air pollution control."

This act contained authority: (1) to prepare or recommend research programs for devising methods of controlling air pollution; (2) to encourage cooperative activities by State and local governments; (3) to collect and disseminate information relating to air pollution; (4) to conduct research to devise and develop methods of prevention and abatement and to support such work conducted by other governmental and private agencies; (5) to conduct research, surveys, and investigations concerning any specific problem of air pollution, upon request of any State or local governmental air pollution control agency, and (6) to make grants to, and enter into contracts with, other governmental and private agencies and individuals for surveys, studies, research, training, and demonstration projects.

Under this basic authority the Public Health Service, for the next eight years, carried out a program of research, technical assistance and training. Beginning in 1960, special emphasis was given to the problem of motor vehicle exhausts and their effects upon human health, in accordance with the directive of Public Law 493, passed by the 86th Congress.

Outside of extensions of the 1955 authority, there were no substantive changes until December 1963 when the 88th Congress passed Public Law 206, the Clean Air Act - the topic for this afternoon's panel discussion.

While continuing, and, indeed, expanding the mission of the Federal program in research and technical assistance, the Clean Air Act added several significant authorties and directives to those responsible for the conduct of the Federal program.

The stated purposes of the Act are -

"(1) to protect the Nation's air resources so as to promote the public health and

welfare and the productive capacity of its population;

(2) to initiate and accelerate a national research and development program to achieve the prevention and control of air pollution;

(3) to provide technical and financial assistance to State and local governments in connection with the development and execution of their air pollution prevention and control programs; and

(4) to encourage and assist the development and operation of regional air pollution control programs."

In essence, the change from the legislation of 1955 to that of 1963 was a recognition that, while many questions need further study, the time had come for truly effective measures to cope with a rapidly growing problem of national significance.

The Clean Air Act acknowledges that the prevention and control of air pollution at its source is the primary responsibility of State and local governments. It encourages cooperative activities by these agencies, and the enactment of improved and, so far as practicable, uniform laws relating to the prevention and control of air pollution. It also authorizes interstate compacts.

Among other provisions, it authorizes grants to air pollution control agencies, to other public or non-profit private agencies, institutions and organizations, and to individuals for the purposes of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention and control of air pollution.

The Federal program is directed, under the Act, to publish for informational purposes, criteria reflecting accurately the latest scientific knowledge useful in indicating the kind and extent of effects, harmful to health or welfare, which may be expected from the presence of a particular air pollution agent, or combination of agents, in the air in varying quantities.

Among the new features in the Act, the one which probably had the quickest noticeable impact was the authorization of financial grants to develop, establish, or improve State, local and regional air pollution control programs.

Another, probably more far-reaching section, provided mechanisms for an active role by the Federal government in the abatement of air pollution, either by official request, or, in situations of interstate air pollution, on its own initiative. In addition, there is authorization for procedures to abate air pollution resulting from operations of the Federal government itself. Another speaker on this panel will discuss this feature in detail.

The only other section of the 1963 Act which I will list here encouraged continued efforts to find an appropriate answer to the motor vehicle pollution problem, established an industry-government committee, and directed that progress reports on this problem be submitted to the Congress semi-annually.

In October 1965, in Public Law 272, the 89th Congress amended the Act with a directive to the Secretary of Health, Education, and Welfare to prescribe and enforce st. dards, applicable to the emission of any kind of substance, from any class or classes of new motor vehicles or new motor vehicle engines.

The amendments also provided mechanisms for Federal participation in connection with potential air pollution, and also in instances involving international pollution problems.

From these abbreviated highlights of the legislative actions of a single decade, one is forcibly struck with the increased recognition of the need for positive action to prevent the progressive deterioration of the atmosphere. The Congress has made it clear by its actions that the Nation, through its various levels of government, has responsibilities which must be met as expeditiously as possible.

Before concluding, I should like to summarize briefly the extent of certain Federal activities following the enactment of the Clean Air Act in December 1963.

In the eighteen months following receipt of the first appropriations to implement the Act, grants to develop, establish or improve official air pollution control programs were awarded to 107 different agencies. More than $9,000,000 has been distributed to 28 State agencies, 39 local programs, and 40 intermunicipal or regional control programs, spread among 41 different States. These grants have stimulated the creation of 68 new programs and have provided support to increase the effectiveness of 39 agencies which already had operating programs. Annual non-Federal expenditures for air pollution control of 107 agencies have been increased by over $3,000,000 or 40 percent.

Grants totalling over $765,000 have also been awarded to 15 organizations for air pollution surveys. In addition, about $260,000 of $975,000 available in the current fiscal year has thus far been awarded for projects in the Appalachia area to demonstrate methods for extinguishing and controlling fires in refuse piles produced by the mining and processing of coal.

Opportunities for training in air pollution control activities, ranging from short courses through graduate degree programs have been expanded. For example, the number of presentations of technical short courses by the Cincinnati training staff of the Division of Air Pollution increased from 24 in Fiscal Year 1964 to 42 in Fiscal Year 1966. The number of attendees increased from 463 in 1964 to 1225 in 1966. A 6-months course of combined academic and field training has been developed at the University of Southern California with the first class started in January 1966. Undergraduate programs of 7 to 10 weeks intensive training for technicians and technologists are presently being developed at Pennsylvania State University.

Work has been in progress to develop air quality criteria for various classes of pollutants. The first of these, dealing with sulfur oxides, will be published shortly. Mr. Vernon G. MacKenzie, Chief of the Division of Air Pollution will be speaking at tomorrow afternoon's session, on the subject of air pollution standards, and will undoubtedly comment further relative to the work in progress on criteria.

With respect to abatement activities, thus far, three requests have been received from States for interstate abatement actions. In two of these, formal conferences have been held. In the third, where the Governor of New York requested action pollution from New Jersey, the Secretary has initiated action concerning the effect of pollution from each of these States on the other. Several consultations have been held to date on this case. In addition, the Secretary has initiated consultations in three other interstate situations.

Pertinent background information is being gathered in some 70 large metropolitan areas that cross or adjoin State lines, in preparation for actions which may be

requested or initiated.

On March 30 of this year, regulations prescribing emission standards for motor vehicles were published in the Federal Register. These will be applicable to the 1968 models of all cars sold in the United States, whether of domestic or foreign manufacture. A Federal certification laboratory is being established at Willow Run, Michigan for use in implementing these regulations.

Over the past decade, the proportions of the air pollution problem in the Nation have come into focus. It is now clear that its present magnitude, as well as its prospective growth, is such that vigorous efforts at all levels of government are essential now if we are to restore and preserve the quality of the air we breathe. That the need for such efforts has been recognized is exemplified by the Clean Air Act. The Congress has provided an opportunity for leadership to be demonstrated. This challenge should be accepted by all who have responsibilities. If this is done, the prospects for conserving the air resource are bright. This is fortunate, because the threat of air pollution has never been more serious nor its future potentially more ominous than it is today.

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STATE AND COMMUNITY REACTIONS TO THE FEDERAL AIR POLLUTION PROGRAM

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Discussing the extent of the impact of the Federal air pollution control program on state and local programs is analogous to discussing the effect of Federal spending on the nation's economy. It would be an understatement to say, as a number of Federal publications say, that the effect has been "significant". During the past five years there has been a revolution in local and state attitudes and programs. Since January 1, 1965, bills have been introduced in 30 state legislatures authorizing or strenthening state control programs.(1) Total expenditures for state and local air pollution programs in 1963 was $12.7 million (of which 48% was spent in California). In 1965, $4.18 million of Federal program grant funds plus $1.8 million of matching funds resulted in a 47% increase in expenditures nationally. Exclusive of California, the increase was approximately 78%.(2) These statistics, in fact any statistics, do not give a true picture of the changes taking place in local and state programs.

The increased availability of funds has led to the development and acquisition of sophisticated air sampling equipment and data handling systems. Enforcement procedures are being automated. An outstanding example of this is the integration of computer techniques in the air sampling and inspection programs of the City of Chicago.(3)

State and local programs are developing comprehensive regulatory programs. The concern is no longer solely with "smoke chasing". The Federal program has resulted in an increased number of technical publications and the development of trained technical staffs. With increased competence, state and local programs are now moving to control air pollution problems caused by a variety of emissions.

Nationwide recognition of air pollution as a public health, economic and conservation problem has been developed by "National Conferences", Presidential messages, congressional hearings, and a very effective Federal public information program. Public support for air pollution control is being increasingly felt in state and municipal legislatures. Agency budget requests are being met with interest, rather than indifference.

There is a growing belief in government that something should and can be done to prevent and control air pollution. To some extent, industry has recognized and accepted the public sector's concern with this problem.

Thus, the Federal program has had an indirect effect upon local control efforts. A brief description of the magnitude of the Federal program will make it obvious that even if there were no programs specifically designed to affect state and municipal programs, (there are, of course such programs--and they will be discussed later) by its size and varied activities alone, the Federal program would have a substantial impact on local agencies.

Figure 1 shows the appropriations and number of authorized positions for Public Health Service's Division of Air Pollution for Fiscal Year:

Figure 1.

Appropriation and Authorized Personnel. PHS Division of Air Pollution. Selected Years*

	1955		1963		1965		1966	
	Position	Appropriation	Position	Appropriation	Position	Appropriation	Position	Appropriation
Research	29	$186,000	329	$9,531,000	354	$12,501,000	380	$14,267,500
Abatement Activities	..	.....	...	.....	49	566,000	96	1,748,000**
Technical Assistance	..	.....	55	790,000	89	6,184,000	93	8,291,000
Direct Technical Assistance	..	.....		790,000		1,239,000		1,441,000
Control Program Grants	..	.....		.....		4,180,000		5,000,000
Survey & Demonstration Grants	..	.....		.....		765,000		1,850,000
Training	..	.....	23	744,000	33	1,679,000	40	2,301,000
Miscellaneous	..	.....	..	4,000	..	65,000	..	54,500
Total	29	186,000	407	11,069,000	525	20,995,000	609	26,662,000

* Source - Private Communication

** Includes $470,000 and 14 positions for motor vehicle pollution control

1955 - The year the Federal air pollution program was established.

1963 - The year the program was expanded (under the "Clean Air Act", P. L. 88-206) to include programs grants, abatement activities, control of air pollution from Federal facilities.

1965 - The year the "Clean Air Act" was amended (by P. L. 89-272) to include the control of air pollution from motor vehicles.

1966 - The present fiscal year.

The rate of growth of the Federal program is indicated by Figure 2.

At present, the Federal air pollution appropriation exceeds all state and municipal appropriations combined. The staff of the PHS's Division of Air Pollution is approximately equal to the full time staffs of all state and local agencies combined.(4)

It is logical to conclude that, although its growth has been gradual and carefully planned, by its size alone the Federal program has affected state and local efforts. A whale, even if it slides into a pool, creates waves.

Three federal programs have had a direct effect on state and local agencies. The full potential of these programs has not been attained and is not generally appreciated.

1. Air Pollution Control Program Grants. The Clean Air Act (P. L. 88-206), signed December 17, 1963) provides for financial grants to aid states and municipalities in the development and improvement of air pollution control programs. Yaffe (2) has described this program in detail. Equally important as the enabling legislation, are the regulations developed by the Public Health Service for the administration of the program. In part, these regulations provide that grant funds be used to match only non-federal funds in excess of the amount of such funds expended for air pollution programs by the grantee agency in the year prior to the one in which a supported control project is to begin. That is, non-federal "new money" must be used to match grant funds. Grants are awarded on what is essentially a "project" basis. The grantee applies for the Federal funds by outlining, in detail, how his program will be developed or improved. The grant application must contain a detailed line-item budget indicating the proposed expenditure of both Federal and non-federal funds.

The need to use "new money" to match Federal funds is unfair to agencies which, in the past, have developed on-going programs. Governmental agencies which have done nothing to control air pollution can obtain up to 3/4 support for the total cost of a new program. Agencies which have had sufficient interest and foresight to develop programs receive minimum support. In its effort to stimulate, the Federal Government rewards the dilatory and penalizes the foresighted.

A bill introduced at this Session of Congress (H. R. 13199, introduced by Mr. Staggers on March 2, 1966) would permit grants to state and municipal agencies "up to one-half of the cost of maintaining programs for the prevention and control of air pollution."

The enactment of this bill would alleviate some of the inequities of the present grant program. It would be important, though, that the Public Health Service regulations, developed for awarding grants for maintaining programs, not interfere with the autonomy of these programs. "Maintenance grants" should not be awarded on a "project" basis. The individual development of state and municipal programs should not be inhibited by

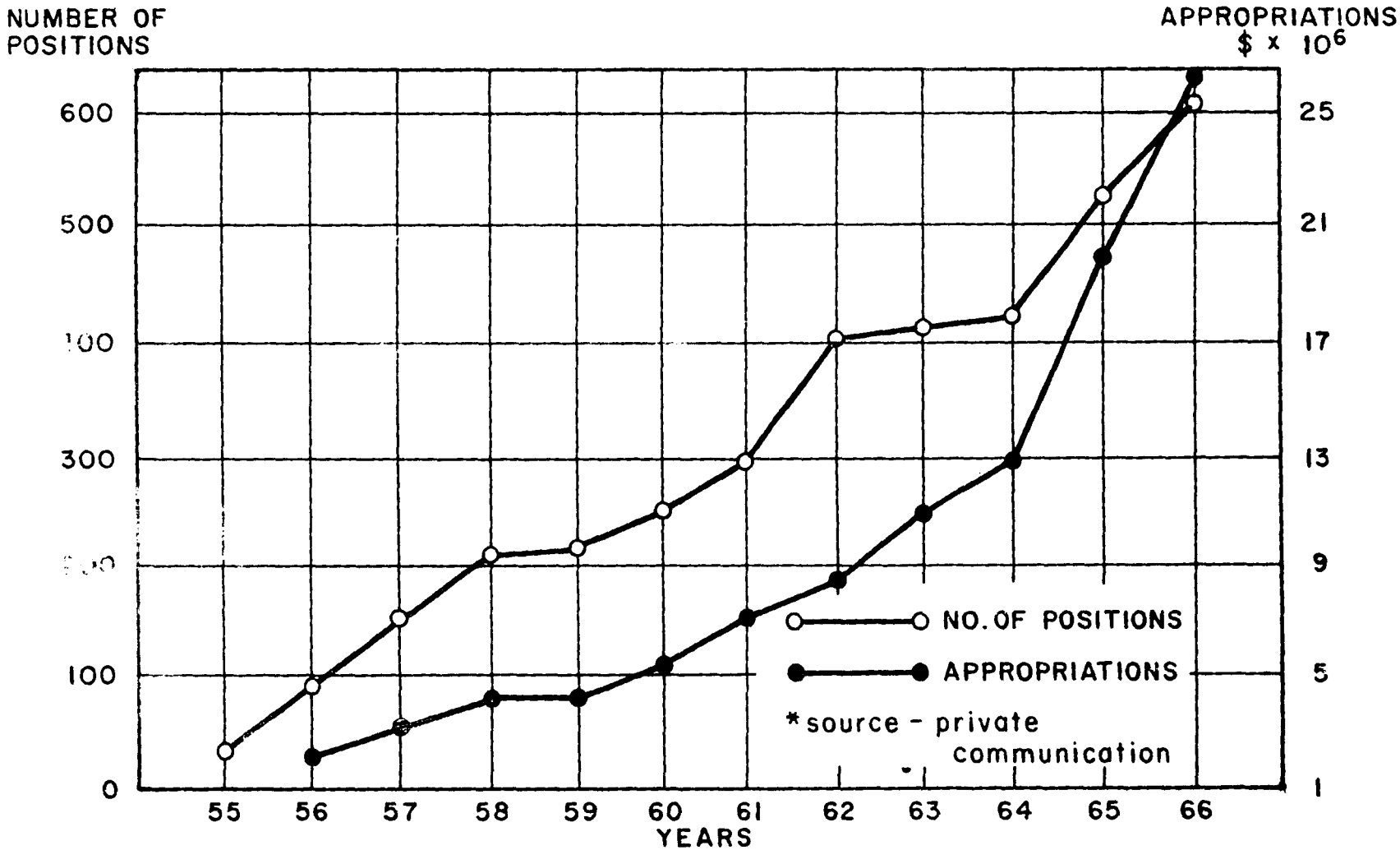

Fig. 2 SUMMARY OF FEDERAL AIR POLLUTION ACTIVITIES *
1955 - 1966

regulations which would have the Federal Government specify how these programs should be operated.

"Maintenance grants" should be awarded on a "fromula" basis. The amount of Federal support to be given to a state or municipal program should be based upon the judicious application of criteria which are related to the extent and nature of the air pollution problems under the jurisdiction of the grantee agency.

At the present time air pollution control concepts, both technical and administrative, are rapidly changing. It is a time to "let a hundred flowers bloom". No single agency has sufficient ability or knowledge to prescribe the administrative techniques which should be used by various state and local air pollution agencies in controlling the many and varied problems they face.

Another concern with the grant program, in fact with all Federal grant programs (it should be noted that the Public Health Service also awards survey and research grants), is the use of "Grantmanship". Dr. John H. Venable, Director of the Georgia Department of Public Health, defines "Grantmanship" as occurring when "the state or local agency having the greatest ability in devising an application (receives) the greater financial support irregardless of the seriousness of the problems it has to solve." Important programs may not receive support because they lack expert advocacy. Federal grants should be administered in such a way that the effect of "Grantmanship" is reduced.

2. Abatement Activities. The program being developed by the Abatement Branch of the Public Health Service" Division of Air Pollution(5) is presenting a challenge to state and municipal programs. For a practical and effective approach to motor vehicle pollution control, state agencies must develop programs to:

a. Determine the need for motor vehicle emission control in their respective jurisdictions.

b. Provide the Public Health Service with information on the needs and desires of the states with respect to motor vehicle pollution.

c. Where appropriate, insure that vehicle emissions are controlled in accordance with Federal standards.

State and local agencies should resist the temptation of using the air pollution control regulations now being developed for Federal facilities as models for their own programs. Unlike motor vehicles, stationary sources should be regulated in accordance with standards developed to meet local conditions. There is no basis for the assumption that standards developed by, for, and for enforcement by, Federal agencies are appropriate for state and municipal programs. At present, Federal abatement procedures for intrastate, interstate and international air pollution are complex and cumbersome. There is no doubt that, by future legislation, procedures will be simplified and the Federal Government will be given authority to act in a more direct manner.

The recent interstate "Conferences" have demonstrated that local agencies must keep their houses in order. Irrespective of the manner in which Federal hearings are held and in spite of assurances from Federal officials to the contrary, the public will assume that the Federal Government instituted abatement action because state

or local programs were inadequate. Whether adequate or inadequate, local agencies should not assume a defensive or antagonistic attitude at these hearings. Federal conferences and hearings can be used to improve and strengthen state and municipal programs.

Thus far there have been no abatement procedures carried beyond the initial conference stages. It remains to be seen how the abatement provisions of the Clean Air Act will be implemented. If Federal abatement activities are conducted on a sound technical basis, with a minimum of hoopla, they can supply real support to local control efforts. When the curtain falls on an interstate conference, the kliegs are struck, and the Public Health Service returns to Washington and Cincinnati, it is the local official who remains facing the audience. It is the local official who will continue to have the direct responsibility for the maintenance of the continuity and effectiveness of a program established by and for his particular community.

3. Technical Assistance. The Chief of the Public Health Service's Division of Air Pollution has stated that it is "the firm policy of the Federal Government that the primary responsibility for the control of air pollution rests with state and local governments and that the chief objective of the Federal air pollution program is to provide leadership and assistance to control programs throughout the country."(6) The Federal program with the greatest potential for support of state and municipal programs is technical assistance. The Technical Assistance Branch has done an outstanding job in publishing information on the air pollution aspects of various industrial operations. Members of the staff of the Technical Assistance Branch have visited local agencies throughout the country. They have provided assistance in conducting surveys, establishing automatic air sampling programs, developing regulations and improving administrative procedures. In publications on the Nashville Study(7) and the Southwestern Ohio-Northern Kentucky Survey(8), the Branch has proposed new concepts in regulations and air resource management. These concepts will affect local programs.

Much more can be done. Trained technicians should be assigned to state and local agencies for from six months to a year to assist in establishing modern air sampling programs and data handling systems. The many new air monitoring devices now being marketed should be evaluated. Specification codes should be developed for equipment (such as incinerators, coke ovens and open furnaces) which cannot be regulated by performance standards. Inspector training aids (such as calibrated smoke generators) should be made available. More information on emissions from industrial operations, regulatory standards and survey techniques should be published.

The staff of the Technical Assistance Branch would have to be increased to provide these services. Increasing technical assistance appropriations to provide more services to state and municipal programs would accomplish more in controlling air pollution throughout the country than using federal funds for programs grants, abatement conferences or obtuse research.

Until recently, most states and municipalities have either ignored or have done a less adequate job in carrying out their responsibilities in air pollution control. The Federal program and public interest (generated, to a large extent, by Federal activities) have led to increased efforts at the state and local level. With proper support from the Federal program these efforts will continue to increase.

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THE FEDERAL CLEAN AIR ACT: ITS IMPACT ON INDUSTRY

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That the Clean Air Act will have a substantial impact upon industry is a conclusion in which we may all concur; the kinds of pressures that will be generated can generally be surmised, but it would be presemptuous of me to predict, for even that segment of industry with which I am personally associated, the points of greatest pressure.

Industry stands today, in this regard, in a position similar to that in which many men of my generation found themselves nearly a quarter of a century ago. My older listeners may recall that, during the war, the armed forces decided to "reclaim" some of the draftees rejected, for example, for inadequate dentition, by doing a comprehensive dental reconstruction job before starting them on their military training. We can imagine the apprehension with which a young man from the hills of Appalachia faced his session at the dental clinic under these circumstances. In spite of his intellectual awareness of the need for remedial action, his uncertainties regarding the procedures to be experienced, the ultimate results of the reconstruction, and the intensity and duration of operative pain somehow made his present dull aches more tolerable. The observation Shakespeare put in the mouth of Hamlet that we "rather bear those ills we have than fly to others that we know not of" is still valid today.

Thus, although the overwhelming majority of industrial management recognizes that an increased emphasis on air pollution control is essential, and that the public is demanding that something be done quickly, I think it understandable that many executives view themselves as involuntary patients in a clinic with controversial therapeutic procedures. In the long run, the pandemic of air pollution will be brought under control; but, along the way, the prospects of some patients dieing, and some experiencing prolonged invalidism from ill-advised surgery, lead industrialists to face the upcoming events with some trepidation.

Our view is too narrow, however, if we just look for places or instances in which industry will suffer. The business economy, industrial segments, or individual plants, may be improved as well as hurt. The certainty is that, as a result of the Clean Air Act, there will be change, both immediate and long term. Whether these changes will be beneficial, harmful, or indifferent to the economic health of the particular element of the industrial complex upon which we focus our attention will be as dependent upon the foresight and prudence of its management as upon the decisions and policies of our legislative bodies and regulatory agencies.

Thus, the first impact of the Clean Air Act must be upon industrial management. They must recognize and identify their own pollution problems, anticipate the actions of the governmental agencies, and provide them with the best technical assistance in their standards-setting processes. They must select those routes by which the corporate activities can best be brought into conformity with those standards. They must anticipate the demands of the public for new and improved products of lower pollution potential, and commit their available financial and technical resources to programs that will have these new products ready to meet the public demand.

These duties impose a very substantial load upon management at all levels. The basic decisions to be made by top management will require that extensive, carefully documented staff studies be prepared, analyzing the complex interactions of proposed methods of pollution control upon capital investments, operating costs, labor requirements and product salability. These studies cannot be completed overnight. Major sectors of industry are already hard at work on this study phase. A feature article in the Chemical and Engineering News for May 2, 1966 describes the elevation of pollution control activities to the corporate level of six of our major chemical companies. A report from the oil industry indicates that thirteen major producers have taken similar action. The pulp and paper industry is doing the same.

This is but a start. All of industry is faced with the need for immediate action. The proportion of management effort that must be devoted to pollution control problems is going to increase throughout the foreseeable future. Management talent, as one of our resources already in very tight supply and with limited capacity for rapid expansion, is perhaps going to be the first area in which the Clean Air Act is going to produce an uncomfortably tight squeeze.

A second area in which we may, with some confidence, predict a major impact of the Clean Air Act is that of capital expenditures. It would be idle for me to speculate on what capital investments will be required for air pollution control equipment, or for process modifications to eliminate present sources of pollutant emissions. Edmund K. Faltermayer, in last November's (1965) Fortune Magazine, put the bill at three billion dollars a year for the next ten years; industry spokesmen have offered numbers up to several times as high. Whatever the value may turn out to be, it will constitute a very appreciable inflationary pressure upon the general economy. This will be felt most by small industry, dependent upon the commercial banks for its deficit financing. In the present tight money market, a need for three billion a year of new financing cannot be ignored.

It is obvious that the expenditures for pollution control will be but a small portion of the total inflationary pressures on our economy. Depending upon other, independent factors, this element could, in its effect, range from the "straw that broke the camel's back" to a significantly stabilizing factor in a shrinking economy, such as might result from a dramatic decrease in military expenditures.

Let me digress at this point to offer some personal views on these costs. Industry is founded upon the concept of investment to produce goods or services for which the market is willing to pay a price that makes the providing of the wares or services profitable to the producer. Today, clean air (and pure water) are items for which the public has indicated a willingness to pay a substantial price.

I believe far too narrow the viewpoint expressed by one industry spokesman, in discussing the requirements for pollution control expenditures that "the prospect is that 12-1/2 per cent of our total industry profit can be siphoned off for waste treatment expenditures-with no income production to the mills-with no practical gain to our customers-with no potential gain to our shareholders". Customers and shareholders are a part of the public that is demanding, and that will benefit from, a clean and healthful environment. The costs of purifying our presently waste-laden air and water must ultimately be borne by the public. The costs of pollution control will inevitably and justly appear in the prices paid by the eventual consumer of industries' products and services. I agree with Faltermayer that these costs can be afforded by society. The key to their acceptability is the phrase "equitably shared" with which Faltermayer qualifies this thesis.

The structure and organization of today's industry has resulted from the economic forces shaping them in yesterday's market. In general, these forces did not include the requirements for stringent air pollution control. The imposition of pollution control requirements that greatly increase the cost of doing business for one producer of a given product or service, without an equivalent economic burden on his competitor, could cause major disruptions in the industry. Economic stability and a regular paycheck are factors just as important to the voter as is a view of the mountains undimmed by industrial haze. The equitable distribution of the pollution control costs remains a thorny and unsolved problem. The inequities and hardships that will develop will be in inverse ratio to the time over which the controls are imposed. An informed public must judge how much speed it is willing and able to pay for.

Manpower is a third area of major impact. The technical skills needed to sample the pollutants in our atmosphere and in our plant emissions, to analyze them, to design, install and operate polution control equipment, and to monitor pollution control performance, are another commodity, already in tight supply, for which demand will be greatly increased by the Clean Air Act. I don't know whether personnel recruiters will be wooing those in this audience with the persistence and lavish enticements reputed to have been used on fledgling football stars and solid state physicists in recent memory, but I am confident that the competition for qualified pollution control scientists and engineers is going to result in upward pressures on their wage structure.

I don't believe that we, who are now in this field, should delude ourselves with the idea that we possess skills and knowledge so unique that we are "indispensable". Formal, or "on the job", retraining of engineers and scientists in related disciplines could substantially increase the supply of manpower qualified for these tasks. At the present time, however, there is little reserve of "under utilized" technical manpower from which candidates for such a retraining could be drawn. The extent to which industries' efforts to meet the new requirements under the Clean Air Act may be restricted, delayed, made more expensive or less effective by the lack of qualified manpower is another element that will be critically dependent upon the time scale on which the pollution control requirements are imposed. Forward-looking industries are building up their pollution control staffs today, but there is no more such a thing as "instant engineers" in pollution control than in any other field. There may be rapid shifting of qualified personnel from one place to another, but the total supply can be expanded only at finite rates.

I hope that not all in my audience will succumb to the blandishments of industrial recruiters and leave the government laboratories for the executive corridors of industry. From a perfectly selfish standpoint, it is important to industry that the level of expertise among the administrative and regulatory agencies be kept at the highest level.

The agencies that will be responsible for the administration of the Clean Air Act are faced with the problem of a rapid expansion of their technical and administrative staffs. Without the nucleus of present senior personnel, it will be impossible to achieve this expansion without serious dilution of the level of competence of those staffs. It would be shortsighted indeed if, by raiding the government agencies, industry ended up with having to live with the ineptitudes of inexperienced and ill-qualified inspectors and control officials.

Most technical problems will be specific to certain sectors of industry. One, however, will be felt generally throughout industry; that is, the sulfur-in-fuel problem.

Although the technology for the removal of sulfur dioxide from stack gases does exist, its application to any but the largest power plants would make high-sulfur fuels non-competitive with other energy sources. The sulfur-in-fuel problem is one that will be felt by all industry in the form of substantially higher energy costs, either from higher fuel prices or as a result of stack-gas cleaning costs. The universal restriction of permissible sulfur dioxide discharges, or the imposition of a penalty charge upon excessive emissions, would constitute a serious, but perhaps equitably shared, burden upon fuel users. The coal mining and petroleum refining industries, however, could experience severe disclocations.

Whether the burning of these high-sulfur fuels in huge central power plants with discharge of the sulfur dioxide through tall stacks is an acceptable long term solution to their utilization is still a moot question. Our knowledge of the long distance transport and atmospheric clearance mechanisms for sulfur dioxide does not permit us to predict, with confidence, just how much sulfur we can discharge into the air, from what place, and through what height stacks, without creating pollution problems at distances remote from the plant. Large central stations, with sulfur dioxide recovery may be the only acceptable long term solution. It would indeed be unfortunate if the sulfur dioxide control efforts should depress the price of high-sulfur fuels to distress levels, divert them into areas not under SO_2 emission restrictions, and result in major economic disruptions among both fuel suppliers and energy users without achieving any substantial reduction in total discharges to the atmosphere.

Industries whose products are themselves contributors to air pollution will have to develop new technologies. California experience has given us a foretaste of this problem. As small a segment of the nation as the Los Angeles Air Pollution Control District, by the imposition of its Rule 66, placing standards upon solvent emissions from paints and cements, has induced national distributors to reformulate their products to meet the local code. The car I bought in Virginia is equipped with a crank case emission control device designed to meet California standards.

Increasingly, in the design and development of its new products, industry will have to give consideration not only to the pollution problems encountered in their manufacture, not just to the pollutants that may be generated by the use of the products, but also to the pollution generated by the final disposition of the discarded item. The water pollution field already presents a classical example of this approach in the development of biodegradable detergents. It may be that tomorrow's automobile will be designed from the start so that the worn-out cars can be processed, with recovery of salvage values and reduction of nonsalvable parts to a stable, nonobjectionable residue, without the generation of air pollutants in the process.

To summarize, we may all agree that industry has an air pollution problem, and that prompt action is required to reverse the rapidly worsening trend in air pollution. I have tried to highlight a few of the ways in which industry will feel the impact of the imposition of controls under the Clean Air Act. Each such control imposed, however, exerts an influence far beyond the stack or vent upon which the restriction is placed. In the language of the pharmacologist, each remedy has, besides the desired effect, side reactions. If not controlled, these can undo the good that the desired activity may achieve. The optimum prescription for the patient requires additional drugs to control or minimize these undesired side effects.

The Clean Air Act, in its present form, is not such a prescription. It does make a finding that its patient, industry, is ill, and sets up procedures whereby a detailed

diagnosis may be made and a remedy prescribed. Only if all the complex interactions of our industrial society are evaluated properly, and only if the package of remedies it prescribes is selected to minimize and control the potentially serious side reactions, can its "combination of ingredients" prescription give the "fast, fast, fast relief" from the air pollution headache with which our nation's industry is suffering.

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MONITORING OF ENVIRONMENTAL DISPERSION OF BERYLLIUM FROM DISPOSAL OF A SOLID PROPELLANT BY TRENCH BURNING AT DUGWAY PROVING GROUND, UTAH

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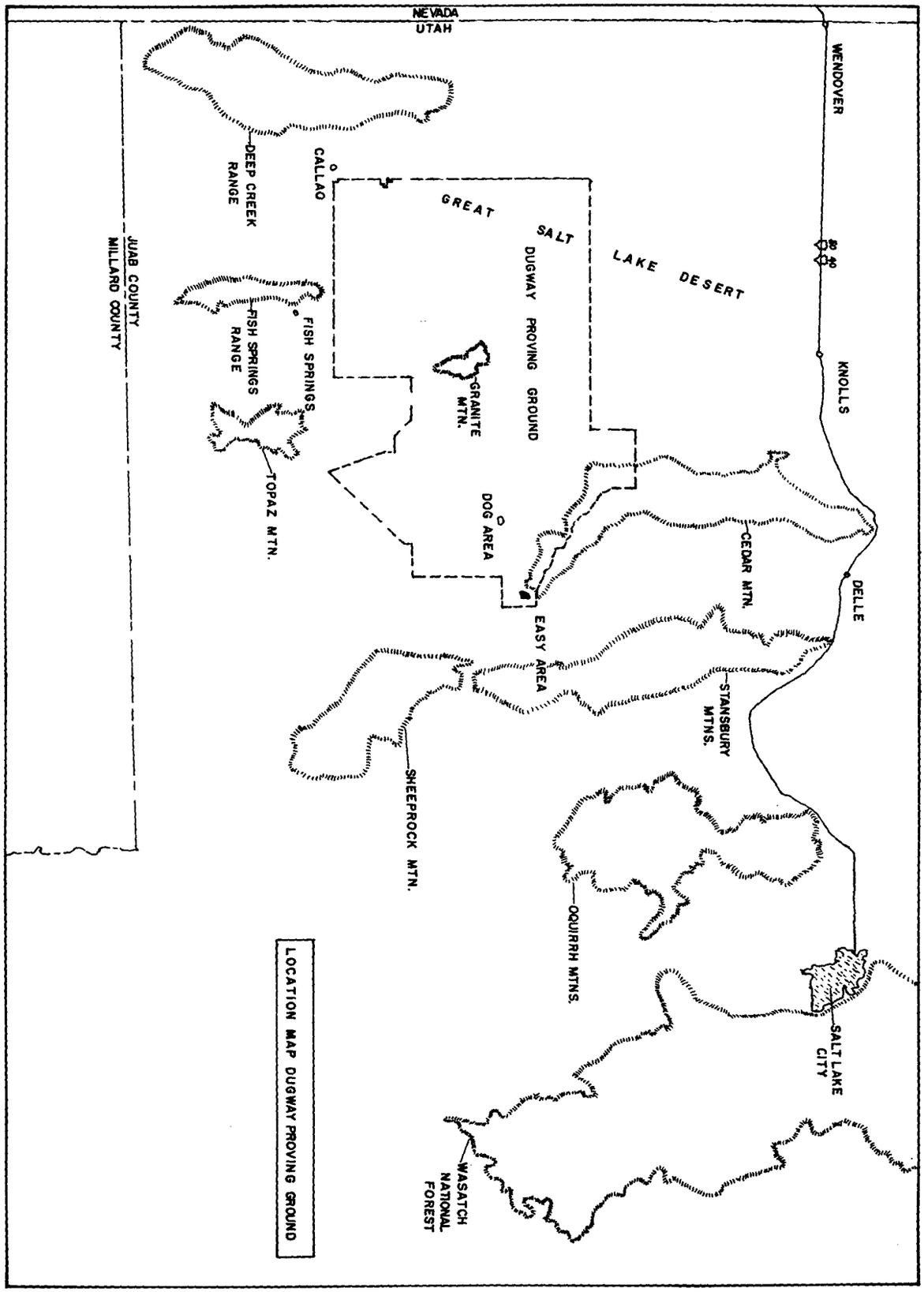
Because of its lightness, its ability to absorb and conduct heat rapidly, and other favorable factors, the use of beryllium is being applied in many operations. Included is its use as a component of missile propellants, in which it has been shown to produce a significant increase in specific impulse and consequently in missile performance.

However, after a period of time propellant fuel may deteriorate or crack in the engine, or for other reasons, disposition of it may have to be made. Additionally, toxic wastes including propellant, handling materials, and protective respirators are produced in laboratories and on the production line and require special disposal techniques. Significant quantities of these materials have been generated by Air Force civilian contractors located in the vicinity of Salt Lake City, Utah. In 1963, an agreement was reached between the US Air Force and Dugway Proving Ground, Utah, in which the latter accepted a contract to dispose of a given quantity of this propellant waste. As a result, shipment began in August of that year and by April 1965, 42,000 pounds of propellant waste were on site at Dugway. Further deliveries during the summer of 1965 ran the total to 50,000 pounds of waste, of which it was estimated that 300 pounds of beryllium metal were present.

While much information concerning the toxicity of beryllium has been collected, the nature and the extent of the hazard associated with its use under a wide variety of conditions are still controversial. However, historically, the use and handling of the metal and its compounds has caused an appreciable number of serious illnesses, and, therefore, the injurious effects of contact with and absorption of these substances are matters of deep concern.

Because of this situation both civilian and military authorities were concerned about the proposed disposal by burning of such a large quantity of beryllium and, as a result, a joint meeting of representatives of the US Air Force and US Army Surgeons General was held during April 1965. It was decided by this group that the US Army Environmental Hygiene Agency would serve as a lead activity in development of, and carrying out an environmental survey, prior to, during, and following disposal of the beryllium waste at Dugway. The study would be conducted as an R&D project and would be funded by the Medical R&D Command, with Colonel Robert G. McCall and Lt. Colonel Alois Pesznik, Directors, Engineering Services and Medical Services, USAEHA, respectively, as principal investigators, and Major Lee C. Herwig as Surgeon General's Project Officer. Analytical support, technical assistance and a large portion of the sampling equipment was to be furnished by the US Air Force. The Regional Environmental Health Laboratory at Kelly Air Force Base, Texas, commanded by Colonel Walter Melvin, would perform all the chemical analyses, and Captain Owen Kittilstad,



VIEW GRAPH NO. 2

The site of the propellant waste disposal itself was Granite Mountain, a peak extending some 3000 feet above the 5000 foot valley floor. It is located on the western range at Dugway Proving Ground 30 miles due west of the Main Dugway post (Easy Area), and 20 miles west of the Technical Operations Area (Dog Area). Wendover is 60 miles across the salt flats to the northwest of the mountain and the four families at Callao are 30 miles to the southwest of Granite Peak.

The disposal area is located in a canyon on the northeast tip of the mountain. The ridge to the north of the canyon is approximately 300 feet above the canyon floor. There are two trenches containing the waste material, one parallel to the ridge and approximately 200 feet long. The second is perpendicular to the ridge and approximately 100 feet long.

Air sampling was accomplished at the occupied and inhabited areas previously shown using ten General Metal Works high-volume (50-70 cfm) samplers enclosed in an aluminum shelter (Fig. 3). They were operated continuously and were shutdown once a day only in order to change the filter paper. They were set in operation about ten days prior to the burn in order to determine background beryllium concentrations. They were all operated from line current, with the exception of the samplers at Callao and the one located on Stark Road which were operated from generators. These samplers continued to operate for a week after the burn.

The other air sampling (i.e., the sampling to determine the local dispersion pattern) was done using 35 Staplex and Gelman battery-operated samplers with a sampling rate from 3-15 cfm. These samplers were located to the north of the disposal area along existing road nets, on a line perpendicular to predicted wind direction and at distances from 380-5500 meters from the burn site. The samplers on Stark Road were located at intervals of 0.3 mile and those on Goodyear Road at 0.5 mile intervals (Fig. 4). They operated for approximately five hours during and after the burn, and were turned on for 2-4 hours on days subsequent to the burn.

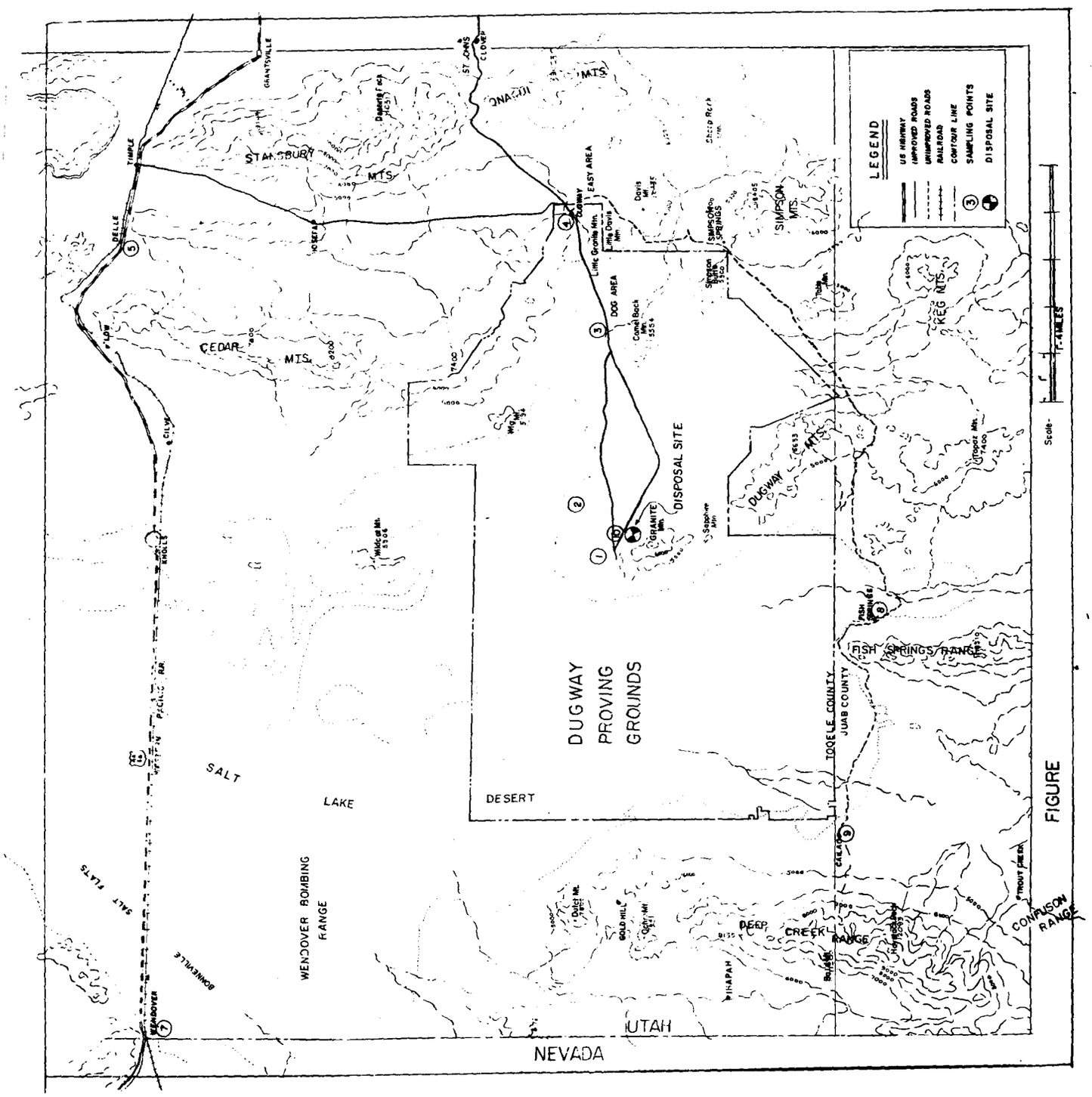
Three Gelman samplers were located in the canyon itself about 30 feet from the north edge of one of the disposal trenches.

Soil sampling and fallout boards were also used. These served to confirm the fact that the great bulk of fallout was within the canyon.

Meteorological conditions for the test had been previously specified in the protocol. The assumption had been made that the test would not proceed unless the following conditions prevailed: Wind from SE, S, or SW Quadrants, wind speed above 10 mph, with at least common Lapse conditions prevailing. These conditions were met during the test.

Both permanent and mobile meteorological stations were used during the test. Meteorological data were recorded at the following five locations: (Fig. 5)

a. Profile mast at the intersection of November and Stark Roads measuring wind speed and wind direction at 2 meter and 16 meter heights, and temperature gradient data.



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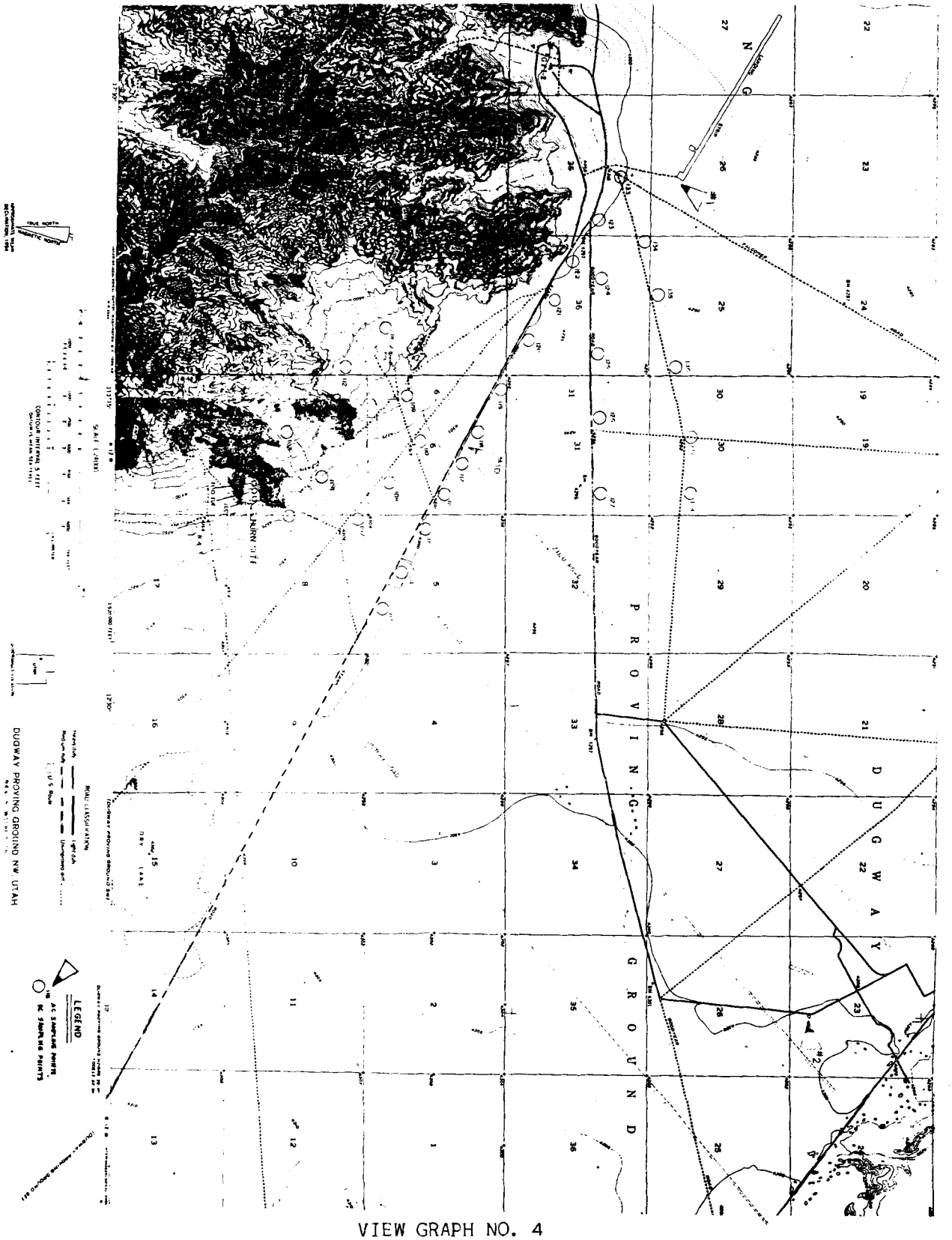

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b. Station #81 at the intersection of Lima Road and West Downwind Road measuring wind speed and wind direction at a height of 8 meters.

c. The C.P. at the west end of X-Ray Road measuring wind speed and wind direction at 2 meters.

d. Downwind #1-Northeast of the C.P. measuring wind speed and wind direction at 2 meters, and

e. Downwind #2 located approximately 6 miles northeast of the burn pit, measuring wind speed and wind direction at 2 and 16 meters.

In addition, Pibal data (or winds aloft) were recorded at Station #81, Downwind #1 and Downwind #2.

During the test there was no cloud cover, temperature of the ground was 91.0 degrees, the relative humidity was 12 percent, and temperature gradient or Δt (from a height of 2 meters to 16 meters) varied during the burning period in a range from -0.2 to -3.9 degrees Fahrenheit. Fifteen minute averages of wind speed for all stations at all heights indicate variation from slightly under to slightly over 10 miles per hour. In general, winds were from the south-southwest. The stations closest to the mountain reflect a more southerly flow, and even a southeasterly flow after the first 90 minutes. Canyon winds were variable but primarily from the southeast, carrying the smoke over the canyon wall to the northwest.

Winds aloft were measured every hour at altitudes of 125 to 2290 feet from each of three stations. They were remarkably constant in direction, from the southwest and varied from an average of 10 mph at ignition, dropping to approximately 8 mph one hour after ignition, and rising again to approximately 20 mph by two hours after ignition.

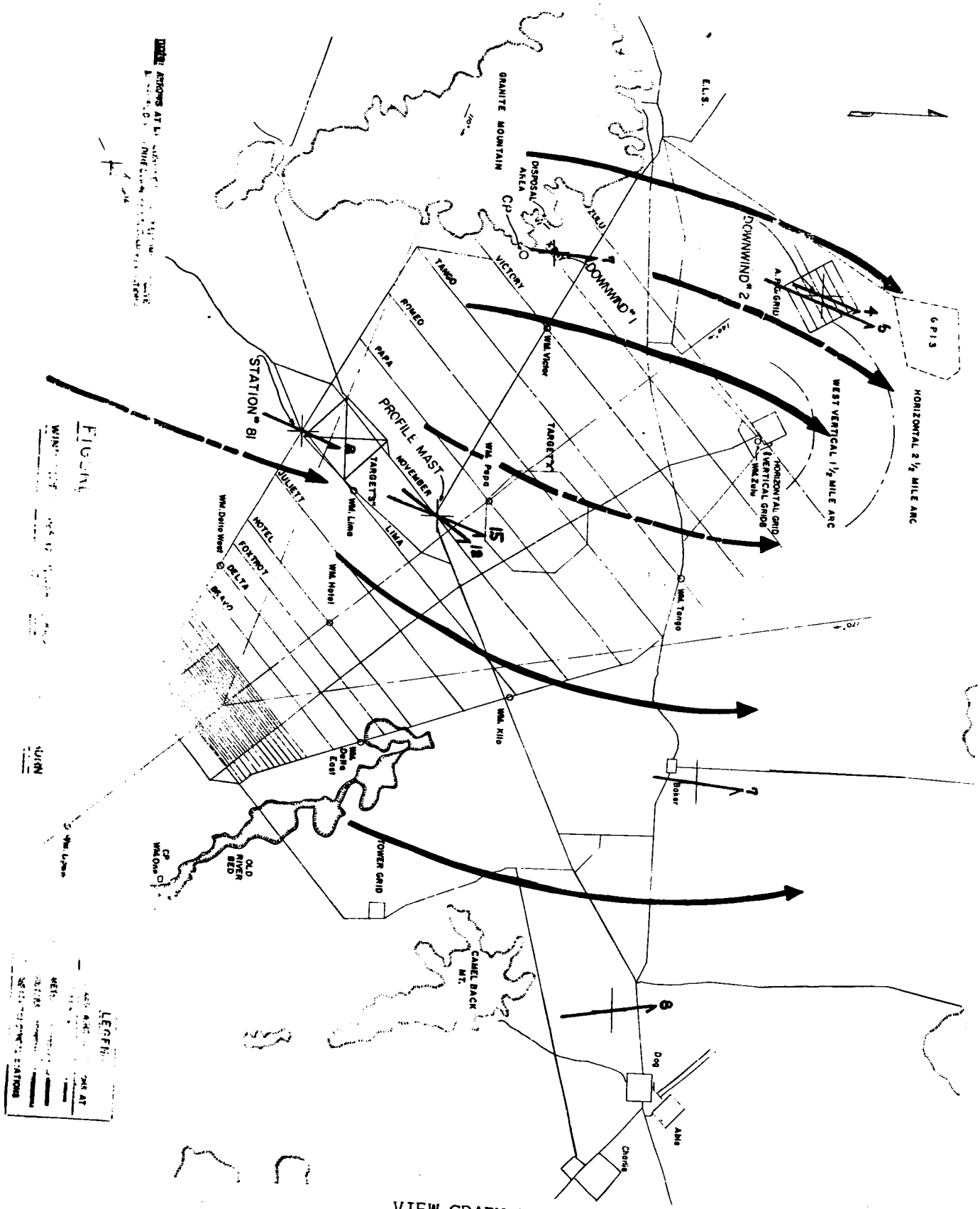
The meteorological data plus visual observation and photographs were such to indicate that the samplers had been properly located.

At 1155, 9 July 1965, the beryllium waste was ignited by a group from the Explosive Ordnance Detachment located at Dugway. Five hundred gallons of fuel oil were poured over the barrels and ignited electrically using thermite grenades.

The fire in the trench had nearly burned itself out after the first 30 minutes, but smoke was still emitted for the following 90 minutes. At this time there were still visible emissions from the pit, although nothing like that seen during the earlier period.

After ignition, grass and sage brush in vicinity of the pits caught on fire, and much of the smoke after the first two hours was due to this source.

What then are the results of this monitoring effort? First, a positive background sample was found in only one of the 56 pre-burn samples, and this was right at the detectable limit. This sample had been permitted to run for 56 hours rather than 24 hours. The indicated concentration was 10^{-4} micrograms per cubic meter or 1/100th of the 10^{-2} $\mu g/m^3$ permissible monthly average concentration in community air.



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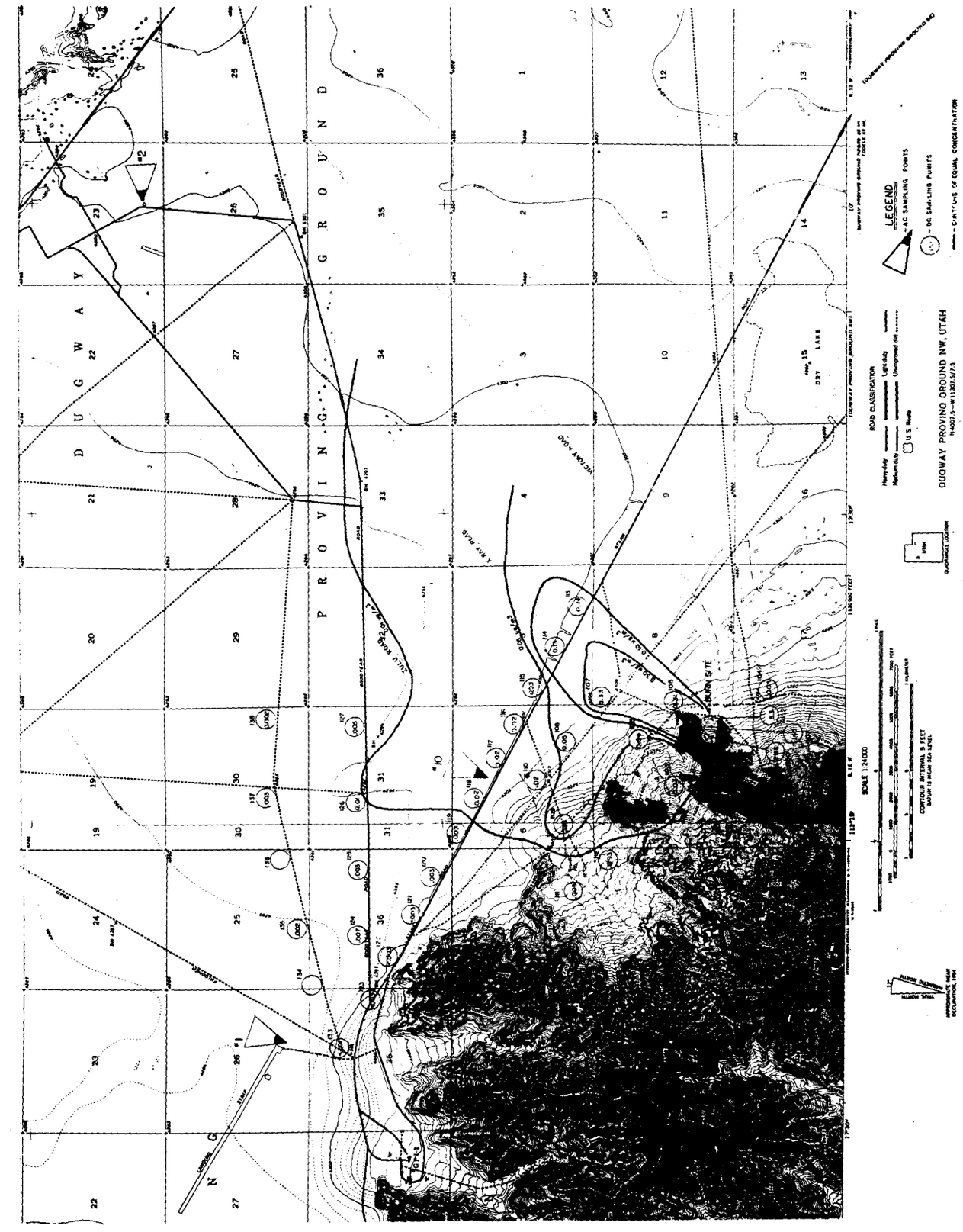


VIEW GRAPH NO. 6

Figure 6 indicates the pattern of dispersion of beryllium to the range area, the lines representing contours of equal concentration. These samples in general represent four hours of sampling time beginning with ignition.

First, let us note the concentrations in the canyon itself. These are two hour samples. Concentrations of beryllium here are 202 $\mu g/m^3$, 145 $\mu g/m^3$, and 5.3 $\mu g/m^3$ respectively. The highest result is from the west end of the pit, and the lowest from the east end of the pit, reflecting wind direction in the canyon. At the end of two hours, we replaced these three samplers with two others. The reduced concentrations during this second two-hour period were 4.0 $\mu g/m^3$ and 0.72 $\mu g/m^3$; again the higher concentration being on the west end. Inasmuch as the concentrations are so high during the first several hours, i. e., averaging more than 100 $\mu g/m^3$, anyone entering the canyon during this period should definitely wear a supplied-air respirator.

Note the lower concentrations outside the canyon. The highest value is .33 $\mu g/m^3$, or about 1/6 the permissible eight-hour average industrial exposure of 2.0 $\mu g/m^3$.

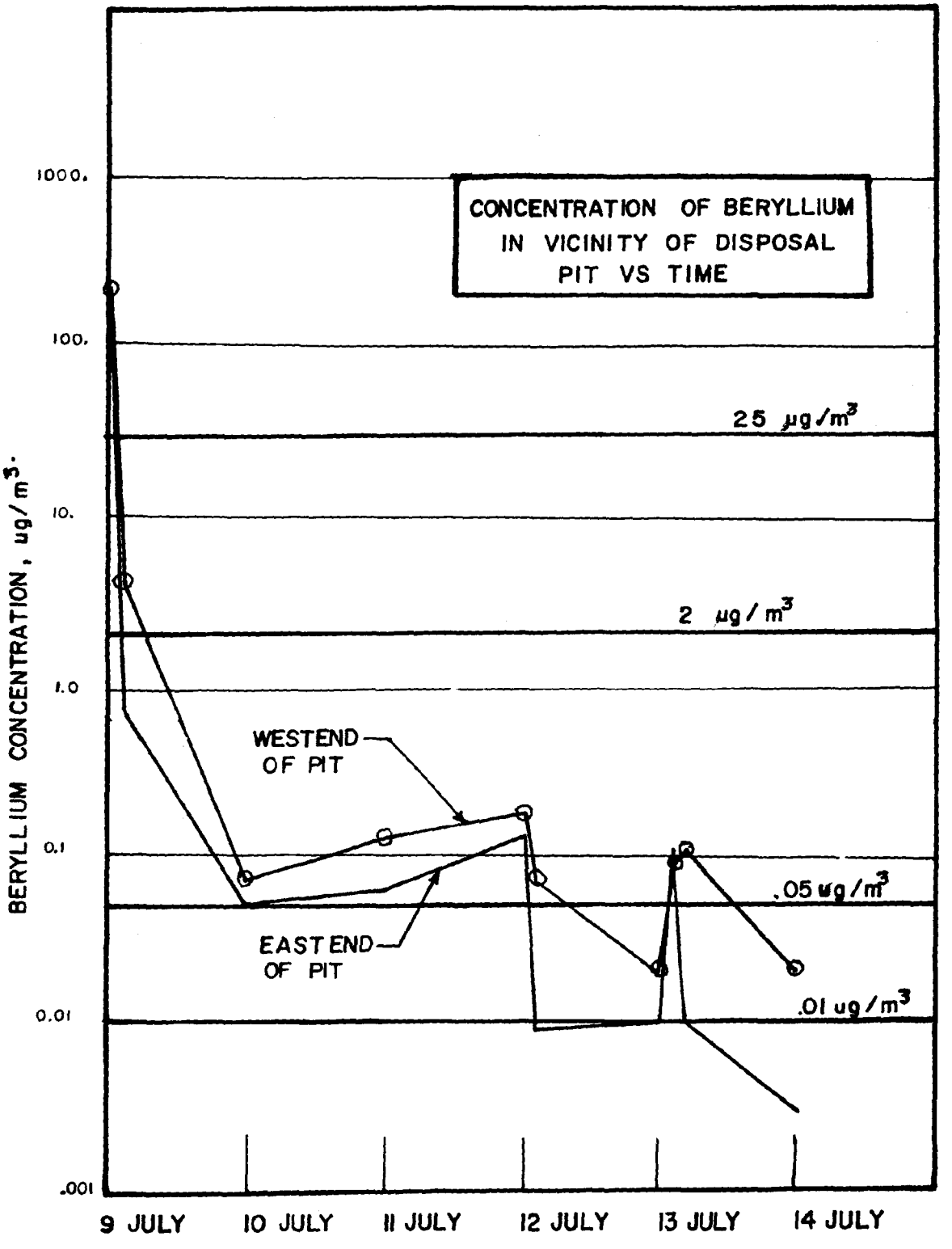
The contours represent 0.3, 0.1, 0.05 and 0.01 $\mu g/m^3$ concentrations respectively. The 0.05 line is significant because it represents the 60 day maximum permissible average community limit. The 0.01 line, of course, is the permissible 30 day average level.

For those of you interested in distances, it is approximately 2000 meters from the canyon to the nearest point on Stark Road. The General Metal Works sampler located at sampling point #2 in the direct path of the cloud at a distance of about 8 kilometers indicated a concentration of 4×10^{-4} $\mu g/m^3$ or approximately 1/25th of the permissible community air level.

Off the range, in the surrounding communities, there were just three positive samples. At Delle, Callao, and at Dog area. All are just above detectable concentrations (0.0001 $\mu g/m^3$) and over one order of magnitude below permissible average monthly community levels.

During the days following the burn, sampling was continued. The trenches in the canyon were still open over the weekend. No emissions were visible from the trenches, but it was interesting to note that a smouldering tree burst into flame during one sampling run. During this two-day period, small concentrations were found on 10 of the high-volume samplers located in the vicinity of the canyon on the range. However, only one of these samples was at the maximum level recommended for community air; all the rest were below this level. This does indicate that there are small quantities of beryllium in the air after open trench burning, either as a result of fallout, because of reentrainment, or a continuing emission from the trench (either burning or ash being blown out of the trench).

On Monday, three days after ignition, covering over of the trenches with earth by use of a bulldozer began. This operation took several hours on each of two consecutive days. The operators wore full protective clothing, including a gas mask. Each man wore a lapel sampler while in the canyon. Additionally, a battery-operated Staplex sampler was mounted on the dozer, and two Gelman samplers were operated on sampling stands in the canyon. During this very dusty operation, the operator is



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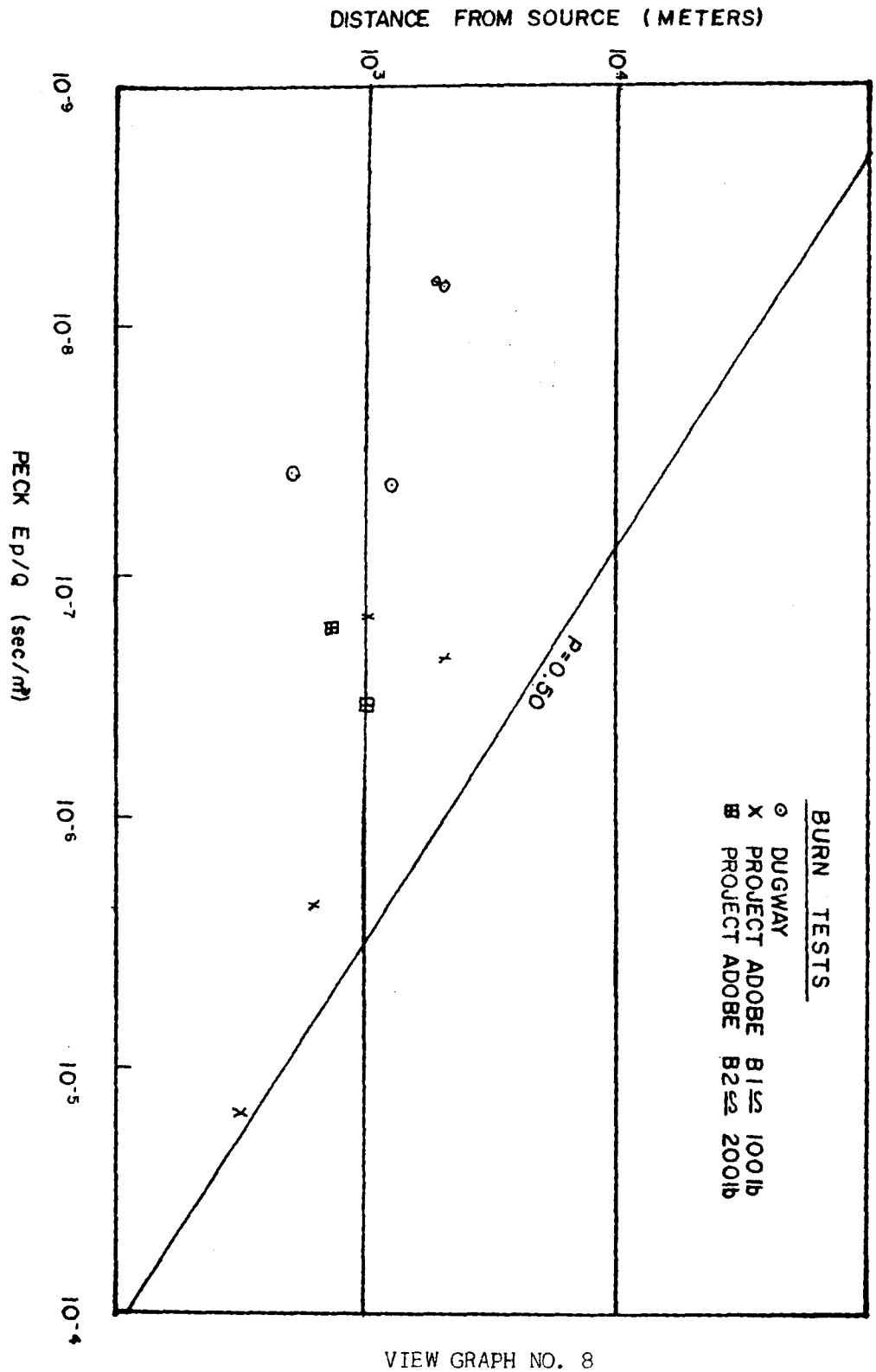

FIGURE: RESULTS OF OPEN PIT BURNING AT DUGWAY PROVING GROUND AND EDWARDS AIR FORCE BASE

VIEW GRAPH NO. 8

exposed to beryllium concentrations of approximately 2-3 $\mu g/m^3$, or roughly to concentrations in the range of the permissible average industrial eight-hour level.

During the study, sampling was accomplished in the burn canyon, some 30 feet downwind from the trenches on six consecutive days, beginning at the time of ignition of the waste material. The graph (Fig. 7) shows the variation in concentration with time over this six day period. Note that this is a semi-log plot. After two hours of burning, the concentration in the pit was below 2.0 $\mu g/m^3$ on one sampler and slightly above this on the other. The day after the burn, the concentrations were below 0.1 $\mu g/m^3$. On Sunday they were slightly higher, and rose again when bulldozing began on Monday. During the dozing operation they fell off as the trench was covered. On Tuesday concentrations rose again when the dozer moved into cover the second trench. On the day after the trenches were covered over, both samplers had dropped to approximately the permissible air level.

Figure 8 shows the results of the burn when plotted against results obtained previously by Captain Owen Kittilstad in his work on beryllium dispersion at Edwards Rocket Propulsion Lab in California. The line represents the peak concentration at various distances downwind one would expect when firing rocket engines. The x's and squares represent the open trench burning of small quantities of missile propellant at Edwards. The circles represent our results at Dugway Proving Ground. They are approximately one order of magnitude below the concentrations found at Edwards, and I believe indicate the reducing effect of Granite Mountain (and the nature of the waste materials) upon dispersion.

What then can be said to summarize these findings?

(1) Meteorological conditions prescribed for the test were proper to insure adequate dispersion of the beryllium. The occurrence of these conditions were predicted correctly by personnel at Dugway.

(2) Concentrations outside the canyon were well below the 2.0 microgram per cubic meter maximum 8-hour average recommended for industrial workers. After the first two hours of the burn, the level inside the canyon approached this level.

(3) Concentrations beyond Goodyear Road were below the recommended permissible 30-day average community concentration.

(4) Covering of the burn trenches reduces the concentration of beryllium in the air to a quantity below that of the recommended average community levels.

(5) Finally, and most important of all, exposures to concentrations of beryllium by the civilian and military communities in western Utah was so low as to be minimal.

In conclusion, I would like to repeat the words used by the Chief, Division of Air Pollution USPHS, in approving the protocol for this test:

> "In our opinion, the interagency cooperation demonstrated in this plan for control of a potentially serious Federal air pollution problem is in comp. e harmony with the intent of Congress expressed in the Clean Air Act of 1963." We hope that it was, and again want to thank all the members of the interagency team who participated in this test.

THE OSMOLALITY ADJUSTMENT IN URINALYSIS

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A major objection to urinalysis as an index of exposure to, or absorption of, toxic substances, is that the results are not invariably consistent. Consecutive samples from the same worker, for example, may yield quite different findings; and samples from several workers with similar exposure may have widely varying contents of toxic element or metabolite. In fact it is not infrequent to find, in industrial hygiene literature, statements to the effect "that there is no relationship between individual excretion and exposure" to a given substance.(1)

The general implication of such statements seems to be that urinalyses are inherently unreliable as indices of absorption of toxic substances. While this may be true in some, if not in all cases, a number of other explanations of the reported variabilities of results are possible. Contamination of the sample on the one hand and loss of the substance being looked for on the other, due to the decomposition of the urine sample, are frequent possibilities. In addition, many of the methods, especially those for determination of microgram and submicrogram amounts of toxic metals, are quite difficult and in such analyses the best laboratories are not infallible. Even if the above difficulties are overcome and our assumptions regarding exposure are accurate, there are other factors which can affect the results of the urinalyses in such a way as to produce inconsistent findings.

When urinalysis results are expressed as parts per million, mg. per liter or other units of concentration, they may be subject to great variation, due to difference in water balance. In Table 1, the concentrations of lead in the urine of a patient with lead poisoning, who was put on forced fluids are shown.

Table 1

Urinalysis Results in Worker with Plumbism

Condition	Lead Found - Mg/L
Forced fluids (1)	0.035
" " (2)	0.015
Fluids restricted	0.22

While this is an extreme case, dilute urine samples are frequently obtained during routine procedures, and failure to compensate for this fact can lead to incongruous results. Measurement of rate of excretion by collection of 24 hour or other timed

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*Messers. Leonard D. Pagnotto and Max Richmond, Massachusetts Division of Occupational Hygiene, were coauthors of this paper.

samples is the classical method of correcting for variation in fluid balance, but the practical difficulty of securing reliable timed samples is a serious drawback to this procedure.

An obvious alternative is to relate the amount of substance of interest to some component of the urine other than water. For example, in the urine sulfate test for benzene exposure, the concentration of sulfate-conjugated phenols is related to the concentration of sulfate. Experience has shown that in general, this compensates for variation in fluid balance, the urine sulfate ratios of similarly exposed workers being the same in dilute and concentrated urines.(2)

Another component of urine which is sometimes used for this purpose is creatinine. The most common method of correcting for variation in fluid intake, however, aside from the use of timed samples, is the specific gravity adjustment.(3) This may be considered as relating the concentration of a single component to the total solid content of the urine. Some studies have indicated that values calculated with the specific gravity adjustment are more consistent than those from timed samples, even when the latter are collected with unusual care.(6) Nevertheless, urinalysis results calculated according to the specific gravity formula have failed to be uniformly consistent. Consecutive samples from the same worker have shown considerable variation, and samples from different workers with the same exposure have given even less consistent results. While a number of factors may contribute to this variation (one of the most interesting suggestions being the presence of natural chelating agents, in the case of heavy metals), it seemed plausible to suppose that specific gravity was not the best possible measure of urine concentration for this purpose.

At the suggestion of Dr. Edward Radford a study was made of osmolality, as a substitute for specific gravity in adjusting urinalysis results.

What is osmolality? We have been unable to find this word in any dictionary, nor does it appear in any of several recent text books of physical chemistry. It is used in recent papers on renal physiology.

A number of properties of solutions of non-electrolytes including vapor pressure, osmotic pressure, freezing point and boiling point, depend on the molality, that is the number of moles of solute per 1000 gm. of solvent, in our case, water. It is possible, therefore, to determine the molality of a solution of non-electrolytes by measuring its freezing point. If electrolytes are present, however, as they are in urine and other body fluids, the depression of the freezing point, and changes in other properties, are greater than from an equal molal concentration of non-ionic solute.

The term "osmolality" indicates the apparent molality of the solution, in terms of non-electrolyte solute. It can be considered an index of the osmotic pressure, a property of great physiological importance. For example, it is believed that under conditions of dehydration the degree to which urine can be concentrated is determined by its osmolality. The specific gravity per se is unimportant. For this reason measurement of osmolality, rather than specific gravity, has been recommended in various kidney function tests, etc.(4)

As a practical test for measuring urine concentration osmolality has both advantages and disadvantages in comparison with specific gravity. The latter property is easily and rapidly determined by a very simple device, a urinometer.

Equally primitive methods of measuring freezing point are not sufficiently rapid or accurate for the purpose of measuring osmolality, and devices of some complexity and cost are commonly employed. We have used a Fiske osmometer, containing a refrigerating unit and cooling system, and with a thermistor and Wheatstone bridge for accurate measurement of temperature. This device requires a 2 ml sample, and reads directly in terms of milliosmols per 1000 gm. of water.

The data obtained by such a unit are more accurate than specific gravity readings with a urinometer--for equally precise and rapid measurements of specific gravity, comparably expensive instrumentation providing close temperature control, would be needed. The usual urinometer method also requires a rather large volume of urine.

Both specific gravity and osmolality are affected in the same way by changes in the fluid balance, being increased by dehydration and decreased by water diuresis. A plot of average osmolality against specific gravity (Fig. 1) shows a nearly linear relationship, up to a specific gravity of about 1.027. Above this value, osmolality increases less rapidly than specific gravity.

The most important components of urine under normal conditions are urea and sodium chloride. The osmolalities of solutions of these compounds are much higher, in comparison with specific gravity, than that found in the average urine sample. This reflects presence of the substances of higher molecular weight, which contribute more to the density of the solution than to its osmotic pressure.

The mean specific gravity of urine samples from workers as found by Levine and Fahy[3] is 1.024. At this specific gravity the average osmolality is about 0.9; at a specific gravity of about 1.027, an average osmolality of unity is reached.

Our results are only in fair agreement with those published by others. Jacobson, et al found markedly higher osmolalities, in comparison with specific gravity, in urine samples obtained from controls and patients, than we found in workers.[4] Holmes reported womewhat higher relative osmolalities in samples obtained from medical students, but lower values from patients with renal disease.[5] The chief reason for the above discrepancies is probably the way specific gravities were figured. For our purposes, in making the specific gravity adjustment, it is important that the density of the urine be related to that of water at the same temperature. Holmes' data, on the other hand, indicate that his specific gravities are relating to water at 4°C, with a density of 1.000. If the urine samples were at room temperature (25°C), his values for specific gravity would be 0.003 units less than ours in the same sample. Neither of these reports listed samples with specific gravities above 1.030, whereas our data include nearly 100 specimens with gravities between 1.031 and 1.042.

For practical purposes we can consider

(a) - Liters x osmolality = osmols

and

(b) - Mg/(liter x osmolality) = Mg/osmol

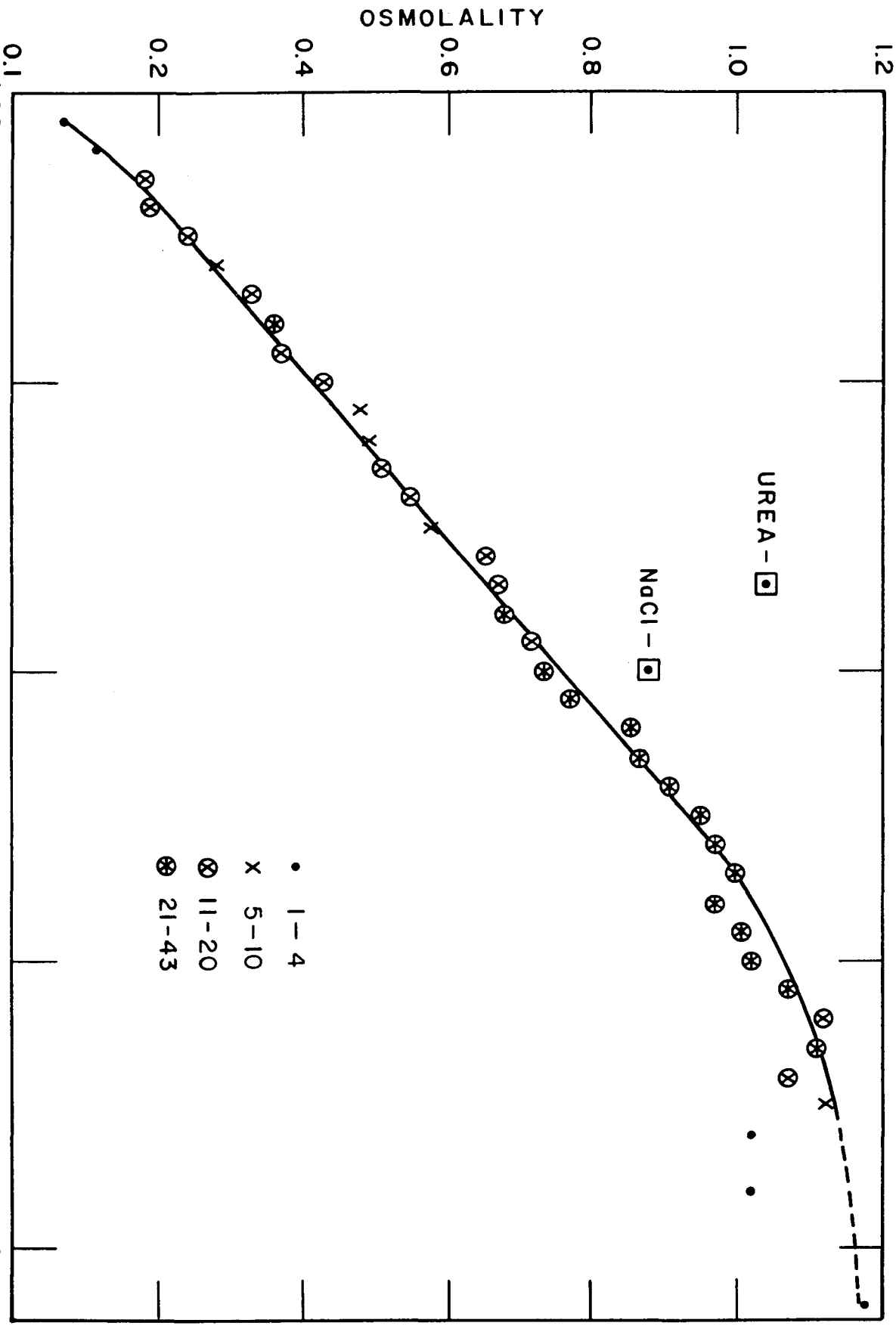

Fig. 1 OSMOLALITY VS. SPECIFIC GRAVITY

Data on 24 hour and shorter timed samples, in terms of osmols per 24 hours, for individuals of different body size, are shown in Table 2.

Table 2

Osmols per Day

Av. Surface Area	Osmols/24 hr.	
m^2	Actual	Projected
1.48	0.61	
1.52		0.60
1.65	0.66	0.69
1.75	0.72	0.83
1.85	0.76	0.81
1.95	0.80	0.90
2.05	0.86	0.91
2.15	1.03	0.95
2.23	0.98	———
2.28	———	1.03

The average excretion per 24 hours varies from 0.6 osmols for very small men and women (weight about 120 lbs.) to about 1 osmol for men over 6 feet and weighing over 200 lbs. This means that the value "mg/osmol" will be greater than "mg/24 hours," in the usual case except where the subject is a very big man. A similar relationship was found for total solids excretion, as measured by the specific gravity adjustment.(6) In Table 3 daily specific gravity adjusted volumes (Lg) are compared with osmols per day for the different size groups. "Actual" and "Projected" values are combined for the purposes of this comparison.

Table 3

Comparison of Osmol and Adjusted Volume Excretion

Surface Area	Osmols/24 hr.	Adjusted Vol/24 hr.
m^2		Liters
1.50	0.60	0.65
1.65	0.68	0.74
1.75	0.77	0.86
1.85	0.78	0.88
1.95	0.85	0.95
2.05	0.88	1.00
2.15	0.99	1.06
2.25	1.00	1.15

In general, excretion calculated as liters adjusted to 1.024 specific gravity exceeded that calculated as osmosis by about 10%. In individual cases "osmols/day" frequently equalled and occasionally exceeded slightly "adjusted volume (liters)/day."

This means that the term "mg/osmol" will on the average, exceed "mg/Lg" by about 10%. A marked difference exists between dilute and concentrated samples, however, as shown in Table 4.

Table 4

Lead in Dilute and Concentrated Urine Samples

Nature	Specific Gravity	Number	Lead Found Mg/osmol	Mg/Lg
Dilute	<1.010	26	0.19	0.22
Concentrated	>1.029	10	0.26	0.18

The average values, adjusted for osmolality, are slightly lower, in dilute samples, and significantly higher, in concentrated urines, than the specific gravity adjusted values. In individual cases the differences may be much greater. In Table 5, a number of samples of high specific gravity from lead workers are listed, together with the values adjusted both to osmolality and specific gravity. The averages for the co-workers are given for purposes of comparison. In all cases the osmolality adjustment yields a higher result, sometimes more than twice the specific gravity value.

Table 5

Samples of High Specific Gravity

#	Sp. Gr.	Lead Found Mg/osmol	Mg/Lg	Average for Co-workers
1	1.033	0.39	0.31	0.30
2	1.034	0.24	0.17	0.30
3	1.034	0.45	0.30	0.30
4	1.035	0.16	0.13	0.14
5	1.036	0.10	0.05	0.07
6	1.038	0.16	0.09	0.18
7	1.040	0.09	0.04	0.17

Several of the urine samples of high specific gravity gave a positive test for sugar, and in all such cases the osmolality was relatively low. It seems highly probable that in such cases the specific gravity adjustment gives too low a value. Whether the osmolality adjustment gives a result that can be substituted for the specific gravity value is open to question, but this does not appear to be an illogical procedure.

Comparison of the consistency of results calculated by both specific gravity and osmolality adjustments yielded no clean cut conclusions. Samples analyzed for lead and trichloracetic acid seemed slightly more consistent when the specific gravity adjustment was used than when calculated on the basis of osmolality, while the reverse was true for samples analyzed for mercury, phenol, and hippuric acid.

For determination of osmolality it is desirable that the sample be reasonably fresh and that no acids be added. The osmolality is greatly increased by small amounts of strong acids, such as are sometimes added to keep heavy metals in solution when the sample cannot be refrigerated.

Summary

A study has been made of urine osmolality as a substitute for, or supplement to, specific gravity, for the purpose of adjusting urinalysis results. The data indicate that, while osmolality has certain theoretical advantages, essentially the same results are obtained as with specific gravity, except in the case of extremely dilute or very concentrated samples, or samples containing sugar or large amounts of other substances of high molecular weight.

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THRESHOLD LIMIT VALUES AND THEIR SIGNIFICANCE

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If we are to preserve the affluent society for the millions who now enjoy it, to say nothing of extending it to the billions who live in relative poverty, it will be necessary to solve the problems of pollution of the air, water and soil by the chemical radioactive and biological wastes of civilization. The development of standards, which will prescribe tolerable limits for contamination of these media under various circumstances, is necessary if rational solutions are to be found.

Threshold limits for workroom air, or more generally, for occupational exposure, constitute an important phase of the general problem of stmospheric pollution. While similar in many ways, threshold limit values (TLV's) differ from atmospheric pollution standards in several obvious respects.

First of all, they apply to a minority of the population, a group whose members are in general more vigorous and robust than are the idle members of the public.

Moreover they are in force less than a quarter of the time, for the most part. When the conventional eight hour day is worked, the system has sixteen hours in which to recover from the effects of exposure during the work period.

For these reasons, TLV's are much higher, as a rule, than air pollution standards for the same substances.

On the other hand, from the economic standpoint workers constitute by far the most important segment of the population. The illness of a retired person, an infant, or even a housewife, is a lesser burden on society at large than is the sickness of a productive worker.

In addition, frequently the occupational exposure of the worker to gases or fumes is superimposed on an exposure to the same or similar substances in the general atmosphere.

It is more likely, moreover, that the air in a factory will contain harmful vapors or dusts in concentration close to the threshold limit, day after day, week after week, than that the outside air will be comparably polluted for equally long periods.

Finally, the number of contaminants which may reach harmful limits in workroom air exceeds by a wide margin the number of substances which are significant pollutants of outside air.

It should be made clear that TLV's are not comparable to physical constants, which can be measured accurately, or even to toxicological properties, such as LD_{50}'s, which are also measured, although frequently with dubious accuracy. Rather they are numbers usually recommended by committees, composed of chemists, engineers, physicians and toxicologists, none of whom is adequately equipped by training for this particular task.

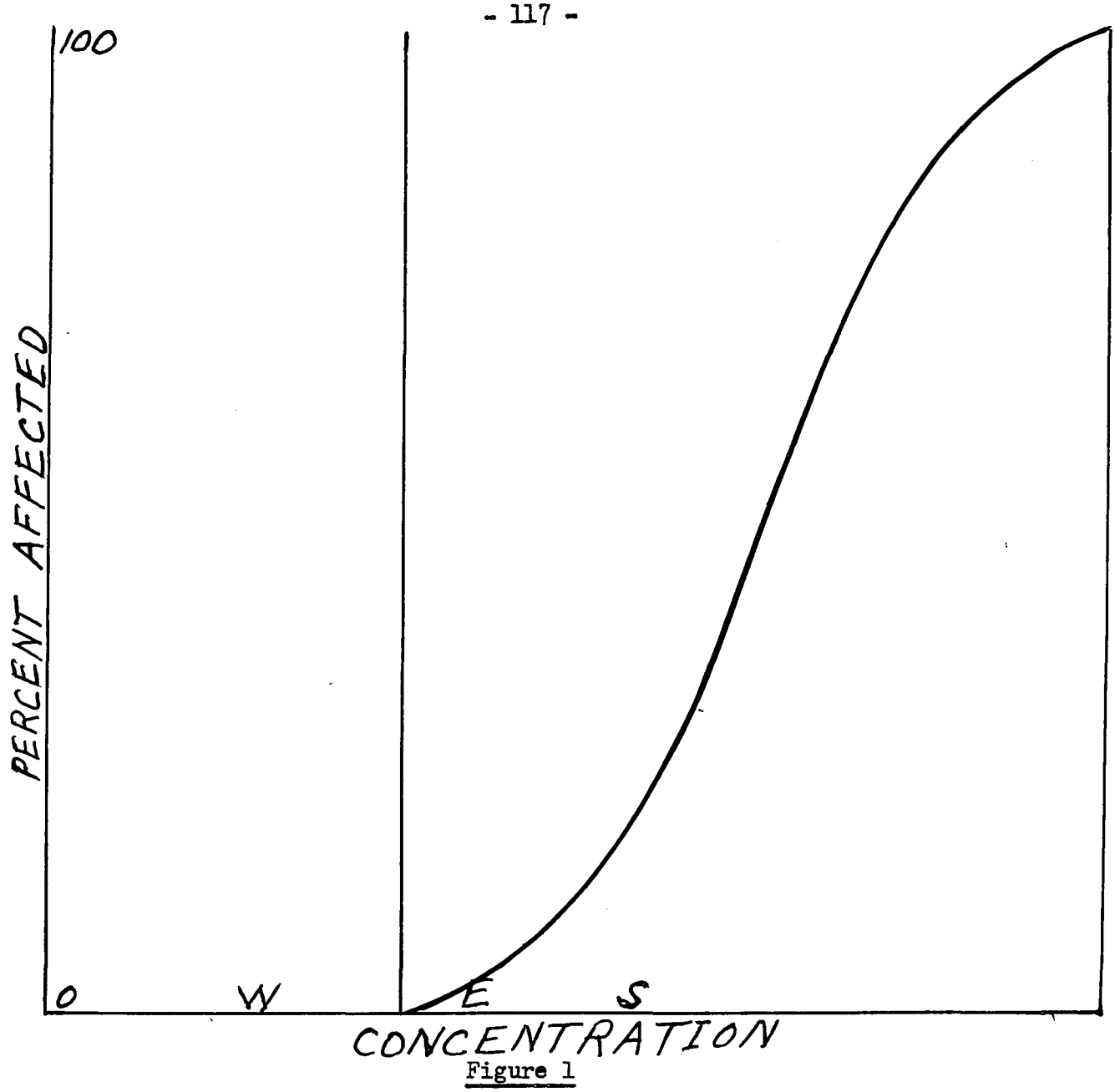

Figure 1

Percentage of Workers Affected vs. Concentration

The selection of the correct threshold limit for most substances presents many difficulties. The pertinent data available on human exposure are invariably scanty, frequently of questionable validity, and often conflicting. If the committee is forced to rely on animal experiments, extrapolation to human exposure may involve assumptions that are highly questionable. Within the past few years two highly reputable toxicological laboratories made extensive animal studies on a not uncommon chlorinated hydrocarbon. The TLV recommended by one laboratory, on the basis of its findings, exceeded that suggested by the other, by a factor of ten.

The uncertainties due to the paucity of reliable technical information, are augmented by marked differences in philosophy, among those responsible for sponsoring threshold limits. Unfortunately, these philosophies seem to depend to some extent on the economic interests of the interested parties. Figure 1 is a comulative probability

curve representing the proportion of workers who will be affected to a given degree by a given concentration of a fume or dust. The exact point at which the TLV should be set depends in part on how severe the effect is with which we are dealing. In general, however, it is to the advantage of the workers (W) to have the limit set at a concentration where no one at all will be affected.

On the other hand, the employer (E) would prefer a limit which will protect most workers, but he would rather not undergo the extra expense of providing for the most susceptible. After all, if he has only a few men exposed, the chances are none is highly sensitive.

Finally, the supplier (S) would like to have the TLV set to protect the average worker, rather than those that are even mildly susceptible. He feels, rightly or wrongly, that a low TLV adversely affects the value of his product in the market place.

Many employers, and proportionately even more suppliers, have industrial hygienists and toxicologists who skillfully and forcefully present their points of view. The workers themselves are not so represented. It has fallen to the lot of the governmental industrial hygienist to protect the workers' interests when TLV's are promulgated. Many representatives of industry probably feel that government agencies side with the worker altogether too strongly.

A frequent criticism of TLV's is that they are misused by government enforcement agencies--a single test result exceeding the TLV causing an order for an expensive ventilation system or other costly alterations.

The other side of the coin carries the corollary that, in the absence of a concentration above the TLV, the government cannot logically require major changes. To be sure, if a blower is running backward, if exhaust ducts are full of holes or blocked, if a room is closed up so tight no make-up air can enter, remedial action can reasonably be required. But, in the absence of data indicating a possibly harmful condition, that is to say, a concentration of dust or fume in excess of the TLV, the government inspector will find it hard to justify an order calling for major expenditures for ventilation or other control measures.

We will grant that no company industrial hygienist worth his salt would be satisfied with a condition where concentrations were at the TLV level continuously, provided the contaminant had potentially serious effects, and he felt the TLV was not unreasonably low. There is general agreement that, with most contaminants, the lower the concentration the better. This fact is recognized particularly in the field of radiation. But when the chips are down and heavy expenses are involved, companies which would never knowingly permit their workers to be over exposed, will allow exposures right up to the recommended or legal limit. Similar situations exist with chemical hazards.

The government hygienist must assume, therefore, that when he sets a TLV, workers will be exposed to concentrations close to this limit while at their work, for prolonged periods, possibly for their entire working career, which may be 50 years or even more. It is granted that few workers will have such exposures. Most will change jobs, or conditions in the work place will change. Actually

gross over exposures for limited periods are more likely than years at concentrations near the TLV. Not infrequently, however, a worker will be successively exposed to a number of hazards, many with similar effects, and intervals of negligible exposure, no matter how probably, cannot be assumed.

It is true that with the majority of contaminants the effects are not cumulative to the same extent they are with silica and other pneumoconiosis-producing dusts. We simply do not know, with certainty, the effects of daily exposures to the TLV levels over a period of years for the majority of substances on the TLV list. We can theorize, as the chairman of the TLV committee has done, that some highly toxic compounds, such as hydrogen cyanide, are so rapidly de-toxified that they have virtually no cumulative effect. At the other end of the scale, we have a number of so-called nuisance or inert particulates that constitute a controversial problem.

Two rather common contaminants of air in workrooms are oil mist and smoke, usually from cutting oils, and fiber glass or mineral wool, which is frequently in various manufacturing and construction processes. The animal studies on these materials have, with few exceptions, indicated little or no pathogenic effect, even in high concentrations.(1)(8) Surveys of workers in plants where these contaminants are present have failed to reveal any evidence attributable to their inhalation.(2)(3)

Because of these findings many hold either that no TLV's should be set for oil mist or fiber glass, or that at the most the highest values, such as have been set for innocuous particulates such as calcium carbonate, be employed. They dismiss as of no consequence the discomfort and minor irritation caused by these substances in concentrations of the order of the TLV's for harmless materials, and reject as unrelated to exposure the occasional reports of moderate to serious respiratory disease among workers where these contaminants are present.(4)(7)

To digress for a moment, if we were to look for a group of healthy, vigorous and physically superior men, a good source would be professional sports. Certainly, in comparison with the rest of us, even those in the same age bracket, the members of a major league football, basketball, or baseball team would be, from the standpoint of physical strength, skill and stamina, supermen. From the statistics available to fans, it is apparent that many professional athletes are at or near their peak at the age of thirty, or even when a little older.

If we examined the personal habits of these men, moreover, we would find that about half of them smoke.* In all probability most have had this habit since the age of 20 or even longer. Many, undoubtedly consume alcoholic beverages, and some may even be in the category of problem drinkers.

The preponderance of evidence is that these habits, which in these cases have had no detectable ill effect in a decade or more, will in due course result in a significant incidence of lung cancer, emphysema and heart disease, in the case of the smokers,

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*Data on smoking kindly provided by Mr. E. A. Roberts, Sports Editor of Boston Evening Globe.

and cirrhosis of the liver, among other dire consequences, in the case of the heavy drinkers. Yet many of these effects, especially those relating to smoking, were not realized until data from millions of subjects, most of them with several decades of experience, were analyzed. And there are still those who doubt these findings.

The fact is we need a great deal of data, with a large number of subjects exposed for long periods of time, before we can accept negative evidence as conclusive, especially if there are a few suspicious though unproven, cases of illness attributable to the exposure. After all, the first cases of berylliosis in this country were diagnosed as sarcoid of non-occupational origin, and the first animal studies indicated beryllium to be a metal of low toxicity.(5-6)

Certainly, ethyl alcohol is not considered a toxic solvent, least of all, a liver poison. When used as a beverage, however, it may indirectly cause liver disease, and its potentiating action with carbon tetrachloride is well established. Are we certain that the chlorinated solvents which are considered non-toxic to the liver, will cause no injury to this organ, if inhaled day after day over a period of years, in concentrations close to the TLV, which means near levels at which symptoms of narcosis may appear? In particular are we sure that such exposures will not hasten the onset of liver disease in the worker who stops regularly at the bar on the way home from work, or who cashes his pay check at the package store? For that matter, should the TLV's for the known hepato-toxic substances, such as carbon tetrachloride, ethylene dichloride, dimethyl formamide, etc. be set to protect the teetotaler, the social drinker, the problem drinker, or the alcoholic?

Absorption of silver in amounts apparently too small to cause any symptoms of intoxication, can result in a pronounced permanent pigmentation of the skin. It seems probable that the impact of such a condition will vary greatly, depending on the sex, age, social station and complexion of the subject. The development of argyrosis in a young woman could be as great a tragedy as a serious physical disability; whereas to a laborer past middle-age of swarthy complexion and uncertain personal hygiene, it might be of no concern at all. The government agency can hardly recognize this fact, however, and must set a TLV which will prevent the occurrence of such a stigma.

Incidentally, in my opinion, the present TLV for tellurium is not low enough to prevent the comparable stigma of unpleasant breath, a condition which, fortunately, is more transient than the skin darkening of argyrosis.

A difficult problem may arise when we try to establish TLV's for dusts which cause a benign pneumoconiosis. In such cases, if we understand the term correctly, there is no detectable functional difference between an afflicted worker and a normal person. Only if X-rays are taken does the condition become apparent.

It can be argued that any chest condition which shows up on X-ray can make a worker less employable, and cause the detection of serious lung disease to be more difficult. It can even be held that such a condition although it is as harmless as the term "benign" suggests, is inherently undesirable; in other words, that limits should be set on the quantities of foreign material permitted to accumulate in the lungs, bones or other parts of the body, even though no injury in the usual sense of the word, is caused.

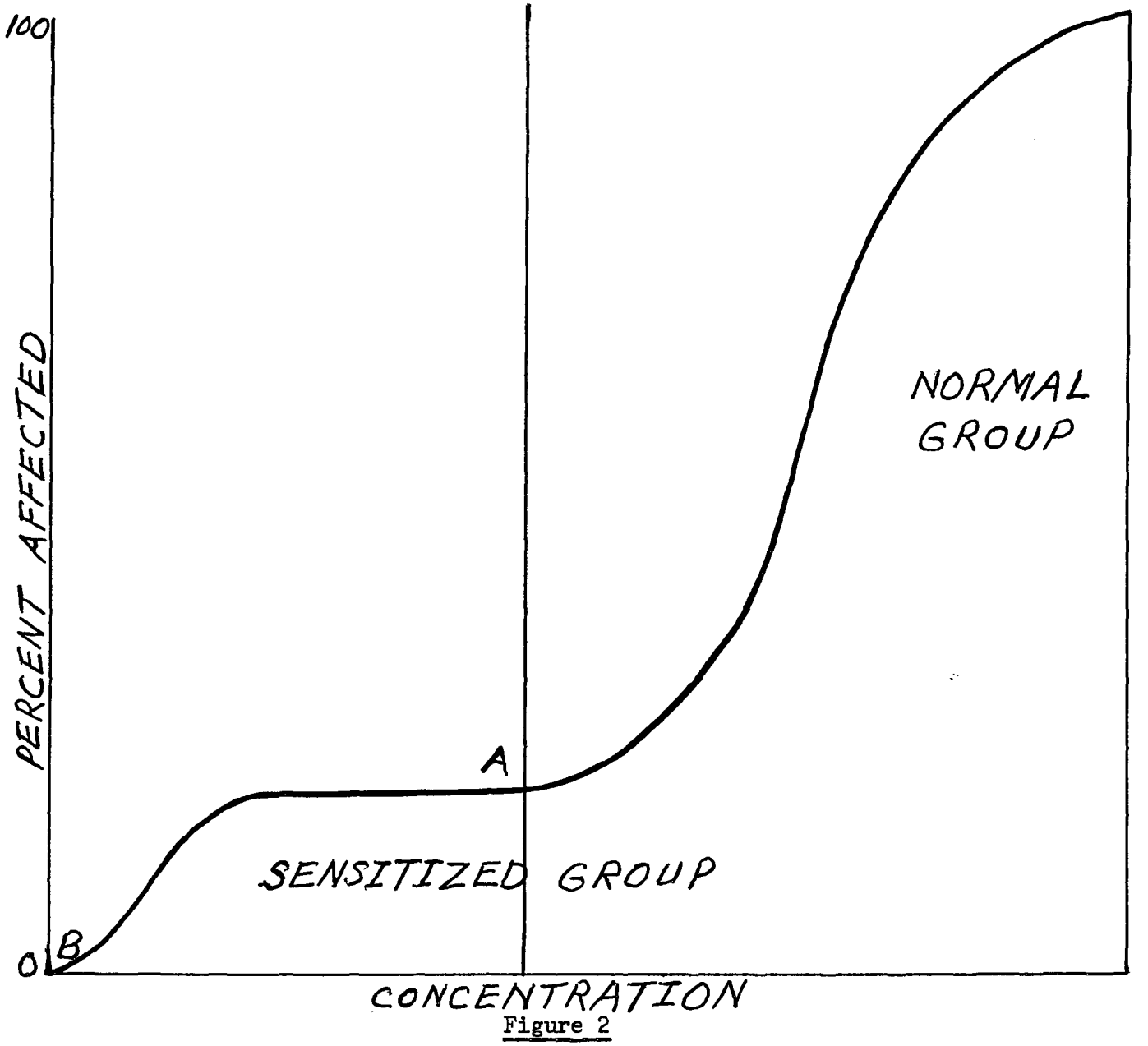

Figure 2

Percentage of Workers Affected by a Sensitizing Agent

The Threshold Limits Committee does not take this extreme view. At its last meeting it was voted, with only two members timidly dissenting, to raise the TLV for tin oxide to the maximum level recommended for the most innocuous particulates.

Another troublesome question arises when we are dealing with sensitizing agents. In Figure 2 a hypothetical curve for percentage response to an agent which can cause sensitization, such as TDI, is shown. A small proportion of workers, ordinarily those who have been previously over exposed, are affected by extremely low concentrations of vapor. When we reach a level at which all such persons are affected, there is no further increase in the number who respond until we arrive at a concentration which affects non-sensitized individuals.

Should we set our threshold limit value at the level which will not effect even sensitized persons, or should it be at a concentration which only the more sensitive of the normal persons are affected? In theory, only individuals who have been over exposed become sensitive. Hence if the threshold limit value is always maintained, the level need not be reduced to the extremely low value required to protect sensitized workers.

In case such persons are employed, respiratory protective devices may be in order. As a general rule, however, respirators should not be worn in areas where concentrations do not exceed the threshold limit value. We find many instances especially in paint spray operations where respirators are worn as a matter of course, but vapor and pigment concentrations rarely exceed the threshold limit value. In an area which is properly ventilated, that is, one in which the threshold limit is not exceeded, only sensitized workers or hypochondriacs should find it necessary to wear respirators. Use of respirators by others would be ipso facto evidence that the correct threshold limit value was being exceeded, at least in the opinion of either management or workers.

If TLV's are set up on the basis of the preceding philosophy, and rigidly enforced, some incongruous situations may result. For example, if our country is engaged in a war, should we close down a plant providing the army with ammunition because a few workers are getting headaches, or metal fume fever? Of course not, but the decision should be acknowledged as choosing between the lesser of two evils, and not made by establishing a liberal TLV. In other words, there are situations where concentrations in excess of the TLV can be tolerated, even for prolonged periods. But in the normal course of events, in our prosperous society, we should be willing to bear the cost of maintaining working environments free of concentrations of contaminants which will repeatedly produce even minor adverse effects on the health and well-being of our workers. And threshold limit values should be established with this as an objective.

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STANDARDIZATION OF CHEMICAL METHODS IN AIR SAMPLING

Robert G. Keenan*

Introduction

During the past quarter of a century, several of our professional and technical societies have become actively concerned about the need of standard methods for the sampling and analysis of atmospheric contaminants. These organizations include the American Conference of Governmental Industrial Hygienists, the American Industrial Hygiene Association, the American Public Health Association, the American Society for Testing and Materials, the Air Pollution Control Association, and the American Society of Mechanical Engineers. Naturally, each society has used its own approach in attempting to meet the need of providing reliable analytical methods to industrial hygienists. I shall first comment briefly on some of the mechanisms employed by the separate societies in developing recommended or standard methods and then I shall discuss in greater detail the operations of the Committee on Recommended Analytical Methods of the A.C.G.I.H., a Committee with which I have been associated since 1950.

Mechanisms Leading to Standardization

The American Society for Testing and Materials has sponsored its Committee D-22 on Methods of Atmospheric Sampling and Analysis. This Committee has functioned through its subcommittees, consisting of experts with demonstrated experiences and skills in the sampling and analysis of specific atmospheric contaminants for which methods are needed. Through the processes of selection of a promising method from the literature, modification of the procedure as warranted, round-robin testing to evaluate the variability of the results of the prescribed procedure, and voting by the full Committee for acceptance or rejection of the evaluated method (with stated reason for a negative vote) a "Proposed Tentative Method" is finally evolved. The tentative method is published first as a preprint and ultimately in a Manual along with proposed tentative or standard methods for other substances.(1) Periodically, the Committee votes to recommend any necessary revisions of tentative methods, their continuation as tentatives, or their adoption as standard methods.

A different approach has been that used by the American Public Health Association. This society has functioned through its Sections and its Coordinating Committee on Laboratory Methods to approve the work of its Committee on Chemical Procedures which is charged with the responsibility of preparing reports on its recommended procedures for single toxic agents. The original and revised reports of the APHA Manual of Methods for Determining Lead in Air and in Biological Materials, published in 1944 and 1955, respectively, illustrate this mechanism.(2)

The American Industrial Hygiene Association through its Analytical Chemistry Committee has compiled analytical abstracts to supply a convenient source of information on methods related to the field of industrial hygiene chemistry. The purpose of these abstracts is to provide the chemist with sufficient pertinent data to help him select the most appropriate method for his particular problem. The first publication of these abstracts appeared in 1965 and dealt with 61 substances.(3)

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A still different approach has been provided by the combined efforts of the six societies mentioned earlier. In 1963, these organizations formed an Intersociety Committee on a Manual of Methods for Ambient Air Sampling and Analysis. This Committee is concerned primarily with the evaluation of methods for contaminants present at air pollution levels. Since its establishment, the Editor of this Manual has reviewed and summarized the literature on methods for most of the 35 substances requiring attention initially assembled 1500 reprints and photostats of original articles and prepared detailed drafts of 30 procedures which are now ready for review by the appropriate substance subcommittee of the parent Intersociety Committee. In the future, the substance subcommittees will be responsible for the initial drafting and development of tentative methods which, after editing, will be submitted to the Intersociety Committee for acceptance or rejection. Accepted methods will be designated as Tentative Methods until they have been evaluated successfully by a Collaborative Testing Coordinating Organization and then have been voted by the Committee for adoption as Standard Methods.

The American Conference of Governmental Industrial Hygienists has used a referee-collaborator system of evaluating analytical methods. This system is modeled, in part, on that of the Association of Official Analytical Chemists, formerly, the Association of Official Agricultural Chemists. As I had the opportunity to serve as the Chairman of the A.C.G.I.H. Committee on Recommended Analytical Methods, during all of the 22 years of its operation, I should like to discuss in some detail the historical background, operating mechanism, minimum requirements of the methods, accomplishments, and my own suggestions for the future program of this A.C.G.I.H. activity.

The A.C.G.I.H. Approach Toward Standardization

Historical

The importance of securing uniform and reliable analytical methods for industrial hygiene studies was recognized by the American Conference of Governmental Industrial Hygienists in 1938, the year of its organization, by the establishment of a Committee on Technical Standards. This Committee formulated a program leading to the development of standard methods for the analysis of industrial hygiene sample materials. This proposed program was then circulated to the State and local industrial hygiene agencies for the purpose of establishing a priority list of those substances which should be given immediate attention. However, the intervention of World War II delayed further action until after the war when the Committee's program was revived with the establishment of the Committee on Standard Methods. The latter title was changed in 1954 to the Committee on Recommended Analytical Methods which seemed to be more commensurate with the working policies and the practical criteria used during the preceding decade for the approval or rejection of proposed methods.

Referee - Collaborator System

The Committee consists of a chairman and a group of 5 to 8 analytical chemists who are knowledgeable in the field of industrial hygiene chemistry. Although appointments are made biennially, numerous individuals have served more than one term. Also, only four members have served as chairman during the 22-year period of the Committee's existence--a factor which has contributed to the stability and uniformity of its operating mechanism.

In practice, the Committee directs a referee-collaborator system of method selection, evaluation, and modification, operating through the process of critical testing of prepared samples in the laboratory. The Committee Chairman appoints as Referee, for a given determination, a chemist who has had considerable experience with the analysis in question. The Referee then solicits the support of some 10 to 15 collaborating analysts. Initially, the Referee reviews all methods available for the particular determination. He then selects one or more promising methods and circulates copies to all of his collaborators for their comments and suggestions. After reaching agreement on the most promising method, the Referee then prepares and sends to a limited number of collaborators a set of 4 to 6 samples along with a copy of the detailed analytical procedure. The samples contain appropriate concentrations of the test substance to cover the required working range of the method. One of the samples also contains reportedly tolerated amounts of known interferences. The collaborators are requested to analyze these samples as "unknowns" by the test method and also by their own procedures and then report their results along with critical comments to the Referee. At this point the Referee correlates the test results and prepares any indicated revision of the method which he proceeds to test personally. When satisfied, he sends a new set of samples to all of his collaborators to test the modified method. This process is continued until the Referee believes that the method meets the criteria of the Committee. He then submits to the Committee a copy of the final method along with the results and comments reported by the collaborating analysts.

The Committee reviews the Referee's report critically for an evaluation of the performance of the proposed method in terms of the following minimum requirements which must be met before Committee approval may be granted:

1. Sensitivity

The method shall be sufficiently sensitive to determine a concentration equal to 10 percent of the A.C.G.I.H. Threshold Limit Value in effect at the time of the method's evaluation.

2. Sampling Rate

The method shall not require a sampling rate in excess of 5 liters per minute for gases and vapors, or a rate in excess of 3 cubic feet per minute for particulate matter.

3. Sampling Time

The sampling rate and method of analysis shall be so designed that the sensitivity requirement is met without extending the sampling period beyond 30 minutes.

4. Precision

The average deviation (a.d.) as determined by the collaborators' analyses shall not exceed 10 percent of the Threshold Limit Value, or 10 percent of the amount of the test substance present in a sample, whichever value (Threshold Limit Value or

amount present) is the greater. In considering collaborators' results, values which are grossly in error may be omitted from calculation of the average deviation, provided that the number of rejected results does not exceed 20 percent of the total number received by the Referee.

5. Exceptions

One or more of the above requirements may be waived in certain special cases when the majority of the Committee membership considers such action warranted.

Accomplishments

To date the Committee has approved a total of 17 methods (the first 3 in 1949) each providing a quantitative procedure for a given toxic substance in atmospheric samples. Whereas several of these methods are also applicable to biological samples, only one--the double extraction, dithizone method for lead--has been so evaluated by referee-collaborator testing.

The text of each method includes sections on sampling, chemical treatment, and analytical procedures in addition to sections on pertinent chemical reactions, reagents, special instrumentation, sensitivity, accuracy, interferences, and calculations.

From 1949 to 1957, the approved methods were reproduced in mimeographed form for distribution to the A.C.G.I.H. membership only. However, the interest expressed in these methods by industrial hygienists in private industry resulted in the production of a printed Manual of Analytical Methods as a looseleaf binder collection in 1958.(4) We have been adding to this collection at the average rate of one method per year.

Future Program

It has been the policy of the Committee to consider only those methods which require basic analytical instrumentation available to all industrial hygiene laboratories. During the past decade, however, a number of State and local industrial hygiene agencies have been able to acquire and take advantage of certain, moderately expensive instruments such as gas chromatographs and infrared spectrophotometers. Also, several agencies now either own emission spectrographs or have them available for their use in an adjoining laboratory of the Health Department. With these developments, it now appears appropriate to broaden our horizons and proceed also to evaluate also those methods which are based on the use of such modern analytical instruments so that our profession may capitalize on the resulting advantages. Some of these methods could well be approved by the Committee as optional procedures.

The rate of progress in the past has been slow. This is due to several factors, including the relatively small number of A.C.G.I.H. chemists available and able to participate in the testing program. Many who have been engaged in this activity have been committed to work on more than one method at a time. The support given by these individuals is appreciated to an even greater extent when it is realized that many of them have had to donate their own time to this project because of the volume of work provided by their official duties.

Meanwhile, the need of standard methods has by no means diminished. The number of toxic chemical substances for which the Committee on Threshold Limits has approved values for the industrial worker has grown from 156 to 1950 to more than 400 in 1966. Obviously, a mechanism must be found to ensure the acceleration of method testing and approval. It is my hope that administrators of official government programs directors of industrial hygiene departments in private industry, and chairmen of occupational health departments at the universities will realize fully the great need for accelerating this essential activity. I trust further that this realization will lead these administrators to encourage their staffs to work with our Committee and to schedule a definite period of each week for this program. I believe that by this combined approach on the part of industrial hygiene chemists in government, industry, and educational institutions, we should begin to meet our joint responsibility in this area.

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INDUSTRIAL VENTILATION STANDARDS

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The major objective of industrial hygiene engineering is the prevention of occupational disease; the second objective is the improvement of working conditions. Ventilation is the primary tool which is used to accomplish both of these ends by controlling concentrations of airborne contaminants.

Historically, the need for ventilation standards has been recognized by many organizations and people, both public and private. The philosophy in Michigan is an example: The Michigan Department of Public Health has believed that it is our responsibility not only to point out the situations that are wrong but to assist and guide so that improvements can be made in the best way possible. With respect to industrial ventilation this attitude led some 20 years ago to the preparation of a field manual as a basic guide for our engineers. This manual not only served us well but became the foundation for the Industrial Ventilation Manual published by the American Conference of Governmental Industrial Hygienists; now it is safe to say that the manual is an accepted, world-wide source of ventilation design principles and standards.

These standards cannot be taken carte blanche, however. For the most part they must be applied with judgment and an understanding of the particular material to be controlled and the factors of the operation or the environment that must be considered. It is axiomatic that similar industries using similar or identical equipment manage somehow to perform their operations in widely different manners. Thus "standard" ventilation designs can often be applied in principle only from one establishment to another.

Recognizing that there is good general agreement of the need for ventilation standards we can direct our attention to their proper application. To do this well requires a brief review of our present standards and the manner in which they have been - and are continuing to be - established. Also we must have a general understanding of what we expect of our ventilation systems and I propose the following statement: A ventilation system must control airborne concentrations of contaminants to acceptable levels.

I have tried to make this statement sufficiently broad to include both industrial hygiene and fire safety, not to exclude the control of "nuisance" materials and further, to be nonspecific with regard to whether the ventilation is to capture or dilute the contaminant. If we all can accept this statement we have established our first standard and, providing that we go no further than this, we have no difficulty in applying it. Ventilation is good or bad depending on the end result: Does it control airborne contaminants to acceptable levels? All that we need do is conduct the necessary sampling programs to insure that this standard is being accomplished.

For many reasons, most of which are quite obvious, we go further than this in that we propose, exchange and apply specific design standards in accordance with which we state that the ventilation system is or is not satisfactory. We do this on the one hand as a manner of sharing our experience with each other and with our "customers" with the intended end result that the money spent for a ventilation system will not be wasted. We do this also upon request or demand of the customer or his vendor who states in effect, "Tell us what you want and we will provide it." Finally, I believe that we prepare ventilation standards out of pride also in the sense that we are functioning beyond the level of mere inspectors and are performing a good evaluation and analytic appraisal of the conditions that are encountered and must be controlled.

The design standards that we use are based solidly in theory but are entirely empirical in their application. Further, with rare exception, these standards are based on both dilution and capture regardless of whether the ventilation "system" is of the local exhaust variety or consists of a fan in the wall.

Theoretical Considerations

Each of us has an inherent desire to find the proper formula to apply to any problem, for a formula is a very definite, mathematical relationship and once it is established soundly there is no room for argument. In the design of local exhaust ventilation we are all familiar with the basic relationship established by Dalla Valle;(1) written in its most popular form it is $Q = (10X^2 + A) \times V$. Timeproven and simple to apply, this formula is the ventilation engineer's dream. Once he has located the point source to be controlled all he needs to do is use the formula and determine the air volume - providing the capture velocity is known or can be determined. Unfortunately we do not have any precise mathematical method of determining this important variable and it is left to the engineer's "judgment." Thus to apply the formula he must rely upon his own experience or such a table of values as this one (Table 1) from the Industrial Ventilation Manual.(2) As the table indicates, V can vary widely, depending upon characteristics of the operation such as particle trajectory and aerodynamic or thermal forces. V can vary also with the environment, depending upon cross drafts principally. No mention is made in the table of the toxic or flammable characteristics of the contaminant itself.

Table 1

RANGE OF CAPTURE VELOCITIES

Condition of Dispersion of Contaminant	Examples	Capture Velocity, fpm
Released with practically no velocity into quiet air.	Evaporation from tanks; degreasing, etc.	50-100
Released at low velocity into moderately still air.	Spray booths; intermittent container filling; low speed conveyor transfers; welding; plating; pickling	100-200
Active generation into zone of rapid air motion	Spray painting in shallow booths; barrel filling; conveyor loading; crushers	200-500
Released at high initial velocity into zone of very rapid air motion	Grinding; abrasive blasting, tumbling	500-2000

Dalla Valle's formula as shown applies to open external exhaust hoods, essentially round or square. Silverman(3) developed similar theoretical considerations for slot exhaust; Stern extended the theory to apply to plating or open surface tank configurations. Silverman's formula will illustrate the point: Q = 3.7 LVX. Here again for a specific application L and X can be determined with certitude. V, however, is left to experience or judgment.

Noteworthy attempts have been made to determine Q directly from theoretical considerations based upon the operation, or determine V from vector analysis. The work of Hatch with respect to the thermal air motion around hot bodies(4) and the text Plant and Process Ventilation(5) by Hemeon describe the many variables that must be considered to determine the necessary exhaust volume from theoretical considerations alone. Their analyses point the way and are recommended to all who are interested in serious study of the problem, but it cannot be said as yet that the work is complete.

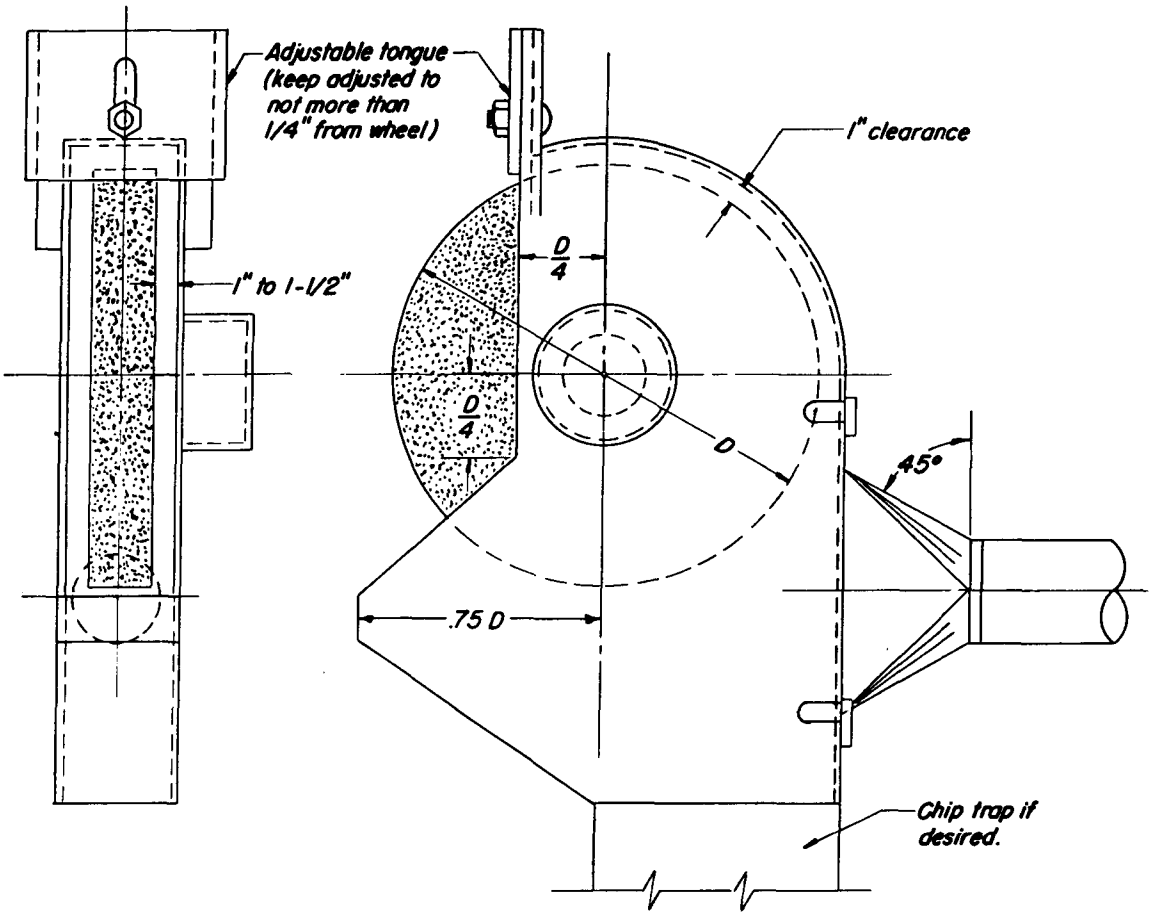
Thus from the theoretical basis for our work we find ourselves face to face with the empirical. For the most part the values of Q or V which we use are the result of experience by ourselves and others; through a process of elimination and exchange of information we have determined which values work. As a further example, Figure 1 shows the typical classical grinding exhaust hood and the recommended air volumes. To this slide I have added the nominal pipe diameters which correspond to the recommended air volume and the minimum duct transport velocity. Does anyone think that it is pure coincidence that the recommended air volumes happen to coincide so neatly with standard pipe sizes?

The grinding exhaust hood is a good example of another aspect of standards. Within the past few years we on the Committee on Industrial Ventilation have learned from many foundry engineers that our recommended exhaust volumes were too low to provide effective dust control in the face of the increased grinding surface-speeds that are in use; it became obvious that our standards had to be changed. Our first thought was that it would be a simple task: Find the accepted grinding speeds in use when the standards were first published and apply a simple formula to determine the increase in Q that would be required. We expended much effort to determine this original relationship and we were unable to find it. Secondly, we thought to apply the traditional fan laws to determine the volume of air set in motion by the wheel and thence the necessary control air volume. One of our committee members spent considerable time on this aspect of the problem and no satisfactory relationship could be found.

Our solution was to compare notes with foundry engineers, to consider our own experiences, to make reference to published data(6) and arrive finally at a practical table of values for increased grinding speeds. Figure 2 from the current 9th edition of the Industrial Ventilation Manual shows the results of our labors. This story illustrates the creation of one standard and thereby the considerations, both theoretical and practical, that enter into these.

Capture and Dilution

This serves as a convenient place to consider another aspect of our standards. In the majority of designs we do not plan to capture all of the material, even of the respirable size, that is released. The majority of industrial ventilation standards



Wheel diam. inches	Wheel width inches	Exhaust volume, cfm	
		Good enclosure*	Poor enclosure
to 9	1-1/2	220	330
over 9 to 16	2	390	600
over 16 to 19	3	500	750
over 19 to 24	4	610	920
over 24 to 30	5	880	1300
over 30 to 36	6	1200	1600

*Hood as shown; or no more than 25% of wheel exposed.
Min. duct velocity = 4500 fpm branch, 3500 fpm main.

Entry loss = 0.65 VP for straight takeoff.
= 0.40 VP for tapered takeoff.

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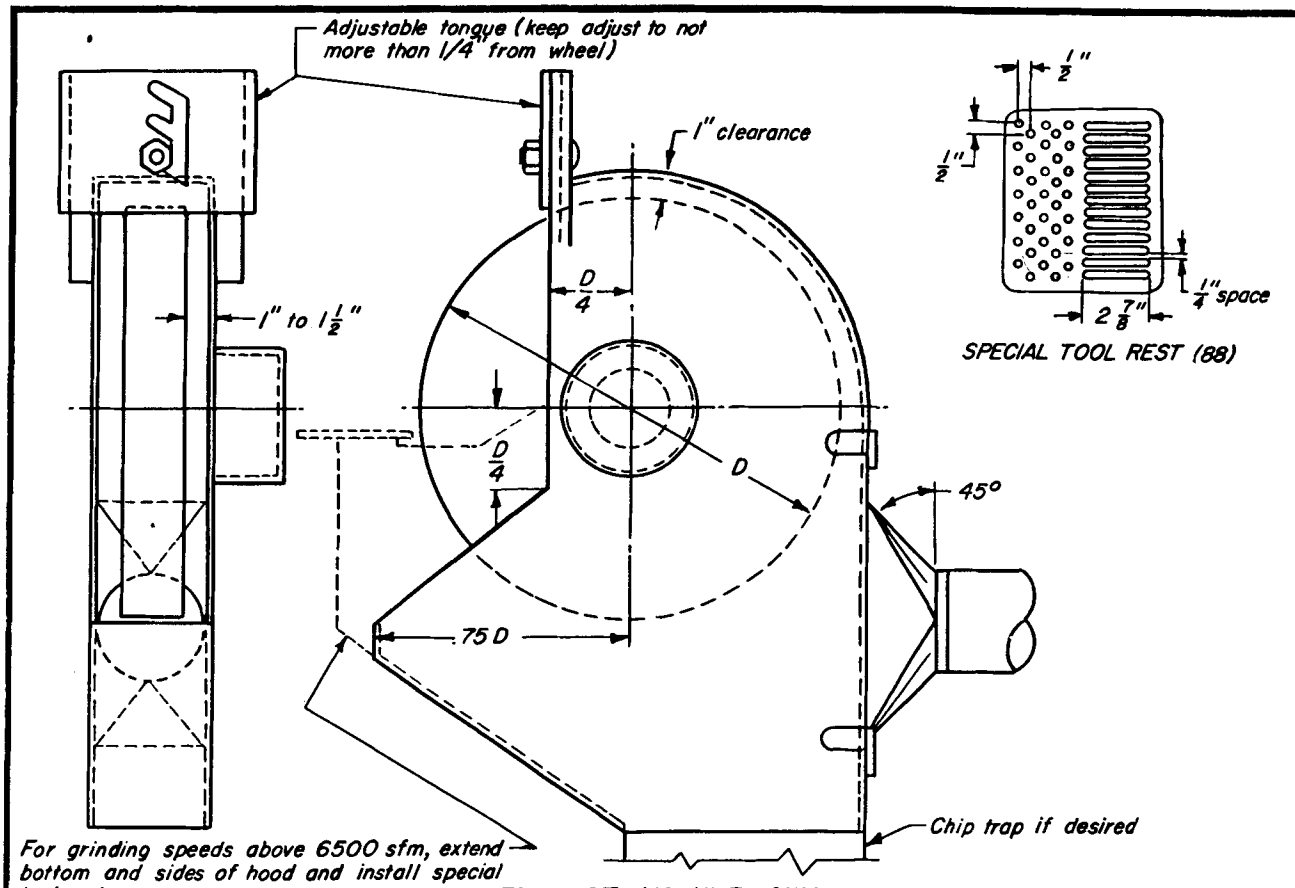
GRINDER WHEEL HOOD

DATE 1-64 | VS-411

Figure 1. Grinder Wheel Hood

(Reproduced with permission from Industrial Ventilation, 8th Ed., A.C.G.I.H.)



EXHAUST VOLUME, CFM

Wheel diam inches	Wheel width inches	Grinding speeds below 6500 sfm		Grinding speeds above 6500 sfm	
		Good encl*	Poor encl	Special hood**	Good encl
to 5	1	220	220	220	390
over 5 to 10	1 1/2	220	300	390	610
over 10 to 14	2	300	500	500	740
over 14 to 16	2	390	610	610	880
over 16 to 20	3	500	740	740	1040
over 20 to 24	4	610	880	880	1200
over 24 to 30	5	880	1200	1200	1570
over 30 to 36	6	1200	1570	1570	1990

* No more than 25% of wheel exposed. ** Special hood enclosure and tool rest.

Minimum duct velocity = 4500 fpm in branch
3500 fpm in main

Entry loss = 0.65 VP for straight takeoff
0.40 VP for tapered takeoff

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

GRINDER WHEEL HOOD

DATE 1-66 | VS-411

Figure 2. Grinder Wheel Hood
(Reproduced with permission from Industrial Ventilation, 9th Ed., A.C.G.I.H.)

in use today are based upon industrial hygiene criteria and are derived directly from the work of industrial hygienists. It is important to recognize this because industrial hygienists are, by and large, practical and reasonable people who are often torn between a desire for maximum control and the practical necessity of keeping ventilation requirements to a minimum. Our basic philosophy is expressed well in the concept of Threshold Limit Values; that total control is not necessary. Man can live and work with certain levels of airborne contamination.

Table 5-5-1

DETERMINATION OF HAZARD POTENTIAL

Hazard Potential	Hygienic Standards		Flash Point (See Appendix)
	Gas and Vapor (See Appendix)	Mist (See Appendix)	
A	0-100 ppm	0-0.1 mg/M^3	Under 100 F.
B	101-500 ppm	0.101-0.5 mg/M^3	100-200 F.
C	Over 500 ppm	Over 0.5 mg/M^3	Over 200 F.

This philosophy is expressed in our ventilation standards nowhere, perhaps, as clearly as in the work of the American Standards Association in the Z9.1 code for open surface tanks.(7) The data shown in Table 5 is that of the American Standards Association as presented in the Industrial Ventilation Manual. Table 5-5-1 illustrates that the first step in selecting a control air volume is to determine the nature of the contaminant based upon its known toxic or flammable properties. A material with a hazard potential of A, such as chromic acid, requires a higher ventilation rate than a material with a hazard potential of C, such as hot water. This data applies the industrial hygiene principle explicitly: We need to capture more of the chromic acid than we do of the hot water.

Table 5-5-2

DETERMINATION OF RATE OF GAS, VAPOR OR MIST EVOLUTION

Rate	Liquid Temperature of	Degrees Below Boiling Point	Relative Evaporation (Time for 100% Evaporation)	Gassing
1	Over 200	0-20	Fast (0-3 hours)	High
2	150-200	21-50	Medium (3-12 hours)	Medium
3	94-149	51-100	Slow (12-50)	Low
4	Under 94	Over 100	Nil (Over 50 hours)	Nil

Table 5-5-2, which is the second step in the ASA method, now considers the nature of the operation with particular respect to the rate at which the contaminant is being released. Thus, to continue our example, chromic acid at room temperature would carry a rating of 1 while hot water would require a rating of 2, taking into account the different rates of evolution. Table 5-5-3 is the next step, in which the hazard potential and physical characteristic are combined to determine an exhaust rate. Chromic acid with a rating of A1 would require a capture velocity of 100 fpm for a lateral exhaust hood. For hot water with its rating of C2, 50 fpm is required.

In the final step of the ASA method (not illustrated) the required capture velocity is related to the physical aspect of the operation, including the shape of the tank and the type of exhaust hood to be applied. The final result is the control air volume per square foot of tank.

The first three steps illustrate the principle involved: For control of these materials we rely not solely upon total capture but rather upon a combination of capture and dilution depending upon the nature of the material and the emission rate.

Table 5-5-3

MINIMUM CONTROL VELOCITY (FPM) FOR UNDISTURBED LOCATIONS

Class (See Tables 5-5-1 and 5-5-2)	Enclosing Hood		Lateral Exhaust (See VS-503-504)	Canopy Hoods	
	One Open Side	Two Open Sides		Three Open Sides	Four Open Sides
A-1,A-2,B-1	75	100	100	125	175
A-3,B-2,C-1	65	90	75	100	150
B-3,C-2	50	75	50	75	125
A-4,B-4,C-3,C-4	ADEQUATE GENERAL ROOM VENTILATION SUFFICIENT				

This ventilation standard cannot be applied without judgment however. For one thing Table 5-5-3 illustrates the minimum control velocity for undisturbed locations; the designer must still determine what correction, if any, is to be applied where cross drafts are encountered.

Another consideration might be termed "condition of use." As indicated, the ASA method relies partially upon dilution; this system works well when control is to be achieved at a number of tanks within an enclosed or segregated plating department. If, however, a single tank is to be located in the middle of an assembly area surrounded by otherwise clean operations partial control would not be satisfactory either to the management or to the workers who might be very apprehensive that a visible plume escaping would contain hazardous materials. In an instance such as this improved capture or total capture would be indicated to provide satisfactory results.

In recent years other standards of a similar nature have been proposed. Under the pressure of an honest desire to reduce exhaust volumes of conditioned air from chemical laboratories, Peterson of the Dow Chemical Company(8) and Brief, et al., of Esso Research and Engineering Company(9) have proposed standards for laboratory hood ventilation.

In the determination of the recommended face velocity Peterson's method accounts for six variables: The toxicity and the volatility of the material within the hood, the effect of air disturbance outside and inside the hood, the characteristics of the hood itself, and the variability of air flow at the face of the hood. The result is a formula that would gladden the heart of any engineer: $V_R=M(1.0+E+C)$.

Peterson's paper provides a complete discussion of the variables affecting laboratory hood design and is recommended for the serious student of both laboratory hoods and standards. Lest anyone be carried away by the beauty of the formula

without reading the paper, let me quote the first paragraph of Peterson's summary: "Variables affecting the performance of laboratory hoods have been combined into an equation for the calculation of specific recommended face velocities for each hood. The equation is strictly empirical and numerical values are assigned to each of the factors on the basis of judgment, coupled with techniques developed for that purpose."

Brief, et al., evaluated laboratory hoods in terms of the same variables: Characteristics of materials handled, conditions of hood usage, and disturbing effects, and proposed three classes of hoods.

1. Class S hoods are recommended for handling highly toxic materials with a Threshold Limit Value of less than .1 part per million or less than .1 milligram per cubic meter. The initial average face velocity should be not less than 150 feet per minute and should not be allowed to decrease below 125 feet per minute.

2. Class A hoods are recommended for materials of moderate to high toxicity with Threshold Limits from .1 to 100 ppm for gases and vapors, .1 to 15 milligrams per cubic meter for fumes, and less than 5 mppcf for dusts. Face velocity should be 100 feet per minute initial average and should not drop below 80 feet per minute.

3. Class B hoods are recommended for essentially non-toxic materials with Threshold Limits greater than 100 parts per million, 15 milligrams per cubic meter and 5 mppcf.

Both of these analyses (Peterson and Brief) take into account the toxicity and characteristics of the material as well as conditions of the operation. Because of the general similarity of laboratory hood design, less attention is paid to the characteristics of the hood but another variable is included in their work: The importance of obtaining uniform velocities of air flow into the hood opening and proper testing and measurement procedures to ascertain that the design goal is met and does not fall off during subsequent use.

One other vital consideration is implicit (in their papers) that is not so obvious: The application of a detailed standard relies not only upon the designer's knowledge of the operation and the materials to be used, his judgment as to the environmental conditions surrounding that use, but also to a very great degree upon adequate supervisory control of the personnel and processes involved. It is obvious, referring to Brief's analysis, that a Class B hood would be totally unsuited for materials of high toxicity; there is nothing in the standards however - or intrinsic to the hood itself - that would prevent such a substitution by an uninformed or careless worker. Both Peterson and Brief represent highly professional industrial hygiene organizations that are capable of a high degree of liaison and effective action with their respective managements. The standards that they propose work well for them. Would they work equally well for all of industry?

The principle of adequate instruction and supervision is not confined only to elaborate standards. We are all acquainted with the difficulties that can be encountered with even a simple exhaust hood arrangement, such as that commonly used for small welding operations. The effectiveness of this hood at any given control volume is dictated by its closeness to the work. Most of us, however, are well

acquainted with plants where the workers have not been instructed properly in the use of these or similar hoods. Hence they are thrown back out of the way and are not able to serve a useful purpose.

Total Control

Many of the difficulties associated with our conventional standards may be eliminated if we set complete capture and removal as our goal.

To achieve total capture we rely either upon total enclosure of the operation or small attached or integral hoods that operate at high entrance velocities and can be tailor-made to the operation.

In a very real sense here we are ignoring the toxicity of the material and basing our design on the predictable aspects of the operation. Through the use of the complete enclosure or the small attached hood we can practically eliminate the workers' responsibility; the ventilation is "built in" and, assuming that the overall design is correct, has a high degree of reliability.

With many materials this approach is dictated by the toxic nature of the material. In other instances a desire for better housekeeping and the difficulty of using standard design methods have shown this technique to be attractive. Aside from the improved capture of material at the operation, savings are possible in terms of total exhaust volume, space required for ductwork and equipment, etc. This idea is not new, of course. Sand blasting rooms and abrasive cleaning cabinets have been controlled by this principle for years. It remains for us to decide whether or not and to what extent we apply the principle of total control to our ventilation designs.

Dilution Ventilation

General ventilation is applied for purposes of diluting the contaminant; unless it is related directly to the nature of the contaminant and the rate of evolution, it cannot be used successfully.

The vast majority of recommended general ventilation rates are totally useless. Based on an air change method of calculation they do not account for the nature of the contaminant, the type of operation or even the nature of the work place.

In recent years there has been a re-evaluation of many of our dilution methods with the resulting restatement of the requirements in terms of cfm per square foot of work area. This method recognizes that it is only the lower 10 to 12 feet of the building that is occupied and that it is the air in this space that must be controlled or changed to affect the working environment. Thus a large volume of the plant can be ignored and the resulting recommendations show lower required volumes of air movement. Inherent in this method, however, is the effective location of both the exhaust and air supply points to insure that the ventilation is well distributed in the lower part of the space. As techniques are improved and proper distribution is recognized we may expect an improvement in our general ventilation standards, primarily for the removal of unwanted heat and nuisance materials.

Application of Standards

From the foregoing it should be apparent that a ventilation standard is not a magic number that can be applied indiscriminately from one location or industrial operation to another; too often, however, this is the pitfall into which we stumble at one time or another.

A ventilation standard must be regarded as a point of beginning and must not be relied upon to provide the final answer for the adequacy of the control to be achieved. In some cases this point of beginning will be a minimum value which requires upgrading to suit individual situations of material toxicity, evolution rate, trajectory, or the environmental conditions of use (disturbances and cross drafts). In other instances the recommended exhaust volume may be needlessly high. This is particularly true when capture of the material is calculated on the basis of available formula for external hoods. Often proper assumptions for capture velocity when related to the size and scope of the operation result in a total exhaust quantity that far exceeds the minimum quantity of air needed for adequate dilution only. In such cases judgment indicates that the air volume can be reduced, the amount of reduction depending upon the toxicity of the material, the amount of enclosure or baffling that can be provided and the location of the worker with respect to the process and the exhaust. Many standards can be used with practically no modification as they have been developed and confirmed by many years of experimentation and technological changes have made no inroads into the equipment type or production rate.

There is no cut and dried method of applying a standard since there can be no cut and dried method of developing standards. It is the responsibility of the designer to understand the principles underlying the type of hood and the capture principles involved so that he can make an intelligent appraisal of the job that is to be done and the best method of doing it.

Future Standards

A final fact influencing the development and application of standards is the rapid technical change in industry, the increase of productive capacity per square foot or cubic foot of space occupied, and the interrelationship of the necessary ventilation control equipment with the process equipment. In short, we are finding a larger number of "non-standard" operations than ever before and it is difficult to apply old techniques to new conditions.

Among the changes that I foresee are the following:

1. An increasing emphasis on the necessity and value of controlled, tempered air supply to the work space not to satisfy merely the demands of the exhaust equipment but to provide a controlled working environment for the people and the machines. This will include increased application of direct air supply to many operations to conserve exhausted quantities of conditioned air and to provide improved worker comfort at hot operations.

2. An extention of the clean room philosophy to more industrial operations and occupancies, relying upon proper control of the air to exclude contaminants at levels below health significance but of importance to the product and the plant or process equipment. An example of this is the trichlorethylene degreaser where present experience shows that quantities of solvent insignificant from the standpoint of health can cause considerable damage to plant and process combustion equipment. Perfection of solvent reclaim equipment will reduce vapor losses through these systems and will provide the necessary economy of operation.

3. An increase in the total control of contaminants through enclosure and low-volume high-velocity exhaust hoods integrated with equipment design.

4. Probably the most important change, I feel, will be a continuing emphasis on the importance of the ventilation engineer in industry. There is a growing awareness that the total volumes of air circulated, removed and supplied for the people and the process justify the employment and utilization of a specialist in this field. In the past 15 years we have seen over 3000 participants at the Annual Industrial Ventilation Conference in Michigan alone; approximately 60 percent of these men are from plant engineering staffs in industry.

Herein lies a challenge and opportunity for all of us, depending upon our ability to work with the ventilation engineer in industry. The industrial hygienist can provide the information and know-how relating to the purpose of the ventilation - the prevention of occupational disease. Further, with his broad experience gained from daily visits to plants of all descriptions, he can suggest the application of the ventilation techniques most likely to succeed. The engineer in industry, "living" with the practical aspects of the problem, can provide the application data and specific design techniques that we need to keep our standards progressing at a pace with technology.

This "feedback" from the industrial ventilation engineer has guided us well in modifying both the Industrial Ventilation Manual and the Industrial Ventilation Conference. Certainly we feel also that we have given much to the engineer - otherwise he wouldn't be "buying" our product. The result, I am certain, is the fulfillment of our primary aim, the prevention of occupational disease. Our second objective, the general improvement of working conditions, is being realized also at a rate that will continue to increase.

Summary

In this paper I have attempted to provide an understanding of our ventilation standards - how they are based and developed. Without such an understanding they cannot be applied properly, because conditions of equipment use in industry vary within such wide limits that no universal, fixed standard can be imagined. Individual judgment can never be replaced by a hard-and-fast formula or a number that happens to be in print.

If we recognize that judgment and experience play a major role in applying our standards we can then recognize that these standards can and must change as technology advances.

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BUSINESS SESSION - May 16, 1966

Bernard D. Bloomfield, Chairman, Presiding

The meeting was convened at 11:00 A.M. by Mr. Bloomfield.

CHAIRMAN BLOOMFIELD: We are now going to start the business session.

The American Conference of Governmental and Industrial Hygienists will now convene.

I wonder if we could all be seated, preferably as close as possible to the front.

As a first order of business, I should like to announce the appointment of a Resolutions Committee to consist of Dr. Lewis Cralley, Howard Kusnetz and Mr. Fred McDermott, and suggest that if anyone has any resolutions, be sure to contact any of these three people, Cralley, McDermott or Kusnetz, and present them with the information so that at the second business session the resolutions can be made.

I should now like to ask the Secretary, Mr. Andy Hosey, for a report.

SECRETARY HOSEY: Mr. Chairman, members of A.C.G.I.H. and guests. The Nominating Committee for 1966 consisted of George Tubich as Chairman, Miss Victoria Trasko, and Ed Baier. The nominees were: Chairman-elect, Mr. Henry N. Doyle, and Dr. Edwin G. Williams; Secretary-Treasurer, Andrew D. Hosey and Howard E. Ayer; and Member-at-Large of the Executive Committee, Benjamin I. Ferber and Dr. Ernest Mastromatteo.

875 ballots were mailed, and 504, or nearly 58 percent were returned.

It is a pleasure to announce at this time that Mr. Henry N. Doyle is the new Chairman-elect, and Dr. Ernest Mastromatteo is the new Member-at-Large for a three-year term. I was re-elected Secretary-Treasurer.

On behalf of the Executive Committee and members of this Conference, I wish to express our deepest appreciation to Drs. Lewis Cralley and Curtis McCammon for their many valuable suggestions and constructive criticisms regarding the operation and functions of this organization. Both of these men retire from the Executive Committee this year.

I am happy to report that the 1965-66 period was another successful year in several respects. Our membership is now 907, an increase of 87 since our last annual meeting. During this year, total assets increased by $6,834.45. Our total net worth is now $40,270.56, compared with $33,436.11 last year. Interest in, and sales of, several of our various publications has continued to increase. Profits from these publications have provided the funds for continued support of our committees and operation of the Conference.

You will be interested to know that to date, 244 copies of the Trade Names Index have been sold. We have more than recovered our investment of nearly $4300 in this revised edition, which became available just prior to the meeting in Houston.

Our supply of the Air Sampling Instruments Manual was sold out before last Christmas, and we are still receiving orders. In fact, this manual is in such demand that we have loaned our only file copy to at least three persons. The Committee on Air Sampling Instruments has been actively engaged in preparing material for the third revised edition, which should be available in the fall of 1966.

As usual, the original supply of 18,000 TLVs were sold out by March, and an additional 2,000 copies were ordered. Profits from the sale of TLV's were $1,208.50.

As usual, TLV sales top the list. Other publication sales were as follows in decreasing quantities: Ventilation Manual, Trade Names Index, Documentation of Threshold Limit Values, Bibliography of Radiation Protection Organizations, Guide for Uniform Industrial Hygiene Codes or Regulations, and Air Sampling Instruments Manual.

Three new publications became available this year -- the 9th edition of the Ventilation Manual, a Guide to Records and Reports for Evaluating Environmental Conditions in Industry, and the revised edition of the Documentation of Threshold Limit Values.

The latter was delivered the last of February, and after filling orders for about 100 copies we discovered, to our embarrassment, that several pages were blank in some books, and in a few others about 10 pages were not printed in correct order. The remaining 900 copies were returned to the printer for a complete check and replacement of those improperly printed. As of March 31st, 160 copies of the 2nd edition have been sold.

These three new publications will be displayed, along with our others, at the A.C.G.I.H. booth.

Most of our 13 standing, 5 ad hoc and 6 joint joint committees with A.I.H.A. have been busy during the year, as you will hear later. Also, A.C.G.I.H. representatives on 13 A.S.A., 2 A.S.T.M., one A.P.H.A. and one Intersociety Committee on Noise Criteria have contributed materially to their activities.

This Conference depends upon these committees for its continued professional growth and for providing information for dissemination to its members and others. Therefore, on behalf of the Executive Committee I express our gratitude to those who have served and worked diligently on these committees.

As all of you know, much time and effort must be spent by many individuals in making arrangements for a Conference, such as the one held here in Pittsburgh. Therefore, A.C.G.I.H. will acknowledge its appreciation to the various Conference Committees in the form of a resolution for their tireless efforts in planning and making arrangements for this meeting. A copy of this resolution will be sent to the chairman of each committee.

I would be remiss if I did not also express my appreciation to other persons involved in the affairs of A.C.G.I.H.

As many of you probably remember, Marlene Schmidt has been my secretary for four years -- ever since Genny Plunkett was first hospitalized in June of 1962. Marlene was quick to learn the office routine and the numerous other details involved in the operation of the Secretary-Treasurer's office, thus relieving me from this responsibility. If it were not for her untiring efforts I would be "bogged down." So, I want to express my appreciation to her for a job well done.

Most of you receive correspondence only from the office of the Secretary-Treasurer during the year, and perhaps you do not realize that the Chairman of this Conference actively participates in its affairs. While serving as Chairman-elect he acts as Program Chairman and must obtain speakers for the next meeting. Then, as Chairman he is called upon for many opinions and decisions during the year. Since many of their activities are seldom known, I want to express our sincere appreciation to all previous Chairmen, and to our present Chairman -- Bernie Bloomfield -- for their interest, support, and the many hours spent for the benefit of this Conference.

Next year the American Industrial Hygiene Conference will be held in Chicago, Illinois, at the Pick-Congress Hotel -- May 1-5. The following year, 1968, we will meet in St. Louis, Missouri, at the Chase-Park Plaza, May 13-17.

This is inserted merely to get it in the record of the transactions.

Mr. Chairman, this concludes the report of the Secretary, and I move that it be adopted.

CHAIRMAN BLOOMFIELD: Is there a second?

...The motion was seconded by Dr. William G. Fredrick and adopted.

CHAIRMAN BLOOMFIELD: Is there any discussion on this? Does anybody want to find out what we do with our money or anything of this sort?

SECRETARY HOSEY: That comes later.

CHAIRMAN BLOOMFIELD: In that case, then, the motion carries. The report is accepted. We heard a report from the Secretary and now I would like to ask the Treasurer to give a report, Mr. Hosey.

SECRETARY HOSEY: The detailed Treasurer's report will appear in the transactions. I think perhaps you would be interested primarily in our total cash receipts for the year, which were $19,313.93, and our total cash disbursements, $12,480.50.

As you probably know, the Ventilation Manual is probably our largest single source of income, and just this morning Jim Barrett was tailing me around to give me a first quarterly check of $585, so this will add to the funds in the treasury.

If anyone desires more detail on the Treasurer's report or has any questions, I would be happy to answer them. Otherwise, the complete thing will be in the transactions, so I move that it be adopted.

...The motion was seconded by Colonel Edward J. Dehne and adopted.

STATEMENT OF FINANCIAL TRANSACTIONS
FISCAL YEAR 4/1/65 to 3/31/66
AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS

Cash Receipts	$	$
Sale of Air Sampling Instruments Manual (published and expensed 1960 and 1962 and reprints)	844.65	
Sale of Analytical Methods (published 1958 and Supplement 1961, expensed 1958, 1961, and 1963)	484.00	
Received from Ventilation Committee from Sale of Ventilation Manuals	4,470.00	
Sale of Guide to Uniform Industrial Hygiene Codes or Regulations and Supplements	23.25	
Sale of Guide to Health Services (published and expensed 1960)	25.00	
Sale of 1965 Transactions	75.00	
Sale of Trade Names Index (published and expensed 1965)	4,956.81	
Sale of Threshold Limit Values for 1965	3,206.73	
Sale of Documentation of Threshold Limit Values (published and expensed 1962 and 1966)	687.00	
Sale of Process Flow Sheets and Air Pollution Controls (published and expensed 1961 and 1964)	48.00	
Sale of Bibliography of Radiation Protection Organizations (published and expensed 1963)	254.00	
Received from Braun-Brumfield (Sale of Respirator Manual - published and expensed 1963)	597.20	
Sale of Plans for Standard Reports	28.50	
Membership Dues	2,014.20	
Share of Profit from 1963 American Industrial Hygiene Conference	630.00	
Sale of Miscellaneous Publications	25.13	
Total		18,369.47
Less: Checks unpaid by banks		38.00
		$18,331.47
Interest Earned - Eagle Savings and Loan Account	$ 461.25	
Interest Earned - Provident Bank Account	270.92	
Interest Earned - PHS Credit Union Account	232.64	
Interest Earned - Mercantile Bldg. & Loan Account	18.75	983.56
Total Cash Receipts		$19,315.03

Cash Disbursements	$	$
Expenses for Secretary-Treasurer to 1965 Conference		363.86
Expenses for Mrs. Schmidt to 1965 Conference		225.05
Miscellaneous 1965 Conference Expenses:		
Banquet	$ 53.89	
Banquet Tickets	4.84	
Honorarium for two Banquet Speakers	100.00	
Stenotypist	137.50	296.23
Miscellaneous 1966 Pre-Conference Expenses		9.77
Printing Costs		
1965 Transactions and Mailing		1,621.67
1965 Threshold Limit Values		1,350.52
1965 Membership Booklet		447.44
Analytical Manual Reprints		93.00
Trade Names Index		4,287.28
Codes		59.71
Principles and Procedures for Developing Experimental Animal Data, etc.		71.58
Miscellaneous Printing		19.25
Stationery, envelopes, etc.		392.67
Committee Meeting Expense		
Threshold Limit Values		497.71
Industrial Hygiene Aspects of Mining		227.09
Occupational Health Nursing		54.72
Executive Committee		814.65
Other Committee Expense		
Plates for Analytical Manual		100.00
Secretarial Expenses for Hyperbaric Environments		20.00
Quartz Grinding for Environmental Factors in the Pneumoconioses		95.28
Office Expenses		
Audit of Treasurer's Report		75.00
Surety Bond for Secretary-Treasurer		62.50
Rebates on Dues and Publications		51.95
Multilithing, addressing, etc., of Bulletin Board and maintenance of addressograph plates		438.76
Postage		589.93

Cash Disbursements (cont.)		$	$
Bank Collection Charges		1.80	
Miscellaneous Office Expenses		199.16	
Copyrights		14.00	
Transfer of Funds to Savings Accounts	($10,000.00)		
Total Cash Disbursements			$ 12,480.58
Excess of Cash Receipts over Cash Disbursements			6,834.45
Add: Balance in Checking Account 4/1/65		$ 14,008.71	
Balance in Savings Accounts 4/1/65		$ 19,427.40	33,436.11
Cash Balance as of 3/31/66			$ 40,270.56

Represented by:

The Provident Bank, Cincinnati, Ohio, Checking Account	10,320.85
The Provident Bank, Cincinnati, Ohio, Savings Account	5,585.82
Eagle Savings & Loan, Cincinnati, Ohio, Savings Account	11,000.00
Cincinnati PHS Federal Credit Union Account	5,345.14
Mercantile Bldg. & Loan, Cincinnati, Ohio, Savings Account	8,018.75
Total	$ 40,270.56

CHAIRMAN BLOOMFIELD: Is there any discussion of this report? Actually, detailed information is available from Mr. Hosey, and, as he indicated, the numbers will be in the transactions.

The next item of business is a report of the Executive Committee. Again, our Secretary Treasurer, who has now covered the secretarial report, the Treasurer's report, will present the report of the Executive Committee.

SECRETARY HOSEY: This is really the meat of the business, and this is going to be a little lengthy.

A mid-year meeting of the Executive Committee was held in Pittsburgh last October following the Industrial Hygiene Foundation meeting, and at this hotel (Penn-Sheraton) last Saturday and Sunday. The following is a brief summary of discussions and actions taken:

1. Plans were finalized for the next annual meeting in Pittsburgh.

2. Discussed the semi-annual report from the Joint AIHA-ACGIH Committee on Respiratory Protective Devices and agreed to the preparation of a supplement to the Manual. Costs and profits to be shared 50-50 with AIHA.

3. Agreed to duplicate and distribute free of charge Dr. Stokinger's paper on "Principles and Procedures for Developing Experimental Animal Data for Threshold Limit Values for Air." (500 copies were reproduced and copies are still available.)

4. The "Proposed Statement on the Use of Threshold Limit Values," prepared by the Joint AIHA-ACGIH ad hoc Committee, was discussed. This statement was returned to the Committee with six suggestions for areas to be included.

5. Discussed and concurred with the recommendations made by Mr. Robert Keenan in his report as A.C.G.I.H. representative on the APHA Intersociety Committee on Methods for Ambient Air Sampling and Analysis. These recommendations were implemented by appointing subcommittees and by requesting the Division of Air Pollution, PHS, to underwrite the cost of this project.

6. The report by Mr. Robert Keenan on the Joint AIHA-ACGIH Direct Reading Gas Detecting Tube Systems was discussed. The Committee drafted a letter to the Surgeon General, PHS, requesting that the Division of Occupational Health establish a program of research and development to prescribe specifications and performance criteria upon which the subsequent provision of an evaluation and performance system could be derived for the certification of these devices. A reply from DOH indicated their desire to undertake such a project, provided adequate funds and personnel could be obtained.

7. A review was made of existing A.C.G.I.H. Committees. Suggestions were made for stimulating activity in some committees. This matter was to be reviewed more thoroughly during the Executive Committee meeting in May 1966.

The following is a summary of matters discussed and actions taken during the Executive Committee meeting held in Pittsburgh, Saturday and Sunday, May 14 and 15, 1966:

The Executive Committee met at the Penn Sheraton Hotel in Pittsburgh May 14 and 15, 1966. Those present were: Drs. Duguid, Cralley, McCammon, and Messrs. Love, Hosey, and Bloomfield. In addition, the recently elected Chairman-elect, Mr. Henry N. Doyle, and the new member of the Executive Committee, Dr. Ernest Mastromatteo, from Canada, met with the Committee. A number of important items were discussed and actions were taken as follows:

1. The Committee agreed to continue our present policy of granting permission to reprint our Threshold Limit Values free of charge except when these Values will be used as a part of advertising. In this case, a royalty of approximately 5¢ per copy would be charged.

2. Herbert H. Jones met with the Executive Committee to discuss the need for establishing a committee on physical agents. After some discussion it was agreed that the ad hoc Committee on Physical Agents would be established with Mr. Jones as the chairman. He will recommend to the Executive Committee additional members for this Committee. The Bill of Particulars for this Committee is as follows: To collect and evaluate existing and proposed standards and criteria involving industrial exposure to physical agents.

3. After considerable discussion, it was agreed that a coordinator of technical committees was definitely needed. The Past Chairman will act as the chairman of this committee and will appoint other members at a later date.

4. The Secretary-Treasurer discussed the need for part-time additional secretarial help, especially prior to and following our annual meetings. The Executive Committee agreed to permit expenditures of $300 to $400 each year for this purpose.

5. At the request of the American Standards Association, a representative from A.C.G.I.H. will be appointed to serve on the ASAZ-117 Committee (safety requirements for working in tanks and confined spaces). The representative will be designated at a later date. (Mr. Peter A. Breysse, University of Washington, was appointed as ACGIH representative.)

6. A lengthy discussion was held on how this Conference could increase an interest in and create an awareness of the need for additional occupational health programs in state and local agencies. Also, the need to strengthen and increase program activities in existing agencies. At the suggestion of Mr. Doyle, it was agreed that he would prepare a proposal outlining the objectives of such an undertaking and submit it to the Executive Committee at a later date for their review and action.

7. The Executive Committee agreed to present the retiring Chairman with a suitable plaque beginning at the next annual meeting. It was further agreed that the retiring Secretary-Treasurer would receive such a gift, also.

8. Two applications for membership were approved, namely, H. C. Sessions and Phillip M. Edwards.

9. Mr. Charles Eason, Assistant Director for State A.E.C. Relations, met with the Executive Committee for over an hour Saturday night to discuss the "Proposed Employer-State- Federal Records and Report Systems for Radiation Workers." The Executive Committee thanked Mr. Eason for discussing this proposal with us, but did not endorse the project. This same subject was discussed Sunday afternoon, during the meeting of the DOH-Directors of State and local programs and Dr. Curtis McCammon expressed his views regarding this proposal. During a later session of the Executive Committee of A.C.G.I.H., it was agreed that Dr. McCammon would prepare a letter addressed to Mr. Eason, expressing our views and concern about this proposal.

Item 10 begins the report of the various Committees. The first is the Committee on Agricultural Health. No report was received. This Committee was abolished last year, and the Chairman was instructed to meet with the Committee on Pesticides of APHA to discuss the formation of a joint committee. An inquiry will be made to determine what action, if any, was taken by the former Chairman of this Committee. Is Paul Caplan here? Does he want to make any comment?

Second, Air Pollution, representatives of this Committee had requested permission to meet with the Executive Committee to discuss plans for future activities. However, no one came to the meeting either Saturday or Sunday. Therefore, the Committee report was accepted and the following individuals were reappointed for a two year term: Messrs. Berghout, Bloomfield, Paganini, and Wunderle.

Incidentally, I think right here, Bernie, we will have to ask for approval of each one or a comment on each one of these Committees to get it in the record, so I move that this report on the Committee of Air Pollution be accepted.

...The motion was seconded by Alan Love and adopted.

REPORT OF COMMITTEE ON AIR POLLUTION

The charge to the committee on Air Pollution was as follows:

"To define the objectives of air pollution control, and develop means to achieve this end, and to investigate and develop air quality standards and emissions levels with particular reference to the process source."

Previous activity of the air pollution committee was concerned with "Process flow sheets."

This charge was circulated to the members of the committee and they were requested to suggest ways and means for approaching our tasks. A few members suggested that the committee continue to develop the process flow sheets; however, no activity occurred in the year on this topic.

There was considerable interest expressed in the assignment with respect to the development of air quality standards. This proved to be a controversial subject with a diversity of opinion among the committee members. At the present time, it is generally agreed that the investigation necessary to develop a standard for community air, required work beyond the capacity of a volunteer committee to perform. The ultimate resolution of this matter seemed to be that the committee could best perform its function by exploring the community air quality criteria that

have been established thus far and review the rationale which led to the adoption of the standard. This subject also raises related questions pertaining to time of exposure, method of sampling, and analytical procedures, which are related to the development of the figures used as the community quality standard.

The next task of the committee seems to be to assemble information on those community air quality standards which have been established and subject them to critical review. Subsequently, it may than develop that a professional organization such as the ACGIH Committee on Air Pollution could criticize the standards which have been established, and suggest alternative standards which might be more appropriate.

No work was done by the committee on emission levels with particular reference to process source. If we are to use the community air quality criteria as a basis for the design of air pollution control efforts, it would seem that the question of criteria for community air quality would of necessity have to be resolved before we could procede with work on emission levels.

It is planned to discuss the findings of the committee at the annual meeting, if information can be obtained in the time between now and then. This activity has been delayed due to a home accident which occurred to the chairman on February 13, 1966. He has been handicapped since that time, and the work on assembling the information about Community Air Quality Criteria has been delayed.

No material for publication is likely to result from the work of this committee this year. Conceivably, if we have sufficient information on Community Air Quality Criteria in time a summary of this data might be appropriately published.

A. It is recommended that the charge to the committee remain substantial as that given to the committee this year. There should be an understanding, however, that the committee can best procede in the manner indicated above.

B. Future committee activities should be directed: first to continue the investigation of Air Quality Criteria; second, after so doing to relate these to emission levels as referenced to the process source, and third, to undertake other activities as determined by a poll of the committee or by direction of the executive committee.

C. It is recommended that the committee be continued to accomplish the above.

It is suggested that the committee be retained substantially as established for the past year. All of the committee members have been contributing to the discussions which have gone on thus far. In view of the limited activity of this committee, it may be desirable to replace the chairman next year. If someone can be found who will devote more energy and time to the assignments, it will be agreeable to the present chairman to step down in order that the committee activities can move forward at a faster rate.

Respectfully submitted,
P. W. Purdom, Chairman

SECRETARY HOSEY: Third, Air Sampling Instruments. Mr. Jones reported that progress is well under way in printing the third edition of the Manual. It was agreed that

the Manual should sell for $10 per copy. The report of the Chairman was accepted and the following individuals were reappointed for a two year period: Messrs. Collins, Davis, Mitchell, and Drs. Hodkinson and Saltzman.

I move that this report be accepted.

...The motion was seconded by Dr. Hervey B. Elkins and adopted.

REPORT OF COMMITTEE ON AIR SAMPLING INSTRUMENTS

The Air Sampling Instruments Committee has been very busy with the preparation of material for the third edition of the Air Sampling Instruments Manual. On September 20, 1965 the Executive Committee gave their approval for the printing of the third edition. The estimated cost of printing 2000 hard-bound copies of the manual is approximately $6300.00. In November the first material was sent to the printer. The last of the material has now gone to the printer and it is estimated that the Manual will be available for distribution by late summer.

The third edition will have approximately 500 pages. It will contain 190 instrument descriptions of which about 50% will be new instruments. There will be one new section on light scattering instruments for particles and one new technical discussion on sampling for microbiological aerosols.

The activities of the Committee for the coming year will be centered around the promotion of the sales of the Manual.

The last copy of the second edition of the Manual was sold in July 1965. The total receipts from the second edition were $13,493.57 with expenses of $7,647.73 which gave a profit of $5,845.84.

Respectfully submitted,
Herbert H. Jones, Chairman

SECRETARY HOSEY: Four, Committee on Awards. The report was accepted and Mr. Lynn Schall was reappointed to serve as Chairman and Dr. Carl Nau was appointed for a two year term to replace Dr. Irma West. You will hear later the presentation of the Annual Award by Mr. Schall. I move that the report be accepted.

...The motion was seconded by Col. Edward H. Dehne and adopted.

REPORT OF COMMITTEE ON AWARDS

1. The Committee was circularized and selected the award recipient, Mr. John C. Soet.

2. Citation for the award is to be prepared under the auspices of the Executive Committee. This should be published in the transactions.

3. For the next year, the following action is recommended:

   A. Preparation and citation of plaque for award recipient.

B. No changes are recommended in the Bill of Particulars of the Committee.

C. The Committee should be continued as is.

Respectfully submitted,
Lynn Schall, Chairman

SECRETARY HOSEY: Five. Epidemiology of Occupational Diseases. No report was received from this Committee. Since this Committee has been inactive for several years, it was agreed to abolish it, and to appoint an ad hoc committee consisting of Dr. Thomas Mancuso, Chairman, and Drs. Clark Cooper and Jean Felton. This committee will be requested to reconsider the mission, Bill of Particulars, and the place of this Committee in A.C.G.I.H.

Mr. Chairman, I move that this report be accepted.

...The motion was seconded by Lyle Cheever and adopted.

SECRETARY HOSEY: Environmental Factors in the Pneumoconioses. The report of the Committee was accepted and it was agreed to publish in our Transactions, papers that were presented by members of this Committee during the A.C.G.I.H. round table discussions held on Sunday, May 15. The following persons were reappointed to serve two year terms: Messrs. Coleman, Olortegui, and Dr. Stan Roach.

Mr. Chairman, I move that this report be accepted.

...The motion was seconded by Dr. Curtis McCammon and adopted.

REPORT OF COMMITTEE ON ENVIRONMENTAL FACTORS IN THE PNEUMOCONIOSES

1. Activity during the year:

A major recommendation of the Executive Committee at the 1965 conference was that this Committee work with representatives of AIHA to consider uniform methods in dust counting. A joint committee was subsequently appointed: those to represent this Committee and ACGIH were appointed by Mr. Bloomfield; those to represent AIHA were appointed by Mr. Vincent Castrop, President of AIHA. Those appointed and accepting appointment for the joint committee are:

ACGIH	AIHA
Howard Ayer	David M. Anderson
E. J. Baier	Howard Bumsted
Irving Davis	Kathleen Kumler
S. A. Roach	William Smith

Chairman: Robert L. Harris, Jr.

This Joint Committee has met two times. Work of the Committee is reported in another memorandum to the Executive Committee and to the AIHA.

In addition to work in the Joint Committee, this Committee has sponsored inquiry into sampling and analysis for composition of dust and has circulated referee samples to cooperating laboratories for free silica analysis. A panel reporting this and other aspects of the Committee work is scheduled for presentation during the Engineers Round Table the afternoon of May 15. The panel of committee members will be:

Introduction - Robert L. Harris, Jr.
Dust Counting Problems - Howard E. Ayer
Free Silica Determination - E. J. Baier
Sampling Strategy - S. A. Roach
Summary - Robert L. Harris

The Chairman and two members of the Committee attended the British Occupational Hygiene Society, Second International Symposium on Inhaled Particles and Vapors, Cambridge, England. A large number of papers presented dealt with pulmonary deposition and retention of inhaled particles, a topic of vital interest to this Committee. Members present met with Dr. H. E. Stokinger, Chairman, Threshold Limits Committee on the common interest of the two committees in sampling for interpretation by threshold limit values.

2. Materials for publication or dissemination to the membership:

Papers presented in the Panel may be offered to the Transactions or to other media for publication as may be agreed by the authors and the ACGIH.

3. Recommendations by the Committee to the Executive Committee:

a. Actions required by the Executive Committee - none

b. Future Committee activity - The Committee is scheduled to meet at the American Industrial Hygiene Conference on May 17, 1966. It is expected that the Committee will continue its participation in the ACGIH-AIHA Joint Committee on Uniform Methods for Dust Counting and in exploring the areas prescribed by its Bill of Particulars.

c. Continuation of the Committee - It is recommended that the Committee be continued.

4. Suggestions for Committee membership - It is recommended that the current 1965-66 membership be continued. The current Chairman will be pleased to continue in membership in the Committee, but will be pleased also to relinquish Chairmanship to another Committee member more closely involved in the practice of industrial hygiene.

Respectfully submitted,
Robert L. Harris, Jr., Chairman

Addressees:

H. E. Ayer
W. O. Bianconi
A. L. Coleman
I. H. Davis
P. P. Olortegui
S. A. Roach

SECRETARY HOSEY: Seven, Industrial Hygiene Codes and Regulations. The report of the Committee was accepted and it was agreed that Mr. Berghout should contact the National Fire Protection Association in an attempt to coordinate the A.C.G.I.H. Guide on Dry Cleaning with the NFPA Code. It was also agreed that this Committee should proceed along the lines outlined in Item 3b of their report. Mr. Fred Berghout was appointed to serve as Chairman for a two year period and Messrs. Baier, Burgess, and Burk were also appointed to serve for two year terms. Mr. George Sprague and William Palmisano were appointed for two year terms to replace Mr. Robert Harris and Mr. Louis Prouix, who resigned.

Mr. Chairman, I move that this report be accepted unless Fred has some comment. No comment?

...The motion was seconded by Fred McDermott and adopted.

REPORT OF COMMITTEE ON INDUSTRIAL HYGIENE CODES AND REGULATIONS

1. The primary Committee activity this past year was taken up with composing a guide on lasers. The second draft is in course of review and editing by the Committee members. It will be submitted for wider review when it is in a form acceptable to the Committee as a whole. The secondary Committee activity consisted of review by one member of the Guide for Dry Cleaning for the purpose of revising it.

2. There are no proposed guides ready for publication or dissemination.

3. Recommendations by the Committee are as follows:

a. One proposal for possible action to be taken by the Executive Committee concerns the coordination of the Dry Cleaning Guide with the National Fire Protection Association. The US Army Environmental Hygiene Agency has had considerable experience with the coordination of military and federal specifications from the health standpoint and has run into difficulty getting acceptance of the ACGIH Guide for Dry Cleaning. A statement on this subject is appended. The problem is therefore referred to the Executive Committee for action.

b. The primary activity of the Committee will be to complete the present work on the guide for lasers. Development of standards for non-ionizing radiation is the suggestion of one Committee member. Another member feels that: "the Executive Committee and the Membership should be requested to submit suggestions for this Committee." All published guides probably need to be reconsidered in the light of possible acceptance by military and federal specification writers.

c. The membership of this Committee is in favor of continuing the Committee.

4. Members of the present Committee plus William Palmisano, US Army Environmental Hygiene Agency, Edgewood Arsenal, Md comprise the suggested list of Committee Members for the coming year. The present Chairman is willing to continue serving in this capacity.

Respectfully submitted,
C. F. Berghout, Chairman

APPENDIX

In the development of Federal Specifications for dry cleaning equipment procurement authorities use standards recommended by the National Fire Protection Association (NFBU No. 32 and/or NFPA No. 32). Up to the present time the procurement authorities have not looked favorably upon citing the ACGIH Guide for Dry Cleaning in specifications in addition to the National Fire Protection Association recommended standard. The reason for this presumably stems from the fact that there is a great deal in the two separate documents which is repetitious plus the fact that the NFPA standard is regarded to be more complete and definitive with reference to the equipment per se whereas the ACGIH Guide is assumed to relate to the overall installation rather than the equipment. There is one important difference between the two documents that should be recognized, namely that the NFPA standards are based on the lower explosive limit as a criterian for safety whereas the ACGIH Guide is based on the threshold limit value as a criterian for health. If mention were made in the NFPA and NFBU standards of this difference there would be sufficient reason for specification writers to add the ACGIH Guide to the list of references cited. It is therefore recommended that the Executive Committee and perhaps the membership explore means whereby the necessary changes could be made in the safety standards to point up their limitations as to health and thereby gain acceptance for the ACGIH Guide in federal and military specifications.

SECRETARY HOSEY: Industrial Hygiene Records and Reports. The report of the Committee was accepted. The Committee has published a "Guide to Records and Reports for Evaluating Environmental Conditions in Industry." This Guide is available from the office of the Secretary-Treasurer for $1.50 per copy. Dr. R. B. Sutherland, from Canada, was appointed to a two year term to replace Mr. Albert Abrahams. Mr. Stan Reno was appointed for a two year term to replace Mr. Jacoe.

I move that this report be accepted.

...The motion was seconded by Fred McDermott and adopted.

REPORT OF COMMITTEE ON INDUSTRIAL HYGIENE RECORDS AND REPORTS

A "Guide to Records and Reports for Evaluating Environmental Conditions in Industry" was completed by the 1964-65 Committee under the chairmanship of Dr. Robert H. Duguid. This Guide, which was approved by the Executive Committee during the Houston Conference, is the major accomplishment of the Committee on Industrial Hygiene Records and Reports over the past several years and represents the combined efforts of the various committee members serving during its preparation.

The present Committee, therefore, has been confronted with the task of developing new ideas and possible new approaches to the problems of industrial hygiene records and reports which are not encompassed in this Guide. We must state frankly that we have finalized nothing of this nature for submission to the Conference at this meeting.

This does not mean, however, that your Committee has been inactive. We have carried on considerable correspondence concerning the following projects which have been suggested by members and which are under current consideration for further development.

1. A form for the lifetime record of hazardous exposures to individual employees, similar to the Atomic Energy Comission's lifetime exposure record.

2. A compilation of forms as used by various agencies for evaluation of specific contaminants.

3. An alternative evaluation form for use in the Guide, when revised.

4. A questionnaire designed to elicit information and comments from recipients of reports of industrial hygiene surveys submitted to industrial plants.

It is suggested that all present members of the Committee be reappointed. The current Chairman will serve during the coming year if this meets with the approval of the Executive Committee.

Respectfully submitted,
Philip C. Hill, Chairman

SECRETARY HOSEY: Industrial Ventilation. The report of the Committee was accepted. The 9th edition of the Ventilation Manual is available from the Committee. Mr. Jose Beltran and David Bonn, Jerry Lynch, and Robert Wolle were reappointed for two year terms. Messrs. Lumsden and Feiner asked to be relieved from this Committee and they were replaced by Messrs. Richard Hibbard and Irving Kingsley.

I move that the report be accepted unless Jim Barrett wants to make a comment. I already told you he gave us a check for $585 this morning.

...The motion was seconded by Marvin Schuman and adopted.

REPORT OF COMMITTEE ON INDUSTRIAL VENTILATION

The Committee on Industrial Ventilation had another busy year. All members contributed to the material for the 9th Edition of the Industrial Ventilation Manual which was received from the publisher in February; at the same time the sales of the Manual continued at a high level, making fiscal year 1965-1966 the third best in our history; this was in spite of the fact that for a two week period in January and February we were completely out of books. Coming on the heels of an all-time record sales in the previous fiscal year, this indicates the wide acceptance of the Manual.

The Manual continues as the basic text for the Industrial Ventilation Conferences held annually in East Lansing, Michigan; Raleigh, North Carolina; and Seattle, Washington. One of the many advantages of this situation is that we are able to keep in contact with experienced ventilation engineers and are able, therefore, to obtain the necessary "feed-back" of information to maintain the Manual as an up-to-date, practical publication. A second advantage, obviously, is the stimulus to sales and distribution that is provided by placing the Manual in the hands of these people who are in the field designing ventilation systems. The Manual continued as a basic reference in many universities and libraries and is quoted throughout the world.

The Manual is, in short, the most popular and successful book in its field and reference to its performance record over the past several years bears this out: Through our first ten years of publication we distributed 25,577 Manuals with a return to the Conference of $22,541.28; in the five years just completed our sales have now risen to a total of 45,613 Manuals with a total return to the Conference of $44,832.36. A glance at these figures will show that sales and returns have practically doubled in the past five years. We cannot predict how long this favorable situation will be maintained but we can promise to the Conference that the Committee on Industrial Ventilation will continue to be a working group, energetic and enthusiastic in the editing and distributing of the Manual.

Attached to this report is a certified audit of our Committee accounts for 1965-1966 and we trust that the members will be satisfied that we are attempting to do our best to discharge our Committee responsibility. We hope also that each member of the Conference will not hesitate to forward to us suggestions and constructive criticisms of the book so that we can continue in our efforts to make it the best possible publication in its field.

Respectfully submitted,
James C. Barrett, Chairman

April 9, 1966

Mrs. Arlyn Donovan, Secretary
Committee on Industrial Ventilation
P. O. Box 543
Lansing, Michigan

Dear Mrs. Donovan:

I have completed my audit of the Statements of Assets, Liabilities and Net Worth as of March 31, 1966, and of Income and Expenses for the year ended March 31, 1966, in accordance with generally accepted auditing standards. The bookkeeping was quite accurate and no major adjusting entries were necessary.

In my opinion the accompanying statements of Assets, Liabilities and Net Worth as of March 31, 1966, and of Income and Expenses for the year then ended present fairly the financial condition and the results of the operations on the basis of cash receipts and disbursements adjusted at the year end for accounts receivable, inventory, and major accounts payable on a basis consistent with the preceding year.

Respectfully submitted,

Charles Lawrence
Certified Public Accountant

COMMITTEE ON INDUSTRIAL VENTILATION
American Conference of Governmental Industrial Hygienists

Statement of Assets, Liabilities and Net Worth - March 31, 1966

Assets

Cash:		
Cash in bank	$ 3,607.59	
Savings Account	2,231.35	
Total		$ 5,838.94
Accounts Receivable:		
Current	726.50	
Over 30 days	1,093.35	
Total		1,819.85
Inventory:		
Paper bound	3,680.64	
Cloth bound	244.50	
Calculation sheets	75.00	
Packing materials	133.00	4,133.14
TOTAL ASSETS		$ 11,791.93

Liabilities and Net Worth

Sales and Withholding Taxes Payable		$ 198.67
Net Worth:		
Balance, April 1, 1965	$10,555.13	
Increase for the year	1,038.13	
Total		11,593.26
TOTAL LIABILITIES AND NET WORTH		$ 11,791.93

COMMITTEE ON INDUSTRIAL VENTILATION
American Conference of Governmental Industrial Hygienists

Statement of Income and Expense for the Year Ended March 31, 1966

Sales of "Industrial Ventilation" and calculation sheets		$ 14,985.32
Cost of Materials sold		5,895.29
Gross Margin		9,090.03
Expenses:		
Secretarial	$1,989.74	
Advertising	90.85	
Postage	682.83	
Committee expense	412.04	
Office Supplies and expense	253.59	
Sales tax	16.00	
Accounting and other contractural services	100.00	
Refunds	108.08	
Bad accounts written off	16.00	3,669.13
Balance		5,420.90
Other Income:		
Interest on savings account		87.23
Total		5,508.13
Submitted to ACGIH		4,470.00
Increase in Net Worth		$ 1,038.13

SECRETARY HOSEY: No. 10 is the Committee on Ionizing Radiation. The report of the Committee was accepted and it was agreed to print the Forms on "The Inspection of Radionuclide Users" in the 1966 Transactions and to make an over-run of 250 copies for free distribution to official agencies upon request. Dr. Moeller asked to be relieved from the Committee and Mr. Ronald E. Bales was reappointed for a two-year term and will serve as Chairman. Also reappointed for two-year terms were Messrs. Cheever, Coleman, Gerusky, Lieberman, Vaden, and Dr. Ed Williams.

I move the report be accepted.

...The motion was seconded by Dr. Ernest Mastromatteo and adopted.

REPORT OF COMMITTEE ON IONIZING RADIATION

The major activity of the Committee on Ionizing Radiation this year was the completion and field evaluation of a suggested format for recording information on "The Inspection of Radionuclide Users." In pursuing this task, the Committee sought to develop a form which would:

1. Provide guidelines to State and local health department personnel responsible for such inspections;

2. Assure that industrial hygiene personnel gather all the necessary information to evaluate whether a given installation meets radiation protection regulations;

3. Permit the ready retrieval of statistical data concerning the radionuclide installations in a given area.

In developing the forms, the Committee made liberal use of a number of similar documents which had been prepared by State and local health department personnel. In addition, the Committee relied heavily on the various Handbooks of the National Council of Radiation Protection and Measurements as reference material. As finally evolved, two sets of forms resulted. One, a "Short Form," which represents the minimum data necessary for a rapid assessment of the status of an installation; the second, a "Long Form," which is designed for a more thorough evaluation and is recommended for use in all cases where budget and personnel permit. (See pages 226-235 for forms)

Through the cooperation of industrial hygienists in several of the State Health Departments, as well as in government and private laboratories, earlier versions of the forms were field tested and the resulting comments and criticisms used in the preparation of a final copy. Supported by these reviews and the unanimous approval of the members of the Committee, itself, the forms were submitted at the end of the year to the ACGIH Executive Committee for approval.

Respectfully submitted,
Dade W. Moeller, Chairman

SECRETARY HOSEY: The Committee on Legislation. There was no activity during the year and the Chairman, Howard L. Kusnetz, tendered his resignation. The Executive Committee agreed that this Committee should be continued for at least another year, and Miss Victoria Trasko will be asked to serve as Chairman.

I move that the report be accepted.

... The motion was seconded by Dr. Lewis Cralley and adopted.

SECRETARY HOSEY: No. 12, Recommended Analytical Methods. I received this report from the Committee this morning by way of telephone when I was trying to get up to the meeting, so it came in after our Executive Committee meeting met, but I will discuss it and relay the information given to me by the Chairman, Mr. Monkman.

He reported that the methods for iron, mercaptans, benzene, and toluene will be ready for publication by June 30. The Committee is working on methods for selenium, phenols, and fluorides. Mr. Monkman will continue as Chairman, and all members who were appointed in 1964 need to be reappointed now.

I don't know how we handle this on protocol. I think we have a quorum of the Executive Committee. Will the Executive Committee approve this report? Okay. The Executive Committee approves it, so now I move that the report be accepted by the Conference. How's that?

...The motion was seconded by Fred McDermott and adopted.

SECRETARY HOSEY: The next one is Standard Labeling Procedures. The Chairman of this Committee, Mr. John Soet, recommended that this Committee be discontinued for the present time, but that it be reactivated at a future date if necessary. The Executive Committee agreed to abolish this Committee.

I move that the report be accepted.

...The motion was seconded by James Barrett and adopted.

REPORT OF COMMITTEE ON STANDARD LABELING PROCEDURES

In previous committee reports it was pointed out that little further work could be done by the committee after preparing the Guide to Rules and Regulations for the Labeling of Hazardous Materials. No progress has been made on the labeling of industrial materials either on federal or state levels. The chairman of this committee feels that this committee should be discontinued and reactivated if it appears that there may be some consideration by the federal government or states to label materials used by industry.

Respectfully submitted,
John C. Soet, Chairman

SECRETARY HOSEY: Now we come to the item that took considerable time on the part of the Executive Committee, namely, the report of the Committee on Threshold Limit Values, and I am glad to see that Dr. Herbert Stokinger, the Chairman, is here, because he may have some comment to make.

Anyway, as usual, the discussion of this Committee's report was lengthy. The report of the Committee dated March 31 was accepted. A list of Tentative Values recommended for 1966 was accepted. Copies of these were made available to those present at this

meeting. In a supplemental report Dr. Stokinger and his Committee recommended that the following substances be transferred from the Tentative Limits to the Recommended list: anisidine, benzoyl peroxide, Carbaryl, cotton dust, dichlorodimethylhydantoin, cyclopentadiene, dimethyiformamide, di-sec, octyl phthalate, hexachloroethane, hydrogen sulphide, L.P.G., methylacetylene, methyl mercaptan, methyl methacrylate, morpholine, naphthalene, nickel, nitric acid, p-nitrochlorobenzene, nitrogen trifluoride, oxygen difluoride, p-phenylene-diamine, phosgene, phthalic anhydride, propane, selenium compounds, silver, tetrachlorodifluorethane, and yttrium. Maleic anhydride, and methylamine will remain on the Tentative list. The Executive Committee agreed to those changes. The Executive Committee agreed that all documentations prepared since the second edition of the Documentation of Threshold Limit Values will be printed in the 1966 Transactions. The TLV Committee recommended, and the Executive Committee concurred, with minor changes, to revise the second sentence under Legislative Action, on page 5 of the 1965 list, as follows: If however, the list is so used the intent of the concepts contained in the Preface should be maintained and provisions should be made to keep the list current. The TLV Committee recommended, and the Executive concurred, with minor changes, that the statement explaining Tentative Values on page 17 of the 1965 list, be revised as follows: These substances, with their corresponding Tentative Limits, comprise those for which a Limit has been assigned for the first time or for which a change in the "Recommended" listing has been made. Documentation for Tentative Values are available for each of these substances. In both cases, the assigned limits will remain in the Tentative listing for a period of at least two years, during which time definitive evidence and experience is sought. If acceptable at the end of two years, these substances and Values will be transferred to the Recommended list. The Threshold Limit Values Committee, during its meeting on April 18 and 19, and the Executive Committee, during its meetings on May 14 and 15, discussed at length the conclusions and recommendations of the Committee on Industrial Hygiene of the Industrial Medical Association, prepared by Dr. H. H. Golz, Chairman. A reply will be forthcoming; however, the Tentative Limits will not be removed from the TLV list and published elsewhere as a notice of intent. However, in order to indicate that Tentative Limits are included, in our publication, and to reduce the possibility that the Tentative Limits will be adopted by some agencies as legal standards, the cover page to our annual list will be modified to show in smaller letters, under the date, the following statement in parentheses: Tentative Values Are Included. The following were reappointed to serve two-year terms on this Committee: Ed Baier, Dr. William Fredrick, Mr. Bernard Grabois, Dr. Paul Gross, Dr. Wayland Hayes, Dr. Harold MacFarland (consultant), Dr. Ernesto Mastromatteo, Dr. Ralph Smith, Dr. George Wright (consultant) and Dr. Mitchell Zavon. Mr. Fred McDermott was appointed to a two year term to replace Russel Scovill, and Mr. William Wagner was appointed to serve a two-year term.

I move that this report be accepted. Do you wish to elaborate on some of this, Dr. Stokinger?

DR. STOKINGER: I just want to make one important change to these Tentative Value changes here. You will notice on this page beside the EGDN plus nitro-glycerin limit, it is changed now, as listed, to two hundredths of a part per million. This should bear an asterisk here, and the asterisk is a planetary to this extent. It is for intermittent exposures only. In other words, the old level of 10 fold values still holds, when the exposure is five days a week, eight hours a day, but due to the nature of the response to these particular nitro-compounds the limit, on an intermittent basis, is indicated.

SECRETARY HOSEY: And, incidentally, there was one typographical error, at least, that I caught on that. "Chromic" instead of "chronic," up at the top.

MR. SOET: Does it go lower for the intermittent basis?

DR. STOKINGER: Yes, lower. The figure above is the former continuous exposure during the week.

MR. SOET: It doesn't make sense.

DR. STOKINGER: Yes, it does.

MR. SOET: Does it go lower for an intermittent basis than for a steady basis?

DR. STOKINGER: Yes, because the response is regulated by the nature of the exposure, and if you have an intermittent exposure, you tend to get exacerbations accrued during the time you are not exposed, whereas you get endurance to the response of continuous 8-hour day, five days a week.

MR. SOET: Plant Managers are going to expose them steadily.

CHAIRMAN BLOOMFIELD: How was this explained, Herb? Was it just simply by the asterisk notation?

DR. STOKINGER: Yes. We will put it in there.

CHAIRMAN BLOOMFIELD: Is there any possibility of adding a few words so that it doesn't leave people automatically thinking there has been a mistake?

DR. STOKINGER: No, I think this will be explained in the Justifications which will be printed in the Transactions.

CHAIRMAN BLOOMFIELD: In the Transactions, all right.

...The motion was seconded by Miss Donovan and adopted.

REPORT OF COMMITTEE ON THRESHOLD LIMIT VALUES

The first meeting of the Plenary Committee of FY '66 was held in Washington on November 15 and 16, 1965. Two members, Drs. Wright and Zavon, were absent. Mr. William D. Wagner acted as Recording Secretary. Developed at this meeting was the Notice of Intent, now adopted as an annual feature of the Committee's activities to indicate to interested individuals those changes and additions to the current list of those substances under consideration by the Committee. As far as possible, numbers are placed against each of the suggested substances in an effort to draw out from industrial sources supporting information for a new limit. Twelve substances for revision, and 31 substances for addition were included in the Notice of Intent for 1966. At the year's end (1965) the Notice was sent for distribution to the members of the American Industrial Hygiene Association, ACGIH, and the Manufacturing Chemists' Association.

During the year a considerable amount of outside static developed in regard to the activities of the TL Committee. The first development occurred in Pittsburgh at a meeting called by Dr. deTreville of the Industrial Hygiene Foundation, at which, in the presence of representatives from more than 50 industries sponsoring the Industrial Hygiene Foundation, the Chairman was asked to discuss the subject, "Industrial Contributions to Setting Threshold Limit Values." The following day was spent presenting the documentation for the intended changes in the 1966 TLVs. The main outcome of this meeting, in addition to informing industrial representatives more closely of the activities of the Threshold Limits Committee, was that a proposal was made that the Industrial Hygiene Foundation serve as the anonymous repository of information that would be of help in developing TLVs. The resources of the Foundation were to be used to develop this information in the necessary number of copies for the Committee members.

A second form of static was recently heard from the Committee on Industrial Hygiene and Clinical Toxicology of the Industrial Medical Association, through its chairman and member, Drs. Golz and Roush. A report, developed by this Committee by direction of the Board of Directors of IMA, led to certain conclusions and recommendations that were discussed recently with the Chairman and Secretary of the TLV Committee in a review of the IMA Report. A copy has been made of the conclusions and recommendations for the Secretary-Treasurer of ACGIH and for TLV members, for consideration at the forthcoming meeting in Washington April 18 and 19. In addition to the offer of the IMA to act as an anonymous repository of information of use to the TLV Committee, a major recommendation was that the Tentative listings be removed from the annual recommended list and be placed separately in the Notice of Intent, thus affording industry a 2-year period in which to develop information without formal publication of the tentative changes.

During the year, publication of the Documentation of the Threshold Limits has appeared as a Revised Edition of the 1962 publication dated 1966, 203 pages. During the year also, "Principles & Procedures for Developing Experimental Animal Data for Threshold Limit Values for Air" appeared, (13 pages).

During the year also, a number of the Committee members spoke on the subject of threshold limits before various groups.

Respectfully submitted,
Herbert E. Stokinger, Chairman

SECRETARY HOSEY: The next report, Trade Names Index. The report of the Committee was accepted and the Committee was requested to continue the collection of Trade Name information and to determine the cost of publishing a supplement. The Executive Committee was in general agreement that a supplement should be published when approximately 500 new Trade Name products have been obtained provided the cost of publishing this information is reasonable. Mr. Morill was reappointed for a two year term as Chairman, and Messrs. Fulwiler, Greenberg, Levadie, and Rosati were also appointed for two year terms. The Executive Committee proposed the following Bill of Particulars: To collect and disseminate, in an appropriate publication, information concerning composition of Trade Name products used in industry.

I move that the report be accepted.

...The motion was seconded by Dr. Ralph Sullivan and carried.

REPORT OF COMMITTEE ON TRADE NAMES INDEX

The Trade Names Index, 1964 (Revised Edition) was received from the publisher in May 1965. A letter was sent by the Committee to all official governmental industrial hygiene agencies announcing the availability of the Index at the purchase price of $20 per copy including prepaid postage. In addition a letter was sent to the National Clearinghouse for Poison Control Centers, Washington, D.C. This organization in turn informed all the Poison Control Centers in the United States that they were eligible to purchase this Index. An announcement as to the availability of the Index was made to the entire membership in one of the Secretary-Treasurer's "Bulletin Board." As a result of this extensive publicity, 266 copies have been sold as of March 1, 1966. The original printing order was for 300 copies at a cost of $4287.28, thus making the sale of 220 copies the "breakeven" point, which was accomplished in about five months after notice was given that the Index was available. There have been many verbal and some written comments to the Committee for a "job well done." The Committee appreciates all the contributions made by the various governmental industrial hygiene agencies.

In December 1965, a letter was sent by the Committee to all the official agencies again requesting their cooperation to submit trade name product data on new items not previously included in this latest edition of the Index. A few of the agencies have already responded by providing the Committee with data for about 150 new trade names products. We anticipate more will be received as soon as clerical work can be accomplished by the respective agencies. One state agency has forwarded to the Committee the names of trade name products along with the complete mailing address of the manufacturer. However, chemical data was not included as it was considered to be confidential. The agency suggested that the Committee attempt to obtain directly the chemical composition data from the companies. A letter has been sent by the Committee to each of these companies. This suggestion was good and possibly other official industrial hygiene agencies who have similarly obtained confidential information could provide the Committee with trade name product names and the name and address of the manufacturer so the Committee could query these companies.

In this regard, one agency has given a suggestion to the Committee as to how trade name product data may be obtained without precommitting one to treat the information furnished as confidential. Of course if a company did request in their reply that such information provided should be treated as "confidential in nature" then the agency would and should do so. The following has been suggested as a means of requesting product data from a manufacturer:

> "Gentlemen: We have a need to render an opinion concerning any harmful effects to health which could arise from the use of your product: '_____.' In order that we may render our opinion on a firm basis and in fairness to the product and to the user it is necessary for us to know the chemical makeup of this product. We shall appreciate it greatly if you would send us information on its chemical composition. Your cooperation in this matter will be most helpful."

Such a similarly worded letter may bring satisfactory results and not precommit one to keep the information confidential.

The Committee will continue to compile and maintain a file on new product data. Any agency having a need for product data should direct their request to the Chairman of the Trade Names Index Committee, ACGIH, 1014 Broadway, Cincinnati, Ohio 45202.

The Committee would appreciate guidelines from the Executive Committee as to the advisability of a supplemental Index in 1966 to the 1964 revised addition, assuming the Committee receives data for a minimum of 500 new trade name products. If periodic supplements are not to be published, the data will become quite old when finally published in a new or another revised edition.

Are there any suggestions from the Executive Committee for future activities of our Committee? Should the Committee be continued? Are its efforts worthwhile or should this activity be abolished?

Respectfully submitted,
E. Elbridge Morrill, Jr., Chairman

SECRETARY HOSEY: Now we have a number of ad hoc Committee reports. The first is the one on Hyperbaric Environments. The report of this Committee was accepted, but it was agreed that it should remain an ad hoc committee for another year. The Chairman will be requested to continue their present studies and to prepare a Bill of Particulars stating the objectives of this Committee.

Is Fred Hertlein here? Does he want to say anything? If not, I move that it be accepted.

...The motion was seconded by Dr. Curtis McCammon and adopted.

REPORT OF AD HOC COMMITTEE ON HYPERBARIC ENVIRONMENTS

The Committee has very little to report in the way of coordinated activity for the past year. Committee members have nevertheless been active in their respective localities by updating regulations concerned with compressed air work, examining air samples periodically from tunnel jobs, and keeping well-informed on "saturation dives" conducted by various experimental diving groups. The proceedings of the International Working Party on Decompression in Civil Engineering Work were also obtained and carefully reviewed. In addition, we are maintaining a current, up-to-date file on Hyperbaric Oxygenation.

Representatives from the United States, the Federal Republic of Germany, Great Britain, the Netherlands, France, Japan, Hungary, Canada, and Italy attended this International Working Party during October, 1965. The basis of each country's decompression schedule was presented as well as results obtained from its use. Bends rates were given in addition to the frequencies of aseptic necrosis of bones in compressed air workers. It is clear from these presentations that there is much need of improvement in decompression schedules of all countries.

Limited studies from Holland indicate the prevalence of bone necrosis is higher in the shoulder than in the pelvis. These same limited studies also reveal that bone infarcts can be experienced even though the worker has never suffered from

decompression sickness. The British representative stated that etiology of bone necrosis is still obscure and these lesions cannot always be detected by radiography. Since the investigation of bone necrosis is an extremely difficult problem there is to date no effective means of prevention of bone lesions.

The Hungarian representative indicated that the central nervous system displays great vulnerability in decompression sickness. It may be damaged, not only in cases of manifest caisson disease of neurological form, but very often without clinical neurological signs and symptoms or without any mark of decompression sickness at all. Blood tests show no advantage in the diagnosis of decompression sickness over clinical examination but there may be some prognostic value in specific cases.

Prior to 1961 all U. S. standards for work in compressed air specified a divided shift with an interval in free air. These are often referred to as "New York Standards" or "Split Shift Standards." These standards did not provide for an increase in decompression time following the second half of the split shift to compensate for the residual nitrogen incidental to the first half of the shift. Permanent partial disability claims for bone necrosis were not uncommon under these standards.

Washington State and the State of California are presently applying standards which allow for a continuous single decompression shift. Because of this single shift rather than the traditional split shift, we feel that considerable information could be gained from review and evaluation of all cases of decompression sickness with reference to causative factors. To this end our committee would like to expend some time and effort.

In order to overcome periodic, long duration decompressions from great depths and long intervals of time, a new concept of "saturation diving" is presently being borne. These dives require so-called "houses-under-the-sea" which serve as a base of operations. After about 24 hours at a given depth, the body tissues become essentially saturated with inert gas at a pressure equivalent to the depth. Divers can remain at the ambient pressure for several weeks and probably longer in order to complete an assigned underwater task. Upon completion of the job only one long period of decompression is required instead of the long, daily decompression schedules presently in use.

To date Jacques-Yves Cousteau and his group of French Oceanauts have conducted 3 experiments in his "Conshelf" program. Conshelf 1 involved 2 men for 7 days at a depth of 35 feet. Conshelf 2 involved 5 men for one month at 33 feet, and 2 men for 7 days at 85 feet. Conshelf 3 recently involved 6 men for 22 days at 330 feet.

The U. S. Navy, with the medical assistance of Captain George F. Bond, has been conducting its "Sealab" experiments along similar lines. Sealab I required 4 Aquanauts for 11 days at 193 feet. Sealab II engaged 28 men for 15 or 30 days each at a depth of 205 feet.

Edwin A. Link and his "Man in Sea" project have to date completed 2 experimental dives. The first involved one man for 24 hours at 200 feet. The second involved 2 men for a period of 49 hours at a depth of 432 feet.

These experiments were all conducted in the open ocean and required much previous experimentation in recompression chambers on land with animals and human beings. Relative humidity in these situations is nearly 100% and this often caused softened skin and rashes. Nitrogen, which is physiologically inert at sea level, must be replaced by helium in the breathing medium because nitrogen has an anesthetic effect under pressure. Helium also affords less breathing resistance which is a problem with nitrogen at great depths. Helium, however, has 2 disadvantages itself: 1) it's thermal conductivity is about six times greater than that of nitrogen so it will increase the loss of body heat, and 2) helium distorts the resonance of a diver's voice, thus making his speech almost unintelligible. An underwater chamber temperature of 82 to 85° F was felt to be optimal. Electrically heated diving suits are required on the forays and expeditions outside of the chamber. Oxygen concentrations at these depths must be reduced to only a few percent in order to prevent hyperoxia. Carbon dioxide concentrations can attain toxic levels in these small spaces, so they must be carefully monitored and controlled. Carbon monoxide and hydrocarbon vapors would, of course, constitute a problem under these conditions as well as under normal routine diving situations.

As men go deeper and remain longer the hazards increase and the safety margins narrow. Men have lived for 48 hours in a test chamber at 650 feet breathing helium. It is felt helium may be all right up to 1000 feet and even beyond. Oxygen-neon mixtures have been tolerated in recompression chambers at 650 feet and voice quality was markedly improved. During the first few days of submergence, subjects were sometimes uncomfortable, noting joint aches, etc. These were not serious and did not debilitate the subjects, although a general slowdown of movement during these periods was noted. To date there appear to be no physiological or psychological barriers that will prevent man to remain at these great depths for extended time intervals.

We would therefore like to continue this ACGIH Committee and, if possible, change it from an Ad Hoc Committee to a Standing Committee. We feel we are on the frontier of great advances in the adaptation of man to hyperbaric environments and these activities will almost certainly increase and require ever more attention from industrial hygienists.

Respectfully submitted,
Fred Hertlein III

SECRETARY HOSEY: The second ad hoc committee is Industrial Hygiene Aspects of Mining. The report of the Committee was accepted and the Committee will continue as an ad hoc committee. The Chairman will be requested to develop a Bill of Particulars stating the objectives of this project. Mr. William Bardswich was appointed a consultant to replace Mr. Richard Walli, who resigned with regret. Mr. Duncan A. Holaday was also appointed to serve on this Committee.

I move that the report be accepted.

...The motion was seconded by Dr. Lewis Cralley and adopted.

REPORT OF AD HOC COMMITTEE ON THE INDUSTRIAL HYGIENE ASPECTS OF MINING

During the past year this committee has met twice. The first meeting was during the ACGIH conference in Houston on May 3, 1965. Present were the chairman and five committee members or their designated representatives. After the purposes for organizing the committee had been outlined there was considerable discussion as to the direction the committee should follow. Committee members were then assigned or chose various problems to study during the ensuing year, with the understanding that the results of such studies would be presented to the committee at large for further evaluation later in the year.

On February 21, 1966 the second meeting of the committee was held in East Lansing, Michigan during the annual Ventilation Conference at which the chairman and five members or their designated representatives were present. Six reports on subjects assigned to committee members in May were presented for distribution and reviewed. These reports were interim reports on the study to date and were not considered to be final reports. A copy of each is appended.

At this meeting the resignation of Mr. Richard Walli was accepted with regret, as he has left his employment with the Ontario Department of Health and is presently employed by the Rio Algom Mines Limited. As Mr. Yourt with the same company is presently a consultant to this committee, it was felt that Mr. Walli should be replaced by another Canadian member of the ACGIH in related work.

It was further suggested by Mr. Yourt that Mr. Duncan A. Holaday of the United States Public Health Service be added to our committee in order that the committee may profit from his experience in the field of radiation control in mines.

There being no further matters to come before the committee, it was decided to adjourn until the annual conference in May at Pittsburgh.

The committee does not propose to publish any material within the next year.

(a) No action is requested by the committee except as designated in subparagraph (c).

(b) It is the intention of the committee to continue work toward the long term goal as previously stated, of gathering material relative to Industrial Health Aspects of Mining, and publish it as a guide to the mining industry.

(c) The committee respectfully requests that the Executive Committee authorize this ad hoc committee to continue its work for the next year.

It is requested that the chairman be allowed to serve as chairman for the forthcoming year and that the present members continue serving for the fourthcoming year with the exception of Mr. Richard Walli who has resigned, as stated above.

It is further requested that Mr. Duncan A. Holaday of the United States Public Health Service be asked to serve on the committee, and that a member of the ACGIH or an individual with the proper qualifications to be a member from Canada actively employed in a field concerning the health of mine workers be asked to serve on the committee.

Respectfully submitted,
J. D. McKichan, Chairman

SECRETARY HOSEY: The next one is Liaison in Other Countries. The report of the Committee was accepted, and it was recommended that this ad hoc committee be continued until the 1967 annual meeting. The Executive Committee designated Mr. Doyle to represent A.C.G.I.H. at the XV International Congress on Occupational Health to be held in Vienna, Austria, this September. Dr. Patterson, from Canada,was appointed to the committee.

Henry, do you want to make a comment?

MR. HENRY N. DOYLE: I don't think it is necessary, no.

...The motion was seconded by Fred McDermott and adopted.

REPORT OF COMMITTEE ON LIAISON WITH FOREIGN COUNTRIES

The Committee met in New York City on February 28, 1966.

Based on the verbal report to the Executive Committee at its meeting in Houston (May 1965) the following items served to guide the discussion.

1. Dues payment for countries having trouble with U. S. currency - This would represent a problem for certain countries. Various possible methods of solution were discussed, but no guide lines were developed. This would not be a problem to those countries of Western Europe where we would expect major interest in ACGIH.

2. Write to industrial hygienists in other countries to represent this Committee to get other members - See later discussion and action.

3. Keep active correspondence with foreign members - Hopefully, this would be accomplished in the ultimate plan to be developed.

4. Formation of regional groups and conferences - This does not appear to be a feasible approach. The Europeans, where major interest in occupational health can be found, have their own system of conferences and regional meetings. It was doubted that ACGIH could have any significant impact, at least at this stage of development. It was Mr. Doyle's opinion that national and Europeans look to such organizations as the European Common Market, the European Coal and Steel Community, the Council of Europe, ILO and WHO as the unifying force in matters relating to occupational health of international interest.

5. Personal contact with members when visiting abroad - This concept should be promoted not only with respect to ACGIH members but with other professionals in the field. Mr. Doyle's office could furnish a list of occupational health personnel in selected countries to ACGIH travelers.

6. Organize international TLV committee - This matter is being handled by WHO and the Permanent Commission and International Association on Occupational Health. It would be unwise for ACGIH, at this time, to represent its TLV committee as an international body. Our services could be offered to the above organizations as contributory to the international effort. Most of the European, as well as

other countries, hold the work of ACGIH in the setting of TLV's in high esteem and it is thought that certain individuals would welcome the opportunity of serving as a technical member of the committee. In Europe, especially, there are individuals who could make a significant contribution to this as well as other committees.

7. Use influence with U. S. Government for translation of literature - The U. S. Government will not provide this service for private or quasi official agencies. Governmental agencies have translation problems and most pay dearly for translators. The International Labour Office, through CIS, offers a partial solution to this problem, in that the major publications of the industrialized countries are abstracted in English. However, a complete translation service is not offered.

8. Correspondence course in industrial hygiene for those for whom other methods are not available - For the reasons given in paragraph 4, ACGIH would have to move with caution on this item. Even so, this could not be done until the Conference has developed an overall plan. WHO is presently organizing regional centers for occupational health which may meet this need. Such centers are to be located in Santiago, Chile; Sao Paulo, Brazil; Alexandria, Egypt; Istanbul, Turkey; and Tehran, Iran. Although it was not discussed by the Committee, it might be well for ACGIH to compliment WHO for this move and offer its cooperation.

Action Plan

The Committee decided that the first effort of ACGIH should be to ascertain the interest of selected official agency and university personnel in other countries in becoming members of ACGIH and participating in its activities. The attached letter is being sent along with the English version and the pamphlet "Official Publications of the American Conference of Governmental Industrial Hygienists" was enclosed.

The Committee recommended that we consider the appointment of a corresponding member in the official occupational health agency of each major industrial country. This mechanism might serve to overcome the problem of currency exchange. It was thought best, however, to first explore the possibility of bringing in a large group of experts from other countries as full members. If this is not possible, we could then fall back on the concept of corresponding members.

It is recommended that the Ad Hoc Committee on Liaison with Foreign Countries be continued until the 1967 annual meeting. During the forthcoming year, the Committee should explore cooperative relationships with international agencies, such as ILO, WHO, the European Economic Community, the European Coal and Steel Community, and others as may be appropriate. A full report to be submitted to the Conference at the 1967 annual meeting.

Respectfully submitted,
Henry N. Doyle, Chairman

SECRETARY HOSEY: Occupational Health Nursing. The report of this Committee was accepted and it was agreed that the Committee should continue to function as outlined in their report. Permission was granted to hold one or two meetings during the year. Miss Edna May Klutas was also appointed to this Committee.

I move that the report be accepted.

...The motion was seconded by Dr. Lewis Cralley and adopted.

REPORT OF AD HOC COMMITTEE ON NURSING

I. Statement of Activity

Three day meeting in September, 1965 at Nashville, Tennessee, with all members present.

Correspondence between members throughout the year.

II. "Guideline" for Qualifications for OHN Consultants

III. 1. Action required by the Executive Committee
(a) *Permission to hold one, possibly two, meetings during coming year.

2. Continuation on development of qualifications, experience and standards of practice for OHN Consultants.

3. Continuation of Committee

IV. Retention of same Committee, reasons stated in cover letter.

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*The last committee resulted in little cost to conference as most of our employers paid expenses.

Respectfully submitted,
Elizabeth A. Neubert, R.N., Chairman

SECRETARY HOSEY: Truck and Air Transport. The report of the Chairman was accepted and it was recommended that he continue with his project.

I move the acceptance of the report.

...The motion was seconded by Paul A. Jankowski and adopted.

REPORT OF AD HOC COMMITTEE ON TRUCK AND AIR TRANSPORT OF HAZARDOUS MATERIALS

This committee has been in existence a little over a year. During this time the Chairman has obtained and studied literature relating to control and regulation of hazardous materials in transport in both state and interstate commerce and has studied actual and potential problems arising under existing systems of control.

Evidence collected to date suggests that present requirements do not in all respects provide adequate protection for workers, emergency personnel or for the general public. It is planned that during the ensuing year the Committee will continue this analysis; identify areas in which present controls are found to be inadequate, and propose measures which should be taken to correct deficiencies found.

No proposed codes, guides or other material for publication have been developed by this Committee.

The Committee has no matters to recommend for action by the Executive Committee or the membership.

Future Committee activity should be devoted to collection of additional information relative to present practice and regulation and drafting of conclusions and recommendations based on information developed.

The Committee should be continued.

The Chairman has refrained from requesting appointments to this Committee until a meaningful protocol based on facts could be drafted for a Committee's consideration. This is now at hand and a protocol and requests for appointment are in preparation.

I should be pleased to continue as Chairman.

Respectfully submitted,
A. E. Lowe, Chairman

SECRETARY HOSEY: Next are some Joint Committees with AIHA. The first, American Board of Industrial Hygiene. The report of the Chairman was accepted. Since the terms of Mr. John Soet and Mr. Lynn Schall will expire shortly, the Executive Committee reappointed Lynn Schall for a six-year term and nominates Dr. William Fredrick and Col. Robert Peterson as a replacement for John Soet, who asked to be relieved from this Committee.

You have to make two nominations if you want to change names. That is why there are these two names.

I move that the report be accepted.

...The motion was seconded by Fred McDermott and adopted.

SECRETARY HOSEY: Incidentally, it is tonight, I think, 8 to 10 o'clock is an important meeting of the Academy of Industrial Hygienists.

CHAIRMAN BLOOMFIELD: This is a meeting open to everybody? This is an open meeting, John?

MR. SOET: No. It is a meeting for the Diplomats of the Academy.

CHAIRMAN BLOOMFIELD: Members?

MR. SOET: Yes.

REPORT OF AMERICAN BOARD OF INDUSTRIAL HYGIENE

In 1965 examinations were given in Houston in May and in New York in September. Examinations in all aspects were offered.

Twenty-two examinations were given, including six reexaminations, eighteen certificates were issued, 15 in Comprehensive Practice, and 3 in Engineering Aspects.

In 1966 examinations are scheduled in Pittsburgh in May and in Los Angeles in October.

A meeting of diplomates will be held on May 16 to discuss activation of the American Academy of Industrial Hygiene to pursue professional programs.

Our examination and certification program is not self-supporting, because of the small number of candidates each year. Our surplus has been reduced to the point where we have decided to assess the fees which each diplomate agreed to pay. This is done in order to avoid appealing to AIHA and ACGIH for a yearly grant to cover our annual deficit.

Respectfully submitted,
John C. Soet, Chairman

SECRETARY HOSEY: The second one, Direct Reading Gas Detecting Tube Systems. The report of the Committee was accepted and no changes were made in the membership of the Committee.

I move that it be accepted.

...The motion was seconded by Dr. Lewis Cralley and adopted.

REPORT OF JOINT A.C.G.I.H. - A.I.H.A. COMMITTEE ON DIRECT READING, GAS DETECTING TUBE SYSTEMS

The Committee met with the officers of the sponsoring organizations at Houston, Texas on May 4, 1965. As a result of the agreements reached at this meeting, at a meeting on February 24, 1965 held at Cincinnati, Ohio and by correspondence and direct consultation between the Chairman and the Committee members, the Committee issued a report to the Chairman, American Conference of Governmental Industrial Hygienists and to the President, American Industrial Hygiene Association on August 9, 1965. This report consisted of the Committee's assessment of the general, current practices and limitations relating to the use of gas detecting tube systems; a set of 11 recommended performance specifications for these devices; the recommendation of the establishment of a central certifying agency vested in the Division of Occupational Health, Public Health Service; 3 suggested modes of operating a certification program; and the recommendation that compliance with the certifying agency's minimum standards be so stated on each box of approved tubes. Copies of this report were distributed to the Executive Committee, American Conference of Governmental Industrial Hygienists, to the Board of Directors, American Industrial Hygiene Association, and to Murray C. Brown, M.D., Chief, Division of Occupational Health.

In response to instructions developed at the meeting of the Executive Committee, American Conference of Governmental Industrial Hygienists in Pittsburgh, Pennsylvania on October 21 and 22, 1965, the Chairman distributed copies of the August 9 Committee report to the following manufacturers of gas detecting tube systems:

(1) Bacharach Industrial Instrument Company
200 North Braddock Avenue
Pittsburgh, Pennsylvania 15208

(2) Brothers Chemical Company
575 Forest Street
Orange, New Jersey

(3) Central Scientific Company
1700 West Irving Park Road
Chicago, Illinois 60613

(4) Compact Air Samplers
825 Belmont Park, North
Dayton, Ohio 45405

(5) Davis Emergency Equipment Company, Inc.
45 Halleck Street
Newark, New Jersey 07104

(6) Drager Corporation
432 Park Avenue
New York, New York 10016

(7) LKB Instruments, Inc.
4840 Rugby Avenue
Washington, D. C. 20014

(8) Mine Safety Appliances Company
201 North Braddock Avenue
Pittsburgh, Pennsylvania 15208

(9) Union Industrial Equipment Corporation
150 Cove Street
Fall River, Massachusetts

Establishment of the certifying program has not been possible to date, although, in his letter of July 21, 1965 addressed to Mr. Bernard D. Bloomfield, Chairman, American Conference of Governmental Industrial Hygienists in response to the June 25, 1965 joint letter sent to the Surgeon General by the Committee's sponsoring organizations, Dr. Murray C. Brown, Chief, Division of Occupational Health expressed keen interest in the Associations' recommendations relating to the direct reading detectors. Indeed, Dr. Brown appointed Mr. Howard E. Ayer, Mr. Howard L. Kusnetz, and the Chairman of this Joint Committee to work closely with this Committee in this area. Since that time, the Chairman has become aware of the intensified efforts on the part of the Division of Occupational Health to secure adequate funding for the proper implementation of a comprehensive criteria and standards program.

No action is required of the A.C.G.I.H. Executive Committee or of the A.I.H.A. Board of Directors at this time.

Respectfully submitted,
Robert G. Keenan, Chairman

SECRETARY HOSEY: Next, Qualifications for Industrial Hygiene Personnel. In view of the difficulties encountered by this Committee in developing qualifications for industrial hygiene personnel, the Executive Committee agreed to abolish this Committee provided AIHA concurs. In any event, Miss Trasko requests that she be relieved as Chairman of this Committee.

I move that this report be accepted.

...The motion was seconded by James Barrett and adopted.

REPORT OF JOINT A.C.G.I.H. - A.I.H.A. AD HOC COMMITTEE
ON QUALIFICATIONS OF INDUSTRIAL HYGIENE PERSONNEL

This Committee has no progress to report as will be explained later. In order to assist the two organizations in determining the future of the Committee, the following background information is offered.

The Ad Hoc Committee was originally established in 1961 and became a joint committee with AIHA the latter part of 1962. The bill of particulars was originally proposed to "evaluate the training, experience and performance of professional and other personnel engaged in industrial hygiene and occupational health, currently ineligible to be certified by a recognized American Specialty Board" and "to classify these personnel in a uniform manner for assignment to such practices and periodically evaluate their progressive improvement and development toward professional excellence.

As a result of considerable correspondence with perplexed committee members and after several amendments which eliminated any reference to certification and setting up standards of performance, the bill of particulars was modified to read "the development and recommendation of qualifications for standards for industrial hygiene personnel in industry and government."

In the meantime, job descriptions were accumulated from several private companies with industrial hygienists and from most of the State governmental occupational health units for review purposes. Education and experience requirements for industrial hygiene personnel in State and local agencies were abstracted by the current Chairman for each State and local governmental unit submitting information. The material was then mimeographed and copies sent to the Committee members in March 1963. These requirements varied widely from unit to unit depending upon administrative organization, size of unit, the professional personnel comprising the units, and the scope of activities, among other variables.

The Committee was inactive for a period of time owing to the transfer of the Chairman to an overseas assignment. The present Chairman was appointed in 1964 and called a meeting of the Committee in December 1964 in order to get a gathering of the minds as to how the Committee should proceed in its assignment. In the meantime, the

Chairman requested the Executive Committee of the AIHA for clarification as to what professions are to be covered by the term "industrial hygiene" with the thought in mind that separate standards would be drawn up for different professional disciplines. The reply was that in light of the AIHA broad definition of industrial hygiene, the Committee should consider the profession of industrial hygiene in the description of qualifications rather than individual disciplines.

The three Committee members who met in December 1964 discussed the preparation of such a general statement and the Chairman agreed to attempt to write a draft and submit it to the other Committee members for comment. However, the drafting of a general statement on qualifications for the industrial hygiene profession as a whole which would encompass more than was already stated in the AIHA definition proved a frustrating task, and as a result she failed to come up with anything satisfactory.

It is recommended that if this Committee is to be continued that the two organizations decide upon a specific and practical bill of particulars for standards that will be of use to the profession. A general statement cannot be tailored to the wide areas of disciplines associated with the profession. There is a need for a series of up-to-date standards for job qualifications for professional disciplines, such as for the industrial hygienist, industrial hygiene engineer, chemist, toxicologist, physicist, etc., which would delineate education and experience requirements at different levels of responsibility. Such standards could be valuable to civil service groups in Federal and State governmental agencies and to personnel departments in industry. However, unless an attempt is made to get the agencies, particularly Federal and State governments, to recognize the standards and incorporate them in their merit systems, the work of the Committee will likely be futile.

To accomplish such an objective, it is suggested that a series of sub-committees be established, one for each of the disciplines for which standards are to be developed. The requirements of the American Board of Industrial Hygiene for certification should be considered a factor in the standards. A statement on minimum qualifications for industrial sanitarians, aides and other auxiliary personnel would also be helpful.

It is also recommended that if the Joint Committee is to be continued that another Chairman be appointed. The present Chairman would be happy to serve on the Committee, but due to many other commitments, is unable to provide the leadership necessary for the successful functioning of such a Committee.

Respectfully submitted,
Victoria M. Trasko, Chairman

SECRETARY HOSEY: Respiratory Protective Equipment. While this report is essentially the same as the one received in October, namely, that the Committee wants to submit a supplement, the report of the Committee was accepted, and it was agreed that a supplement to the Respiratory Protective Devices Manual should be published. ACGIH will share the costs of publishing the supplement with AIHA on a 50-50 basis. It was suggested that Mr. William Revoir be appointed Chairman to replace Mr. Schutz.

I move the report be accepted.

...The motion was seconded by James Barrett and adopted.

REPORT OF A.I.H.A. - A.C.G.I.H. JOINT TECHNICAL COMMITTEE ON RESPIRATORY PROTECTIVE DEVICES

During the past year, the Respirator Committee has been engaged in the following activities:

(1) Providing information on selection of respiratory protection for new and revised Hygienic Guides and Data Sheets. The work on National Safety Council Data Sheets is new this year. We have been enjoying cordial relations with the AIHA Hygienic Guides Committee during our second year of working with them.

(2) Preparing and distributing a list of persons interested in speaking on respiratory protection. Copies of this list were sent to all local sections of AIHA, all local chapters of ASSE, all regional offices of the Federal Safety Council, and all local chapters of the Health Physics Society.

(3) Preparing a proposal for publication of a supplement to the Respirator Manual. A copy of the proposal is enclosed with this report.

Members of the Respirator Committee met with representatives of the U. S. Department of Agriculture in November 1965. We attempted to interest them in formalizing their respirator testing program, but were apparently not successful.

I have asked Mr. W. T. McCormick to accept my resignation as Chairman of the Respirator Committee. I feel it is important that the committee be revitalized with new leadership at least every other year. I am, therefore, not suggesting the names of members for the forthcoming year.

Respectfully submitted,
Robert H. Schutz, Chairman

SECRETARY HOSEY: Uniform Methods for Dust Counting. The report of the Committee was accepted and no changes were made in the membership of the Committee.

I move that the report be accepted.

...The motion was seconded and adopted.

(Note: See report of Committee on Environmental Factors in the Pneumoconioses.)

SECRETARY HOSEY: Ad hoc Committee to Develop a Statement on the Use of TLV's. There was considerable discussion concerning this report, and the Executive Committee agreed to accept it provided the report was also approved by AIHA and by the ACGIH TLV Committee.

I move that the report be accepted.

...The motion was seconded by Paul A. Jankowski.

Since TLVs are guides, interpretation of exposure levels should only be made by qualified persons. The number of samples, method of sampling and location of sampling points shall be such as to allow a valid approximation of the actual time weighted average concentration in the breathing zone. The analytical procedures used shall be such as to give valid results. This implies frequent and accurate calibration of sampling and analytical equipment and reagents. The amount by which the concentration may exceed for short periods of time the concentration which represents the maximum recommended 8-hour time-weighted average (TLV) without undesirable effects depends upon a number of factors. These include the nature of the contaminant, whether very high concentrations even for short periods produce acute poisoning, whether the effects are cumulative, the frequency with which high concentrations occur and the duration of such periods. All must be taken into consideration in arriving at a decision as to whether or not an undesirable situation exists.

The basis on which TLVs are established may differ from substance to substance; protection against impairment of health may be the guiding factor for some, whereas reasonable freedom from irritation, narcosis, nuisance or other forms of stress may dominate the basis for others.

As a matter of good industrial hygiene practice a TLV of 15 mg/m^3 or 50 mppcf (whichever is applicable) for nuisance dusts and particulates is recommended even though appreciably higher concentrations produce no harmful effect (see Appendix D of Threshold Limit Values). Also, a minimal oxygen content of 18% by volume under normal atmospheric pressures (equivalent to a pO_2 of 135 mm Hg) is required to sustain life in the presence of "inert" gases.

For a proper understanding of the TLVs it is essential that the most recent Documentation of Threshold Limit Values (published by the American Conference of Governmental Industrial Hygienists, Committee on Threshold Limits) be consulted and the pertinent literature studied when TLVs are used.

Qualifying factors for use of TLVs - a. A TLV bearing the notation, "ceiling limit" or "C", means that this limit is an upper boundary of permissible concentration which should not be exceeded in the breathing zone for even short periods of time. b. TLVs bearing the notation, "skin," means that absorption of these substances through the skin, including mucous membranes and the eye may contribute significantly to exposure. With such materials the TLV is a safe guide to total exposure only in those cases where significant contact with the skin and mucuous membranes is eliminated. c. There is no infallible way of predicting the safety of mixtures from the TLVs of the components. d. The stated TLVs pertain to exposures at normal temperature, pressure and humidity as well as the 8-hour day, 40-hour work week. They cannot be expected to apply without modification to hypo- or hyper- baric conditions, high humidity, temperatures in excess of 90°F or substantial overtime work. e. TLVs are not intended for use, or for modification for use (1) as a relative index of toxicity, by making a ratio of two limits, (2) as sharp dividing lines between safe and dangerous concentrations, (3) as quantitative ceilings in governmental codes and regulations, (4) in the evaluation or control of community air pollution or air pollution nuisances, (5) in estimating the toxic potential of continuous uninterrupted exposures, (6) as proof or disproof of an existing disease or physical

condition, (7) for use in advertising to compare toxicities for commercial purposes, or (8) for use in countries where working conditions or other pertinent circumstances differ from those in the United States.

The ACGIH Threshold Limits Committee issues a "Notice of Intent" at the beginning of each year. This "Notice" outlines proposed actions and provides not only an opportunity for comment, but solicits suggestions of substances to be added to the list. The suggestions should be accompanied by substantiating evidence.

Respectfully submitted,
E. J. Baier, Chairman

SECRETARY HOSEY: This essentially concludes the reports of the Committees. We have 17 representatives on ASA Committees. Reports were received from only 9 of the 17 Committees represented, and appointments were made as indicated.

We have one representative on an ASTM D-22 Committee. No report. D-26, Mr. Howard Kusnetz. This Committee has not been too active during the past year, either, and Mr. Robert Keenan is our representative on the APHA Intersociety Committee on Air Sampling and Analysis, and he submitted a report which was accepted by the Executive Committee and agreed to continue and asked him to serve as our representative on this Committee.

Then, the final one was a report of the Committee Representative on the Intersociety Committee on Development of Noise Criteria. The Committee report was accepted, but Dr. Cohen asked us to approve the "Guidelines for Noise Exposure Control," but we haven't seen them yet so we can't approve that report until we receive a copy. This, then, concludes the presentation of the Committee reports, Mr. Chairman, and the Executive Committee's report.

CHAIRMAN BLOOMFIELD: Thank you very much for the detailed and interesting report.

I have a commercial that should not appear in the minutes of the meeting.

(Discussion off the record.)

CHAIRMAN BLOOMFIELD: The next item of business is one that is particularly enjoyable, and I think comes at an appropriate time, following the detailed Committee reports. I would like to call on the Chairman of the Awards Committee, Mr. Lynn Schall, to get on with that matter of business.

I might add that on Lynn's committee are the following people: Miss Elizabeth Neubert, Miss Victoria Trasko, Dr. Irma West and Dr. Hervey Elkins.

MR. SCHALL: Thank you, Mr. Chairman. Ladies and gentlemen. On behalf of the Awards Committee, I wish to thank you for the many suggestions of names for consideration this year.

The recipient of the 1966 A.C.G.I.H. Award is a graduate of the University of Michigan in 1928, receiving a B.S. in Mechanical Engineering, and Columbia University in 1932, where he received a Master of Science Degree in Chemical Engineering. He is past President of the A.C.G.I.H., having served in 1954. He has served on eight important A.C.G.I.H. Committees, either as Chairman or as Committee Member. He has been Chairman of the American Board of Industrial Hygiene since incorporation in 1960, and is certified in the comprehensive practice of Industrial Hygiene. He has been a member

of the American Sanitary Engineering Intersociety Board since 1958.

He is a registered professional engineer in Michigan and Ohio. He has given more than 75 talks and lectures including radio and television. He has many publications, including one in 1943 on "Dermatitis Due to Formaldehyde Resins;" in 1955, "From Carpet Tacks to Cargo Ships," and the latest one in 1964, which was "A Focus on Air Pollution."

He holds the United States Patent on blood drawing instruments. Our recipient for the Award this year is Mr. John C. Soet, Director of the Division of Occupational Health of Michigan Department of Health.

John, would you come up, please?

...Applause.

John, I take pleasure in giving you this plaque with our congratulations.

MR. SOET: Thank you very much. I feel that I should be pressing Andy Hosey's panic button here. This was, indeed, a surprise. Bernie Bloomfield, before the meeting this morning, asked me to be sure and be here because he wanted me to make a presentation, and, so, instead of making a presentation, I am receiving one, and I assure you that at this particular moment it is nicer to receive than to give. Thank you all very much.

...Applause.

CHAIRMAN BLOOMFIELD: Mr. Secretary-Treasurer, do you have any further business?

SECRETARY HOSEY: No, sir.

CHAIRMAN BLOOMFIELD: One announcement before adjourning the meeting, and that is that the second business session will be held tomorrow at 11:00 A.M., and I urge that if any of you have any resolutions you wish to be made, please see the members of the Resolutions Committee.

Meeting adjourned.

(Thereupon, at 12:20 o'clock P.M., the meeting was adjourned.)

BUSINESS SESSION - May 17, 1966

The second business session was convened at 11:00 A.M. by Mr. Bernard D. Bloomfield, Chairman.

CHAIRMAN BLOOMFIELD: The second business session will now convene. I would ask you all to come up front, but you look like you are very comfortably situated.

There is one item of unfinished business that has to do with a Committee report, and Mr. Hosey will now discuss this, following which we will have reports of the round table discussions, and I will ask someone from the group to give a brief report on the American Board of Industrial Hygiene activity that took place last night.

SECRETARY HOSEY: This is very simple. I made an error yesterday on the report of the ad hoc Committee on Liaison in Other Countries. I stated erroneously that Dr. Patterson was also a representative of A.C.G.I.H. to the XV International Congress. He is not. Mr. Henry Doyle is the representative, but Dr. Patterson has been appointed to the Committee. I guess we should move that that report be amended to this effect. I so move.

...The motion was seconded by Jeremiah R. Lynch and adopted.

SECRETARY HOSEY: If we just goof on one, we are doing pretty good.

CHAIRMAN BLOOMFIELD: I should next like to ask the representatives of the different round table groups to present reports and I should first ask that Mary Louise Brown give a report on the Interdisciplinary Round Table Discussion.

MISS MARY LOUISE BROWN: I am not sure I need all this wiring for sound. I report for the Interdisciplinary Round Table headed by Dr. Marcus M. Key, which I had the fun of chairing on Sunday morning. I would say we were made up of quality rather than quantity. There were 7 people, 3 nurses and 4 physicians. We literally had a round table.

Instead of using the room as it was designed for a meeting, we used the speaker's table and put our elbows on the table, and we had coffee, and we talked about problems of physicians and nurses as they relate to occupational health.

We started off by talking about a recent outbreak of headache, nausea and fainting that has occurred in electronic plants in several states. This discussion was started by Miss Benning from Ohio.

As we talked about this one, we found ourselves wondering about what other occupational diseases are not being recognized and found ourselves greatly concerned about increased recognition and under-reporting of occupational diseases.

As you can guess, our discussion took us then to the fatal and near fatal cases of cadmium poisoning from silver soldering. Then, as we talked about the recognition of, and control of, problems in industry, we found ourselves talking about the legality of certain procedures that nurses in industry are called upon to carry responsibility for.

The group met only for the morning. Our one concern is that there were not more of us to participate in the session. Thank you.

CHAIRMAN BLOOMFIELD: Thank you very much.

Next I would like to call on Bob Keenan to give a report of the Chemist's Round Table.

MR. ROBERT G. KEENAN: Thank you, Mr. Chairman. I guess we goofed this year. We sent out announcements of the round table discussions. I believe they were incorporated as part of the bulletin board. I don't know whether that was the reason or whether it was our failure to send some post-cards, but we didn't receive any written topics beforehand. However, that didn't stop us. I guess, maybe, with age, the chemists are becoming more extrovert in character, because we had good, lively discussion from about 5 after 9 until 12:30, and then the session adjourned for lunch, and resumed discussions later on in the afternoon, along about 2:00 or 2:30, for another two-hour session.

Atomic absorption was the first topic of interest to our group. Quite a few of us now have atomic absorption spectrophotometers. We have found them very useful in particular areas of analysis for industrial hygiene samples.

It is fortunate that it has so worked out that certain elements like selenium, tellurium and bismuth, which are difficult to determine by other procedures involving rather elaborate chemical pretreatment of the samples, lend themselves to atomic absorption analysis, and we, in our own laboratory, have used atomic absorption for this very purpose within the last week to analyze a group of some 60 air samples directly for selenium and tellurium.

It was pointed out that the salt concentration is somewhat critical in preparing samples for atomic absorption, so you must take note of this.

The commercial instrumentation still is not sufficiently sensitive for the direct analysis of lead in urine and blood. Ken Nelson and others have built their own custom jobs in order to overcome this deficiency by providing longer path lengths so that they can increase their sensitivity and, as you all know, I am sure, Ken published a brief paper in the AIHA Journal last fall on his work in this area.

It was brought out, and I think this is of general interest to many of you, that there are certain commercial analytical laboratories operating in the Country about which we know little or nothing regarding the quality of their results. In some cases we do know that misleading results have been derived from the processing of samples submitted to some of these, so we mentioned a word of caution here. It would be well to check on some of these before you put too much credence in data obtained therefrom.

The silver solder bit came up for discussion. I believe all of you have become familiar with this incident of silver solder containing cadmium that is available on the shelves of various retail establishments, containing cadmium up to about 24 percent concentration for the solder that melts at 1175. We consider that possibly part of the problem, since we all know that silver solder has been used industrially for many years, that there is a lot of home use of this product now and

home hobbyists probably are getting their noses down pretty close to their work. They are working in relatively confined spaces like in boats and tiny workshops, and maybe getting more cadmium and are certainly unaware of the potential danger from the use of this product for their home hobby activities.

In connection with this, Dr. Fredrick pointed out there is a lot of home costume jewelry operations going on, and with this fine work it is typical for the worker to have his nose down pretty close to the operation. So he gets the full benefit of whatever fumes are being produced from soldering and brazing techniques.

The specific gravity correction for urine came up for its perennial discussion. I don't know if we reached any more profound agreements than we have in the past, but it was pointed out that it has been the experience of at least one industrial hygienist that the 1.018 average value seems to be in better conformance or seems to give better agreement in his own work than the 1.024 value reported by Levine and Fahy about 24 or 25 years ago.

The specific gravity correction is preferred almost vehemently by some people and then, of course, we have the controversial group that feels that results can be misleading. So I suspect we will be doing some more work on this, I hope in the near future.

I was very interested in Dr. Elkins' presentation this morning in connection with this general topic.

I believe these cover the highlights of our round table, Mr. Chairman. Thank you very much.

CHAIRMAN BLOOMFIELD: Thank you very much. I would like now to call on Mr. Howard Ayer to give us a review of what took place at the Engineer's Round Table.

MR. HOWARD AYER: Thank you, Mr. Chairman. Ladies and gentlemen. The Engineer's Round Table was rather well attended, considering that it started at 9:00 on Sunday morning. The attendance in the morning varied from 25 to 35, and in the afternoon the attendance was just under 50, which indicates the people are just about as interested in dust as they are in A.C.G.I.H. business, I guess.

SECRETARY HOSEY: Which isn't good.

MR. AYER: In the morning session we had a general discussion. The hazards discussed were mostly those of earlier years; however, they were offered from different sources. Such substances as carbon monoxide, formaldehyde, TDI, ozone, solvents and fiberglas came up.

Carbon monoxide was reported as being produced from gas-infrared unvented space heaters. Those heaters seem to be initially satisfactory, but they produce carbon monoxide as they age in an industrial environment. One opinion was that no gas fired unit heater proved satisfactory in industries where there were dust problems, corrosive gases or halogenated hydrocarbons. Like the camel with his foot in the tent, the direct fired makeup air heater was said to be promoted now for use as a primary heat source for some buildings--an application which was felt, at least by some, to be hazardous.

The application of breath carbon monoxide and blood carbon monoxide tests in garage and inspection station surveys was discussed.

Getting back to heaters again, one opinion was that oil fired jet heaters in construction jobs were more satisfactory than the salamanders and other improvised heaters which were ordinarily used.

Methylene phenyl isocyanate (MDI) was reported as a constituent in the no-bake core process in foundries.

One study found no MDI in core preparation, little at pouring, but average concentrations above the threshold limit at shakeout and core knock-out.

At least one opinion was that this might present a serious problem in foundries in the future.

Formaldehyde was reported as a relatively serious problem in the garment manufacturing industry where permanently pressed or creased clothes were manufactured. Formaldehyde from stored mats and formaldehyde resins in paper products were also mentioned.

Concern was expressed over the vague specification of double wall fume hoods for laboratories. "Double wall hood" could apparently mean almost anything, depending upon the manufacturer, and it was suggested that a standard in this area was badly needed.

Other problems, or potential problems mentioned included the need for reliable indicating tubes, the use of potassium permanganate impregnated pellets for odor control, glass fiber linings for ducts, with some questions as to whether this glass fiber was eroded from the ducts and put into the occupied space.

We also spoke of cadmium in silver solder briefly, and another topic mentioned was ozone from so-called ion activators.

In the afternoon session, prepared papers were given on dust counting problems, free silica determinations and sampling strategy. The session was introduced by Bob Harris, who emphasized that this panel limited its discussion to mechanics of the impinger method.

Adequacy of the impinger method for evaluation of mineral dust exposure was not discussed.

In the first paper the coefficient of variation of duplicate impinger dust counts was reported to vary from 25 percent to 50 percent. Because this was less than the usual environmental variation, different groups would ordinarily reach the same conclusions from several samples at an operation, but disagreement by a factor of two to four would not be uncommon where only one or two duplicate samples were taken.

Mr. Baier's talk was summarized as follows: In order to determine analytical precision for free silica analysis, referee samples were sent to governmental agencies who agreed to participate. With the exception of one state agency, determinations

agreed very closely between wet chemical and x-ray diffraction techniques when practically pure quartz of very small particle size was analyzed. Current analytical procedures in use in the United States for free silica are acceptable for application of the threshold limit value formula.

This study also points up the feasibility of analyzing airborne dust for composition as demonstrated by the close results obtained by different agencies when quantitizing samples of very small and respirable particle size. Effects of mixed dusts of small particle size on analytical methods remains unresolved.

Roach, in a paper which will undoubtedly be required reading for dust workers in the future, concluded with the following recommendations:

1. The inlet to the impinger should be held upstream of the worker's nose and mouth, and no more than two feet from the worker's nose and mouth. This is for a true breathing zone sample.

2. The sample should be spaced throughout a shift or complete cycle of operations. The samples should be taken at regular intervals, or at times chosen at random beforehand. If taken at regular intervals, care should be taken to see that the interval does not coincide with any other regular cycle of events which might be related to the dustiness.

3. The environment complies with the Threshold Limit Value when the estimated average concentration is less than that given by the following formula: TLV - K x rang In this formula, TLV equals threshold limit value, the range is the difference between the maximum and minimum results, and K is a constant related to the number of samples taken.

In summarizing, Bob Harris pointed out that although this session was limited to the impinger method, the principal concern of the Committee on Environmental Factors in the Pneumonconiosis was an orderly conversion from a count to a size-selective mass standard. There is sufficient information available now to make this transition.

This concluded our session with some comments on the dust session as a whole.

SECRETARY HOSEY: I might add that the papers presented on the aspects of dust at the Round Table discussions will appear in our 1966 transactions.

CHAIRMAN BLOOMFIELD: I should like to note for the record that the Joint AIHA-ACGIH ad hoc joint committee on the statement on the use of threshold limit values has prepared a modified document as a result of a meeting which was held yesterday, and I would like to submit this officially for the record and for consideration by the Executive Board at the next meeting of the Executive Board.

I don't think a motion is necessary on this; I just want you to know that another statement has been prepared.

MR. LYNN SCHALL: Bernie, when will that meeting be held? In the near future?

CHAIRMAN BLOOMFIELD: The next meeting? This is something that hasn't yet been decided. I have to admit that characteristically we take care of your joint matters of business even before meetings are scheduled through the mails, and that typically the next meeting is scheduled at the time of the Industrial Hygiene Foundation meetings, again in Pittsburgh, so that would be in October. I think we will take care of this before October.

MR. SCHALL: Yes. AIHA has already accepted this, and it is a shame for us to hold it up nine months.

SECRETARY HOSEY: We can probably have a special meeting here.

CHAIRMAN BLOOMFIELD: We could make arrangements to take care of this with some speed. It would not be necessary to hold it up, then.

MR. SCHALL: Thank you.

CHAIRMAN BLOOMFIELD: But I think it would perhaps be quite a problem trying to go over the detailed wording of the statement, which is quite lengthy, at this time.

MR. SCHALL: I didn't want to do it now, but I didn't want it held up.

MR. E. J. BAIER: Bernie, may I ask, could this statement go into the transactions rather than the other statement?

CHAIRMAN BLOOMFIELD: Yes.

MR. BAIER: It is not that much change, really.

CHAIRMAN BLOOMFIELD: I believe that this can be done.

MR. BAIER: Good.

CHAIRMAN BLOOMFIELD: Without any difficulty.

Mr. Baier has asked that we replace the original statement with a new statement for the transactions, and we will do this.

As the next order of business, I would like to ask for a report from the Committee on Resolutions. Will the chairman of that committee please present his report?

DR. LEWIS CRALLEY: Mr. Chairman, I have two resulutions to present. There may be others from the floor.

Resolution No. 1, In Memorium. The Conference has suffered the loss through death of a number of distinguished members during the past year. Each one will be remembered through his individual professional contributions and through the heritage of his association with fellow members.

It is from such members that the Conference has built up a wealth of prestige and service to the profession. We are deeply saddened through the death of Mr. Albert P.

Abrahams, New York State Department of Labor, Mr. John F. Cabell, Kentucky State Health Department, Dr. J. Grant Cunningham, Ontario Health Department (retired), Mr. Kenneth M. Flocke, San Diego County Department of Public Health, Mr. Albert J. Grossman, Baltimore City Health Department, Major Claude A. Ledwell, U. S. Army, Chief Industrial Hygienist of the Second Army, Mr. Robert F. Pero, Virginia State Health Department, Dr. Leslie Silverman, Harvard School of Public Health and Mr. William M. Strump, Baltimore City Health Department.

Be it resolved that the Conference express this sense of loss and sympathy by the inclusion of this in memoriam statement in the minutes of the Twenty-Eighth Annual Meeting of the Conference and by sending a letter expressing this loss to the families.

I move the adoption of this resolution.

...The motion was seconded by Mr. E. J. Baier.

CHAIRMAN BLOOMFIELD: Thank you. Is there any discussion of this?

UNIDENTIFIED SPEAKER: I might say in following the remarks, the Executive Committee expressed, authorized and requested the Secretary to send letters of sympathy to the families of deaths of members of our Conference when it becomes known to the Secretary. That is in the future.

UNIDENTIFIED SPEAKER: There is one gentleman who wasn't mentioned. William B. Harris wasn't mentioned. Was he on there?

SECRETARY HOSEY: That was last year.

CHAIRMAN BLOOMFIELD: William B. Harris' was mentioned last year.

UNIDENTIFIED SPEAKER: Did they say New York office?

CHAIRMAN BLOOMFIELD: Yes, it was in the Transactions for the previous year.

DR. CRALLEY: Resolution No. 2. Whereas the membership of the American Conference of Governmental Industrial Hygienists recognizes the vast amount of work the General Conference Committee has devoted to the organization and smooth functioning of the Conference, and has contributed in large measure to the success of the Conference, be it resolved that the membership of the American Conference of Governmental Industrial Hygienists extend to the General Conference Committee their appreciation and thanks.

Be it further resolved that a copy of this resolution be forwarded to the Chairman of the General Conference Committee.

I move the adoption of this resolution.

...The motion was seconded by Dr. F. A. Van Atta and adopted.

CHAIRMAN BLOOMFIELD: We will proceed with the next resolution.

DR. CRALLEY: Are there other resolutions from the floor?

DR. DAVID A. FRASER: I would like to read a statement.

CHAIRMAN BLOOMFIELD: Dave, you better use the mike.

DR. FRASER: With your permission, I would like to read a statement that has been prepared by Professor Emil T. Chanlett of the Department of Environmental Sciences and Engineering at the University of North Carolina. He was unable to be here and has asked me to read this statement for him. This statement has to do with the Reorganization Plan No. 3 of 1966, providing for the reorganization of the health functions of the Department of Health, Education, and Welfare.

On April 25, 1966, the President sent the Congress Reorganization Plan No. 3 which abolishes the existing agencies of the Public Health Service, and which transfers all functions of the Surgeon General to the Secretary of Health, Education and Welfare. In effect, it clears the slate for a new organization by the Secretary for all existing functions of the Public Health Service.

On April 18, 1966, Surgeon General William H. Stewart sent the Secretary a memorandum of his ideas for the reorganization of the Public Health Service.

Environmental health is relegated to a Bureau of Disease and Injury Prevention and Control in Dr. Stewart's proposal. We must make our thinking heard before the House Committee on Government Operations to save environmental health from a death blow as a Public Health function. Dr. Stewart's proposal will deliver that blow, however good his administrative intentions may be.

In the last six years, five major documents have set forth the urgency and the action needed to salvage the physical environment of our country from progressive despoilage and wastage. Each recognizes health factors to be of major importance. Our National Health Agency must have a vigorous and visible arm for environmental health. Following the acceptance by the Congress of Reorganization Plan No. 3, the Secretary must establish a Bureau of Environmental Health in the reorganization of health services of health, education and welfare. The Environmental Health Sciences Center should be the research strength of the Bureau and an integral part of the Bureau.

Anything less than such a strength for environmental health in the organizational plan will produce a rapid attrition of functions to other departments of the Government. Anything less will make the recruitment of capable young people to the environmental health field impossible. Anything less will make the retention of competent administrative, research and operational personnel more precarious than it is now.

Those who have dedicated their professional lives and committed their professional development to environmental health, sanitary engineers, sanitarians, industrial hygienists, air pollution control officers, radiological health specialists, and a host of scientists in biology, chemistry, and physics, surely deserve greater support than this.

Certainly those of us who depend upon Federal leadership and participation in our day-by-day professional practice of environmental health must request our Senators and Congressmen to make known to the Administrators of HEW and the Public Health Service our deep concern for the dissipation of the environmental health vitality and capacity which it has taken at least all of this century to create within the Public Health Service.

Reorganization plans cannot be amended. These go in effect 60 days after submission unless vetoed.

Professor Chanlett has asked that you write your Senators and Congressmen and get formal action by our professional societies through the preparation of a statement for the record of the Health Committee on Government Operations so that the Secretary and the Surgeon General will get the message.

Such statements should be sent to the Honorable William L. Dawson, Chairman of the Committee on Governmental Operations, 2111 House Office Building, Washington, D.C. 20000.

I would like to propose the following resolution:

Be it resolved that this Conference go on record as being in agreement with the reorganization of the Public Health Service to meet present day health needs. In view of the prominence of environmental health as a Public Health function, the Conference recommends to the Secretary of Health, Education and Welfare that a Bureau of Environmental Health or an organization of equal status be included in this reorganization plan.

I would like to submit this resolution and ask that the Secretary of our Society be instructed to communicate this resolution to the Secretary of Health, Education and Welfare.

CHAIRMAN BLOOMFIELD: Dave, I take this as a motion that you have made?

DR. FRASER: Yes.

...The motion was seconded by Dr. F. A. Van Atta.

CHAIRMAN BLOOMFIELD: I think this should be aired out and discussed, and we would lik to ask that if there is any discussion, if anybody has any comments, we would like to hear them now.

This is a problem for the consideration of whether this Conference, the A.C.G.I.H., ca or should try to effect a reorganization of this type by virtue of the status of our organization, which I think demonstrates some type of ambivalence. On the one hand we

try to keep away from influencing Government action, in some areas, and on the other I am sure that we do participate. In this case it is going to be a matter of whether we as an organization feel that we should take part or attempt in any way to influence what I believe is a rather touchy situation in A.C.G.I.H. today, and I think we should discuss this before deciding on what action we wish to take.

Mr. Schall.

MR. LYNN SCHALL: Bernie, I am not sure, and Mr. Hosey might straighten us out, but isn't there something legally in our tax free status that prevents us from doing things of this nature?

SECRETARY HOSEY: That has never been clarified, to the best of my knowledge. We have avoided such things just to keep our skirts clean, so to speak, but Pete Yaffe tried to determine whether or not our tax free status would be changed if we did lobby, and I don't think he ever obtained a clear statement from any lawyer on it, so I don't know what the situation is.

MR. SCHALL: Thank you.

CHAIRMAN BLOOMFIELD: We would assume, then, that if we wanted to, we may have our wrists slapped, but there is nothing in the Constitution that would prevent us from being in favor of submitting this as a resolution or a letter.

Mr. Kusnetz.

MR. HOWARD L. KUSNETZ: Thank you, Bernie. I am not speaking to the substance of the resolution. May I make one point in line with Mr. Schall's comment? If this resolution is adopted by the Conference, may I suggest that it would be embarrassing and perhaps illegal for the Secretary, in the position as an employee of that Department, to sign it, and that the resolution be amended for the present Chairman who is not a Federal employee to so sign.

CHAIRMAN BLOOMFIELD: What is your feeling?

MR. KUSNETZ: I will not speak on the subject now. I would rather wait on that a little bit.

CHAIRMAN BLOOMFIELD: Wait until when?

MR. KUSNETZ: I will get back in the discussion. I make this one suggestion, if you would consider that.

DR. HARRY HEIMANN: I would suggest, in the first place, let me say that I agree with Professor Chanlett that in the reorganization, environmental health is being downgraded in the apparent reorganization as it looks right now. I would suggest, too, that some kind of an expression of opinion from this organization should be sent to the appropriate authorities.

I am not so sure that it ought to be sent to the Congress. I think we probably could do better by sending our opinion to the Surgeon General.

I suggest furthermore finally that rather than sending a separate resolution, that we will probably find that the AIHA is going to, I would anticipate. Clark was just whispering in my ear he thought so, that the AIHA will probably get up some kind of a resolution in this direction, and it seems to me that we might do better if we said we join with them as an organization. We join with them in their resolution, and I suspect the wording of their's will be similar to ours. I don't know to whom they are going to send their resolution, but my own feeling is that it ought to be sent to the Surgeon General.

I have a strong suspicion its going to the Congress is not going to accomplish much of anything. Even if it goes to the proper Committees, I don't think it will do very much. I think the time is so short.

CHAIRMAN BLOOMFIELD: You are in favor of our going on record and supporting this?

DR. HEIMANN: Oh, yes, on record for ourselves, yes, but to send a resolution, I suggest it might be done together with AIHA, and I suggest furthermore that it might go to the Surgeon General rather than through any other way.

CHAIRMAN BLOOMFIELD: Technically, then, it would be impossible for us to act on the resolution at this time without being able to consider the AIHA statement. We couldn't join with it unless we knew what it was.

DR. HEIMANN: That's right.

CHAIRMAN BLOOMFIELD: So we can't take any action in that regard.

DR. HEIMANN: What you wanted is a discussion here.

CHAIRMAN BLOOMFIELD: I didn't know that they were going to. I don't know that they are, but I would suspect that they would. Is anybody here from the AIHA? I suspect they are going to.

DR. FRASER: May I speak to this for one moment? The resolution that I proposed was to be sent to the Secretary of the Department of Health, Education, and Welfare.

The Surgeon General might be the more appropriate person. I have not yet had an opportunity to appear before the AIHA Board of Directors, but I hope to do this tomorrow and ask for a similar resolution from them.

DR. HEIMANN: You don't know that they are going to do anything in this direction?

DR. FRASER: No. I am only going to meet with them and make this same proposal.

CHAIRMAN BLOOMFIELD: Miss Trasko.

MISS VICTORIA M. TRASKO: I was just going to suggest can't we pass a resolution to the effect of asking AIHA to submit the resolution to the Secretary of HEW? Can we pass a resolution here to that effect?

CHAIRMAN BLOOMFIELD: We can pass this resolution but would this then include in some way reference to the A.C.G.I.H.?

MISS TRASKO: Asking AIHA to consider adopting that as one of their resolutions.

CHAIRMAN BLOOMFIELD: We would assume that perhaps they would be in favor of this resolution, but, then, if we are in favor of it and they are not, we would be out of line as far as what subsequent action is taken. So, unless we know what AIHA is going to do, we are in a rather difficult position.

Is there any other discussion? Yes, Dr. Van Atta.

DR. F. A. VAN ATTA: I am not inclined to think that we should put from us the action of this organization on the action of the AIHA. I can't quite imagine that they wouldn't be in favor of this sort of a resolution as an organization, but I don't think that should pertinently influence this thing, and I think it is perfectly appropriate and desirable for this organization to send such a resolution to the Secretary of Health, Education and Welfare or to the Surgeon General, whichever seems more appropriate, and I think that it would be a nice courtesy and might have some influence if a carbon copy went to Bill Dawson as Chairman of the Committee.

This is not a legislative matter, so it doesn't involve lobbying, and it does not, I am sure, have anything to do with the tax free status of the organization. That, as I was drilled in great detail when I worked for the National Safety Council, gets involved when you try to influence specific legislation. This is not specific legislation, and sending it to the Chairman of the Committee would be classified as an educational act since he has no bill in front of him to act on at the moment.

I don't think there is any problem about that at all. I don't think Andy Hosey should sign it, really.

CHAIRMAN BLOOMFIELD: Dr. Williams, did you wish to speak?

SECRETARY HOSEY: I want to keep working a little while longer.

DR. EDWIN G. WILLIAMS: I just had perhaps a minor question with regard to Harry Heimann's suggestion. The question is has the Surgeon General already sent forward his plan to the Secretary? If he has, it might be too late. I mean, he might have his hands tied. It is just a question that I thought you should consider. Thank you.

CHAIRMAN BLOOMFIELD: Howard, do you want to speak on this subject?

MR. KUSNETZ: The Surgeon General worked very closely with the Committee which developed this plan and at every meeting of that Committee he or an immediate representative, such as a Deputy or Assistant Surgeon General, and this has gone as a follow-up to the reorganization plan.

DR. WILLIAMS: Has gone?

MR. KUSNETZ: Yes, sir.

CHAIRMAN BLOOMFIELD: Do you want to add anything to that, Howard?

MR. KUSNETZ: I think this is why I wanted to wait. I think Dr. Van Atta pointed out the fact that it would be appropriate. I think it would be inappropriate for me to comment here again as a member of the organization which is affected. This is why I wanted to restrain my remarks, trying to get other members of our organization out of a possible embarrassing situation here.

CHAIRMAN BLOOMFIELD: Situation, yes, sir.

MR. E. J. BAIER: I think that we should act independently of AIHA regarding this. I don't think we should tie in together. I think it might be better to have two organizations opposing it than one joined organization opposing it.

CHAIRMAN BLOOMFIELD: I believe we are going to have to do this, to take action on this particular motion.

Are there any other comments on this? Yes, sir.

MR. C. FRED BERGHOUT: I imagine it is going to be embarrassing for particularly the Public Health Service people to comment, themselves, on a resolution of this type, but, on the other hand, a good percentage of the people are not Government workers in the Federal level, but are in the State and local level, and they ought to have a voice, too, in a resolution of this type, I would think, and perhaps we ought to consider where the major voice lies, whether it is with PHS personnel or with others.

MR. JOHN SOET: I have two suggestions on the resolution. Send the resolution that he just told us about signed by the Chairman to the Surgeon General and send another resolution to the Resolutions Committee of the AIHA, asking them to consider this very seriously and to transmit both resolutions at the same time so we should do this.

CHAIRMAN BLOOMFIELD: John, would you like to - - -

MR. SOET: All right. You request that I make that in the form of a motion. I so move.

SECRETARY HOSEY: Could you sort of repeat it, please? I don't think our stenotypist quite got it.

MR. SOET: I don't know exactly what I did state. I said that we should adopt the resolution as Dr. Fraser stated it and have it sent to the Surgeon General signed by the Chairman of the Conference, and then draw another resolution informing the Resolutions Committee of AIHA that we have adopted this resolution and that we would appreciate their Committee's consideration on the same resolution, and to act in cooperation with us in sending a resolution to the Surgeon General, their own resolution.

CHAIRMAN BLOOMFIELD: You so move?

MR. SOET: Yes, I so move.

DR. VAN ATTA: Second.

UNIDENTIFIED SPEAKER: That is invalid. You have a motion on the floor.

DR. VAN ATTA: This is an amendment to that motion.

CHAIRMAN BLOOMFIELD: Then it will be invalid temporarily. Is there any more discussion on the first resolution or the resolution that we are now considering. That is essentially that the American Conference of Governmental Industrial Hygienists prepare a letter and send it to the Surgeon General's Office, not be be signed by ---

SECRETARY HOSEY: Secretary of HEW, wasn't it? Send it to the Secretary of HEW?

MR. SOET: I thought we had decided to send it to the Surgeon General.

SECRETARY HOSEY: Well, there is confusion on that.

CHAIRMAN BLOOMFIELD: We are going to have to decide who we are going to send this recommendation to. As I recall, Dave ---

SECRETARY HOSEY: Dr. Fraser said Secretary.

CHAIRMAN BLOOMFIELD: Is it Secretary?

DR. FRASER: The Secretary of the Department of Health, Education and Welfare was the original proposal.

CHAIRMAN BLOOMFIELD: Somebody suggested that maybe this should be sent to the Surgeon General. Should we iron this one out at this time? Dr. Van Atta.

DR. VAN ATTA: John Soet just proposed an amendment to this resolution which I seconded which provided that the letter would be signed by the President of this organization and would be accompanied by a parallel resolution to the Committee of AIHA. I think it is appropriate to vote first on the amendment.

SECRETARY HOSEY: He is right.

CHAIRMAN BLOOMFIELD: Please read the resolution.

DR. CURTIS P. McCAMMON: I think it would be much better to go on the order of what somebody back here said, adopt a resolution in which you are going to send it to the Surgeon General or whoever we do send it to, and then adopt a resolution saying to the AIHA Committee that the following resolution has been passed by our Committee, and we transmit this resolution to you for action, rather than getting it all messed up with an amendment to the resolution.

CHAIRMAN BLOOMFIELD: John, who is going to sign the resolution?

DR. FRASER: Shall I read this resolution again?

CHAIRMAN BLOOMFIELD: Yes, please.

DR. FRASER: The resolution which was proposed is be it resolved that this Conference go on record as being in agreement with the reorganization of the Public Health Service to meet present day health needs.

In view of the prominence of environmental health as a Public Health function, the Conference recommends to the Secretary of the Department of Health, Education and Welfare that a Bureau of Environmental Health or an organization of equal status be included in the reorganization plan.

UNIDENTIFIED SPEAKER: Mr. Chairman, I think we are ready for the question.

MR. SOET: Does the Chairman always have the authority to sign a resolution or does the Secretary-Treasurer have to sign it, if there is any resolution?

SECRETARY HOSEY: Either one. There is no set rule on that as far as I know. The Chairman can sign it, and he will, too, in this case.

MR. SOET: I think perhaps the Chairman does have the prerogative to sign rather than the Secretary-Treasurer in anything of this order.

CHAIRMAN BLOOMFIELD: This has been done before.

DR. McCAMMON: Could I have an explanation of what you mean by that? You say establish a Bureau or have equal status. Why do you put that in there?

DR. FRASER: I put this in because I don't think that I can tell the Secretary of Health, Education and Welfare how to organize the department. I am only suggesting that he give a weight to environmental health which is at least equivalent to Bureau status.

UNIDENTIFIED SPEAKER: Let's have the question.

CHAIRMAN BLOOMFIELD: We are now ready for a vote on this issue.

...The motion carried.

CHAIRMAN BLOOMFIELD: We now have to vote on the second resolution which was that we attempt to exert influence on the AIHA by asking their Resolutions Committee to take action on the resolution which would in a sense reflect a similar attitude on the part of AIHA, in other words, ask the AIHA to send a similar letter to the Secretary.

Is there any more discussion on this resolution or does anyone require any explanation on it? If not, then I will call for the question.

...The motion carried unanimously.

CHAIRMAN BLOOMFIELD: Are there any more resolutions?

DR. LEWIS J. CRALLEY: Are there any other resolutions from the floor?

Thank you.

CHAIRMAN BLOOMFIELD: Is there any old business that anyone wishes to bring up at this time?

If not, is there any new business that anybody wishes to bring up?

Mr. Paul Woolrich, do you want to come up here, or, can we hear you?

MR. PAUL F. WOOLRICH: Maybe you can hear me from here. Yesterday we heard that the A.C.G.I.H. has a balance of approximately $40,000 in its treasury with approximately a $6,000 income last year.

If this is an indication of what our income will be for years to come, personally, I think that we have enough of a reserve in our treasury that we can start doing some worthy things with the income that we have in this organization, it not being a profit making organization.

Having given considerable thought to the type of project that A.C.G.I.H. could possibly embark upon, many of these type of things, such as plugging the general field of industrial hygiene, publicity or research projects, perhaps involve so much money off of the top in getting organized and what-not, and inasmuch as we are talking only about perhaps $5,000 or $6,000 a year, the thought occurred to me that a very effective way of spending this money that would be utilized to the fullest and benefit the organization would be in the form, perhaps, of undergraduate scholarships to the dependents, sons and daughters of the Conference.

So I would like to propose that the Executive Committee consider the establishment of three to five undergraduate scholarships of $1,000 each to the sons and daughters and/or dependents of the Conference members, scholarships to be awarded on the basis of academic standing and leadership and not reflecting in any way whatsoever the need of the recipient as reflected in the salary of his father.

CHAIRMAN BLOOMFIELD: Do you so move?

MR. WOOLRICH: I so move.

CHAIRMAN BLOOMFIELD: Is there a second?

SECRETARY HOSEY: Can I speak to that, Paul?

CHAIRMAN BLOOMFIELD: Why don't we get a second.

SECRETARY HOSEY: Oh, I thought you had one. I am sorry.

CHAIRMAN BLOOMFIELD: Is there a second to this? We will not be able to discuss it unless we get a second.

UNIDENTIFIED SPEAKER: Second.

SECRETARY HOSEY: At the meeting of the Executive Committee a year ago, this subject was discussed, and it was decided in view of the complications that might be involved on this particular point that you mentioned, Paul, that we would not do anything about it.

The same subject was discussed this past Saturday evening, and in view of that, Mr. Henry Doyle is going to make some proposals to the Executive Committee which would probably involve the use of some of these surplus funds in an area to increase the awareness of the need for occupational health programs in State and local agencies and what else, Henry, were you going to do?

It is in the notes there that I read yesterday, but Henry is going to come up with a proposal which I think will probably use up most of this surplus, and which the Executive Committee felt would serve a more useful purpose in line with the objectives of our organization than giving scholarships or something of that nature.

Do you want to talk to that, Henry? This is all nebulous right at the moment.

MR. HENRY N. DOYLE: I came in late here, so I don't really know what the resolution on the floor is.

SECRETARY HOSEY: Scholarship.

MR. DOYLE: It was pointed out in the Executive Committee meeting the other day that the American Conference of Governmental Industrial Hygienists was originally organized as an organization to assist in the promotion of Occupational Health and Industrial Hygiene, the original concept being that it was primarily an administrative type of an organization rather than a technical organization.

Over the years the American Conference of Governmental and Industrial Hygienists, I think, has done an outstanding job of developing technical standards. I think during these years, though, we have tended to de-emphasize our responsibilities in the administrative field, so the proposal was made at the Executive Meeting the other day in reference to two points. One was the utilization of these excess funds and another point was how do you go about strengthening State programs; that the Conference reaffirm its activities in this administrative aspect, and one of the concepts that was put on the table was for A.C.G.I.H. to appoint a special Committee to assist, well, really, to first look at State programs to see what kind of activities they are participating in, and then come up with the document similar to the kind of technical documents that we have had in the past, which would lay out the elements of a good State program, give suggestions as to how a State might go about getting support for its activities, and several other features of this type.

The Committee, as I understand it, did not spell out what this should do, but has instructed me to give them a document that they can review which would be in this general field of providing assistance to States or developing a document which States can use as a guideline for programs.

DR. LEWIS J. CRALLEY: I see no conflict here. The resolution recommended that the Executive Committee give consideration to the merits of establishing a scholarship, so they can still study. There is no conflict here. We can vote yes and it is still in the lap of the Executive Committee, which it has to be anyway.

MR. DOYLE: If I might comment just a little bit further on this, I don't know what you could do with one scholarship or two scholarships, which is all you can probably finance in this. You look at the available scholarships today, and they are going begging. They're probably much greater in terms of money than A.C.G.I. H. could give, so I question the wisdom of the utilization of the funds in this respect.

MR. HOWARD L. KUSNETZ: I have a question here, and I suspect Paul has the same thing. If I understood Paul, he is not in his resolution adding any strings or qualifications to scholarships in industrial hygiene. You are talking about scholarships per se, is that right?

MR. WOOLRICH: That's right, and I am not talking, Henry, about the graduate school scholarships at all. I am talking about undergraduate scholarships that are not going begging, but these things are hard to come by, particularly if the parents of the child or the student isn't a member of the Poverty Program. He has no chance of getting one of these scholarships. There are no strings attached. If this son or daughter is, say, above a 3.5 average, whatever the Committee that approves these awards sets up, if he has a 3.5 average or above, and is a real potential leader, and has so demonstrated, then he would be eligible whether she wanted to study music, whether she wanted to study dramatics, whether he wanted to be an engineer or whether she wanted to become a nurse, but there will be a $1,000 scholarship, several of them available to the membership of this Conference or to the dependents of the membership of this Conference.

MR. C. FRED BERGHOUT: I see no reason or need to rush into the idea of spending the money just because we have it. We don't have to hurry up and spend it for something for some reason or other. Right now is the time to hold it, according to President Johnson.

CHAIRMAN BLOOMFIELD: I should like to assure the Conference that as long as I am on the Executive Board, at least, and I am sure everybody else feels this way, that we are going to be very careful before we blow $40,000 and any of the suggestions that have been made to this time. The concept of beefing up State activities will be very carefully considered and the motion on the floor now is that the Executive Committee give consideration to the establishment of scholarships at a later date, at its next meeting.

The vote, then, if you vote in the affirmative, it will be purely to just indicate that this will be given consideration. It will in no way effect the establishment of scholarships as an immediate end. We will just have to decide what to do, so if there is no further discussion --- Is there any?

MR. WOOLRICH: Well, it will also indicate interest on the part of the group for this concept.

CHAIRMAN BLOOMFIELD: That they are in favor of the motion, yes

MR. SOET: Could it be limited that the present Committee, who has this under consideration, that it is only a matter of considering this thing?

CHAIRMAN BLOOMFIELD: Yes.

MR. SOET: Yes. In my time of life, I would also like to amend the statement to include ---

SECRETARY HOSEY: To include what?

CHAIRMAN BLOOMFIELD: Mr. Soet, would you please repeat this? We could not hear it. What was that you suggested, John? Could we have a repeat?

MR. SOET: Never mind.

CHAIRMAN BLOOMFIELD: It must have been funny. Are we ready to vote? If so, we will take a vote on the question.

...The motion carried.

CHAIRMAN BLOOMFIELD: Is there any other new business that anyone would like to bring up?

MR. CARL R. JENSEN: I may be out of order here, but may I suggest that we have a letter sent by the Secretary, he can sign this one, to Duncan Holaday wishing a speedy recovery and say that we missed him here?

(Note: Such a letter was sent to Mr. Holaday on 5/24/66--A.D.H.)

DR. RALPH R. SULLIVAN: Appropo of that, I don't know whether this announcement was made or not, but I saw how Henry Doyle manifested considerable concern regarding Duncan Holaday's situation because of the announcement and the knowledge that he was undergoing surgery yesterday morning, only to find that Duncan is going to have a disc operation on his back, and I was worrying about an abdominal tumor.

I think for the friends of Duncan, very close to the Conference for so long, giving out a little information from the podium regarding undergoing major surgery and not giving us the whole story is really a worrisome thing to do, and although Duncan will be unable to move about for a while, I was considerably relieved to find it only a disc.

CHAIRMAN BLOOMFIELD: I know we have to break. There are a few other items of business that have to take place in the formality of transferring the chairmanship.

I know that we are running into the Harvard Luncheon, for example, but I don't know any other way of circumventing this.

I have to ask John Soet to give a one-minute report on the Academy proceedings last night.

Could you tell us what happened, John?

MR. JOHN SOET: The American Board of Industrial Hygiene at the past two or three meetings have been discussing activating the Academy. While the Board has been active, the Academy itself has not been active in the past five or six years, since we started the certification movement.

In our meeting last night, we decided at one of our Board meetings that we would have a meeting of the Academy to discuss the whole situation of what the Academy should be doing, and we had a meeting last night.

We started out in a small room on the third floor and there were too many members, Diplomats of the Academy, to get into the small room, so we moved up here to the Monongahela Room, and we discussed this thing for about an hour and a half, I believe, or two hours, and Henry Doyle outlined six things in which the Academy could be active, including the areas of education and ethics.

We appointed a committee last night to see what could be done to activate the Academy to get into these six areas that Henry Doyle pointed out.

Russel Hendricks is Chairman of the Committee. Warren Cook is a member, Henry Doyle is a member, and one more is a member on it; oh, yes, C. J. Low (?) is a member.

So we hope we can get the Academy activated, and we have also discussed fees, I might mention that, also, which will be of interest to all you people.

The Board announced that from here on in, beginning July 1st, there will be a fee of $5.00 for the members of the Academy, those people who have been certified. There was some expression on this last night. I don't know if this is the result of going to some of the hospitality rooms or not, but some people even talked about $25 a year, at least having enough money so that the Academy could actually do some work. So the committee is going to come up with a plan for action and activity of the Academy.

CHAIRMAN BLOOMFIELD: Thank you very much.

As the next order of business, and really in the way of singing my swan song, I should like to first thank Dr. Lewis Cralley and Dr. Curtis McCammon for the fine service that they have so willingly given to the American Conference of Governmental Industrial Hygienists. They will now be in the category of retired members of the Executive Committee, but this in no way means that we don't expect interest, while we don't expect active participation and contributions on their part. They have done a fine job and they have worked many years, and I think we ought to give those two fellows a hand as retiring committee members.

... Applause ...

I should now like to call on Dr. Robert Duguid, who will take over as Chairman of the Conference. As a matter of fact, as his first order of business, he takes over right now.

I should like to introduce him to the group. I am sure you all know him.

...Applause ...

Bob, it is with great pleasure that I turn the meeting over to you and hand you the microphone and wish you luck.

DR. ROBERT H. DUGUID: Thank you, Bernie.

It is somewhat unpopular to come in at a point where the time has already expired. I assure you that my comments, however, will be brief.

As your Chairman for the next year, I shall do my best to serve you well. Coming as I do from a non-Public Health Service and a non-state agency, but rather from an agency in the field of occupational health operated by the Army, I am, of course, aware of my lack of familiarity with many of the matters which are important to many of you from the point of view of the Public Health Service and state relationships.

I, therefore, ask that all of you make a special effort to assist in making the coming year a successful one for A.C.G.I.H.

I invite you to write to me at any time you might feel you have suggestions which you believe would be of assistance to your Chairman or to the Conference. I would especially like to have ideas from younger members of the Conference who have joined within the past few years. I believe it is important to elicit the ideas and suggestions of the younger members if A.C.G.I.H. is to continue to grow in stature as an organization carrying out important functions in the field of occupational health.

Thank you.

... Applause ...

Next, in recognition of his devoted service to A.C.G.I.H. during his tenure as Chairman, it is my honor now to present to Bernie Bloomfield this gavel which is appropriately engraved -- a beauty.

CHAIRMAN BLOOMFIELD: Thank you very much.

DR. DUGUID: And on behalf of all members of the Conference, may I thank you, Bernie, for a job well done.

CHAIRMAN BLOOMFIELD: Thank you.

...Applause...

DR. DUGUID: As far as I know, Andy and Bernie, that is it. Do you want to adjourn the meeting?

SECRETARY HOSEY: Meeting adjourned.

DR. DUGUID: I now declare the meeting adjourned.

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(Thereupon, at 12:20 o'clock P.M., the meeting was adjourned.)

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APPENDIX A

Appendix A is an alphabetical listing of new and revised Documentations for changes and additions in the 1966 TLV list. These supplements were prepared since the revised edition of the Documentations of Threshold Limit Values was published in February, 1966. Copies of Appendix A are available to non-members at nominal cost from the Secretary-Treasurer.

ACRYLAMIDE - SKIN

0.3 mg/m^3

Acrylamide is used as a reactive monomer and intermediate in the production of organic chemicals. It has a wide variety of uses as a polymer or copolymer in such applications as: adhesives, fibers, paper sizes, molded parts, water coagulant aids and textiles. It is quite reactive and is known to polymerize with violence when heated (1).

The oral LD50 for laboratory animals is reported to be in the range of 150-180 mg/kg which rates it as of moderate toxicity (2). It thus has a relatively comparable toxicity for all species of experimental animal in which it has been administered. It produces an unusual toxic effect on the central nervous system which is manifested by muscular weakness, ataxia, incoordination, tremors, and hallucinations. The hind quarters of animals are affected more than the fore quarters. Cases of occupational poisoning in man with this type of clinical picture have been noted according to Fassett (3).

Toxic effects may be produced by any route of administration - ingestion, inhalation, injection, skin contact or contact with the eye. Dogs developed the neurologic syndrome within 24 hours when given single oral doses of 100 mg/kg. Cats, the most sensitive species, given 1 mg/kg daily by intravenous or intraperitoneal injection developed the same picture in about 6 months; however, dietary levels in this species between 0.3-1 mg/kg represented a "no-ill effect" dosage. The available studies indicate that the pathologic process is probably limited to the brain, but extensive histopathologic study of the central nervous system in severely poisoned cats have not revealed any significant abnormalities. Kuperman (4) reported that the toxic disturbance was probably subcortical and in the midbrain.

The toxic effects on the central nervous system appear to be quickly reversible in mild cases of poisoning if exposure is terminated; if exposure continues, however, the recovery period may be greatly prolonged. From the results of feeding experiments in the most sensitive animal species it was recommended (2) that no more than 0.05 mg/kg/day be absorbed by workmen. Assuming a respiratory exchange of 10m^3/day, a TLV of 0.3 mg/m^3 (0.1ppm) may be calculated. This limit has proven to be a practical working limit for the prevention of nervous disorder (6).

Fassett in his review (3) noted that the action of acrylamide probably arises from its conversion to a more toxic material by some metabolic process in view of the delay in onset and the need for what appeared to be a definite threshold dose before symptoms became apparent. Stokinger (5) commented on the unusual toxicity of this compound and the fact that there is an anamnestic response--following recovery from the effects of poisoning, the same syndrome is recalled with lesser amounts on reexposure.

References:

1. American Cyanamid Company, Chemistry of Acrylamide, Technical Bulletin Revised, March 1956.

2. McCollister, D. D., Oyen, F., Rowe, V. K., Tox. & Appl. Pharm. 6, 172 (1964).

3. Fassett, D. W., in Industrial Hygiene and Toxicology, F. A. Patty, Ed., 2nd Revised Edition, Vol. II Toxicology. Interscience Publishers. J. Wiley & Sons, New York (1963). p. 1832.

4. Kuperman, A. S.: J. Pharm. Exptl. Therap. 123, 180 (1958).

5. Stokinger, H. E.: Am. Ind. Hyg. Assn. J. 17, 340 (1956).

6. Shaffer, C. B. personal communication to Committee (1966).

sec-BUTYL ALCOHOL

150 ppm (Approximately 450 mg/m^3)

Limited data on the acute toxicity of sec-butyl alcohol indicate it to be less harmful than n-butanol. Smyth, et al. (1,2) found the oral LD_{50} values for rats to be 6.5 and 4.4 g/kg, respectively. Five of six rats exposed at 16,000 ppm of sec-butyl alcohol vapor for 4 hours died. This was more than twice the maximal concentration attainable with n-butanol (3) that caused no deaths in 8 hours.

The TLV for n-butanol is based primarily on its eye effects, however. No information is available on eye irritation from the vapor of sec-butyl alcohol. Liquid sec-butyl alcohol was less injurious to the eyes than n-butanol, however. This relatively meager information suggests that sec-butyl alcohol is somewhat less toxic and irritating than n-butanol. Many years of industrial experience with exposures approximating 100 ppm associated with manufacture "have resulted in no difficulties" (4). A threshold limit of 150 ppm is recommended, therefore, to prevent narcotic and irritative effects.

References:

1. Smyth, H. F. Jr., Carpenter, C. P., Weil, C. S.: Arch. Ind. Hyg. & Occ. Med. 4, 119 (1951).

2. Smyth, H. F. Jr., Carpenter, C. P., Weil, C. S., Pozzani, U. C.: Arch. Ind. Hyg. & Occ. Med. 10, 61 (1954).

3. Mellan, I.: Industrial Solvents, 2nd ed., Reinhold Pub. Corp., New York (1950) p. 489.

4. Communication to Committee, O. M. Banks, Feb. 1966; also D. W. Fassett, Apr. 1966.

α-CHLOROACETOPHENONE (Phenacyl chloride)

0.05 ppm (Approximately 0.3 mg/m^3)

A sufficient number of deaths have been reported in the literature to show that α-chloroacetophenone (CN) can be lethal through its use as a lacrimator (1). Jacobs (1) has estimated the lethal Ct for man to be 8,500 mg-min./m^3 for a t of 10 min; other estimates from animal data (6) indicate an LCt_{50} for man in the same range (8,000-11,000 mg-min/m^3). Accidental over-exposure of the eyes to CN

can result in permanent partial opacity (leukoma); under ordinary exposure, however, the severe conjunctivitis, corneal haziness and pain, though of considerable duration, are not permanent (2). The effective concentration to produce casualties as estimated from volunteer exposure is greater than 100 mg/m^3; a Ct of 150 to 200 mg-min/m^3 is required to force withdrawal from exposure.

The main symptoms of exposure to CN are tingling in the nose, with rhinorrhea, burning of the throat and eyes with lacrimation. Irritation and burning of the skin is experienced especially if the skin is moist. More severe exposure produces pulmonary congestion and edema. The onset of the edema is usually delayed, sometimes as long as 12 hours (1b). An occasional individual may show hypersensitivity to CN, developing a skin rash after a few days without sequelae. Dermatitis has been a common problem in the manufacture of CN (3) but skin absorption is not believed to be a significant health concern.

Human volunteers exposed at 350 mg-min/m^3 indicated CN to be relatively free from systemic toxicity at doses which are extremely irritating to the eyes and respiratory tract (4). Along the same lines, no histopathologic changes were found in animals below Ct of 1,000 mg-min/m^3 (5).

A peculiar, short-lived (45 min.), rapidly developing tolerance occurs to CN when exposure concentrations are sufficiently high to cause profuse lacrimation and other signs of irritation; persistence of CN in the atmosphere leads to cessation of signs and symptoms (6). Cross-tolerance rapidly develops also to brombenzyl cyanide, chloropicrin, chlorocrotonaldehyde, ethyl-chloroformate and trichloromethyl formate.

No permanent effects have been found to occur from severe exposures to CN as far as has been determined from examination of hospital records and questioning of human volunteers. In a few susceptible persons, (3 of several hundred exposed), skin rash was severe, but this disappeared after a few days.

Irritation thresholds range from 0.15-0.4 mg/m^3; lacrimation thresholds from 0.3-0.4 mg/m^3, and odor threshold is at 0.1 mg/m^3.

In light of the minimal effective Ct value being 20 mg-min/m^3, the above information on signs and symptoms and the lack of chronic effects either in animals or man, a TLV of 0.05 ppm (0.3 mg/m^3) is recommended. This level should be sufficiently low to permit tolerated working conditions, i.e. about one-tenth of the minimal effective level for 10 minutes.

References:

1a. Gonzales, T. A., Vance, M., Helpern, M., Umberger, C.: Legal Medicine, Pathology & Toxicology, Appleton-Century-Crafts, Inc. N. Y., 1954; b. Stein, A. A., Kirwan, W.: J. Forensic, Sci., 9, 375 (1964); c. Prentiss, A.: Chemicals in War, McGraw Hill, N. Y. 1937; d. Jacobs, M. B., War Gases, their Identification & Decontamination, Intersci., Pub. Inc. N. Y. 1942.

2. McNally, W. D.: J. Am. Med. Assn., 98, 45 (1932).

3. Personal communication from Charles L. Punte, 1966.

4. Punte, C. L., Gutentag, P. J., Owens, E. J., Gongiver, L. E.: Am. Ind. Hyg. Assn. J. 23, 199 (1962).

5. Punte, C. L., Ballard, T. A., Weimar, J. T., Am. Ind. Hyg. Assn. J. 23, 194 (1962).

6. Communication to Committee by Dr. M. H. Joffe, Edgewood Arsenal, Mar. 1966.

CHROMIUM

Soluble chromic and chromous salts - 0.5 mg/m^3

Metallic chromium and insoluble compounds - 1 mg/m^3

The literature on chromium toxicology is devoted primarily to hexavalent chromium Early studies indicated trivalent (and presumably bivalent) chromium compounds to be essentially nontoxic (1). Dermatitis from certain chromic salts has been reported, however, (2,3) and trivalent chromium compounds have been found to react with protein (4).

Chest roentgenograms have revealed "exaggerated pulmonic markings" in a number of workers exposed to chromite dust (5). A number of cases of pulmonary disease occurred in a plant making ferrochrome alloys (6). An average chromium concentration of 0.27 mg/m^3 was reported in one area. Other dusts and fumes were present in the plant, however.

Although hexavalent chromium has usually been present in plants where lung cancer incidence was high, experimental evidence has been reported indicating that trivalent chromium possesses carcinogenic properties (7). Animals ingesting chromic salts showed one-ninth as much chromium in the tissues as did animals ingesting equal amounts of chromate (8).

The above reports indicate that chromic compounds, although less toxic than hexavalent chromic acid, cannot be considered harmless. The TLVs of 0.5 mg/m^3 of soluble chromium and 1 mg/m^3 of insoluble chromium (with the exception of hexavalent chromium compounds) are recommended to prevent pulmonary disease or other toxic effects.

References:

1. Akatsuka, K., Fairhall, L. T.: J. Ind. Hyg. 16, 1, (1934).

2. Morris, G. E.: Arch. Derm. 78, 612 (1958).

3. Fregert, S., Rorsman, H.: Arch. Derm. 90, 4 (1964), abstracted in J. Occ. Med. 7, 49 (1965).

4. Pierce, J. O., Scheel, L. D.: Arch. Environ. Health 10, 870 (1965).

5. Government of India, Ministry of Labour, Report No. 1 (1953) p. 24.

6. Princi, F., Miller, L. H., Davis, A., Cholak, J.: J. Occ. Med. 4, 301 (1962).

7. Hueper, W. C., Payne, W. W.: Arch. Environ. Health 5, 445 (1962).

8. MacKenzie, R. D., Byerrum, R. U., Decker, C. F., Hoppert, C. A., Langham, R. F.: Arch. Ind. Health 18, 232 (1958).

COBALT (Metal Dust & Fume)

0.1 mg/m^3

Pulmonary involvement consisting of chronic interstitial pneumonitis has now been reported with sufficient frequency in workers associated with the tungsten-carbide industry to give credence to the belief of Miller, et. al. (1) that cobalt is the probable etiologic agent, although the carbides of tungsten, tantalum and titanium are commonly present in the exposure atmosphere. A chronic pneumonitis has been also produced in animals from cobalt metal (2). Fairhall and Keenan (3) showed cobalt to be ubiquitously present throughout the entire industrial plant and serious and occasionally fatal responses occurred from exposures of the order of 1 to 2 mg or less cobalt/m^3. Lung changes frequently were not progressive, often improved considerably upon removal from exposure. Hypersusceptibility appears to be involved because the pulmonary responses occurred at low incidence, varied in intensity and time of onset. Animal studies tended to confirm the hypersusceptibility theory (4), but were not productive of the characteristic lung lesion seen in workers. A dermatitis of the allergic type has been described by Schwartz (5) from contact with cobalt and its compounds; a "carboloy-itch" has also been described.

Air-borne dust samples of metal dust and fume collected and analyzed in a large industry by the Michigan Dept. of Health for cobalt in 1946, 1956, 1958, 1960 and 1964 showed a gradual reduction from a high of 14.42 mg/m^3 in '46 to a maximum of 1.5 mg/m^3 ten years later. Since 1956, improved control measures have further reduced exposure to concentrations at or below 0.1 mg/m^3 determined as cobalt. Concomitant with this reduction, no new cases of systemic cobalt disease or dermatitis have occurred.

Another small survey made by the Pennsylvania Dept. of Health showed breathing zone concentrations could be controlled to about 0.07 mg/m^3; without control, the concentrations were about 0.5 mg/m^3.

A TLV of 0.1 mg/m^3 of cobalt metal fume and dust has been achieved without undue economic or technical difficulty and is recommended in view of the industrial experience of lack of hypersusceptible reactions. Whether 0.1 mg/m^3 is sufficiently low to prevent responses in all workers must await further experience at this level.

References:

1. Miller, C. W., Davis, M. W., Goldman, A., Wyatt, J. P.: Arch. Ind. Hyg. & Occup. Med. 8, 453 (1953); Lundgren, K. D., Ohman, H.: Arch. path. anat.: 325, 259 (1954); Lundgren, K. D., Swensson, A., Acta Med. Scand.: 145, 20 (1953).

2. Schepers, G. W. H., Arch. Ind. Health 12, 127 (1955).

3. Fairhall, L. T., Castberg, H. T., Carrozzo, N. J., Brinton, H. P.: Occup. Med. 4, 371 (1947); Fairhall, L. T., Keenan, R. G., Brinton, H. P., Pub. Health Rep. 64, 485 (1949).

4. Stokinger, H. E., Wagner, W. D.: Arch. Ind. Health 17, 273, (1958).

5. Schwartz, Tulipan, Birmingham, Occupational Diseases of the Skin, 3rd Ed. Lea & Febiger, Phil., (1957).

DIBUTYL PHOSPHATE

5 mg/m^3

Di-n-butyl phosphate is a pale amber liquid, and is a moderately strong monobasic acid (1). It decomposes at temperatures over 100°C. It has limited industrial use at present as an organic catalyst. Some workers exposed to it have complained of respiratory irritation and headache (2).

A TLV of 5 mg/m^3 is proposed by analogy with tributyl phosphate. This should be sufficiently low to prevent sensory effects.

References:

1. Albright and Wilson (Mfg.) Limited, London, England: Brochure, Organo Phosphorus Compounds, Nov. 1960.

2. Mastromatteo, E.: Personal communication to Committee, 1964.

DIISOPROPYLAMINE - SKIN

5 ppm (Approximately 20 mg/m^3)

Treon, et al., found that 20 to 40, 7-hour exposures at 260 ppm caused deaths in rabbits and guinea pigs, but not in rats and cats (1). Opacity of the cornea of the eyes was observed in these animals, as well as irritation of respiratory mucous membranes. They cite reports of disturbances in vision in workers where concentrations averaged between 25 and 50 ppm.

The acute toxicity of diisopropylamine is considerably greater than that of isopropylamine, diethylamine or ethylamine, the concentrations causing death to animals in 4 hours being approximately 1000, 6000, 4000, and 8000 ppm respectively (2,3).

Although these results would indicate a considerably lower threshold limit for diisopropylamine than for the corresponding monoamine, the industrial experience above cited indicates that a level of 5 ppm should provide a reasonable margin of safety against disturbance of vision, as well as irritation of respiratory passages.

References:

1. Treon, J. F., Sigmon, H., Kitzmiller, K. V., Heyroth, F. F.: J. Ind. Hyg. 31, 142 (1949).

2. Smyth, H. F. Jr., Carpenter, C. P., Weil, C. S., Pozzani, U. C.: Arch. Ind. Hyg. & Occ. Med. 10, 61 (1954).

3. Smyth, H. F. Jr., Carpenter, C. P., Weil, C. S.: Arch. Ind. Hyg. & Occ. Med. 4, 119 (1951).

DIBUTYLPHTHALATE

5 mg/m^3

Dibutylphthalate has low acute and chronic oral toxicity according to Smith (1). The maximal concentration that did not inhibit growth of rats in a chronic 1-year feeding study was 0.25% of the diet. In vitro studies with pancreatic lipase indicated that dibutylphthalate is metabolized similarly to fat in the diet.

Cagianut (2) reported that a chemical operator who swallowed by accident 10 g dibutylphthalate became nauseated and dizzy, experienced photophobia, lacrimation and conjunctivitis, but made a prompt and uneventful recovery.

Although no specific information has been reported on the local irritative effects of dibutylphthalate, the phthalate esters closely related to dibutyl are regarded as inert. They rarely cause skin difficulties and are not absorbed by this route. It is however, irritating to the eyes and nose.

From the standpoint of hazard by inhalation, the dibutyl ester should present little problem because of its low vapor pressure; inhalation of significant amounts would occur only by spray or mist exposures. Its wide use as an insect repellent for man during World War II resulted in no reports of toxic symptoms.

A TLV of 5 mg/m^3 is recommended more from the standpoint of controlling excessive air-borne mists of dibutylphthalate rather than as a health measure.

References:

1. Smith, C. C., Arch. Ind. Hyg. & Occup. Med. 7, 310 (1953).

2. Cagianut, B., Schweiz Med. Wochschr. 84, 1243 (1954).

DIMETHYLPHTHALATE

5 mg/m3

Dimethylphthalate has been used as an insect repellant, with no reported skin irritation or sensitization; some skin absorption has been reported (1). Ingestion causes gastrointestinal irritation and coma, and hypotension has been reported (2). The oral LD_{50} for a variety of animal species varied from 2 to 8 ml/kg (2.4 to 9.5 g/kg) with a cutaneous LD_{50} of more than 10 ml/kg (12 g/kg) in the rabbit (2). Like dibutylphthalate, exposure to dimethyphthalate occurs from spray or mist, rather than from the vapor, unless heat is applied.

A TLV of 5 mg/m^3 is recommended to control the excess mist.

References:

1. Handbook of Organic Industrial Solvents, Technical Guide No. 6, 2nd ed., National Association of Mutual Casualty Companies, Chicago (1961).

2. Sollmann, T.: A Manual of Pharmacology, Saunders, Philadelphia (1957).

DIPHENYL (Biphenyl)

0.2 ppm (Approximately 1 mg/m^3)

Diphenyl is not highly toxic by ingestion, the oral LD_{50} being of the order of 2 g/kg body weight (1). The effects of repeated exposure to the dust consisted chiefly of irritation and lesions of the respiratory passages. According to Deichmann, et al., (1) the maximal safe concentration of diphenyl dust for repeated exposure is above 300 mg/m^3 for rabbits, between 5 and 40 mg/m^3 for rats, and below 5 mg/m^3 for mice.

Gerarde states that no cases of chronic diphenyl intoxication in man have been reported (2). Exposure to a mixture of diphenyl and diphenyl oxide in concentrations well below 7 ppm is irritating to the eyes, nose and throat (3). Diphenyl is converted in the body (rabbit) largely to 4-hydroxy compounds conjugated with glycuronic and sulfuric acids, and is thus detoxified (4).

A threshold limit of 0.2 ppm (1 mg/m^3) is recommended to prevent irritation and injury to the respiratory passages.

References:

1. Deichmann, W. M., Kitzmiller, K. V., Dierker, M., Witherup, S.: J. Ind. Hyg. 29, 1 (1947).

2. Gerarde, H. W.: Toxicology and Biochemistry of Aromatic Hydrocarbons, Elsevier Pub. Co., New York (1960) p. 200.

3. Health Hazards and Precautions for the Safe Handling and Use of Dowtherm A. The Dow Chemical Co., Midland, Mich., May 10, (1950).

4. Hake, C. L., Rowe, V. K., in Ind. Hyg. & Toxicol. Vol. II, Irish & Fassett, eds., p. 1703, Intersci. Pub. N. Y., (1962).

C ETHYLENE GLYCOL DINITRATE AND/OR NITROGLYCERIN - SKIN

0.2 ppm (Approximately 1.9 mg/m^3) EGDN
1.2 mg/m^3) NG
0.02 ppm, For intermittent exposures only.

Repeated Daily Exposures (0.2 ppm). The past threshold limit of 0.5 ppm relates to exposures to nitroglycerin (NG). Continuing industrial experience clearly indicates that this limit is in need of revision in two respects. First, major

exposures in dynamite-producing plants is to a mixture of ethylene glycol dinitrate (EGDN) (60% or 80%) and nitroglycerin (20 or 40%); second, the 0.5 ppm limit may not protect the worker against fatalities. Not all exposures are to combined NG and EGDN, however.

Although there is at present no firm toxicologic basis for determining precisely what reduction should be made in the past limit, the following facts indicate that some reduction in the 0.5 ppm limit is required. In general, the industries that maintain atmospheric levels daily around 1 to 2 milligrams per cubic meter (0.25 ppm) as an upper limit of combined EGDN and NG have experienced no serious difficulties. Therapeutic doses of 0.3 mg NG are known to have an effect on the heart (dilatation of coronary arteries) and the arteries of the dura, and may result in headache in some individuals (1). This is a dose well below that obtained from exposure at the limit of 0.5 ppm for an 8-hour working day. The other difficulties, related to the recommendation of the threshold limit for EGDN and NG, are the practically incomplete knowledge of the mechanism of the action of these organic nitrates (2). Fatalities apparently occur as a result of withdrawal symptoms, not directly from the exposure itself (3). Moreover, the magnitude of the dose obtained by the cutaneous route relative to that by inhalation is variable and unknown; EGDN is known, however, to be absorbed with considerable ease through the intact skin (4) (5).

Zurlo, et al. (6) have developed a method of analysis that permits separate determination of NG and EGDN in the presence of each other and thus a separate limit for each substance. On present knowledge the limit for each separately should be equal to the limit of the combined EGDN + NG namely 0.2 ppm. Because of the type of risk involved, this limit should represent a ceiling "C" value, not to be exceeded.

Intermittent Exposures. A recent study by Trainor & Jones (7) of the thresholds for lowered blood pressure and headache among volunteers exposed to a mixture of NG and EGDN showed immediate fall in blood pressure and marked headache at the TLV of 2 mg/m^3. A mean concentration of 0.7 mg/m^3 for 25 minutes also produced lowered blood pressure and slight headache. Similar observations were reported by Hanlon & Fredrick (8); complaints of headache and irritation were made by workers exposed on an intermittent basis from breathing-zone levels of from 0.03 ppm to 0.11 ppm. Headache complaints subsided when concentrations were reduced to below 0.01 ppm.

A ceiling TLVof 0.02 ppm for NG and EGDN combined for intermittent exposures only is recommended to prevent blood pressure lowering and headaches.

References:

1. Drill, V. A.: Pharmacology in Medicine, 2nd ed. McGraw-Hill Book Co., New York, 1958.

2. von Oettingen, W. F.: The effects of aliphatic nitrous and nitric acid esters on the physiological functions with special reference to their chemical constitution. Nat. Inst. Health Bull. No. 186, U.S. Government Printing Office, Washington, D. C., 1946.

3. Barsotti, M.: Med. lavoro 45, 544 (1954).

4. Gross, E., Kies, M., Resag, K.: Arch. Toxikol. 18, 194 (1960).

5. Forssman, S., Masreliez, N., Johansson, G., Sundell, G., Wilander, O., Bostrom, G.: Arch. Gewerbepath, Gewerbehyg. 16, 155 (1958).

6. Zurlo, N., Conti, M., Nichelatti, T.: Med. lavoro 54, 166 (1963).

7. Trainor, D. C., Jones, R. C., Arch. Envir. Hlth. 12, 231 (1966).

8. Hanlon, J. J., Fredrick, W. G., Arch. Envir. Hlth. 12, 676 (1966).

GASOLINE

The composition of gasoline varies greatly and thus a single TLV for all types of gasoline is no longer applicable. In general, the aromatic hydrocarbon content will determine what TLV applies. Consequently the content of benzene, other aromatics and additives should be determined to arrive at the appropriate TLV (Elkins, et al. A.I.H.A.J. 24, 99, 1963).

HEXACHLORONAPHTHALENE - SKIN

Animal studies have shown that mixtures of pentachloronaphthalene and hexachloronaphthalene were more toxic than the penta-, tetrachlor-derivative mixtures (1). Air studies in a plant where fatal cases of yellow atrophy of the liver occurred, revealed concentrations of mixed penta- and hexachloronaphthalene between 1 and 2 mg/m^3 (2).

Ingestion experiments with cattle have shown hexachloronaphthalene to be more toxic than pentachloronaphthalene (3). Since the TLV for the latter compound is 0.5 mg/m^3, a somewhat lower value is indicated for hexachloronaphthalene.

A limit of 0.2 mg/m^3 is recommended to prevent liver damage and to minimize the incidence of chloracne.

References:

1. Drinker, C. K.: J. Ind. Hyg. & Toxicol. 21, 155 (1939).

2. Elkins, H. B.: The Chemistry of Industrial Toxicology, John Wiley & Sons, Inc., New York, 2nd Ed. (1959) pp. 151-152.

3. Bell, W. B.: Vet. Med. 48, 135 (1953).

iso-BUTYL ALCOHOL

100 ppm (Approximately 300 mg/m^3)

Limited data on the acute toxicity of iso-butyl alcohol indicate it to be somewhat more toxic than n-butanol. According to Smyth and coworkers, the oral LD_{50}s for rats are 2.5 and 4.4 g/kg respectively (1,2). A 4-hour exposure at 8000 ppm resulted in the death of two of six rats. No deaths occurred after eight hours in air nearly saturated with n-butanol. Air saturated with n-butanol vapor at 25°C will contain 7900 ppm; at 20°C - 6600 ppm (3).

The TLV for n-butanol, however, is based primarily on eye irritation. No data are available on the effects of iso-butyl alcohol vapor on the eyes. The injury to the eye caused by the liquid, however, is comparable to that from n-butanol. By analogy with n-butanol and tert-butyl alcohol, a limit of 100 ppm is recommended.

References:

1. Smyth, H. F. Jr., Carpenter, C. P., Weil, C. S.: Arch. Ind. Hyg. & Occ. Med. 4, 119 (1951).

2. Smyth, H. F. Jr., Carpenter, C. P., Weil, C. S., Pozzani, U. C.: Arch. Ind. Hyg. & Occ. Med. 10, 61 (1954).

3. Mellan, I.: Industrial Solvents, 2nd ed. Reinhold Pub. Corp., New York (1950) p. 489.

MALEIC ANHYDRIDE

0.25 ppm (Approximately 1 mg/m^3)

Maleic anhydride closely resembles phthalic anhydride in its toxicologic properties of skin, eye and upper respiratory tract irritation. As an irritant, it is recognized to be somewhat more potent than phthalic. Similarly, it is regarded to be a sensitizer of the skin and respiratory tract (1).

On the basis of analogous but more severe toxicologic action of maleic anhydride in comparison with phthalic anhydride, a TLV of 1 mg/m^3 is recommended. Experience is needed to confirm or deny the suitability of this limit; it may not be sufficiently low to prevent occasional respiratory sensitization in highly susceptible workers (2).

References:

1. Communication to Committee Member by J. J. Ferry, Jan. 1964.

2. Communication to Committee Member by J. J. Ferry, March, 1965.

NAPHTHA, COAL TAR

100 ppm (Approximately 400 mg/m^3)

This is primarily a mixture of toluene and xylene; see documentation on these chemicals.

NITRIC OXIDE

25 ppm (Approximately 30 mg/m^3)

Nitric oxide is converted spontaneously in air to nitrogen dioxide, hence some of the latter gas is invariably present whenever nitric oxide is found in the air. At concentrations below 50 ppm however, this reaction is slow, (1) and frequently substantial concentrations of NO may occur with negligible quantities of NO_2 (2).

Similarly, NO, when generated at high temperatures (oxyacetylene torch, 5600-6000°C) has been shown to comprise 95% of the nitrogen oxides (6).

The chief toxic effect of NO has been ascribed to the formation of methemoglobin (3) and subsequent action on the central nervous system.

Animal experimental data indicate that NO is about one-fifth as toxic as NO_2 (4.5) assuming minimal contamination with NO_2 and no synergistic action.

The information available on the mechanism of NO intoxication suggests that in mixtures with carbon monoxide, as well as NO_2, additive effects should be assumed. A threshold limit of 25 ppm is proposed for NO alone.

References:

1. Elkins, H. B.: J. Ind. Hyg. & Tox. 28, 37 (1946).

2. Wade, H., Elkins, H., Ruotolo, B.: Arch. Ind. Hyg. & Occup. Med. 1, 81 (1950).

3. Flury, F. and Zernik, F., Schadliche Gase, Springer (1931).

4. Gray, E. L.: Arch. of Ind. Health 19, 479 (1959).

5. Pflesser, G.: Arch. exptl. Path. Pharmacol. Naunyn-Schmiedelberg's 179, 545 (1935).

6. Norwood, M. D., Adley, F. E. et al., J. Occup. Med. 8, 301 (1966).

OCTACHLORONAPHTHALENE - SKIN

0.1 mg/m^3

No data are available on the effects of inhalation of octachloronaphthalene fumes or dust. Ingestion experiments on cattle have yielded divergent results, insofar as the relative toxicities of the octa- and hexa-chloronaphthalenes are concerned. Sikes, et al. fed both compounds to cattle, and concluded that the greater the degree of chlorination, the more toxic the compound (1). On the other hand, Bell found octachloronaphthalene definitely less toxic than the hexachlor derivative (2). It is possible that this finding was due to poorer absorption of the less-soluble octachloronaphthalene.

Until more data are available, a limit of 0.1 mg/m^3 is recommended for octachloronaphthalene. This should prevent serious liver injury and probably minimize skin effects.

References:

1. Sikes, D., Wise, J. C., Bridges, M. E.: J. Amer. Vet. Med. Assn. 121, 337 (1952).

2. Bell, W. B.: Vet. Med. 48, 135 (1953).

PARAQUAT - SKIN

(1,1'-dimethyl-4,4'-bipyridinium dichloride and dimethosulfate)

0.5 mg/m^3

Paraquat is an ionizable organic compound used as an herbicide. Toxicity depends solely on the cation moiety, and all salts have equivalent toxicity. A wide species variation of acute oral toxicity is reported by Clark (1) extending from 30 mg/kg ion as cation for the guinea pig to 262 mg/kg ion for the hen. The same author gives a value of 127 mg/kg ion as the acute oral LD_{50} for female rats. The dermal toxicity is of the same order of magnitude, the dermal LD_{50} for rabbits being 240 mg/kg ion (2).

The 4-hour LC_{50} to rats for paraquat in air is 6,400 mg/m^3. A concentration of 100 mg/m^3 was tolerated 6 hrs/day, 5 days/week, for 3 weeks by dogs, rats, and guinea pigs with only moderate retardation of growth (3).

The TLV of 0.5 mg/m^3 is believed to be sufficiently low to prevent systemic toxicity.

References:

1. Clark, D. G., Industrial Hygiene Research Laboratories Report England, 1 HR/170, 1964.

2. McElligott, T. F., Industrial Hygiene Research Laboratories Report, 1 HR/172, 1965.

3. Palazzolo, R. J., Subacute aerosol inhalation toxicity of Ortha Paraquat. Report to Imperial Chemical Industries, Ltd., 1965.

PHENYL GLYCIDYL ETHER (PGE)

10 ppm (Approximately 62 mg/m^3)

A group of 10 rats exposed to 100 ppm PGE 7 hours a day for 50 days, showed mean weekly weight gains which did not differ from those of the control animals (1). Tissues were grossly and microscopically normal in most cases, but two rats showed peribronchial and perivascular pulmonary inflammatory cell infiltration and "cloudy swelling" in the liver. Only minimal signs of eye irritation and respiratory distress were noted. The LC_{50} for mice (4 hours) was 100 ppm, and for rats (8 hours) 100 ppm (highest vapor concentration attained). Intragastric LD_{50} values were 1.40 and 3.85 g/kg respectively for mice and rats, while percutaneous LD_{50} for rabbits was 2.99 g/kg. Predominant toxicologic activity was depression of the central nervous system after intragastric administration. Death results from paralysis of the respiratory muscles. Animals which survived exhibited a reversal of the depressant effect with increased degree of activity of the central nervous system. Smyth et al. (2) reported a single dose oral LD_{50} for PGE of 426 g/kg. 8 hours

exposure to near-saturated vapor produced no deaths. PGE is practically nontoxic on percutaneous absorption, mildly irritating to the eye, and use experience indicates moderate skin irritation on prolonged or repeated contact and several cases of skin sensitization.

The TLV of 10 ppm is believed sufficiently low to prevent depression of the central nervous system, and is just below the saturated vapor pressure at room ttmperature.

References:

1. Hine, C. H., Kodama, J. K., Wellington, J. S., Dunlap, M. K., Anderson, H. H., A.M.A. Arch. Ind. Health 14, 250 (Sept. 1956).

2. Smyth, H. F. Jr., Carpenter, C. P., Weil, C. S., Pozzani, U. C., A.M.A. Arch. Ind. Hyg. 10, 61 (1954).

PROPYL ALCOHOL (Normal propyl alcohol)

200 ppm (Approximately 490 mg/m^3)

The principal action of n-propyl alcohol is that of a mild narcotic. It is considered to be somewhat more toxic than isopropyl alcohol (1).

Smyth and associates found the LD_{50} of n-propyl alcohol for rats to be 1.9 g/kg (2) and that of isopropyl alcohol 5.8 g/kg (3). Munch and Schwartze (4) cited data indicating that the oral lethal dose (producing death within 24 hours) of the normal and the isomeric alcohol for rabbits is 3.5 and 10.0 ml/kg. respectively. Starrek (5) found that when mice were exposed to n-propyl alcohol vapor, deep narcosis occurred in 60 minutes at 24,500 ppm and in 240 minutes at 4,100 ppm. Ataxia appeared in 90 to 120 minutes at 3,250 ppm. With isopropyl alcohol vapor, deep narcosis was evident in 100 minutes at 24,500 ppm, and in 460 minutes at 3,250 ppm. Ataxia was manifested in 180 to 195 minutes at 3,250 ppm.

Many industrial hygienists consider the vapor to be somewhat more irritating to the throat than isopropyl alcohol vapor. However, no experimental work on human subjects has been reported to show the concentrations at which sensory response to the vapor is experienced. Nelson and associates (6) described tests with isopropyl alcohol vapor in which unaccustomed subjects experienced mild irritation of the eyes, nose and throat at a concentration of 400 ppm.

By analogy with isopropyl alcohol, a threshold limit value of 200 ppm is recommended.

References:

1. Gleason, M. N., Gosselin, R. E., Hodge, H. C.: Clinical Toxicology of Commercial Products, Williams and Wilkins Co., Baltimore, Md. (1963), p. 99.

2. Smyth, H. F. Jr., Carpenter, C. P., Weil, C. S., Pozzani, U. C.: Arch. Ind. Hyg. Occ. Med. 10, 61 (1954).

3. Smyth, H. F. Jr., Carpenter, C. P.: J. Ind. Hyg. Toxicol. 30, 63 (1948).

4. Munch, J. C., Schwartze, E. W.: J. Lab. Clin. Med. 10, 985 (1925).

5. Starrek, E.: Dissertation, Wurzburg, 1938. Cited in Ind. Hyg. & Tox. F. A. Patty, Ed., Interscience Publishers, N. Y. (1963), pp. 1434-1438.

6. Nelson, K. W., Ege, J. F., Ross, M., Woodman, L. E., Silverman, L.: J. Ind. Hyg. Toxicol. 25, 282 (1943).

RONNEL

0,0-dimethyl-0-(2,4,5-trichlorphenyl)-phosphorothioate

15 mg/m^3

Ronnel is an indirect cholinesterase inhibitor whose oxygen analog is a relatively weak inhibitor which seems to affect primarily the pseudoesterases of the blood plasma rather than the red cell acetylcholinesterase (1,2). The acute oral LD_{50} has been found to be about 1,250 mg/kg for the male rat, and 2,630 mg/kg for the female rat. Other species tested have shown comparable reactions, with the dog having an oral LD_{50} greater than 500 mg/kg. Ronnel has not been shown to potentiate the effect of any of the commonly used organophosphorus insecticides to any significant extent. Rats fed Ronnel in their diets in concentrations of as much as 50 mg/kg/day for 2 years did not show any differences from the controls in growth rate, food consumption, mortality rate or hematopoiesis (3). No skin sensitizing potential was found with patch tests on 50 human subjects (3).

On the basis of the work reported and analogy with parathion and malathion (see justifications for those materials) a threshold limit value of 15 mg/m^3 has been assigned to Ronnel. This TLV sets an upper limit for exposure to that of a relatively inert particulate. It should afford a reasonable margin of protection against irritation and central nervous system effects.

References:

1. Plapp, F. W., Casida, J. E.: J. Agr. & Food Chem. 6, 662, (1958).

2. Plapp, F. W., Casida, J. E.: J. Econ. Ent. 51, 800 (1958).

3. McCollister, D. D., Oyen, F., Rowe, V. K.: J. Agr. & Food Chem. 7, 689 (1959).

C TERPHENYLS

1 ppm (Approx. 9.4 mg/m^3)

The terphenyls are used as heat-exchange fluids and also as atomic reactor moderator-coolants. The commercial preparations used contain mixtures of the three isomers and other polyphenyls. The ortho isomer is the most soluble of the three and

has the highest vapor pressure; it is also the most toxic on ingestion. In general, because of the low vapor pressure and the low order of toxicity of the terphenyls, little industrial hygiene hazard would be expected in handling them under ordinary conditions (1).

Experimental toxicity data particularly relating to inhalation of concentrations likely to be encountered in the use of terphenyls are limited. Haley et al. (2) found that the vapors were irritating to the conjunctiva and skin of rabbits. Intracutaneous injection produced both chemical necrosis and evidence of sensitization in guinea pigs. Inhalation of relatively high concentrations (ranging from 660 to 3,390 mg/m^3) of mixed and single isomers for periods of one hour and 14 days, caused respiratory irritation in rats with death at the higher concentrations. The pathologic changes noted in the respiratory tract were: acute tracheal necrosis, acute tracheobronchitis, pulmonary edema, bronchopneumonia, atelectasis and petechial hemorrhages.

Cornish et al. (3) carried out acute oral and 30-day feeding studies. In general they found the terphenyls to be of low order of toxicity by ingestion. Rats fed 0.25 to 0.5 gm/kg per day over 30 days showed a diminution in weight gain and differences in liver and kidney organ weights. Petkau and Hoogstraaten (4) carried out acute and chronic feeding studies in rats. Their results were in general agreement with the earlier work reported. Chronic feeding over 235 days in rats at relatively high dietary intake levels (350 mg/kg per day) resulted in reduction of weight gain, fall in hemoglobin and cellular changes in the kidneys which were irreversible.

Testa and Masi (5) described methods of determining polyphenyls in air. In their article they gave results of air sampling for terphenyls associated with its use as a reactor coolant. These results are of interest. Concentrations in the reactor room under normal operating conditions (terphenyls at 220 to 230°C in the reactor) ranged from 0.1 to 10 mg/m^3. When the coolant was heated to 330 to 340°C, the concentrations ranged from 10 to 280 mg/m^3. These authors noted that concentrations above 10 mg/m^3 were associated with eye and respiratory irritation in exposed workers. They erroneously quote a 50 mg/m^3 as a maximal allowable concentration for terphenyls, attributing this figure to the "United States Industrial Hygiene Department."

The available toxicologic data indicate that terphenyls may produce eye, skin and respiratory irritation; they may also cause sensitization, but this has not been shown in man. Workers in exposure to dust and vapor experienced marked irritation at concentrations in air above 10 mg/m^3. On this basis a Threshold Limit Value of 1 ppm (about 9.4 mg/m^3) as a ceiling value is recommended to prevent irritation of the eye and respiratory tract.

It should be pointed out that when terphenyl mixtures (and other polyphenyls) are used in atomic reactors, chemical changes are produced by irradiation. The toxicologic effect of irradiated terphenyls is substantially different. Higher boiling, long-chain polymers are formed which may be less irritating to the skin, eye and respiratory tract (2) but present other toxicologic considerations. For example, Petkau and Hoogstraaten found that irradiated terphenyls produced changes in the liver of rats on a dietary intake of 33 mg/kg or more per day, while the

non-irradiated terphenyls at levels of 350 mg/kg or more per day produced kidney changes. The suggested TLV of 1 ppm (9.4 mg/m3) refers, therefore, to the non-irradiated terphenyls.

References:

1. Gerarde, H. W., in Industrial Hygiene and Toxicology, F. A. Patty, Editor, 2nd Revised Edition, Vol. II, Toxicology. Interscience Publishers. J. Wiley and Sons, New York (1963) p. 1220.

2. Haley, T. J., Detrick, L. E., Komesu, N., Williams, P., Upham, H. C., and Baurmash, L.: Toxicol. & Appl. Pharmacol. 1, 515 (1959).

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4. Petkau, A., Hoogstraaten, J.: Am. Ind. Hyg. Assoc. J. 26, 380 (1965).

5. Testa, C., Masi, G.: Anal. Chem. 36, 2284 (1964).

TETRACHLORONAPHTHALENE - SKIN

2 mg/m3

Small-animal studies with mixtures of tri- and tetra-chloronaphthalene have shown them to be less toxic to the liver than more highly chlorinated derivatives, both by inhalation and ingestion (1,2).

Industrial experience is compatible with the above finding, and most cases of human intoxication from this group of compounds have involved penta- or hexa-chloronaphthalene. One nonfatal case of toxic hepatitis was reported from a plant where air studies revealed a concentration of about 3 mg of trichloronaphthalene per cubic meter of air (3). In all probability some tetrachloronaphthalene was present (4).

Ingestion experiments with cattle have indicated tetrachloronaphthalene to be more toxic than trichloronaphthalene, but not more than 1/6 as toxic as the pentachlor derivative (5).

A limit of 2 mg/m3 is recommended for tetrachloronaphthalene to prevent liver injury and minimize skin effects.

References:

1. Drinker, P., Warren, M. F., Bennet, G. A.: J. Ind. Hyg. & Toxicol., 19, 283, (1937).

2. Drinker, P.: J. Ind. Hyg. & Toxicol., 21, 255 (1939).

3. Mayers, M. R., Smith, A. R.: N. Y. Ind. Bull., January 1942, p. 30.

4. Koppers Company, Inc.: Halowax Chlorinated Naphthalenes. Koppers Company, Inc., Tar Products Division Division, Pittsburgh, Pa.

5. Bell, W. B.: Vet. Med. 48, 135 (1953).

TRIBUTYL PHOSPHATE

5 mg/m^3

Tri-n-butyl phosphate is encountered in industrial operations where it is used as an antifoaming agent, plasticizer, and complexing agent in the extraction of heavy metals from their ores (1). Workers exposed to it have complained of nausea and headache (2). There is little published information on tributyl phosphate. The majority of the phosphate esters which are used industrially are liquids with very high boiling points. Few of them have received intensive toxicologic investigation. The diesters are more acidic and hydrolyze more readily than the triesters (3).

Tributyl phosphate is a clear, colorless liquid with a boiling point of 289°C (with decomposition). It has a weak cholinesterase inhibiting property (4). Fassett (5), writing in Patty's textbook, noted that tributyl phosphate possessed a definite central nervous system excitatory action with production of terminal pulmonary edema in experimental animals. Vapors of tributyl phosphate, particularly if heated, can be very irritating if inhaled.

It is difficult to assign a TLV for tributyl phosphate in the absence of more data. A TLV of 5 mg/m^3 should be sufficient to prevent complaints of nausea and headache associated with its use.

References:

1. Electric Reduction Sales Company, Limited Brochure on Tributyl Phosphate.

2. Mastromatteo, E.: Personal communication to Committee, (1964).

3. Patty, F. A.: Industrial Hygiene & Toxicology, 2nd ed. Vol. II, Toxicology, Interscience Publishers, N. Y. (1963).

4. Sabine, J. C., Hayes, F. W.: Arch. Ind. Hyg. & Occup. Med. 6, 174 (1952).

5. Fassett, D. W.: Lab. of Industrial Medicine, Eastman Kodak Co., Rochester, N. Y. Unpublished data. (Quoted by Patty, F. A.)

ZINC CHLORIDE FUME

1 mg/m^3

Exposure to zinc chloride fumes can cause damage to the mucous membranes of the nasopharynx and respiratory tract. Exposed persons have experienced a pale gray cyanosis. Zinc chloride is caustic and can cause ulceration of exposed surfaces of the skin (1). Inhalation may produce a severe pneumonitis resulting from irritation of the respiratory tract (2).

Hunter (3) reports 10 deaths and 25 cases of non-fatal injury among 70 persons in a tunnel, when 79 smoke generators caught fire in a storage area. Most of the patients began to recover on the 10th day and were up and about 6 weeks after the incident. In two necropsies performed on the fatal cases, membranes lining the larynx, trachea and bronchi were red and edematous, with spots of necrosis. A similar report was made by Milliken, et al. (4) when two firemen were exposed during a smoke generator demonstration. One recovered, and one died. Milliken et al. (5) have reported a case of fatal, acute interstitial fibrosis from inhaling $ZnCl_2$ fumes from a smoke generator. In 18 days the patient developed advanced pulmonary fibrosis, acute cor pulmonale and right ventricular hypertrophy. The patient appeared at first to respond, but ultimately died from acute respiratory insufficiency. Elkins (6) states that zinc chloride is an irritant, and points out fatalities have resulted from lung damage caused by the inhalation of high concentrations of the fumes. Ferry (7) in investigating a borderline condition, found that levels between 0.07 and 0.4 mg/m^3 for 30 minutes did not result in sensory effects. The fumes are corrosive to metals at these levels, however.

In order to reduce the likelihood of complaints from exposed workmen, and to prevent respiratory irritation, a TLV of 1 mg/m^3 is recommended.

References:

1. Sax, N. I.: Dangerous Properties of Industrial Materials, p. 1268, Reinhold Pub. Corp., New York (1957).

2. Gafafer, W. M.: Occupational Diseases. A guide to their recognition. PHS Pub. No. 1097 (1964).

3. Hunter, D.: The Diseases of Occupation, pp. 367-377. Little, Brown & Co., Boston (1955).

4. Milliken, J. A., Waugh, D., Kadish, M. E.: Can. Med. Assn. J. 88, 36 (1963).

5. Milliken, J. A., Waugh, D., Kadish, M. E., Can. Med. Assn. J. 88 36 (1963).

6. Elkins, H. B.: The Chemistry of Industrial Toxicology, John Wiley & Sons, N. Y. (1959) p. 222.

7. Ferry, J., Communication to Committee, 1966.

N O T E S

APPENDIX B

Appendix B contains the short and long forms for use in the inspection of radionuclide users. These forms were prepared by the ACGIH Committee on Ionizing Radiation as a suggested format for recording information. A limited number of extra copies of these forms will be available to members free of charge while the supply lasts.

THE INSPECTION OF RADIONUCLIDE USERS
- SHORT FORM -
A Suggested Format For Recording Information

I. FACILITY & PERSONNEL IDENTIFICATION

A. Facility Name: _____

B. Address: _____
City County State

C. Telephone: _____

D. Major Type of Operation in Which Facility is Engaged:

_____

E. Total Number of Employees: _____
Number Engaged in Radiation Work: _____

F. Date of Last Inspection: _____

G. Person(s) Contacted:
1. Non-User(s) *(Name & Title)*

_____

_____

2. User(s) *(Name, Title, Bldg., Room No.)*

_____

_____

H. Person to Whom a Report of This Inspection Should be Sent:

Name: _____

Title: _____

Address: _____
(if different from above)

II. DETAILS OF RADIONUCLIDE LICENSE

A. License Number(s): _____

_____

_____

_____

_____

B. Type and Authorized Radionuclide Applications:

Type	Authorized Radionuclide Application		
	Specific	Broad	General
Human Use			
Industrial			
Institutional			
Research			

III. TYPE, AMOUNT, AND FORM OF MATERIAL

Radio-nuclide	Form		Type***	# Sources/Total Activity		Application or Use
	S*	U**		Amount Licensed	Amount On Hand	

*S-Sealed **U-Unsealed ***Byproduct, Source, Special Nuclear, Machined-Produced, or Naturally Occurring

IV. ADMINISTRATIVE AND OPERATIONAL CONTROL

A. Source Procurement, Use, and Storage:

_____

_____

_____

_____

B. Source Control and Records:

_____

_____

_____

V. A. Radiation Protection Organization

1. Person Responsible for Radiation Safety:

Name_____

Title_____

Supervisor_____

Title_____

2. Radiation Safety Committee:

Members (names, titles, departments represented)

_____

_____

_____

_____

3. Radiation Protection Staff (describe):

_____

_____

_____

_____

_____

4. Medical Program (type and description):

_____

_____

_____

_____

_____

B. Extent of Radiation Protection Services:

Radiation Protection Services	Service Available		Description or Comments
	Yes	No	
1. GENERAL SERVICES			
Leak Testing			
Effluent Monitoring			
Waste Disposal			
Contamination Survey and Control			
Records			
2. PERSONNEL MONITORING			
Dosimetry			
Bioassay Services			
Records			
3. RADIATION PROTECTION LABORATORY SERVICES			
Instrument Calibration			
Instrument Repair			
Counting Facility			
Radiochemical Capability			
4. AREA SURVEY SERVICES			
Facility Monitoring			
Environmental Surveillance			

Date Prepared: _____ Prepared By: Name _____

Title _____

THE INSPECTION OF RADIONUCLIDE USERS
- LONG FORM -
A Suggested Format For Recording Information

I. FACILITY & PERSONNEL IDENTIFICATION

A. Facility Name: _____

B. Address: _____
City County State

C. Telephone: _____

D. Major Type of Operation in Which Facility is Engaged:

_____

E. Total Number of Employees: _____
Number Engaged in Radiation Work: _____

F. Date of Last Inspection: _____

G. Person(s) Contacted:
1. Non-User(s) *(Name & Title)*

_____

_____

2. User(s) *(Name, Title, Bldg., Room No.)*

_____

_____

H. Person to Whom a Report of This Inspection Should be Sent:

Name: _____

Title: _____

Address: _____
(if different from above)

II. DETAILS OF RADIONUCLIDE LICENSE

A. License Number(s): _____

_____

_____

_____

_____

B. Type and Authorized Radionuclide Applications:

Type	Authorized Radionuclide Application		
	Specific	Broad	General
Human Use			
Industrial			
Institutional			
Research			

III. TYPE, AMOUNT, AND FORM OF MATERIAL

Radio-nuclide	Form		Type***	#Sources/Total Activity		Application or Use
	S*	U**		Amount Licensed	Amount On Hand	

*S-Sealed **U-Unsealed ***Byproduct, Source, Special Nuclear, Machined-Produced, or Naturally Occurring

IV. ADMINISTRATIVE AND OPERATIONAL CONTROL

A. Source Procurement, Use, and Storage

_____
_____
_____
_____
_____

B. Source Control and Records

_____
_____
_____
_____

V. RADIATION PROTECTION ORGANIZATION

A. Person Responsible for Radiation Safety
Name_____
Title_____
Supervisor_____
Title_____

B. Radiation Safety Committee: Yes_____ No_____

Members (names, titles, departments represented)

_____
_____
_____
_____
_____

C. Radiation Protection Staff (describe):

_____
_____
_____
_____
_____
_____

D. Medical Program (type and description):

_____
_____
_____
_____
_____
_____

VI. PERSONNEL EXPOSURE

A. External Exposure

1. Personal Dosimeter Measurements

   a. Film Badges Used? Yes _____ No _____ Commercial Supplier: _____

   Are "Control Badges" sent with each batch processed? Yes _____ No _____

   Number of People Monitored: _____

   b. Dosimeters or Pocket Chambers Used? Yes _____ No _____

   c. Records: _____

   _____

B. Internal Exposure

1. Bioassay Data: Yes_____ No_____ Commercial Supplier (*if used*): _____

Type of Specimen	Number of People Covered	Sampling Frequency	Analyses Performed	Comments

2. Whole Body Counting: Yes_____ No_____

   Where: _____

3. Records: _____

   _____

VII. RADIATION PROTECTION INSTRUMENTATION

A. Survey Equipment

Description	Number Available	Application	Comments

B. Laboratory Equipment

Description	Number Available	Application	Comments

C. Fixed Position Monitors (Hand and Food Counters, Air Monitors*, etc.)

Description	Number Available	Application	Comments

*Off-site as well as on-site. Specific locations may be shown with the sketch on the last page of this Form.

VIII. SOURCE CONTROL PROGRAM

A. Sealed Sources*

1. Source Use and Application (Procedures for Use and Adequacy of Technique)

2. Equipment and Facilities
   a. Handling Equipment (Types and adequacy)

   b. Storage Facilities (Inventory and distribution of sources and adequacy of shielding and ventilation)

   c. Transportation Facilities (Adequacy of Containers and Administrative Control)

3. Leak Testing
   a. Test Methods

   b. Frequency

   c. Results and Follow-up

*For further details, see National Bureau of Standards Handbooks 66, 73, and 93, issued by the National Committee on Radiation Protection and Measurements.

B. Unsealed Sources**

1. Physical Safeguards
   a. Containment and Ventilation
      (1) Hood Use and Performance (Face Velocity, Hood Location, etc.)

      (2) Glove Boxes (Use, performance, and adequacy)

      (3) Exhaust Systems (Location of discharge, filtering system, duct velocities, etc.)

2. Protective Clothing
   a. Garments (Adequacy and supply for levels of radionuclides handled)

   b. Respiratory Protection (Procedures for proper fitting; adequacy for the hazard)

3. Laboratory Design (Location and general layout, suitability of surfaces, waste disposal facilities, etc.)

4. Shielding and Storage (Administrative control and adequacy of facilities)

5. Contamination Control (Isolation of areas, good housekeeping, and decontamination)

**For further details, see National Bureau of Standards Handbook 92, issued by the National Committee on Radiation Protection and Measurements.

IX. PROCEDURAL SAFEGUARDS

A. Operational Controls
1. Source Identification_____
2. Labelling and Posting of Controlled Areas
3. Surveys and Inspections
   a. Type_____
   b. Frequency_____
   c. By Whom Performed_____
4. Air Monitoring
   a. On-site_____
   b. Off-site_____
5. Waste Management
   a. Methods of Disposal_____
   b. Effluent Monitoring_____
   c. Records and Inventory_____

X. INCIDENTS

A. List of incidents since last Visit_____

B. Records, Follow-ups, and Corrective Action

C. Emergency Planning_____

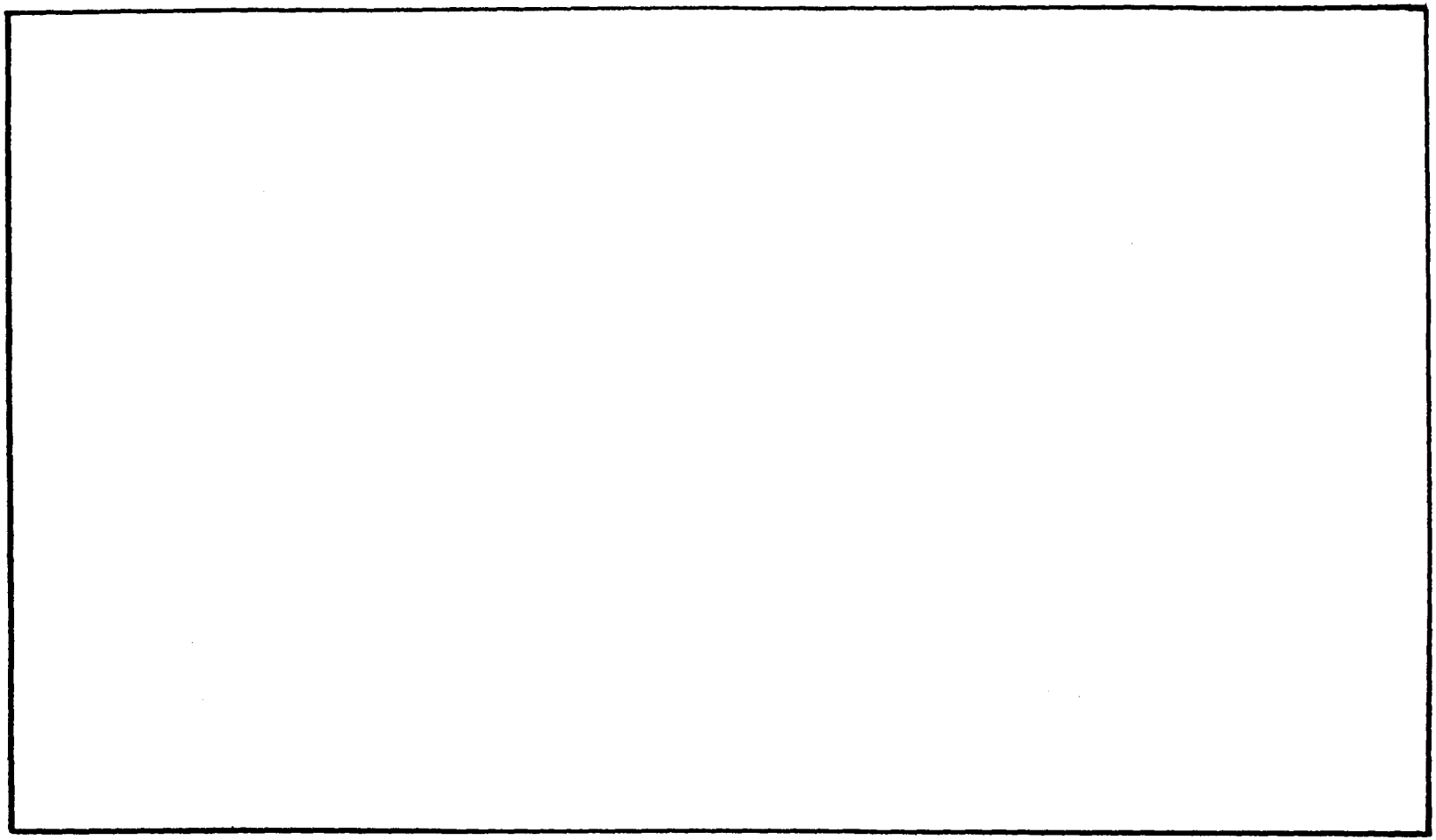
COMMENTS_____

Prepared by: Name_____

Title_____

Date Prepared: _____

XI. SKETCH OF FACILITY



This page may be used to show a sketch of the inspected facility, controlled and non-controlled areas, as well as places being used for the storage of radioactive materials. Any radiation measurements made during the inspection and sites selected for collecting samples should be recorded on the sketch.