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CONTENTS

NSC OFFICERS p. 5-10

CEMENT, QUARRY SECTION OFFICERS p. 45, 46 (USS AND RUBBEROID)

CHEMICAL SECTION OFFICERS p. 66, 67

ARTICLE: COAL MINING SECTION - DUST MEASUREMENT AND STANDARDS
p. 18-26
asbestosis and silicosis - benefits paid chart p. 19

COAL MINING SECTION OFFICERS p. 40-42

CONSTRUCTION SECTION OFFICERS p. 54-56

ELECTRICAL EQUIPMENT OFFICERS p. 14, 15

GLASS CERAMICS, RUBBER PLASTICS OFFICERS p. 35-38

INDUSTRIAL CONFERENCE p. 113

LABOR SAFETY OFFICERS p. 52, 53

ARTICLE: MARINE SECTION - GUIDES OF U.S. DEPT LABOR SAFETY
REGULATIONS p. 59-62
shipyard regulations for medical care of employees exposed to
hazardous atmosphere: contaminants, free silica p. 61

MARINE SECTION OFFICERS p. 78-79

METALS SECTION OFFICERS p. 17-19

ARTICLE: MINING INDUSTRY SECTION - DUST HAZARDS RELATED TO HEALTH
p. 7-12
asbestosis p. 10
silicosis p. 11

MINING INDUSTRY OFFICERS p. 39-41

PETROLEUM OFFICERS p. 29, 30

PUBLIC UTILITIES OFFICERS p. 41, 42

RAILROAD OFFICERS p. 21, 22

TEXTILE OFFICERS p. 43, 44



1965

VOLS. 1-12

TRANSACTIONS

COUNCIL

SAFETY

NATIONAL

NATIONAL
SAFETY
COUNCIL

REPORT

TRANSACTIONS

VOLS. 13-27

1965

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1965

National Safety Congress
Transactions

Volume 1

GENERAL SESSIONS

ANNUAL MEETING OF MEMBERS
CONGRESS BANQUET
LIST OF EXHIBITORS
GENERAL INDEX OF ALL VOLUMES

NATIONAL SAFETY COUNCIL

425 N. Michigan Avenue

Chicago, Illinois 60611



VOLUME 1 OF THE TRANSACTIONS of the 53rd NATIONAL SAFETY CONGRESS

CONTENTS

Five Years of Future Dates for the National Safety Congress	2
Officers of the National Safety Council 1965-66	5
Trustees of the National Safety Council 1965-66	7
Board of Directors of the National Safety Council 1965-66	10
 ANNUAL COUNCIL MEETING	
Invocation	Erwin D. Canham 2
Minutes of the Annual Council Meeting	27
What More Can We Do For Safety?	Howard Pyle 25
What More Can Youth Do For Safety?	Betty Johnston 26
 NATIONAL SAFETY CONGRESS BANQUET	
Invocation	Rev. Warren R. Ebinger 3
Minutes of Banquet Meeting	2
The Next Step In Safety	Charles W. Ferguson 3
Exhibitors — 53rd National Safety Congress & Exposition	3
Index to All (27) Volumes of 1965 National Safety Congress Transactions ..	5
Other Volumes in 1965 National Safety Congress Transactions	Back Cover

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000510

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000511

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000512

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000513

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000514

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000015

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0000516

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ANNUAL COUNCIL MEETING

INVOCATION

By ERWIN D. CANHAM

Editor in Chief, *The Christian Science Monitor*, Boston, Mass.

Dear Heavenly Father:

We are gathered here today to learn better how to fulfill our responsibilities to one another as Your sons and daughters. In Your infinite goodness, You have provided us with the capacity to reflect and to demonstrate great technical knowledge in the organizing of complex mechanical undertakings such as the flight out into space, which is even now taking place. We pray that we may have applied and may apply the intelligence. You have given us with accuracy and skill, so that this further effort to prove man's dominion, under God, over the physical universe may be safe and fruitful.

But even as this further adventure out into space is undertaken, we, gathered here in Chicago, turn the intelligence and dedication You have given us to other equally—indeed more urgent purposes—the safe and fruitful living of our daily tasks and destiny here on this beautiful planet.

We need to learn two things: *first*, the technical terms of how better to live together in a mechanical age so that respect for the preciousness of life and limb of ourselves and others will be more fully manifested; *second*, the state of mind and dedication by which we more vigilantly and effectively accept our responsibilities to one another and apply this information.

Both the knowledge and the dedication come to us from You. We pray they will be with us during these meetings so that we may ourselves grow and help others to grow in the living of safe lives and the deeper fulfilling of the privileges and opportunities You have given us.

We reverently ask for this re-dedication through Your infinite grace as the source of all Mind, all Life, all Truth, all Love, which we strive to manifest as men and women created in Your likeness, having the privilege of living our lives in a glorious and challenging period in the history of the human race. We ask it in Your holy and precious name. Amen.

on a back road, or the reporting of fires along the highway.

The citizens band radio is a 5-watt unit and operates on 27.015 megacycles and costs about \$185 installed. These small units used for inter-plant communication are installed in the plant offices, the cars, pickup trucks, the leaders, and the bulldozers. The use of these is the best way we know to keep in contact with our key men and equipment operators for fast and safe communication.

These units have many advantages in the operation.

1. Office contact with supervision at all times.
2. Office contact with leaders for faster dispatching.
3. Calls to shop for equipment breakdowns.
4. Detection of electrical storms in summer.
5. Close communication with flagmen at blasting time and many other operating advantages too lengthy to mention.

Also, these low frequency radios are not hazardous around electric blasting caps for safety in your operation, as noted in certain pamphlets made available by the Institute of Makers of Explosives.

Signs at the entrance to plant property stating that it is private property.

Clearance under 33,000 volt overhead lines indicated by a warning sign for large equipment operators.

A sign indicates all 2-way Industrial Band radios must be turned off in quarrying areas.

Directional signs are used for trucks and visitors.

A sign indicates the property protected by special police to keep trespassers out.

Stop signs are installed at all plant road intersections to prevent accidents.

Signs indicate 15 mile speed limit in plant areas.

Warning signs caution drivers to drive slow around plant buildings.

Others warn of blind corners for truck traffic.

Others direct "No visitors in quarry areas; no visitors in the plants, only employees with proper safety equipment."

Different safety slogans are carried on the bumper of each inter-plant truck.

The company-wide safety slogan which is on about 200 trucks that haul in the Baltimore area is as follows:

"Watch That Child!"

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000518

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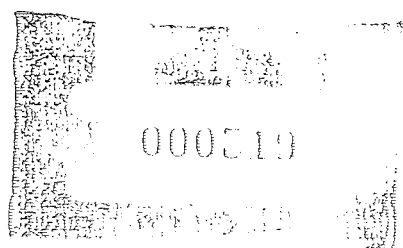
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000510

ifications. In the future design of new mining equipment, the manufacturers should make their own evaluation of the foreign research and development work performed on machine design to see if it is applicable.

New mining methods using principles of remote control or continuously removing the coal from the face pneumatically offer solutions to the dust problem, but these are long range developments and, many mines will never see such systems employed. Continuing research efforts are required on both

the dust and methane problems, although it is felt that the present technology, correctly applied, will allow us to make significant improvements during the next several years.

The material presented in this paper has been accumulated during the course of an investigation of methods for control of dust in coal mines, sponsored by the Commonwealth of Pennsylvania through a grant in funds by the Pennsylvania Coal Research Board. Permission to publish this information is gratefully acknowledged.

DUST MEASUREMENT AND STANDARDS

By EARLE P. SHOUB

Chief, Division of Accident Prevention and Health, Health and Safety Activity,
Bureau of Mines, Interior Department, Washington, D. C.

A consideration of how dusts are measured and of the standards imposed in various places seems to be an integral part of this discussion. Some dusts present ignition hazards, others hygienic hazards, and some involve both dangers. Because of the growing interest in the health hazards of dusts found in the atmosphere in coal mines, this discussion will be limited to hygienic aspects.

For several very valid reasons interest in chest diseases traceable to inhaled dusts has grown considerably among members of the coal mining industry.

First, it is now generally agreed among medical experts that the dusts in the atmosphere of coal mines are harmful if breathed in sufficient quantities over a long enough period of time.

Second, the Public Health Service and the Bureau of Mines are cooperating in a study of coal miners' pneumoconiosis. The Bureau has responsibility for the environmental phases of the study and the Public Health Service for the medical phases. Preliminary information is available from the Public Health Service on a study of chest diseases in bituminous coal miners and former coal miners of the Appalachian Area.

It is reported that about 10 per cent of the currently employed miners in the area have pneumoconiosis and that roughly 20

per cent of men formerly employed in the mines are stricken. Evidence that years of exposure is a factor in the disease can be seen in the following tables:

Age (years)	Per cent with pneumoconiosis	
	Currently employed	Formerly employed
All ages	9.6	18.6
25-34	1.2	
35-44	4.2	2.7
45-54	10.1	18.6
55-64	20.7	18.7

When the same group of subjects is tabulated by years of work underground, we find a similar relationship.

Years Underground	Per cent with pneumoconiosis	
	Currently employed	Formerly employed
All years	9.6	18.6
0-9	2.0	1.6
10-19	4.0	6.3
20-29	6.0	11.6
30-39	20.6	21.6
40 and over	24.2	23.0

Third, is the indication of the widespread nature of the disease in coal mining states to be found in the record of benefits paid for workmen's compensation. An article which appeared in the October 1964 issue of Archives of Environmental Health, an American Medical Association publication, reports all cases for which benefits have been paid for chest diseases of this type and is not limited to bituminous coal miners. Some pertinent parts of one of its tables follows:

State	Disease	Years Covered	No. Cases
Ill.	pneumoconiosis	1952-1960	1,982
Ill.	silicosis, asbestosis	1950-1963	402
Ohio	silicosis, other	1950-1954	
Fl.	pneumoconiosis	1958-1962	1,113*
Fl.	silicosis, asbestosis, anthracosis	1950-1961	9,126
Utah	silicosis	1950-1959	35
W. Va.	silicosis, pneumoconiosis	1950-1960	114
W. Va.	silicosis	1950-1962	7,802

*Partially estimated

At the Pennsylvania Governor's Conference on Pneumoconiosis held in Harrisburg late last year, it was stated that the annual compensation payments in Pennsylvania for pneumoconiosis are increasing rapidly each year.

In the United States, one of the widely accepted standards of acceptable dust exposure for bituminous coal miners is one suggested by Westfield, Anderson, Owings, Harmon, and Johnson in Bureau of Mines Information Circular 7615, Roof Bolting and Dust Control:

"In bituminous coal and lignite mines, the average full shift concentration of atmospheric dust to which a workman may be exposed should not exceed 20 million particles per cubic foot of air, and a maximum concentration for any single operation should not exceed 40 million particles per cubic foot of air. When the dust contains silica, not more than 5 million particles of silica per cubic foot of air should be present in the above limiting concentrations. The dust count may be multiplied by the percentage of silica concentration, and if the result is less than 5 million, the dust concentration will be considered safe. The above limiting concentrations are based on impinger samples in which light-field counts are made under a microscope."

The actual origins of this recommendation are not clear. A search of the still available records leads to the conclusion that they stem from field observations by C. W. Owings of the Bureau of Mines which were described in Mechanization of November 1946, and from findings reported by the Public Health Service in its Bulletin 221

and 270. There is also an earlier reference to the 20 million particle figure in Bureau of Mines report of Investigations J-61 published in 1942. The method of evaluating silica exposure by multiplying the dust count by the percentage of free silica had been suggested some years before, was also suggested in the transactions of the National Silicosis Conference in 1947, and is mentioned in Industrial Hygiene and Toxicology by Patty.

A 1965 publication of the International Labour Office, Guide to the Prevention and Suppression of Dust in Mining, Tunneling and Quarrying, includes standards of Australia, Canada, Poland, the United Kingdom, and of the United States. From this publication, we learn the following:

Australia

In New South Wales dust is measured in particles under 5 microns in size per cubic centimeter. The number of particles may not exceed 700 when the free silica content of the parent rock (including coal and oil shale) does not exceed 10 per cent and decreases by 100 particles per cubic centimeter as the silica content increases in units of 10 per cent. Thus at 50 per cent or more free silica, the dust count of 5 microns and smaller particles may not exceed 200 per cubic centimeter. (Nothing is said about the method of dust sampling and counting to be used.)

Canada

The midget impinger is used in Quebec where 5 million particles per cubic foot is permitted when the dust composition is above 40 per cent silica. Between 5 and 40 per cent silica, 10 million particles per cubic foot is permitted and below 5 per cent silica in the dust, 50 million particles per cubic foot is allowed.

Poland

The Polish standards apply to particles of 0.5 to 5 microns in size per cubic centimeter of air. Workplaces are classified as coal faces or rock faces. The dust is classified on the basis of its content of stable incombustible material. Up to 10 per cent rock, that is incombustible, 1500 particles per cubic centimeter is allowed. The number of particles decreases in steps to 500 when 70, or more, per cent rock is involved. When sampling the airborne dust shows silicon dioxide is present, the limits are based on the amounts of silica present. For 25 per

cent, or more, SiO_2 500 particles per cubic centimeter from 0.5 to 5 microns is permitted. From 15 to 20 per cent silica, the number is raised to 850. In the 5 to 15 per cent range, it is increased to 1200. When the silica content is 5 per cent or less, 1500 particles per cubic centimeter is allowed.

United Kingdom

Conditions are "approved" if they comply with standards of dustiness. Anthracite dust clouds are not to exceed 650 particles between 1 to 5 microns in size per cubic centimeter. Other coal dusts, which include bituminous coal, are restricted to 850 particles in the same size range per cubic centimeter. In stone drifts and hard headings, the maximum is reduced to 450. Measurements are made with the thermal precipitator and the limits apply to periods of maximum dust production.

The British are experimenting with a standard which would approve a working place, provided the limit is not exceeded on more than one shift in ten. In the case of bituminous mines, where the 850 particle per cubic centimeter standard applies, this would work out as follows:

A face would be approved if:

- (1) the mean concentration on a single shift is a less than 450 particles per cubic centimeter in the range 1 to 5 microns; or
- (2) the mean concentration on each of two successive visits to the face is less than 700 particles per cubic centimeter in the range 1 to 5 microns.

A working face would not be approved if:

- (1) the mean concentration on a single shift is greater than 850 particles per cubic centimeter; or
- (2) the mean concentration on each of two successive visits is over 700 particles per cubic centimeter.

United States

This ILO publication refers to the Threshold Limit Values established for silica by the American Conference of Governmental Industrial Hygienists and describes the standard last used in Threshold Limit Values for 1961. That is, when the airborne silica is 50 per cent or higher, the limit is 5 million particles per cubic foot; between 5 and 50 per cent silica, 20 million, and below 5 per cent silica, 50 million particles per cubic foot.

More recent editions of the same publication of the American Conference of Governmental Industrial Hygienists set the limit in millions of particles per cubic foot by a formula, $\frac{100}{\% \text{SiO}_2 + 5}$. In both the older and

new publications the ACGIH specifies the use of the midget impinger and light field counting.

It is interesting to note that in 1961 the limit on silica was carried under the heading "Mineral and Non-Metallic Inorganic Dusts." In the current edition of the ACGIH publication, the title of the portion just described is "Respirable Dusts Evaluated by Count."

From other sources, there is information regarding standards in other countries.

Soviet Union

It is said that the dust concentration standard in the U.S.S.R. is gravimetric in nature, but it is not clear whether the limits apply to total airborne dust or to the respirable portion only. Visual observations by visitors to Soviet mines lead to the assumption that a selected size fraction is involved. Two limits are reported. Above 70 per cent free silica, 1 milligram per cubic meter is permitted; and below 70 per cent free silica, 2 milligrams per cubic meter (mg/m^3) is allowed.

Germany

The Tyndalloscope is in general use for routine measurement in coal mines. They feel the Tyndalloscope gives readings which are directly related to surface area especially in the 1 to 2 micron range. Because of the empirical nature of the readings, the instrument must be carefully standardized in a central laboratory. The instrument scale is divided into four ranges or categories, very high, high, medium, and low, which in millions of particles per cubic foot, represent over 30, 15 to 30, 7 to 15, and less than 7, respectively. Workplaces in the very high category are tested every three weeks. High category places are tested every six weeks, medium category workplaces are examined at three-month intervals, and low category, every six months. It is mandatory that the dust of places in the very high category be analyzed for silica and recommended that this also be done for places in the high category.

Medical surveillance of the miners in-

000522

at Mining

cludes a detailed record of work conditions and dust categories. Men who show no evidence of pneumoconiosis are permitted to work in the high and very high concentration areas. Miners with marginal pneumoconiosis are permitted to work only in low and medium category areas. Those with definite diagnosis of pneumoconiosis are barred from working underground.

France

In French coal mines filter samples are taken and microscopically counted with a diffraction objective. Only particles from 0.5 to 5 microns are counted. The decision as to which particles fall within this range is essentially one of the judgments of the person doing the counting.

In general their limits appear to be close to the ones set by the ACGIH formula except that two different methods of analysis are involved.

The Netherlands

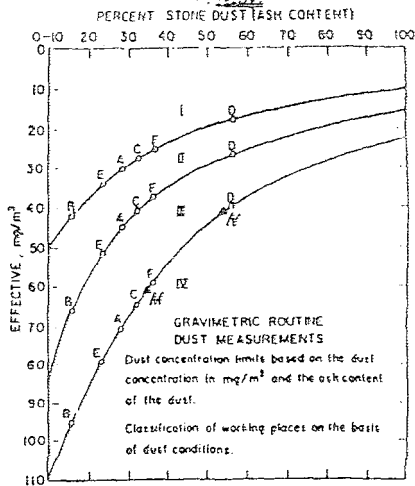
Dustiness standards were developed after a consideration of the following beliefs:

1. Quartz is the most dangerous of the silicogenic materials. Silicates are also dangerous, but less than quartz.
2. The harmfulness of coal dust comes from the mineral contaminants, and because its respiration overburdens the lungs.
3. Modern thinking is that the number of particles per unit volume is less meaningful than the surface area per volume of air, or than the weight of the particles in a unit volume of air.
4. Silicosis is caused by the inhalation of fine dust.

Based on appropriate consideration of these factors as they apply to the coal mines in the Netherlands, there was introduced a "dust index" for evaluating the results of routine dust measurements.

"The dust index is the content of fine dust, smaller than 5 microns, in milligram per cubic meter of air, awarding multiplication factors to the components of the dust, notably 5 for quartz, 3 for other mineral components, and 1 for coal dust. This means that a dust composed of X milligrams of fine quartz, Y milligrams of other fine minerals, and Z milligrams of fine coal dust per cubic meter of air, has a dust index of $5X + 3Y + Z$; this index

is expressed in effective milligrams per cubic meter of air (eff. mg/m³)."



This can be expressed for the minus 5 micron fractions as:

$$\frac{5(\text{mg quartz}) + 3(\text{mg other minerals}) + 1(\text{mg coal dust})}{\text{cubic meters of air}}$$

$$\text{Effective milligrams per cubic meter} = \frac{\text{Eff. mg/m}^3}{\text{cubic meters of air}}$$

Limits were established for four categories, class I (dust free), class II (low dust content), class III (dusty), class IV (very dusty). Originally these were preliminarily fixed at 0-15 eff. mg/m³, 15-30 eff. mg/m³, 30-45 eff. mg/m³, and over 45 eff. mg/m³.

Other sets of limits were established for stone dust. Stone dust is usually taken as the weight of the residue after ignition (ash). Four categories were set:

dust free	0-10 mg/m ³
low dust content	10-15 mg/m ³
dusty	15-22 mg/m ³
very dusty	over 22 mg/m ³

In recognition of the ability of coal dust to overload the lungs, these limits are lowered at intervals until at 10 per cent ash they are about 50 per cent of the ones for stone dust.

Even these limits would permit the inhalation of large amounts of coal dust and stone dust containing less than 10 per cent

ash. In actual practice, the avoidance of overburdening the lungs by dust of any kind is considered so important that a further reduction is made for situations in which there is less than 10 per cent ash.

The curves of the previously shown graph each represent what is believed to be the same hazard and are the boundaries between the four categories. For example, point M represents a man inhaling 60 mg/m^3 of dust with an ash content of 35 per cent; Point N represents another man inhaling 40 mg/m^3 of dust with an ash content of 55 per cent. It is contended that both men are being exposed to the same hazard. Also points A, B, C, D, E, and F are the results of a total of 206 dust measurement experiments involving various types of work using the dust index in effective milligrams per cubic meter as a reference.

The standards described in this paper do not include those of still other coal producing countries, but are sufficient to show there is generally little agreement among them when taken collectively. They differ on particle size range, what is meant by particle size, on method of collection, on method of determining concentration, and on the importance of composition.

Particle size may be determined in two ways. One is to examine the particle under a microscope and from linear measurements or from a judgment of the cross-sectional area estimate the size and volume of the particle. The other is to relate the performance of a particle suspended in air to the size of a sphere of unit density which would behave identically if it were suspended in air. The latter method can be called size equivalent to unit density spheres and is a way of expressing the aerodynamic qualities of a dust.

The respiratory system, we are told, generally conforms to the laws of aerodynamics. Also, medical testimony says that if we expose an average or normal human to a cloud of unit density spheres of all sizes, most of the particles below 20 microns (in diameter) will enter the nasal passages. Nasal retention will remove a goodly portion of this cloud. Eliminated will be about 75 per cent of the particles 10 microns and larger, about 55 per cent of the 5 micron particles, about 25 per cent of the 2 micron particles, and around 10 per cent of the 1 micron particles.

Further screening occurs in the ciliated portion of the respiratory system between the nose and the lower lungs. By the time the dust cloud reaches the part of the lungs with which we are most concerned, essentially all the 10 micron particles will have been screened out, and the lower lungs will receive about 35 per cent of the 5 micron particles, about 75 per cent of the 2 micron particles, and approximately 90 per cent of the 1 micron particles.

Remember, these are unit density spheres. Quartz has a specific gravity of 2.65 and coal from which the mineral matter is removed approximately 1.25. This means that the equivalent of 5 micron unit density spheres are spheres of quartz about 3.6 microns in diameter and of coal about 4.6 microns in diameter. It also means that spheres of quartz about 3.6 microns in size will behave in air similarly to spheres of coal a full micron larger.

Another area of difference which should be considered involves the relative significance of counting the number of particles as compared to measuring surface area or determining the weight or mass of the particles, all on a unit volume basis. There has probably been more work done in the United Kingdom on this question than elsewhere. In 1943 the Medical Research Council which made a study in the South Wales coalfield concluded that the mass of particles not exceeding 5 microns in size provides the best measure of the hazard to health. However, for administrative reasons they recommended the standard should be given in terms of numerical concentration of particles not less than 1 micron in size.

Other work has supported the conclusion that the mass or weight of particles reaching the lower lungs is more important than the number of particles. One of these is that the examination of post mortem lungs of pneumoconiotics showed a correlation between severity measured by X-ray with the mass of dust retained in the lungs.

This subject was one of the topics of the 1959 Johannesburg Pneumoconiosis Conference. The Dust/Engineering Group of participants at the Conference recommended:

"that in the light of present available evidence the best descriptive parameter to measure be considered

(a) in the case of total dust to be the mass concentration of the respirable dust,

(b) in the case of quartz dust to be the surface area of the respirable dust."

The same conference concluded that respirable dust should be defined in terms of the aerodynamic equivalent to unit density spheres and, that on this basis the respirable fraction of the dust is the portion which conforms to a curve running from 0 per cent at 7 microns, through 50 per cent of the 5 micron particles, to 100 per cent at a fraction of a micron. This curve is not identical with one developed for deposition by particle size in the alveolar area (or lower portion) of the lungs but does approximate it reasonably well in a direct relationship.

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. I will have more to say about these points later.

One question which immediately presents itself is--is there a definite relationship between the results of particle counting and gravimetric dust determinations? Setting aside any questions about the precision of the measurements in each case, the answer appears to be that although there seems to be a reasonably constant relationship when the same operation, mining method, and coal seam is involved, there is considerable variation among different coals, methods, and operations. J. Cartwright of the Safety in the Mines Research Establishment, Sheffield, England, has published a two part paper, Relationships Between Mass and Number Concentrations of Respirable Airborne Dust in British Coal Mines, in the *Annals of Occupational Hygiene* of 1965. He has chosen the term "Mass/Number Index" (MNI) to express the relationship of mass concentration in milligrams per cubic meter divided by the number concentration in thousands of particles per cubic centimeter all multiplied by 1000. "For example," he says, "a dust cloud whose mass concentration is 10 mg/m³

and whose number concentration is 500 particles per cubic centimeter has a MNI of 20." That is, 10 over 500, all times 1000. He goes on to say "Typical values of the MNI so far measured in British coal mines lie between 10 and 30; but values up to 100 have been encountered."

I have made several references to the vagaries of counting techniques. Some of them are mine and some came to me from responsible persons in the United States and abroad. The British use the thermal precipitator, a device which causes the dust in the air passing through it to be deposited on a glass slide. The slide is examined by projection microscopy and counts made in a manner similar to that employed in the United States for midget impinger samples except that they count as one each group of touching, overlaying or agglomerated particles. They conduct workshops and training sessions for the persons who count thermal precipitator slides. From personal discussions, I have learned that at the end of a training session the technicians are reasonably in agreement in counting of test slides, but that by the time they assemble for the next session, three or four months later, there is significant disagreement among them.

We have had similar experience in counting midget impinger samples of coal dust and of silica dust. Experiments were conducted in June 1964 in which about a dozen experienced, highly trained persons were assembled with their own equipment and each given a midget impinger which had sampled a common dust cloud simultaneously. Each person was requested to count in the same manner as was his custom. In the case of the coal sample there were twelve counts ranging from 4 to 32.5 million particles per cubic foot (mppcf). There were differences in the usual procedures which may account for some of the variation. These included the impinger liquid, the settling time, the counting chamber, and the microscope. Nevertheless, we can not ignore the fact that a variation of about 8 to 1 results when truly competent persons perform in their normal manner. Somewhat better agreement was found in the case of silica dust. Here the variation among 11 operators was from 11.4 to 44 mppcf, and about 4 to 1.

There have also been several references to gravimetric sampling, but very little said about the instruments for the purpose. The simplest method is to draw the air to be sampled at a known rate for a specific time through a membrane or other non-hygroscopic filter. By weighing the filter before and after the test period, the weight of the dust is determined. The weight of the dust divided by the volume of air gives the weight or mass concentration. This method measures all the dust, regardless of size, including that which is beyond the respirable fraction. There are three instruments which are designed to screen out the larger size particles so that the portion of the airborne dust which is ultimately weighed conforms to the curve of particle size vs. percent retention established by the Johannesburg Conference of 1959.

All three employ horizontal elutriators through which the incoming air passes to remove the undesired portion. Horizontal elutriators are stacks of rectangular plates of such dimensions that for the selected velocity of the dusty air passing through them a unit density sphere of predetermined size will have sufficient residence time to drop to a plate and be retained on it.

The Hexhlet instrument utilizes compressed air of at least 40 pounds per square inch pressure to energize the instrument. Its elutriator is a stacked bank of aluminum plates each separated by 0.032 in. There is an effective floor area of 1690 square inches with a length of 10 inches. Flow rate of sampled air is 100 liters per minute or 6 cubic meters per hour. The respirable dust sample is collected in a Soxhlet thimble of a single thickness extraction type, 4x12 1/2 millimeters. For several reasons this instrument does not appear attractive for use in U.S. coal mines. First, many of them do not have compressed air at the pressure and volume required. Second, the filter paper thimble can absorb water from the air. It is therefore necessary to remove the sample of dust for weighing. Third, the Dutch have tested this instrument and say in one of their reports,

"It is seen that the so-called coarse fraction of the Hexhlet instrument contains much fine dust; in most cases even more than half of the total fine dust is found in this fraction. . . . It has further been proved that the fine fraction obtained

in the Hexhlet instrument contains much coarse dust; roughly 60-70% by weight of the fine dust fraction has a diameter above 10 microns."

For all these reasons, it appears that the Hexhlet instrument, one of the first on the market, is not suitable for use in U.S. coal mines.

Another instrument which also avoids the use of electric power is called SINGARD and was developed at the Safety in Mines Research Establishment at Sheffield. It was designed to collect, during one shift, a sample of respirable dust sufficiently large to weigh and on which some compositional measurements can be made. The basic components are an elutriator, membrane filter, and an ejector powered by compressed carbon dioxide from two small cylinders. Air is drawn at 3 liters per minute through the elutriator and filter by the suction created in the ejector. The elutriator consists of a stack of 35 plates, each 6.0x1.56 centimeters spaced 0.125 centimeter apart. The total floor or settling area is 327 square centimeters giving a 50 per cent cut-off of 5 micron unit density spheres at the design flow rate. Other parts of the instrument include a pressure regulator-control, a timer, and a fiber glass two-part case.

The cylinders (935 cubic centimeters each) hold enough liquid carbon dioxide to operate the unit for almost 12 hours. A slightly smaller model is now being produced in the laboratory which has an 8 hour supply of carbon dioxide. Neither the 12 hour nor the 8 hour model is yet being produced commercially. It is reported, however, that negotiations are under way to make them commercially available.

Eight units were hand made and tests indicate that they all performed in the same manner. We have been able to borrow two of the eight and are evaluating them in our Government laboratories.

Finally, there is a battery powered, intrinsically safe instrument developed at the Mining Research Establishment of the National Coal Board at Isleworth. This instrument is now being manufactured and sold by C. F. Casella and Co., Ltd. of London.

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 limits of

000524

Coal Mining

precision weighing with a balance having a sensitivity of 0.01 milligram.

The horizontal elutriator consists of four identical rectangular sections, one above the other, with a total floor area of 275 square centimeters. Each section is 17.19 centimeters long x 4 centimeters wide x 0.238 centimeter high. Overall area tolerance is 0.5 per cent.

The dust is collected on a 5.5 centimeter circle of Whatman's GF/A glass fiber paper. The air is drawn through the fiber by a reciprocating pump driven by a constant speed electric motor. A ratemeter on the outlet side of the pump indicates air flow, and the total volume of air sample is recorded on a counter.

Recent word from MRE indicates that they have successfully substituted a membrane filter for the glass fiber one. This will permit examining the collected dust for silica without fear of contamination from glass fibers.

Both of the new instruments will operate satisfactorily in air flows up to 1000 feet per minute into the wind and cross wind with no detectable difference in sampling efficiency. At somewhat higher air speeds errors are detectable.

The principal goal of the Bureau of Mines and the Public Health Service is:

to conduct a meaningful integrated study 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.

Unfortunately, although we can list the important factors which should be included in the development of recommendations, we are not yet able to quantify all of them. We are not prepared to state, for example, how much silica free coal dust a normal person can breathe over an extended period without harm. Also we are not able to state with conviction the relationship between quantity and time. That is, is a given concentration of dust breathed for 5 years equivalent in hazard to half as much dust breathed for 10 years?

A purpose of the environmental study,

which is a phase of the joint endeavor, is to obtain sufficient data to make possible a valid statistical study of dust levels in relation to the occurrence of disease to obtain answers to these and other similar questions. Those answers must be pertinent to American coals and American mining methods.

Another purpose of the survey is to develop a simple, instrumental control method which bears a direct relationship to what coal miners breathe. To accomplish this we believe the survey should be based on certain fundamental concepts as follows:

1. This survey is concerned only with hygienically significant dust.
2. It should determine, as best possible, the hygienically significant dust in the breathing zone of coal mine workers.
3. It should simultaneously determine the hygienically significant dust in the work area.
4. The relationship between data obtained from the breathing zone and corresponding information obtained in the work area, must be established.
5. Measurements should 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, should be made.

Since there is reasonable agreement between the theoretical retention-size curve for the alveolar (or lower) portion of human lungs with the corresponding curve for the dust which is not trapped in the horizontal elutriators, devices so equipped can be accepted as means of selecting the hygienically significant portion of the dust. But because these devices must be kept horizontal during operation and the sampling rate maintained at the design value, and because sampling in the breathing zone of a workman requires instruments which are compact, light, and unaffected by position when properly applied, none of the size-selective samplers I have so far mentioned is suitable for monitoring the breathing zone of an active, mobile person. For this purpose, we plan to use an intrinsically safe personal monitor equipped with a membrane filter and a 10 millimeter cyclone separator.

The retention curve of the cyclone size selector differs from that of the horizontal

elutriators. It is somewhat concave whereas the elutriators are convex, and the particle size cut-offs are also slightly different. Because the findings of Cartwright in connection with determining what he calls the Mass/Number Index suggest that the particle size distribution varies from place to place and depends on the operation, we will take simultaneous control samples, as necessary, to provide a reliable conversion factor for each part of each survey.

It is not our plan to abandon casually or reject the midget impinger—light field counting method of dust measurement. We will utilize it in a parallel fashion in laboratory studies to provide a bridge of knowledge with previous surveys and with all the other valuable data developed in the United States over the years.

Some of you may feel that I've outlined a situation in which we appear to be groping in the dark. This isn't true. Advancements of the last few years make it possible to

reduce considerably the uncertainties which have plagued dust work in the past and have brought into focus the problems and methods of sampling and analysis in terms of reliability and meaningfulness.

To anyone who still feels that darkness surrounds a program leading to the establishment of sound recommendations of maximum dustiness, I'd like to say:

"Let us remember that there have been dark days in the past. There was a famous one in New England in 1780 when the sun scarcely appeared at all. Thousands of people took it for the end of the world. Among them were many in the Connecticut Assembly, in which Colonel Abraham Davenport was sitting. It was proposed that the Assembly adjourn. Colonel Davenport said, 'The Day of Judgement is either approaching, or it is not. If it is not, there is no cause for adjournment. If it is, I choose to be found doing my duty. I wish therefore that candles may be brought!'"

WILL THAT EXTINGUISHER WORK WHEN I NEED IT?

By S. E. AUCK

Associate Managing Engineer, Underwriters' Laboratories, Chicago, Ill.

I am sure that many times, you have looked at a fire extinguisher, all shiny and bright, hanging on the wall, and said to yourself, "Will that thing work when I need it?"

If we assume that it will work, the next question is usually, "How good is it?" or "How much fire can I extinguish with that device?"

All of these questions are important because, if the people who will someday be called upon to use these extinguishers have no faith in them, they will not be used.

Let us examine these questions in the light of the methods used in rating the efficiency of fire extinguishers, the test methods used to insure that an extinguisher will work, and a brief history or resume of how these various tests and methods were developed.

For over 30 years, Underwriters' Laboratories, Inc. followed a classification program of its own invention in evaluating fire extinguishers. The results of this program were reflected in a letter and numerical designation on the UL portion of the extin-

guisher name plate. The letters, A, B, and C, were intended to denote the type of fire for which the extinguisher was suitable. The numerals were used as a measure of the effectiveness or extinguishing potential of that extinguisher.

The numerals were used also by the National Fire Protection Association as a means of indicating the number of such appliances required to form what was then called a "Unit of First-Aid Fire Appliance." That is to say, an extinguisher which was rated B-2, would be located in an area to protect against flammable liquid hazards in that area on the basis of two such devices for 2500 sq. ft. of floor area to be protected. If it was rated B-1, then only one such device was required for the same 2500-sq. ft. area.

This system was of service for many years, but as the science of fire protection progressed, the system began to develop serious weaknesses. For example, the old classification method for flammable liquid fires had only two basic Class B fire tests.

The tests were essentially built around the 1-qt. vaporizing liquid and the 2½-gal. foam extinguisher.

We found that these two tests were not very effective in evaluating carbon dioxide and dry chemical and other new types and designs of extinguishers and inequities in the ratings began to appear. In some cases, extinguishers that differed in extinguishing potential by as much as 800 per cent received the same classification.

Then in 1954, Underwriters' Laboratories, Inc., Factory Mutual Laboratories, and Underwriters' Laboratories of Canada, in cooperation with the Fire Extinguisher Industry and the National Fire Protection Association Committee on Portable Extinguishers instituted a new program of rating the fire extinguishing ability of extinguishers. That program brought about a revolution in the design of extinguishers which has continued, uninterrupted, to the present time and has resulted in consistent improvements in fire extinguishers.

Basically, the new classifications are determined as follows:

Class A ratings are directly related to the extinguishing potential of water. It was decided to use the then recognized 2½-gal. extinguisher as having a rating of 2-A. Water extinguishers or extinguishers using water solutions are then rated on the basis of 1-A unit per 1¼ gal. of water. For extinguishers with capacities of 10 gal. or more, the number of "A's" is reduced by 25 per cent.

Extinguishers which use agents which are not directly related to water or water solutions, such as dry chemical, are rated on the basis of test fires. The test fires were developed which could just barely be extinguished by a 2½-gal. water extinguisher used by an expert operator. If the same size of fire can be extinguished using a dry-chemical extinguisher, that extinguisher is said to be equivalent to a 2½-gal. water extinguisher and is given the rating 2-A.

Class B ratings are directly related to the size of flammable liquid fire which can be extinguished by a particular extinguisher. We assign a rating based upon the area of fire consistently extinguished by an expert. For instance, an extinguisher which consistently extinguishes a 50-sq. ft. fire is rated 20-B.

000525

Coal Mining

There are no numerical ratings for Class C extinguishers. The Class C acceptability is developed on the basis of the dielectric strength of the extinguishing agent. It was felt that the knowledge that the extinguisher could be successfully used on an electrical fire was sufficient information for this type of hazard. Ninety-nine times out of 100 an electrical fire will also involve Class A and/or Class B materials, so the extinguishing potential of the device is indicated by the A or B ratings. When the electrical supply is cut off, the Class C part of the fire is gone.

That, basically, is what the numbers and letters on the classification part of an extinguisher label mean. Now let us examine the process by which Underwriters' Laboratories, Inc. goes about determining which numbers and which letters shall be placed on a given extinguisher.

Fire tests are obviously a first step. The rating system requires it. But one can easily fool himself as to the apparent capability of an extinguisher by the fire test condition that is used. The problem then becomes a need to develop a realistic or representative type of fire test which can be related to conditions which can appear in the field. Also a test must yield consistent results. That is to say, the results on a given unit tested today should be obtainable if that extinguisher is again tested tomorrow or next year. Finally, the test must be an extremely difficult test for the expert. Our people are called upon to conduct these tests almost daily and since practice makes perfect, they become quite proficient, hence experts.

Now let's examine the specific fire test programs of Underwriters' Laboratories, Inc. They fall into the Class A, B, and C fire categories. There are no full scale fire tests conducted on the Class C condition.

In the Class A tests, we have three basic test fires—a panel fire, an excelsior fire, and a crib fire. All test fires up to the 6-A rating are conducted indoors. This adds to the extinguishing problem due to the built-up smoke and heat. Fires in the 10-A size and larger are conducted out of doors.

The panel fire, depending upon classification, will be sized from 8 by 8 ft. to 17 by 17 ft. square—essentially 50 sq. ft. of panel area per unit of A classification. A typical

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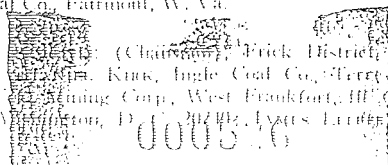
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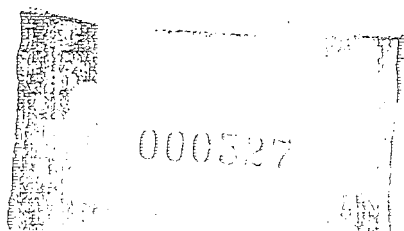
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000529

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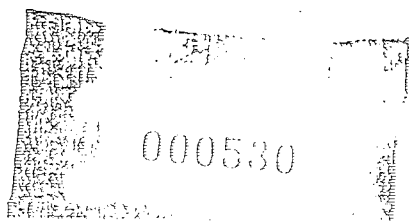
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000531

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000532

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000588

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000534

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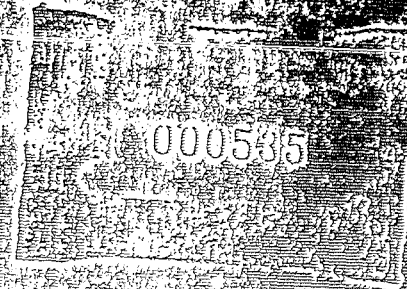
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*Deceased



should wear his respirator and use an arc area exhaust.

Remember that I have actually overstressed this hazard since there is no cumulative effect and the welder actually even develops temporary immunity to metal fumes. It is only the exceptional welding situation which demands more than ordinary ventilation precautions.

Shock is a hazard when welding just as it is when using electrical equipment in other tasks and the causes are just as typical: worn or frayed wires or cables, improperly grounded equipment, wet floors and carelessness.

Seldom is a welder shocked, and even then there is no real danger unless the voltage line of travel includes the head or heart. Of course, he might not like it, but he won't get hurt.

Gas tungsten-arc welding's higher voltage provides more hazard potential than found in other processes, generally, and the constant current processes use higher voltages than the constant voltage. Also, the AC of transformer welders is more harmful to the body than DC.

However, the standard electrical precautions of grounded equipment, attention to equipment overload, dry floors, firm connections, good wiring, dry gloves, and operator respect and caution eliminate the hazard of electrical shock. Two things especially the stick welder should remember: never to lay his electrode holder on his table or floor and never let his holder touch any gas cylinder. When temporarily not in use, he should hang his holder on the front of his welding machine since the cable, holder, and electrode are electrically hot until the machine is turned off.

The hazard of fire is always present and most bothersome in transient welding tasks. In a shop situation, most fire potentials are easily and almost automatically eliminated.

Sparks landing in oily materials, paper, cracks can start fires easily. Floors are frequently cleaned with flammable solvents easily ignited. Unknowingly, a welder may start a fire by welding metal backed by wood or near other flammable materials.

Every arc welding process creates a potential fire hazard but the high spark processes—stick electrode, core wire, large wire, CO₂—need to be watched most closely.

Be sure welding areas are cleared of flammables or screened. Know what cleaning compounds are used and, if necessary, reclean with water and dry. Clean new welding environments closely for potential fires. Whenever you're uncertain, worried, have appropriate fire extinguishers present and establish a fire watcher for the first 30 minutes of welding. These precautions will make your welding operation fire-safe.

There are two types of explosion we need to consider—hot and cold. By cold explosion we mean a sudden release or expansion of gases without fire.

The potential for hot explosion always exists when people are spray painting or working with other fume producing materials and even when the materials are stored near welding. The arc can easily ignite the gases when the air concentration reaches a critical point.

Another similar potential explosion exists whenever we weld containers which hold combustibles. The procedures for welding these containers is carefully spelled out in the American Welding Society's pamphlet "Safe Practices for Welding and Cutting Containers That Have Held Combustibles." The welder should have these procedures and follow them carefully or not at all. Essentially, the container should be thoroughly cleaned, depending upon the particular combustible it held, with water, soap, water, hot chemical solution, or steam. Certain industries have their own special procedures for air or inert gas purging. Such cleaning and welding should always be supervised by someone who knows the property the chemical the tank has held.

There is no hot explosion hazard in arc welding gases since these are all non-flammable. However, the arc welder will frequently use oxyacetylene welding, oxygen and acetylene gases, do present a hazard. One exploding cylinder can injure others, spreading damage and death.

Whenever you work with gas cylinders you have potential cold explosion and, in addition, you have potential hot explosion with any flammable gas.

A gas cylinder with its valve knocked off acts like a rocket gone amuck. It shoots in one direction after another with force and no predictability. If other cylinders

are near, they too may be knocked off, have valves broken, and add themselves to the melee. Buildings, equipment, and humans are all endangered.

All gas cylinders should be handled gingerly and carefully with great care taken to protect the valves. When in use, they should be chained upright. All cylinders should be stored outdoors, but the main

precaution with gas cylinders is proper handling.

Another hazard is the problem—hot sparks, fumes, and radiation. But in clean shop, equipment in good electrical condition, careful handling of cylinders, protective clothing, and proper and appropriate ventilation will minimize all your welding hazards.

PRACTICAL GUIDES IN THE APPLICATION OF THE U.S. DEPARTMENT OF LABOR SHIPYARD SAFETY REGULATIONS

By JOSEPH J. LARROCCA

Chief, Shipyards Branch Office of Occupational Safety, Bureau of Labor Standards

Much has been said in these yearly sessions, and in the various associational and union conferences held around the country, about the broad intent, scope, and requirements of the Federal shipyard regulations, but little about the specifics of their applications.

This year, it has been suggested that we put up practical guides that should be followed in the application of the Federal regulations, in order to attain more effective results in terms of reduced number of accidents.

We, at first, would like to identify the causes underlying the misapplication or the absence of the application of the regulations. These are:

1. The lack of awareness or recognition of the potential accident-causing conditions or practices.

2. The application of regulatory precautions and controls to only parts of the hazards, because the remainder are not deemed imminent accident-producing hazards, or important enough to warrant consideration for control.

We are discounting such causes as willful regard in which the regulations are put aside because of expediency or because they are considered unnecessary. In carrying out its inspections, investigation

and enforcement responsibilities, over the last six years, our field staff have reported many hazardous conditions and practices observed in the shipyard, which fit into the pattern of the aforementioned underlying accident causes. In my inspection trips around the country, I have made similar observations.

The purpose of this paper is to identify and discuss these conditions and practices in order to guide you to an more effective application of the safety regulations and thereby eliminate, to the extent possible, accident experiences.

We feel that a frank discussion of these points, at a session such as this, can be of mutual benefit to all of us. We must be sure to not only point out the shortcomings, but also to provide the remedial

Remediations Related to the Competent Person. The regulations, one which we presently are placing a great deal of emphasis on, those which deal with the responsibilities of the competent person, primarily in situations posing flammable hazards.

I should like to parenthetically state that the emphasis on the fire hazard has been in the program since April, 1961, is now a part of the program. We would like to believe that the training efforts provided by our staff throughout the nation in the large measure has been responsible for the downward trend

1965 National Safety Congress

in accidents attributable to fires, explosions, and toxic materials. But, we have a great deal farther to go, if we ever are to become satisfied with our accomplishments.

The conditions and practices with which we are concerned in this category are:

1. The designation of a Marine Chemist by an employer as a competent person, without informing him that he has been designated. This lack of communication between the employer and the marine chemist has resulted in misunderstandings and faulty performance by the marine chemist of the regulatory requirements.

2. The inability of the marine chemist designated as the competent person to perform all of the duties required by the regulations, because of the press of other work.

3. The inability of some marine chemists to cope with ship-breaking operations because of their lack of experience in this activity.

4. The refusal on the part of some management to encourage or assign supervisors to our competent person training classes, which are being held by our district offices throughout the nation. This same attitude has been assumed by some of the union leadership.

5. The negligence displayed by some shipyards to keep a log or record of the tests and instructions issued by the competent person of the precaution and control measures to be taken.

The regulations require that this record, known as the Log of Inspections and Tests by Competent Person, or the MAR-9 form is to be kept by the competent person. The marine chemist designated as the competent person must also keep this log acting in his capacity.

Suggested guidelines for overcoming these deficiencies are as follows:

1. The employer should inform the supervisor for the marine chemist he chooses to designate as the competent person, of his designation and arrive at a clear understanding of what he expects of him with respect to meeting the requirements of the regulations which apply to his particular operations.

2. The marine chemist must make a definite commitment of his availability to carry out the requirements of the regulations.

3. The marine chemist is obligated to expand his horizon of knowledge so that he will be able to cope with all the activities and operations with which he will become involved—such as those in ship-breaking previously mentioned. For your information, a special tri-partite task group organized by the N.E.P.A., of industry, government, and the N.E.P.A., is presently meeting to formulate an educational paper on the practical aspects of shipbreaking. It will be distributed to industry, to the marine chemists, and to our Bureau staff.

4. We suggest that both management and labor exercise a more vigorous interest in participation in the various safety training courses, particularly those dealing with the duties of the competent person.

The advantage of having trained persons, especially to deal with the areas of fire, explosion, and toxic hazards, is now recognized by the employers who have operated in these courses. They find that the trained supervisors have been extremely useful as connecting links between the marine chemists and the men doing the work.

5. Greater care should be exercised in recording of test results, and issuance of instructions to control the hazards in the work environment. The MAR-9 log, required by the regulations is designed to provide the record. This form is available from the local Bureau field office nearest you. The competent person should occasionally be checked out by the employer as to whether he is adequately and properly carrying out the requirements of the regulations pertaining to him. Our field staff is presently doing the same during their inspections of the work locations and work procedures.

Regulations Related to Exposures to Toxic Materials

Before control measures can be exercised against toxic contaminants, the contaminants themselves must be identified. To do this, the ingredients in the work materials must be known.

Although in most instances the flammable and toxic properties of the common materials are known, little or no knowledge is possessed of the hazardous materials in a number of work materials.

It is immediately suggested that the employer should be taken to identify the

hazardous ingredients in the work materials, such as cadmium or zinc, lead, steel in the construction or repair materials category, fluoride coated welding rods in the process materials category, and methyl ethyl ketone solvent in the application materials category.

We are therefore, in the near future, referring to industry, labor, and other interested parties proposed language for amendments to the regulations that will, in effect, require that none of the hazardous construction, process, or application materials shall be used unless the employer obtains information from the manufacturers or other sources that will enable him to exercise the proper controls over these hazards.

It may be well, at this junction, to remind you that in April, 1964, the Bureau proposed amendments to the shipyard regulations which provided for periodic medical tests of employees exposed to hazardous atmospheric contaminants, such as metallic fumes and free silica. Management, through the Shipbuilders Council has taken a firm position against them, while labor has submitted some inconclusive comments. As of this time, the matter is still open for discussion. Future evidence and development in this area may suggest a new course of action.

Regulations Related to Tripping, Slipping, and Falling

The regulations related to the number one accident type in shipyards, viz., tripping, slipping, and falling, are those that deal with scaffolding, protection of openings, housekeeping, safety belts and lifelines, ladders, and walking and working surfaces.

The following conditions and practices which have violated these regulations are cited for your guidance:

1. Partially dismantled scaffolding was left in that condition for a short period of time. Another craft, using the scaffolding without the knowledge of the workman dismantling it, was injured. The remedy is to rope off or by some other method deny access to the partially dismantled structure.

2. Back rails, which had been removed to permit passage of some bulky materials, were not reinstalled and resulted in a serious injury to an employee who intended to use the scaffolding for only a short period of time. The answer is to replace back rails as soon as the material handling is completed.

3. Guard rails were not erected around openings in the tween decks because they were not being used in the work operation. Nevertheless, one of the workmen fell his death through one of these openings. The guide to follow is to guard openings in the work area even though they are not directly involved in the work operation.

4. Hoses, electrical lines, welding leads, and air ducting were scrambled together with many useless hoses and leads which resulted in a loss of identity of the ones in use. Several deaths were incurred in two distinct cases; one involving misidentification of an oxygen and acetylene hose and another involving confusion in tracing an electrical power lead. Three guides are suggested. One, hoses, leads, and other sources should be pulled whenever these are longer in use are confusing identification of those in use. Two, some system should be used, such as a mark, tag, or color, whereby a welder or burner, for instance, can trace and identify his lead or hose. Three, leads, hoses, etc. should be kept in an orderly arrangement and supported by some suspension or support device.

In a recent inspection trip to Bath Iron Works, Bath, Maine, I saw an excellent example of suspension hook arrangement for supporting hoses, leads, etc. In addition, workmen kept them and permitting the tracing of individual lines.

5. Safety belts and life lines were not used by employees working on the top level of a building. Most of the workmen were not wearing them and resulted in several deaths. No thought was given to the floor suddenly surfacing on the work level at any time and if he missed it, to catch safety belts and life lines on the work on the top level of the building with many employees falling into the water, and one died.

6. Hand lines of other means were not used to handle materials from one level to another. Instead they were carried in the arms and resulted in slips and falls, some injured several employees and resulted in the death of another.

In the following, the remedy for the possible remedy is suggested. Carry up and down in the hands and arms while carrying a bulky is a common practice, but it

can result in a serious injury or even death. Accidents have occurred on inclined ship's ladders as well as vertical ladders. Training the employees to lower the materials by some hand line or light tackle is the answer. It may require training and retraining to attain consistent compliance.

7. Adequate walkways not provided in the machinery spaces of newly constructed vessels being outfitted, were responsible for a significant number of falls and injuries to workmen. In most cases, the walkways were not erected because of anticipated installation of piping systems or equipment. Another reason was that the area was located remote from the immediate work operations and therefore did not pose an imminent accident producing situation.

But men did walk in that area, and did fall and injure themselves. The answer is to either provide appropriate and safe walking and working surfaces on the various levels of the machinery spaces or barricade the unused areas. The rails for barricades, of course, should be substantial for the use intended.

Regulations Related to Materials Handling Equipment

The significant number of crane accidents, which have been recorded over the past 6 years, suggests the advisability of extending the cargo gear certification requirements, which presently cover cargo handling equipment, to floating derricks, drydock gentries, and other floating hoists used in shipyards. This would be a step toward standardization of certification of materials handling equipment used for maritime work.

Regulations Related to Personal Protective Equipment

I would like to call your attention to several work practices in this category where, due to lack of appreciation of the hazards present, the requirements of the regulations were not fully or correctly applied.

1. No goggles worn under the welding helmets for shields.

2. Inadequate protective clothing worn by welders and burners against hot slag and radiation.

3. No protective or shaded lens goggles worn by other workers in the proximity of chipping, blasting, or welding operations.

4. No respiratory protection worn by workers in the proximity of operations requiring such protection.

5. Wearing of respiratory equipment approved by Bureau of Mines.

6. No respiratory protection worn and welding shields while exposed to heat, smoke and fumes.

7. Wearing of improper filter and chemical cartridge type respirators for the particular exposure.

8. No buoyant life vests or working worn in smaller boatyards, while working on small boats, work floats, or near guarded edges of floating equipment.

Regulations Related to Electrical Hazards

The major need in this category is positive determination by an electrician or technician working on a circuit, of whether the circuit is live or dead. Due to absence of the knowledge, whether through personal error or through the lack of a proper lock-out procedure, several fatalities have occurred. The suggested guide is that strict, positive lock-out procedures should be enforced by the employer through the electrician or technician.

Several electrocution cases have occurred.

One, when a welder's body was grounded as he contacted the bare electrode in a A.C. welding circuit, while in an extreme sweaty condition, and while pressed against the steel structure in a confined space. Several others occurred through use of grounded electrical hand tools.

What was considered a proper ground was either inadequate or was no ground at all.

Several others occurred because the employees using the tools thought the ground arrangement unnecessary.

Although we have highlighted only a few of the existing unsafe shipyard conditions and practices to which our regulations apply, we hope that these will serve as a guide for developing a keener recognition of the presence in your work operations.

We are convinced that efforts directed at controlling the deficiencies discussed in this paper will be well spent, will better protect accident experience, and produce the full life, limb and property being exacted with the shipyards of America.

TANKER SAFETY IN AN ERA OF CHANGE

By JOHN T. KNEPPER

Manager, Employee Relations Division, Marine Transportation Department
Socony Mobil Oil Company, Inc.

We are living in an era of change that is obvious to all.

The extent and speed with which these changes are taking place, however, is rather more difficult for us to grasp. Some values which have gone unquestioned for generations and centuries are now viewed with skepticism or have been discarded entirely. The accepted practice of yesterday is being questioned today. The sacred cow of today may be the dead duck of tomorrow.

Our own tanker industry has not been exempted from this upheaval. If we have any doubt of it, let's recall that, within the memory of most of us, the average tanker was something under 10,000 deadweight tons with a speed of about 9½ knots. Not long ago a contract was signed for construction of a 167,000 tonner.

Many of us can remember the last of the commercial sailing vessels. Today nuclear propulsion is no longer a novelty and the hovercraft and hydrofoil are rapidly coming up over the horizon. The giant submarine tanker could even be commonplace in the not too distant future.

Changes never come easily in the maritime field. With good reason, we are one of the most conservative of industries. While far planning, had judgment or corner cutting in the shoreside business can be expensive, it is seldom catastrophic as it may well be when a ship at sea is involved. The elements seldom give us a chance to make more than one mistake. Change for the sake of change under these circumstances is entirely out of place, where safety may be compromised.

Whether we like it or not, we are being forced to make radical changes in our practices and in our thinking to keep abreast of the times and meet the demands placed upon us by present day conditions—particularly the keen competition in the tanker industry. These changes have brought with them new problems and hazards. How we in Socony Mobil Marine Transportation Department are attempting to solve them is the general subject of my remarks.

Before talking about these hardware involved, I'd like to review for a moment some of the changes which have caused us to revise, or at least to reconsider, our standing practices.

The first and most spectacular of the tremendous increase in size of tankers which has taken place in the last 20 years, and which incidentally shows little sign of slowing in its course. As the tanker gets bigger and the number of cargo tanks increases, the problem of protecting it from attack grows accordingly greater.

Another change which has stimulated thinking in tanker safety is the increasing number and variety of products we are called upon to carry in our ships. The rapid development of the petrochemical industry has brought us into an entirely new field and presented us with safety problems of an entirely different nature. Liquefied gases under great extremes of temperature and pressure pose still different problems. While we have not yet become involved in it, we will be before long, be called upon to provide transportation for L.N.G. and other new loads with attendant problems to be solved.

The skyrocketing cost of labor and still competition within the industry has made it essential to keep maintenance at a minimum wherever possible and reduce the amount of work to be done by the ship crew. Much of this is being done by taking advantage of equipment and materials requiring less maintenance, and automated controls of vital shipboard functions. All these have presented new problems involving safety of life and property.

With a whole new set of problems to be solved, it soon became obvious that merely continuing on in the same old way would not do. Simply adding more of the same was not the answer. Fortunately, the climate was induced to change in the first place. And some of the answers are in other words, we had to learn to "think big" in safety too.

0005308

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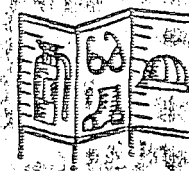
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000540

1965 National Safety Congress

demands safe practices in all phases of the operation.

The most important auxiliary equipment in the shop is the communications system. Our public address is designed for the direction of all movements in the shop and through this system, all employees are alert to the exact stage of the heat cycle.

This is a two-way system and instructions are repeated, as heard, to eliminate any misunderstanding. Audible alarms, such as sirens and horns, are used to supplement verbal announcements.

The furnace operator announces, over the public address system, the pouring of hot metal, oxygen lance movements, flux addition time and other instructions to keep all

personnel in the shop informed on progress of the heat cycle.

The importance of good public address and audible warning systems is absolutely necessary because of the remote areas where employees perform auxiliary duties. Experience has taught us that these warning terms must be loud and unmistakably clear to maintain a safe operation.

As we gain in knowledge and operating experience, we believe the basic operating process will become the safest steelmaking method. We know that we have many safety and related problems to refine, but through the application of sound management and safe practices, the lives, happiness and well-being of all our employees will be improved for the better.

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000541

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Past General Chairman

000542

We are faced with the need to develop new techniques; new equipment; and new thinking if we are to develop and produce the mineral materials which remain immediately available to us, let alone find new deposits covered by hundreds of feet of overburden.

Contrary to the situation which existed 50 years ago, there is, today, a real dearth of qualified candidates for the jobs available in our industry. There is an acute lack of young people training for technical or supervisory positions. The closing of mining schools, due to a lack of students, is shocking. I cannot help but attribute these conditions to the unfortunate change which has been created.

Our Nation is committed to assist new nations in their efforts to improve living standards and our industry is dedicated to do its part in meeting domestic needs as well. Neither of these objectives can be met unless we make a dramatic change in manpower availability. Competent technical skills will be needed to help the emerging countries develop and produce their resources as well as find ore-bodies not readily apparent from surface manifestations. Similar talents will be urgently needed at home if we are to maintain our own standards of living.

As a result of these almost unprecedented demands, every effort must be made to present to the potential candidate for a natural resource career a true story of the opportunities that exist within our industry.

Conservatives in the mining industry have been slow to recognize that a revolution has hit our industry. Science has been let in the back door with seeming reluctance. The mining engineer is too often regarded as a creature of tradition, and the credit has been given to the development of the mineral sciences.

In modern mining one can see at least three distinct fields of scientific application which are rapidly becoming apparent. The first requires an approach from pure mathematics and physics to rock mechanics and environmental engineering. The second requires an approach from statistical mathematics to evaluation, control and economic engineering. The third embraces the social sciences with human factors, ergonomics

All of these revolutionary changes in 50 years ago can do little if we neglect to provide a safe and stable working environment. Where our fathers designed and reported their workings by shrewd instinct and experience, we can today add qualitative knowledge; and our sons add growing precision in numerical prediction.

With so many obvious opportunities and challenges facing our industry, the need for talent is at once apparent. We must point out to our sons that these opportunities exist and that they are as fully challenging as any which are publicized in the exotic and sophisticated fields of space or communication. We must emphasize that ultimate reward is not the reward for a minerals career and this is attested to by the record we have made. We must point out that a mining communities offer families opportunities to develop under the influence of the best academic, medical, religious, cultural and recreational facilities.

This is not a new problem, but the urgency is more acute than when Agricola, 1556, reported as follows:

"Many persons hold the opinion that the metals industries are fortuitous and the occupation is one of the sordid and altogether a business requiring not much skill a labour. But as for myself when I reflect carefully upon its aspects points one by one, it appears to be far otherwise. For the miner must have the greatest skill in his work."

Modern nations, like man, do not live by bread alone, but by the evergrowing consumption of metals for tools and products. Nations desperate for these metals often take ill-conceived measures to acquire them. A hungry world is hungry for a world—and the world is hungry for food with which to produce.

We must, therefore, begin a position to assist in the orderly location, development of new ore deposits wherever they may occur in the world. Only a well-trained cadre of skills, available to our neighbors will allow our industry to make significant contributions to world stability.

The Russians, like the Romans of yesterday, put political prisoners and conquered peoples in their mines. God grant that

alternative, but be assured that our national welfare would be seriously jeopardized without mineral products and survival could well dictate such actions.

Even though Agricola pointed up our problem over 400 years ago, little progress has since been made in appraising the public of our importance to them. Our vote potential is so much less than "other minority groups" that our voice is seldom heard or our problems considered in political circles. Commitments of national minerals significance are too often made without painstaking consultation and analysis which under emergency circumstances can dangerously deplete our existing mineral supplies without feasible plans for replacement.

I cannot help but repeat again and again

—we must not let another 400 years go by before effectively appraising the public and its political representatives of our industry's significance to national well-being, its opportunities, its challenges, its security, its true family environmental advantages, and its working conditions.

You men in this accident prevention field, closely cooperating with industrial relations people, have laid a firm foundation and have built a sound structure. You have a marketable product for America and the world.

Our job is now to sell ourselves. Only in this manner can we hope to have men in the mines and minerals available to avert national disaster and meet our world commitments to bring an enduring peace to a mineral-hungry world.

DUST HAZARDS RELATED TO HEALTH

By ROBERT L. HARRIS, JR.

Field Investigations Section, Abatement Branch, Division of Air Pollution,
U.S. Public Health Service

The overall problem of dust hazards related to health is only partially solved. Much has been learned in the past and put to use; much remains to be done. The complex problems which remain require combined efforts in the fields of engineering, physics, chemistry, toxicology, physiology, pathology, and medicine.

One link, or relationship, between hazards and their adverse effects on health is the assessment of exposures to predict their biologic effects. Precise and specific means of assessment would permit accurate predictions of effects and economical and effective control of the hazards. Completely satisfactory methods for the assessment of exposures to dusts are not yet proved or in use.

Precise definition of the cause-and-effect relationships in the pneumoconiosis is especially difficult, because disease may first appear a number of years after initial exposures.

This discussion reviews some of the relationships between dust hazards and health by

respiratory system copes with dust particles which are inhaled, some of the present sampling methods to measure degree of exposure and some of the effects on health which may result from excessive exposure.

The Nature of Dusts

Dust particles which are hazardous to health when inhaled are invisible to the unaided eye. The smallest particles ordinarily seen without magnifying devices are about 30 to 40 microns in size. Those which are visible to the unaided eye are smaller than 10 microns. (1 micron is approximately 1/25,000 inch).

Small particles, those in the range of 1 micron diameter, behave in a most different manner than 10 microns which are large enough to be seen. These small particles, once airborne, remain in the air for long periods of time. For example, small particles of 1 micron diameter settle only 0.01 foot per minute in still air. In turbulent air, sedimentation is the only mechanism for removal of the 1 micron particles.

airborne 8 hours after generation of dust had stopped. A 1-micron quartz particle projected into still air with an initial velocity of 10,000 feet per minute (about 100 miles per hour) will lose its momentum in a distance of 0.01 inch and will thereafter settle or move with air currents. Particles smaller than about $\frac{1}{4}$ micron (0.3 micron for quartz, 0.7 micron for coal) in diameter are affected more by forces of diffusion than by the force of gravity. At ordinary temperatures, the Brownian displacement in air of particles of this size is about the same as their Stokes settling velocity, about 1 millimeter per minute. Thus, the dynamic characteristics of small particles are such that once airborne, for all practical purposes, they move with air currents. Sedimentation has a negligible effect upon dust particle concentrations in normal work situations, and the kinetic energy they possess at generation is quickly dissipated.

Particle size is also important in matters involving the composition of dust. Dust produced by drilling or crushing rock does not necessarily have the same composition as a sample of the parent rock. Even in dust which has become airborne the small particles may have composition different from the larger ones. Three kinds of samples, host rock, settled dust, and airborne dust were obtained from each of nine locations in metal mines. Two fractions of the settled dust samples were analyzed; one fraction contained all particles which passed through a 325-mesh screen (-325 mesh fraction), the other contained only particles smaller than about 5-microns diameter (-5μ fraction). The airborne samples were taken well downstream from the points of generation to permit large particles to settle prior to sampling. These results indicate decreasing free silica content with decreasing particle size.

Data from some coal mines show more ash in airborne dust than in the coal being mined. In the airborne dust from these mines the samples of fractions containing only particles of small size have a lower percentage of free silica than do the fractions with particles of larger size. For example, the fraction containing only particles smaller than 5 microns may contain 2 percent free silica, whereas the gross airborne sample may contain up to 20 percent.

The coal seems to break along seams of high impurity or high ash content, but in the dust generated, the particles of quartz tend to be larger than those of the other minerals. These data illustrate that mechanics and particle dynamics have effects upon the composition of dusts.

Respiratory System

The respiratory surface in the lungs of a normal man ranges from about 300 square feet at rest to about 1000 square feet at deepest inspiration. The membrane separating the alveolar air space from circulating blood may be only one or two cells in thickness. In the course of an 8-hour day of moderate work, a man breathes about 300 cubic feet of air. Contrast the forced ventilation exposure of the large delicate lung surface with the ambient air exposure of the skin, which has some 20 square feet of surface and a thickness measured in millimeters. It is evident that the lungs represent by far the most extensive and intimate contact of the body with the ambient atmosphere.

The respiratory tract of man branches successively from the trachea to some 25 to 100 million ultimate branches. These branches terminate in some 300 million air sacs, or alveoli. The cross section of the trachea is about 2 square centimeters, and the combined cross sections of the alveolar ducts, which handle about the same quantity of air, are about 8,000 square centimeters.

The aerodynamic behavior of particles varies with size, density, and shape. Discussion of dust deposition in the respiratory system is simplified by the concept of "equivalent size" of particles. The equivalent size of a particle is the diameter of a unit density sphere which has the same terminal falling velocity in still air as does the particle.

The respiratory tract, with its successive branches and tortuous passageways, is a highly efficient dust collector. Essentially all particles greater than 4 or 5 microns equivalent size which enter the respiratory system are deposited in it. About half of those of 1-micron equivalent size appear to be deposited and the other half exhaled. The sites of deposition in the system are different for various sizes.

Some studies indicate that particles greater

than $2\frac{1}{2}$ or 3 microns equivalent size are deposited, for the most part, in the upper respiratory system, that is the nasal cavity, the trachea, the bronchial tubes, and other air passages; whereas particles 2 microns in equivalent size are deposited about equally in the upper respiratory system and in the alveolar or pulmonary air spaces. Particles about 1 micron in size are deposited more efficiently in the alveolar spaces than elsewhere; essentially none are collected in the upper respiratory system.

Although the respiratory system is a very efficient dust collector, all of the dust collected is not retained. The system has a highly efficient mechanism for removing the collected dust. For example, during 30 years of work a coal miner may inhale and collect in his respiratory system 10 to 15 pounds of dust, but after this 30 years, his lungs may contain only 0.1 to 0.15 pound of dust. The efficiency of removal is thus in the order of 99 percent.

The primary mechanism of clearance in the upper respiratory system is ciliary action. The respiratory tract, from the epiglottis to the terminal bronchioles, is lined with cells having minute hair-like processes called cilia. The cilia, by continuous whip-like motion, cause a blanket of mucous-like fluid to flow upward on the surfaces of the air passages. This blanket carries dust particles and other foreign material upward and out of the respiratory tract to be swallowed.

Surfaces in the alveolar spaces do not have cilia. The primary clearance mechanism here is phagocytosis. Phagocytes are cells which engulf foreign materials such as dust particles. These cells appear in the lungs, possibly by disengaging from the surface lining, and migrate with their burdens of foreign material either to the pulmonary lymph system or outward to the ciliated air passages, where they are carried away by the ciliary action.

Because the efficiency of lung clearance is so great, a small decrease in it may result in a great increase in the amount of material retained in the lungs. Several observations on interference with lung clearance have been made. The efficiency of lung clearance appears to decrease with increasing lung dust burden. Irritant gases have been shown to decrease or stop ciliary action in animals. Some materials which appear to be toxic to

phagocytes reduce their effectiveness in removal of material from the pulmonary spaces. The mechanisms of pulmonary deposition and clearance deserve careful study and will receive a great deal more study.

Dust Sampling

Any program for control or reduction of exposures to dust requires a means of assessing exposures. Since the etiologic and toxic occupational diseases, particularly the pneumoconioses, are not fully known, it is not possible to define all the characteristics that contribute to the toxicities or biological effects of dust. All of the sampling methods used in different parts of the world for estimating exposures to mineral dusts are empirical. None is an absolute method which will yield data from which the hygienic significance of exposures can be precisely judged.

In the United States, the American Conference of Governmental Industrial Hygienists promulgates Threshold Limit Values for toxic materials for use by industrial hygienists as guides in devising control of occupational exposures. Threshold Limit Values have been developed for a number of toxic dusts. The Threshold Limit Values for dusts with systemic toxicities lead or cadmium, for example, are ordinarily expressed in mass units, i.e., in milligrams per cubic meter of air.

Sampling for such materials may be by filter or other means which collect all of the airborne material. The Threshold Limit Values for pneumoconiosis-producing mineral dusts, on the other hand, are expressed in terms of particle count, i.e., the customary unit of concentration is millions of particles per cubic foot of air (mppcf).

The Threshold Limit Values for mineral dusts can be used to judge only data yielded by a standard procedure of simplified sampling in liquid medium and by direct microscopic counting of the collected dust. The Threshold Limit Values for mineral dusts cannot be applied to data from other particle counting methods of sampling.

The standard method of numerical sampling and counting was first described in 1924 at a meeting of the National Conference of Governmental Industrial Hygienists. Since that method is empirical, it must be followed closely by all its users if data obtained by one person are to be comparable to those

obtained by another. Even then, variables in sampling and counting within the method as it is described may permit two investigators, both applying the method skillfully and conscientiously, to obtain quite different results to represent the same environment.

Sampling may have different purposes, which merit employing different techniques. These generally fall into two major categories: (1) sampling for engineering, surveillance, testing, or control and (2) sampling for health research or epidemiologic purposes.

Engineering applications of sampling may include locating sources of contamination, monitoring performance of environmental control systems, or doing research in such problems as collection efficiencies of air cleaners. A sampling program for engineering purposes should be designed to yield the specific information desired. For example, one might need only a single sample before and another after a change in ventilation to determine whether the change has had the desired effect.

Hygienic applications of sampling, on the other hand, may be directed at predicting the health effects of an exposure by comparing sampling results with hygienic guides, determining compliance with health codes or regulations, or research to define as precisely as possible environmental factors for comparison with observed medical effects. In the latter case, sampling may provide the basis for development or refinement of hygienic guides such as Threshold Limit Values.

Sampling for atmospheric particulates presents quite different problems from those of sampling for gases and vapors. Gases and vapors, when inhaled, can penetrate all portions of the pulmonary system and follow the laws of distribution by diffusion and absorption. The sizes and densities of particles, on the other hand, are major influences in determining the sites at which they will be deposited in the pulmonary system. Since the effects produced by particles trapped in the nasal passages or deposited in the ciliated portions of the pulmonary system may be quite different from those of particles which are deposited deeper in the pulmonary system, site-selective sampling is generating increasing interest among industrial hygienists.

At the Pneumoconiosis Conference held in Johannesburg, South Africa, in 1959, in which experts in pneumoconiosis from all over the world participated, it was concluded that in the light of present available evidence the best single parameter to measure in the case of coal dust, is the mass concentration of respirable dust, and in the case of quartz dust, is the surface area of the respirable dust.

The respirable fraction of a dust cloud was then defined as all particles smaller than 1 micron, half of those of 5 microns, and none of those 7 microns or larger in equivalent diameter. Sampling devices have been developed to sample this respirable fraction. They either reject particles too large to penetrate to the deeper portions of the lung or collect larger particles in a pre-sampler so that the respirable portion can be collected separately for weighing and analysis.

The results of sampling for dusts using such devices, either for gravimetric determinations or for determination of composition, cannot be interpreted by use of our current Threshold Limit Values or similar guides for judging exposures. Such sampling, however, may represent a sensitive method for predicting the disease-producing potential of exposures to mineral dust.

The devices might also be used to distinguish the portion of an exposure to toxic dusts which results from pulmonary absorption and the portion which results from absorption through the gastrointestinal tract. Such samplers are worthy of much greater study and use than they now receive in this country.

Some Effects from Exposure to Dust

The two types of occupational diseases which may result from exposure to dust are the pneumoconioses and chemical intoxications. Pneumoconioses are diseases of the lungs which result from exposure to dust. Chemical intoxications are not limited to the lungs and are characterized by local or systematic effects which result from fractionation, or absorption of, toxic material.

The most common pneumoconiosis is silicosis, a coal workers' pneumoconiosis, and asbestosis. These diseases are characterized by pulmonary fibrosis which is detected by chest X-ray examination and by impairment of pulmonary function as the disease progresses.

In 1963 the Public Health Service published a report by the Service and the Bureau of Mines on a study of silicosis in the metal mining industry.² In this study some 11,000 workers at some 50 metal mines were examined. X-ray examinations showed a crude prevalence of 3.4 percent silicosis among the study population. The prevalence of silicosis among underground workers was about twice that among surface workers, 4 percent versus 2.2 percent. Underground face workers showed an overall crude prevalence of about 5 percent silicosis.

In a further breakdown of these data the rates for face workers according to years of work were: less than 10 years of work, 0.1 percent silicosis; 10 to 20 years, 2.5 percent; 20 to 30 years, 11 percent; and more than 30 years, 26 percent.

It is reasonable to suspect that older men suffered higher dust exposures in earlier years than are common in the industry now. This matter was examined in some degree by comparing silicosis rates among men who worked in metal mines at some time prior to the year 1935 with rates among men who worked only after that year. The examination showed 8 percent silicosis among men with 10 to 15 years of total work in metal mining, but with some work prior to 1935. Among men with all of their work experience after 1935, 20 to 25 years of work produced a silicosis rate of 7 to 8 percent.

Thus, the earlier exposures seem to have resulted in the 8 percent rate of silicosis with about 10 years' less work experience than did the later exposure.

In May of this year, the Division of Occupational Health, Public Health Service, announced the results of a study of coal workers' pneumoconiosis among a sample of Appalachian bituminous coal miners. The prevalence of the disease among the active miners examined is about 10 percent among retired and other inactive miners examined the rate is almost 20 percent. More than 20 percent of active miners in the 55- to 64-year group are affected. The duration of exposure seems to be very significant; the prevalence of cases increases markedly among groups with more than 20 years of underground work. The problem of pneumoconiosis is far from solved. Control of the disease depends upon control of exposure. All presently

available knowledge should be applied toward control, but this is not sufficient to assure that the disease can be economically controlled in all cases. Additional medical and engineering studies are needed to find the most reasonable, economical, and safe means of control.

Relatively few problems of intoxications from dust arise in actual mining operations, but they are not infrequent in milling and smelting operations. The effects of absorption of toxic dust are extremely variable. Effects may range from muscle and joint pain from antimony compounds to chills and fever from zinc fumes. Some chromium compounds may cause lung cancer and perforation of the nasal septum. Mining dust may cause staggering high blood pressure and other disturbances, and mercury may cause irritability and emotional instability.

In contrast to the pneumoconioses which do not regress with any known treatment, most chemical intoxications respond favorably to medical treatment and cessation of exposure.

Summary
Human lungs are size-selective dust collectors. Only relatively small particles, generally those less than 5 microns in diameter, reach the alveolar spaces. Such small particles move with the air currents; they settle very slowly in still air, and even when thrown into the air with high velocity they travel through the air only a short distance. The lungs have an area of about 100 to 150 square feet, a very thin membrane, the surface of which is exposed to contamination from the air breathed. The lungs have good defenses against particulates which may be inhaled, but the efficiency of these defenses is about 90 percent of the insoluble dust deposited in the lungs.

The control of exposures to dust requires a means of assessing dust concentrations in the air. Methods used for sampling and quantitating mineral dust concentrations are empirical and results yielded by the methods cannot be judged by standards based on animal tests. Even with a single method for examining the lungs, sampling and evaluation methods differences in application can cause differences in results obtained by two investigators.

Dust sampling may be undertaken for either of two rather distinct purposes, for engineering testing and control or for health studies. The objectives of sampling program should be kept well in mind while it is being planned and carried out.

Because only the relatively fine dust reaches the lungs, size-selective sampling devices intended to simulate the deposition characteristics of the lungs have been developed. The mass concentration or surface area of particles of such size that they penetrate to, and are deposited in, the deeper portions of the lungs may prove to be a sensitive index of hazard from exposures to pneumoconiosis-producing dusts. Although data derived from such sampling cannot be interpreted by standards based on count, size-selective gravimetric sampling may eventually represent a major refinement in assessment methods.

The effects of exposure to pneumoconiosis-producing dusts is similar for the various dusts and are irreversible. Chemical intoxications vary with the toxic material absorbed and ordinarily improve with medical treatment and removal from exposure.

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CAN COST CONTROLS SABOTAGE SAFETY?—FACT OR FANCY

By J. EDWIN J. FAHLGREN.

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To eliminate waste in administration, cost control is absolutely essential. Without it management lacks the foundation for knowing which costs are excessive or unproductive, and the mechanics for keeping them under constant observation. Top Management has no other proper means of controlling and fixing the responsibility for excessive costs.

A cost control system has as its objective means by which intelligent management is kept informed. The system of control in itself will not solve problems and solutions are derived from the system only after enthusiastic administration and intelligent interpretation. If the controls are properly administered, any variations between the actual and estimated costs will become conspicuous in time to be corrected before significant losses develop. Complete cost control is based on certain criteria or

comparison and as measurement units to provide essential information for the modern functions of management.

When a significant variation appears, management is in a position to analyse it and determine where it occurred, why it happened, and who was responsible. The fact that, because of a proper cost system, management can put the finger on the person or a new policy responsible for the variation is one of the greatest factors in efficient operation. It eliminates "guessing" or "passing the buck."

The establishment of cost control within an organization sets in motion cost reduction. They are different entities and should not be confused as being the same thing. Cost control is concerned with the maintenance of costs in accordance with standards that have already been established through cost reduction programs. It is a device to hold the line in accordance with the established

to consolidate the gains made. Cost reduction, on the other hand, is a progressive instrument against waste and inefficiency engaged in a never ending battle to push costs downwards. It challenges all cost standards, and its endeavours are directed to reduce them continually. Cost control is the established authority, and cost reduction is the "progressive opposition," always seeking to improve the situation. Cost reduction should be promoted as a state of mind. It must be a continuous program without any let-up, as it is never completed. Cost reduction must be a live and vital part of a company's functions. Any product line that is competitive today demands analysis for tomorrow.

In every organization, irrespective of size, attractive opportunities exist for cost reduction. In fact, only those industries and businesses, large or small, who realize their competitive position and the economic situation as a whole; who realize we are now actively engaged in an economic world war; who realize that whatever the changing conditions of the world there is no substitute for cost reduction and efficiency—only those will survive in the battle for markets of the next decade.

It is generally recognized by industry today, that our respective working force is our first and greatest asset. Our success is dependent upon its competence. As we research and analyze operating problems and our manpower resources, we are, in fact, projecting tomorrow's expectancies. Our present period is an era of radical change. While change is the normal condition of life, the rate of change in our world is greater in scope and rapidity than that of any era. Rapid change brings a certain amount of confusion and conflict, as is apparent when we note that youth in general feels uncomprehended. There is incomprehension between parents and their offspring and between society and youth. It is even greater between that section of society who actually experienced the great depression and today's youth. Science and technology have caused a greater spread between the educated and skilled versus the uneducated and unskilled, similar to that between developed and underdeveloped nations. As we question and probe the problem of trying to understand youth, we finally realize that youth feels frustrated

they are ahead of the times. They wish to satisfy all of their longings without having to undergo the "learning" work and sacrifice experienced by preceding generations. They wish to live the full life immediately, without comprehending life, and they rebel against rules and any direction which they can interpret as coercion.

This may have little if any effect on safety or cost control directly. But indirectly, in the future, it can well have profound effect, and the demands for management resourcefulness to cope with employees of the new society will present many challenges. Today we hasten to place stress on human rights and the welfare state and little on human obligations. The rapidity of change is unprecedented in operating history and we will be working with a different complement of personnel, who are indicating a lack of decorum. I introduce this observation, because it is important that we recognize an unmisgiving problem that is entering the field of cost. It is a problem we will resolve, but we should be aware of it and be prepared to take more time and patience to overcome a serious condition that has sprung from our affluent society.

Time and change brought our respective Workmen's Compensation Acts several decades ago. It is a doctrine which stated that the risk of economic loss, through personal injury on the job should be borne by industry, and that economic loss which results from such disablement is to be considered a cost of production and should be incorporated in the price of production in accord with the current price system.

Subsequently industry began to study the "real" cost of personal injury and operational accidents. These costs involved:

- (1) The rising premiums on compensation insurance.
- (2) The cost of premiums on occupational health (dust diseases).
- (3) The cost of wages paid workers for the time lost by workers who were injured.
- (4) The cost of light duty work when a man is physically and mentally unable to undertake this work.
- (5) The cost of damaged equipment.
- (6) The overtime made necessary by an inefficient worker.

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trouble that we have in this area is that the supervisors do not check to see that transferred employees have the proper eye protection for grinding operations. In our factory, employees can transfer from job to job and it is the supervisor's responsibility to see that he has the right goggles for the job that he is going to do.

During 1964, we had four accidents involving a foreign body in the eye as a result of employees wearing the wrong type of goggles on grinding operations. All of these were on employees who had been transferred from a machine operation to a grinding operation and the type of goggles were not changed.

In our plant, we have found that preventive maintenance and air tool safety are twin brothers. Everyone seems to believe in safety with air tools; however, getting something done about preventive maintenance and air tool safety as one and the same problem is sometimes difficult when talking to management or the worker.

I believe that the maintenance of pneumatic tools is a must, and that a good maintenance program on your tools is money in the bank. I also believe that a good preventive maintenance program will eliminate the majority of air tool accidents. Effective and organized maintenance not only reduces operating costs for portable tools

but can also be a substantial aid in reduction of employee accidents.

Tool repair should be performed by authorized, qualified personnel and in a pair area that is properly equipped and maintained. Preventive maintenance and periodic checking of tools for performance, wear, air consumption, and operating is a vital factor in the efficient operation of portable tools.

There should be a central control who has the responsibility for tool performance and repair maintenance. Tool repair records should be kept for each individual to cannot stress too much the importance of keeping records on all repairs to air

In closing, I would like to give you an example of the misuse of air. A few years ago, in one of our plants, we had a group of drill presses in a row with employees these drill presses who had been with the company twenty years or more. Of course it was very hard to change the method which these people worked and they had been used to cleaning shavings, dirt, from their clothing and arms with the hose. One employee had a cut on his arm and while using the air hose, air went into the tissues and the employee had to be taken to the hospital.

As you can see, the safe use of pneumatic tools is a never-ending job for all of

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000570

but if this be so, I would question whether their former use was quite as extensive as that to which they are presently being put.

There is one unexpected result which has occurred from their use also: each gimmick idea put forth at a field location seems to produce a number of others. From this, I have concluded that a lack of such ideas should never be a problem. Their incorporation into safety training programs will undoubtedly remain difficult, but with all due respect, I leave that problem to our program writers.

The other results I mentioned previously, the increases in interest on the part of both presenter and audience and the resultant increase in the retention of the safety messages we are striving to implant must make the effort worthwhile.

This then is what I call the gimmick or "dancing girl" approach to safety training. The impact of any training aid used must be aimed at the building and retention of a safety attitude in those being trained. Whether the safe way of doing something

springs into the mind of an employee immediately following a mental picture of an automobile wreck or a semi-clad female is of no real importance. At this point, I can only say that it appears easier to remember the semi-clad female rather than an automobile wreck.

There may be others in this group who may have entertained, even acted upon similar gimmick ideas to use in safety training. There may even be the feeling that a "gimmick idea pool" of some kind might be of value. I am sure that Northern would be more than pleased to contribute any ideas we have developed to such a pool should it come into existence. I merely thought, plus any detail work it entails, in your capable hands.

I am sure that each of us in the field safety training has but one real goal. The goal is to impress indelibly upon the mind of each person who comes in contact with us or our designated lieutenants in the training effort, the fact that Safety Pays. Always.

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000551

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000552

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000553

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000554

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000355