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40th National Safety Congress

(Index to Transactions
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PLAINTIFF'S
EXHIBIT

NSC-69

New Approaches . . .

If safety is to keep pace with today's rapidly advancing technology, we must continually have "new approaches."

Each year, at the National Safety Congress, the ideas and experiences of many of the nation's top safety men are presented in the various sessions. Many of these ideas, devices and methods, first presented at a Congress session, later become generally accepted within their fields.

In order to present this information conveniently and at small cost, the Congress Transactions are published in volumes, one for each Section or Division, along with a General Sessions and Detailed Index to all volumes. The 34 volumes of the 1952 Congress Transactions are listed on the last page of this volume.

Safety directors everywhere have found the Congress Transactions a useful aid in their accident prevention programs. In industry, for example, their judicious distribution to key personnel in management and supervision has proved to be of invaluable service.

In preparing these Transactions, the proceedings of the Congress have been condensed and edited for reference purposes. Complete original manuscripts, with any charts or illustrations which were used, are available in National Safety Council files. Views expressed at the Congress or in this record are those of the Congress participants and are not necessarily those of the National Safety Council.

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The Importance of Non-Siliceous Dust in Industrial Operations

By EDWARD C. J. URBAN

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A common concern related to the health of workers in mining, tunnelling, granite quarrying, in the foundry industry and in all of the other so called "dusty trades" for many years in the past, has been for the protection of the workers from breathing air borne particulate matter, arising as the direct result of their occupations, which might cause disease.

It has been shown by geo-chemical study that eight primary elements make up 98 per cent of the earth's crust—this is based on the standard assumption for the outer 10 miles of thickness. In the order of their predominance these are: oxygen, silicon, aluminum, iron, magnesium, calcium, sodium and potassium. The chief element, oxygen is present in 47.2 per cent of all rocks. Silicon (Si) constitutes 28 per cent. The remaining six elements combined, total but 22.9 per cent.

It has been further determined that eight compounds or simple combinations of these basic elements are present in 97.6 per cent of the lithosphere. The principal compound is silicon dioxide (SiO_2) which occurs in almost 60 per cent of all rocks. The remaining compounds are chiefly oxides of the other seven elements previously mentioned.

Chemically silicon dioxide is plainly acidic while the metallic oxides are basic in character. In nature, silicon dioxide occurs in two main forms. Twelve per cent exists as the definite independent compound, Free Silica. The remaining 48 per cent of the silicon dioxide occurs in complex chemical combinations with the basic oxides as "silicates." These silicates are the chief rock forming minerals and several hundred species have been identified.

There are many varieties of Free Silica. The types which are present more commonly in industrial atmospheres can be classed as those being either crystalline or amorphous.

In Free Crystalline Silica the atoms are arranged in repeated uniform patterns giving the particles a definite structure. Quartz is the variety which has been formed at temperatures below 573 degrees C. and is the

most common. It occurs as the ordinary crystalline form or as cryptocrystalline chalcedony, flint, chert or jasper.

The two high temperature varieties of crystalline free silica are Tridymite which results from heating above 870 degrees C. and Cristobalite from heating above 1470 degrees C. Both of these are not common in nature but do occur in industrial processes which involve high temperatures.

In Free Amorphous Silica the atoms are arranged in a non-uniform manner and as a result, the particles have no definite structure. Several varieties of Opal occur. In this class may be included natural diatomaceous earth. A distinction however, must be made between the natural mineral as it is found in place and the diatomaceous earth which for industrial reasons has been heated to high temperatures. This latter product can contain Cristobalite in varying quantities. Vitreous Silica is silicon dioxide which was heated to a fusion temperature with the mineral still retaining its amorphous state.

During the past several years technological advancements and industrial demands have created a variety of new artificially produced amorphous silicas. These synthetic products are for use as filters, insulation, diffusion coatings for incandescent lights, in strengthening cotton thread, a substitute for certain materials in vulcanized rubber and as water repellent coatings for cloth.

It is a well recognized fact, substantiated by laboratory research and observations in industry that free crystalline silica as quartz is the specific causative agent of the pulmonary disease Silicosis. Further, it has been common practice in the consideration of industrial dust exposures which involved a silica hazard to imply that quartz was present and that it was the chemical substance of chief concern. Because of the preponderance of quartz in the rock minerals of the earth and our lack of knowledge relating to the toxicity of other Silicon dioxide forms, this view was to be expected.

Recent studies, particularly those made at The Saranac Laboratory, however, have

demonstrated that certain varieties of free silica other than quartz, yet similar to quartz in chemical composition, can produce pulmonary lung changes in animals. These lung changes are unlike Silicosis. In addition, clinical studies have reported that diatomaceous earth, for example, may produce pulmonary changes in workers inhaling dust and that amorphous natural diatomite is less hazardous than is the crystalline cristobalite content which was formed subsequently by high temperature calcining processes.

Currently observations are underway at the Saranac Laboratory also, concerning the effects upon animals to prolonged inhalation of several of the new artificial amorphous silicas. These studies are significant in two respects. The first relates to the particle size and the second to the chemistry of these new products.

One of the earlier comprehensive studies made in this country of the size distribution of dusts found in various industrial environments was reported by J. J. Bloomfield of the U.S. Public Health Service in 1933. Some of his work is shown as Reference A on the slide. A light field microscope system with a magnification of 1,000 diameters was used which allowed particles as small as .5 micron to be measured and somewhat smaller particles to be seen. The data indicates that the greater percentage of the particles were larger than 0.5 micron. H. L. Green reported in the Transactions of the Faraday Society in 1936, the data shown on the slide as Reference B. With the magnification of 1,500 diameters which Green used, particles of .4 micron were measured and as small as .2 micron were seen. His data shows a higher percentage of fine particles, less than .5 micron in size, than does Reference A, probably due to the difference in the magnifications of the two systems. However, these data do agree in the fact that most of the dusts observed were microscopic in size, that is, they were .2 micron in size and larger.

It has been the contention of some investigators that there is a limit to the extent to which solids can be reduced in size by ordinary disintegration methods. This limit supposedly is imposed by the operation of cohesive or surface tension forces upon each separate fragment of material as it is being formed during the process of disinte-

gration. The lower limit of particle size for such disintegration aerosols was considered to be in the order of 0.1 micron.

Perlite is a volcanic glass. This product mined from the earth and later subjected to industrial processing shows comparatively few dust particles are present which are less than one micron in size.

In an electron-photo micrograph of an airborne sample of common quartz dust the quartz had been ground and ball-milled industrially to reduce it to a fine powder. Only a few particles less than one micron in size are present.

It would seem that photographs conform to the view that the ordinary disintegrating processes in industry as crushing, milling, drilling and blasting do not produce dusts of sub-microscopic size. However, additional observations must be made with the electron-microscope to substantiate this.

The significance of sub-micrographic dust particles is a subject which receives periodic attention in the literature. The common thought has been that if particles are fine enough in size, even if they are breathed into the lungs they will not be retained but will be expelled with the expired air.

Four observations have been completed at The Saranac Laboratory with dry aerosols of four different kinds of artificially produced free silicas. All the aerosols were sub-microscopic in size. The particle sizes ranged from .02 to .2 micron. These silica compounds are identified as a—b—c—and d. Preparation was made by a cool physicochemical process. B, C, and D were prepared at high temperatures.

In an electron-photo micrograph of Product A, the primary particles are extremely fine in size with large surface areas.

In a photograph of Product B, the particles are sub-microscopic. This dust appears to have a lesser tendency to form large aggregates.

In Product C, the particles are all well under one micron in size. In some respects they tend to resemble Product B in physical appearance.

The fourth product D differed from the others in several respects. A, B, and C were prepared outside of the Laboratory and sent to us in bulk for study. These materials were then generated as aerosols by various disseminating technics. Preparation D was

initially a liquid which chemically contained SiO₂. This liquid was combined in the Laboratory with a gas and burned. The resulting fume was practically pure amorphous free silica.

In a recent photograph which was produced by an outside agency, the primary particles are very fine in size. We think that these large spheres are Latex that had been added to the sample as a reference for size measurement.

The X-ray diffraction patterns of each of these four aerosols show wide diffuse rings indicating that the materials are amorphous and not crystalline in structure. On the basis of the X-ray the materials are indistinguishable but because of the diffuse nature of the rings it is difficult from the X-ray alone to determine how much, if any, of the silica in each preparation may have been combined as silicate with the metals present.

Data pertinent to the experimental observations with the four silicas are summarized. Analysis of the parent or bulk material of A, B, and C showed that silicon dioxide was the chief constituent, but that small amounts of the oxides of iron, aluminum, magnesium, sodium, calcium and potassium were also present. Some moisture in molecular combination with the silica was present in each sample and was removed by ignition. The corresponding increase in total silica content is indicated. Preparation A was formed in the absence of heat. D is almost a pure silica. Consequently A and D are undoubtedly amorphous. Heating in the presence of certain metals was required to produce B and C. It is judged that these two preparations may be partly glasses or combined silicates.

Various species of laboratory animals were exposed to the inhalation of these four silicas, 8 hours each day, 5½ days per week for periods of two years or longer. The average atmospheric concentrations of the dust to which these animals were subjected ranged from 2.6 to 4.2 mg/cu ft. On the basis of pathological findings A and D produced pulmonary damage and were judged to be active. The disease produced was not like the reaction to quartz. B and C were considered to be inactive.

Two conclusions can be made from these observations which have important significance in industrial dust exposures.

1. Particles as fine as .02 micron can be breathed and retained in the lungs in sufficient quantity to produce disease.
2. Forms of free silica other than quartz can produce pulmonary damage.

Aluminum pneumoconiosis, or Shavers Disease has been recognized as a specific disease, different from other pneumoconioses, including silicosis. It has occurred in bauxite workers, particularly those exposed to electric furnace fumes. An electron photomicrograph shows the particles to be much less than one micron in size. Chemically the fume is composed chiefly of aluminum and amorphous silica with possibly some glass present.

Shavers Disease is another example of sub-microscopic particles causing pulmonary damage.

Industrial environments which contain predominantly sub-microscopic dust particles or more properly, dry aerosols, pose a real problem for the industrial hygienist.

First: The particles are too small to be seen by ordinary microscope techniques. At the present time estimation of atmospheric concentrations must necessarily be made on some weight basis. The proper collection of these particles may be difficult. They may be, and some of them definitely are, fine enough in size, to pass through a No. 41 Whatman filter paper. Some because of their peculiar hydrophobic property cannot be wetted by ordinary liquid collecting agents.

The particles of one of the materials with which we are familiar, carry a static charge high enough to disrupt the operation of the electrostatic precipitator. Further, and probably of most importance, if the material has any degree of toxicity, because of the fineness of the particles, allowable concentrations of exposure will necessarily have to be low. The collection of sufficient dust to weight accurately will in itself be a problem.

Second: The determination of the chemical composition of these aerosols will require more detailed analytical work which will include chemistry as well as X-ray diffraction studies. Micro-chemical methods may have to be applied as the amounts of dust collected may be small.

Obviously new and specialized methods both for the collection and analysis of such aerosols will have to be developed. And finally, a dust control system to fit specific

requirements which may be different from those of ordinary dusts must be devised.

It may appear that this discussion has related mainly to dusts containing silica. Most of the views which have been presented, however, can be applied equally as well to other materials. Even with substances which have been considered inherently inert, it should be recognized that certain factors may operate to alter this condition.

Referring again to Shavers disease, powdered metallic aluminum and hydrated aluminum have been used as therapeutic agents in the control of silicosis on the theory that particulate quartz is inhibited by these materials. On the other hand, recent laboratory studies intended to duplicate Shavers disease at the University of Toronto have demonstrated that sub-microscopic alumina by itself or in combination with silica fume can cause lung changes. As an opposite, with asbestos the fibres longer than 10-20 microns appear to cause disease while the finer particles do not.

New industrial processes are being developed which utilize heat and high energy releases. In effect, new methods of disintegration have been created. The effluents from such processes may have properties

entirely different from the materials employed. Such factors may have been introduced as change in particle size, surface area, surface coatings, electrical charges, adsorption and absorption qualities which alter their behavior.

Increased production activity through advanced mechanization is a significant factor in creating correspondingly denser conditions of dustiness. The experience in the coal mines in England and more recently in this country are examples. Carbon has long been considered inert. Pulmonary changes in the lungs of coal miners have occurred. Some authorities feel that the carbonaceous component of the coal itself is responsible.

It would appear that the terms, "siliceous hazard," or "siliceous dusts" need modification since some forms of free silica other than quartz may be capable of pulmonary reactions which are different from the reaction of quartz itself.

Of increasing concern in certain industrial environments are the sub-microscopic particles and considerable research work needs to be done to determine their significance. A matter of no small importance in this regard is that these small particles may exhibit properties different from the parent materials from which they originated.

Current Safety Topics in the

**PUBLIC UTILITIES
INDUSTRIES**

*as presented in sessions of the Public Utilities Section
at the 40th National Safety Congress*

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NATIONAL SAFETY COUNCIL • 425 North Michigan Avenue • Chicago 11, Ill.

Let's Talk About Ourselves

By EARLE S. HANNAFORD

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New York City

One of the first things I wanted to know was just where does the Council fit into the national picture and, more particularly, where does our utilities section fit into the industrial safety spectrum. It seemed confusing to me that we should have seemingly overlapping organizations, such as the Edison Electric Institute, the American Gas Association, the communications associations, and the American water association accident prevention committees.

Just to name a few others, there are the accident prevention committees of the American Institute of Electrical Engineers and other engineering societies, as well as the American Society of Safety Engineers itself. I believe it goes without saying that all of these organizations would not have existed over the years and turned in such surprisingly good performances if they had not been needed.

In deciding just where we fit in, let's look first at our national scheme of life because the underlying principles of our national safety setup stem from it. Only a democratic system of representative government which has free enterprise as one of its basic foundation stones could have given birth to such a system and made it work. In these days when communism is a threat to our way of life, it is of more than casual interest that, of the four possible alternative types of economic organization, free enterprise, communism, state socialism and hybrid systems, only free enterprise makes our system possible.

To review a moment, in the United States there are five general types of business and industrial organizations. They are production and manufacturing, sales and service, public utilities and other organizations subject to government regulation, foundations in the public interest, and government itself.

To fit our public utilities section into the picture, it is necessary to point out that the National Safety Council is fundamentally a foundation in the public interest much the same as the American Red Cross and others too numerous to name. They attack problems broadly for the benefit of all Ameri-

cans, yes, all the world. They are firmly rooted in the individual specialized groups from which they draw the necessary knowledge and support.

Trade associations and special professional associations, such as the Edison Electric Institute, the American Gas Association, the American Water Association, and the American Institute of Electrical Engineers, to mention a few in our own special field, serve the interests and objectives of their own groups well. However, they are especially equipped to contribute to the overall broad picture also. Their accident prevention committees are pointed particularly to the problems peculiar to one utility operation or to the professional group to which they belong. They are, of necessity, highly specialized and most objectively oriented.

Why, then, is it necessary to have the broader foundation? Cannot these individual specialized groups care for all angles of the problem in solving their own? Moreover, when we come to think of it, don't we waste an awful lot of time in America with the tremendous number of conventions, meetings, committee gatherings of all kinds of foundations in the public interest, trade associations, industrial organizations, etc.? What is the secret behind their total effort? How in the world do they aid each other, rather than hinder?

In a democracy, we must somehow merge all of the "know-how" and draw from it the best that a cooperative effort can bring. Thus, during the last hundred years, a democratic, interlacing network of voluntary industrial activities has developed.

As a foundation in the public interest, the National Safety Council acts as a catalyst for all of the safety aspects of our national life. It is the forum in which representatives of the specialized groups meet and develop the broad guiding activities and principles necessary for overall concerted action. Peculiarly enough, however, this melting pot also feeds the new ideas, revisions, and refinements which have resulted from this testing in a broader sense, back to the specific individual participants.

In our case, this involves individual utilities of all types through our special representatives the Edison Electric Institute, the American Gas Association, the Communications Associations, the American Water Association, etc.

Here, then, is a basic reason for our being. It is important that we know and work within the limits of our sphere of operation, as well as that others do the same thing. Most important of all is the working together cooperatively and effectively. The Edison Electric Institute, the American Gas Association, the communications associations and the American Water Association, for instance, are concerned with all phases of utilities operation, not safety alone. Accident prevention is only one phase, and their accident prevention committees are concerned with the specialized problems of the electric and gas utilities.

The National Safety Council is concerned with safety alone in all areas of American life and effort.

We in the public utilities section have the safety problems of all utilities as our field, plus the job of taking what is applicable and best out of other industrial and general safety work and putting it into suitable form for utilities use. Conversely, we take the things that utilities do and disseminate them, adapting and adjusting them for broad use or for particular utility fields other than the one in which it originated.

When we set up our projects, we evaluate them as to whether they belong in our section or should be referred to the Edison Electric Institute, American Gas Association, American Water Association or the communications associations. Also, we check to see whether the trade or professional associations are already working on them. There is and must be cooperation. There are some projects which are purely ours, some best suited to the specialized associations and some which are best done jointly. Proper project selection, assignment and planning are important for there is more to be done than we can do and overlapping or unnecessary duplication would be an unfortunate thing for utility safety.

The Public Utilities Section needs and depends upon its members being drawn from all utilities. In fact, a goodly proportion of those on our committee serve also on the Edison Electric Institute, American Gas

Association, American Water Association and the communications associations committees. This is in no way detrimental, undesirable or unnecessary. To a reasonable degree, it is essential if the fundamental principles upon which our industrial organization is founded, are to operate and to contribute, as well as receive, benefits beyond those which can be derived under individual functioning as isolated groups. It is not our system that is at fault. If anything, it can, at times, be the lack of a clear picture as to the overall objectives and the methods of accomplishing them. Isolationism in safety will bring the same withering away and dying off as extreme isolationism will do in any sphere of man's social effort.

We must not lose sight of these basic American principles of which we are a living example. It calls for work and hard work. Unless we have good planning, sound execution of the plans and constant evaluation of results, our public utilities section will be no more than a weak and unwanted echo of the safety efforts of specialized trade associations and professional groups. We have no right and, I believe, we have no desire to be parasites in a virile, hard-working American safety setup.

The reorganization which our section is currently undergoing was conceived with this in mind. The changes in various committee setups, reduction in number of committees, including representatives of each type of utility on subcommittees, and the proposed advisory committee which includes line executives from the utilities and the utility representative on the board of directors are all pointed toward active and immediate fulfillment of the purpose for which our group was founded.

Do not misunderstand me. This is in no way critical of our organization in the past, for many, many wonderful things have been accomplished. The very fact that our form of organization has not changed appreciably since 1915 when we were first organized indicates of itself the need for review.

In addition, the safety picture has changed from one in which the plan of attack, which has brought such pleasing reductions in frequency and severity in the last quarter century, no longer quite fits the problem. As we all know, the most striking reduc-

tions come when the record is bad. As it gets increasingly better, it obviously is more difficult to better the record.

I strongly suspect that we are now up against such things as attitude, emotional status and the other more personal sides of accident prevention which cannot be attacked only by solving our own individual industrial or utility operations problems. The future will measure us and find us wanting if we cannot match our organizational setup and our achievements to the facets of today's problems. There is no question in my mind but that the public utilities section of the National Safety Council is just coming into its own but it must have "the will to do" if we are to succeed.

Let's take a look at the tools with which we must work. We, in the public utilities section, have no choice with respect to our method of operation. In this tremendous American industrial picture, companies contribute the money to foundations like the Council but that actually is only a small part of it.

For actual accomplishment, it is necessary that they be willing to contribute the time and incidental expenses of their representatives who participate. No matter how fine the concept of our plan may be, it can only be made to live through the efforts of living men who have the know-how and the will to do, which comes, and I am not ashamed to say it, from a practical idealism. It takes

real men to do it when they have their own job to carry on and have to accomplish this tremendous task on a somewhat limited part-time basis.

Moreover, except for meetings two or three times a year, they work alone contributing their individual parts to their own subcommittee's efforts under the handicap of geographical separation and the delays incident to correspondence.

For real accomplishment, men must serve on the executive committee over a period of years in order to give continuity and progressive know-how to the work being done. One or two years, no matter how well intended, can only help; it cannot control. I believe that the utilities as a whole want to continue the work which has been so well carried on in the past. In my correspondence with the presidents of companies as chairman of your nominating committee of the section, I have yet to find a responsible official who is unwilling to meet the challenge when he understands the problem and how we fit into it. America has become a great nation through and with the understanding cooperation of the men who lead its industries, and our utilities' executives are among the leaders.

We, the members and life blood of the public utilities section executive committee, have before us one of the greatest opportunities for service ever to face a group of this type.

Questions and Problems Pertaining to Electric Utilities Safety

(A Discussion Group)

Question—What are the major problems coincident with the adoption of a mandatory sleeve rule?

One organization has the mandatory sleeve rule. They have tried to impress the workers that the sleeve rule is for their own protection. They explain to them what they are trying to do so the employee will clearly understand. If the rule is sold to them it is not so hard to enforce it. This company had some trouble with this sleeve rule, but not more than with the rubber-glove rule. This problem is explained to them through

foremen. The mandatory sleeve rule is used on all ground work.

Another company requires rubber gloves before the men get within reach of primary conductors, and where the gloves are worn, the sleeves are worn.

A third company said the men don't like to wear the sleeves in extremely hot weather, so they give employees some time for rest. It is required that they wear them in the primary zone. This rule requires clarification at times, and it requires constant vigilance. This company also has the rule

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