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NSC-31

National Safety News

Published monthly in the interest of accident prevention and the health of industrial workers

VOL. 32, No. 3

CONTENTS FOR SEPTEMBER, 1935

Louisville The 1935 Congress City 11

No Half Way Measures in Dust Control—*Arthur S. Johnson* 17

The Driver Has His Troubles—*Henry J. Drogas* 19

"Every Possible Safety Measure"—*T. W. Osgood* 20

An Accountant Analyzes Safety Savings—*Stanley Pembridge* 23

Grand Rapids Is Safety Conscious—*Curtis Billings* 25

Kansas Health Authorities Fight Accidents—*Earle G. Brown, M. D.* 27

Steps to Safety—*Roy R. Randall* 29

Cleaning Exterior Walls of Buildings by Sandblasting or Steamblasting—*Industrial Data Sheet D-Gen. 12* 32

ing the Standards of Industrial Medicine—*M. N. Newquist, M. D.* 34

Looking Toward the Congress 38

Elementary Safeguarding Is Still Important 58

And Sudden Death—*J. A. Furnas* 66

Regular Departments

Editorial	9	The Safety Library	60
The Managing Director's Page	10	The Honor Roll	60
The Safety Exchange	30	Coming Events	65
Industrial Health	34	With the Manufacturer	72
The Bulletin Board	40	The Buyers Service	76
Personals	53	The Accident Barometer	80

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Copyright 1935 by National Safety Council, Inc. Printed in U.S.A. Published monthly. Entered as second-class matter June 1, 1921, at the Post Office at Chicago, Ill., under the act of March 3, 1879. Additional entry at St. Joseph, Mich.

The subscription price to members for extra copies of the NATIONAL SAFETY NEWS is $4.00 per year. Single copies, 40 cents. Reduced quantity prices for yearly subscriptions and single copies on request.

Subscriptions are available only to members of the National Safety Council.

Member Audit Bureau of Circulation.

This magazine is indexed in the Industrial Arts Index.

Statements and opinions advanced in signed articles are to be understood as individual expressions of their authors, not those of the National Safety Council.

National Safety Council, Inc.

(Cooperative—Non-Commercial—Non-Political—Non-Sectarian)

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No Half Way Measures in Dust Control

By ARTHUR S. JOHNSON

Assistant to the Manager, Engineering Department, American Mutual Liability Insurance Company

Dust control is not an event; it is a program that requires concentrated day-to-day attention

TO CONTROL its dust hazard to the extent of making the occurrence of pneumoconiosis improbable, industry must do much more than buy mechanical dust removal equipment and set it going. With it there must be set up a routine of check and double check, perhaps whole new operating practices and a sharp definition of responsibilities. This all boils down to day-to-day attention to a program designed upon a long range health conservation policy. Half-way measures unrelated to each other won't work. Nor is this a "done once, done forever" affair. Dust control is not an event, it is a program that never finishes.

Experts seem to be in rather general agreement about four grades of pneumoconiosis hazard. First, quartz causing real silicosis, a serious solidification of the mass of the lungs by fibrosis or growth of scar tissue. It takes years to get started, but once started is progressive, a condition which will not stop and cannot be cured. After exposure of 15, 20 or 25 years, men in certain trades accumulate this fibrosis of the lungs which lessens their capacity for physical labor. It makes them short of breath and causes certain well-defined clinical symptoms. X-rays of their chests show characteristic shadows. A few of these men die as a direct result of this condition.

Although few of them have their physical capacity to work lessened even in 15 or 20 years, there may be actual lung impairment which predisposes them to tuberculosis. The cause of this silicosis is silica, as free quartz, not combined with other elements in the form of silicates, but the quartz as found free in [illegible] and in its purest natural form as [illegible] ganister. The studies made of many cases of silicosis and the exposures which caused them in the rock industries, sand grinding industries, firebrick making, etc., have shown that the hazard is silica and that it is proportional to the amount of silica in the air breathed. A new ray of hope lies in some fairly good evidence that there may be mixed dusts in which such dust as limestone, gypsum, coal, hematite, clay or cement dilute the silica hazard and produce less physiological reaction than the silica content operating as pure quartz alone.

A second group of dusts produces somewhat the same clinical picture as silicosis in its early stages, yet the x-ray of the chest shows the shadows pretty much confined to the lymph ducts. The damage appears not to be so serious as silicosis in many ways, particularly in that it is not progressive nor does it predispose to tuberculosis. The dusts producing it certainly should be classified as absorptive and therefore harmful although not in the same category as quartz. There is no question but that lessened lung capacity results from them after long enough exposure but it certainly takes more dust and more time to lower capacity for work. Asbestosis falls in this group and apparently similar conditions develop from exposure to excesses of many mineral dusts relatively low in free silica content.

Inert Dusts

A third group of mineral dusts may be harmless in reasonable quantities. The result of work by some investigators which has been published recently indicate clay, talc, emery and carborundum dusts to be inert. In some animal experimentation these dusts did not produce fibrosis. Contrarily, there have been claims for disability from workers who alleged that the exposure to these same dusts caused their ailments. Experts state that these dusts generally do not produce disabling lung pathology, yet we are faced with the facts of claims prosecuted successfully. Quantity of dust, rather than quality, was doubtless responsible for any ill health. Some state regulations require dust exhaust machinery on some operations. We must, therefore, include for control some dusts which by nature may not be harmful.

Our fourth grade of hazard is tuberculosis. Tuberculosis is a disease caused by a germ, and probably more useful work has been done to control this disease than almost any other. From time immemorial the dusty trades which we now speak of as having a silicosis hazard were always among the danger spots for tuberculosis. What we now know is this: that silicosis makes a first class place for tuberculosis to thrive in and kill the patient off much earlier than would silicosis alone. Opinion seems to be that perhaps simple silicosis uncomplicated by tuberculosis may seldom be fatal, but shortens the working life of the victim just as angina, arterio sclerosis, and such degenerative diseases do.

On the other hand, we may expect from tuberculosis one of two things: first, a man brings tuberculosis, no matter how dormant it may be, into a dusty trade, he may reactivate the tuberculosis and have his case diagnosed as "aggravated by" the dust; or second, by getting simple silicosis or perhaps other pneumoconiosis, and then contracting tuberculosis from tubercular associates either at work or elsewhere, die of tuberculosis superimposed on silicosis. Tuberculosis associated with silicosis does not respond well to treatment. Regardless of the fact that tuberculosis is an infective disease not necessarily occupational, we must face this fact, that tuberculosis is so *often the disabling result of* dust exposure, that dust control must include tuberculosis control at the same time.

Measuring the Hazard

Summarizing, we have three dust hazards: (1) quartz, which produces true silicosis — a progressive, lung-disabling disease; (2) some dusts which produce a pathology which usually is not serious and is not progressive after exposure stops, yet a pneumoconiosis none the less, and (3) some dusts which paradoxically are probably relatively harmless, yet have been the claimed basis for tuberculosis and other disabilities. In the absence of adequate diagnoses, occupational histories and a more satisfactory method of adjudicating [illegible]ims than prosecution at common la[illegible] we must conclude that it is necess[illegible] to find a practical method for controlling all mineral dusts. Let us now see whether it is necessary to give them all the same degree of control.

We have learned that the silicosis hazard is measured by the amount of silica in the air breathed. This means that with but few exceptions it is directly proportional to the amount of dust in the air and the percentage of silica that is in the dust. The studies which have established the safe limit, or tolerance, or threshold limit for continuous exposure without deleterious effect, have arrived at 5 million particles of quartz dust per cubic foot of air, none of which dust is larger than 10 micra in size. [redacted]. The particles, therefore, are so small as to thwart imagination.

As one looks across a dusty room and sees great gobs of dirt floating in the air, settling out rather rapidly, or being blown around by draft currents, he is told that that is not the dust we are talking about. The danger lies in such tiny particles that they could be run between the bearing and the shaft of a very fine machine and not touch, for a micron is roughly .00004 of an inch. Five particles of sand, each piece so small as to be only .02 of an inch in [illegible] loading a cubic foot. This means that *if it is found necessary to exhaust the* dust at its point of origin so that that which gets into the breathing zone of the workers will be 5 or fewer million invisible motes in each foot of space, we haven't begun when we get out only the visible dirt. We are confronted with the astounding fact that the health hazard has not been touched, even though an exhaust is 98 per cent efficient in terms of the weight of dust. If we cannot visualize such an invisible hazard, it at least warns us not to throw together some tin ducts, motors and fans, and call it dust control.

Returning to our main theme, let me repeat 5 million particles per cubic foot as the bench mark for quartz dust. Since the hazard is in proportion to quartz, the less quartz the less danger, or conversely, the less quartz the more dust may be permitted. Now, is there a top limit of dustiness which, regardless of quartz content, might be considered a maximum above which nothing would be safe, and up to which only the inert or so-called "safe" dust might go? It seems to be pretty well agreed among the investigators that there is a top limit and this figure, or second threshold limit, is 100 million particles. In other words, no matter what the dust is, it's dangerous if the concentration is greater than 100 million particles per cubic foot. In between these limits must lie the points of safety which take the proportion of silica into account.

Standards for Dust Tolerance

What is the practical answer? A table of dust tolerances such as is contained in some state regulations does well enough, and in them we find a general agreement but with some variation. In principle most such tables show 5 to 20 million particles as the limits where the quartz content of the dust runs from 100 per cent down to 30 or 35 per cent respectively. To use these tolerances which are based upon percentages of silica, both chemical and petrographic analyses of the dust must be made to get reasonable estimates of the silica. The sampling and analyses are both very difficult and expensive. It is doubtful if the settled out dust represents the hazard, and the raw material certainly does not. Also much evidence indicates that petrographic analyses of the smaller sizes is impossible. It seems to me that, [illegible] things by arbitrary standards.

1. Dusts which are known to be [illegible] quartz, 50 to 100 per cent, which represent the sands, and sand stones which are us[illegible] in molding operations, sand blasting opera[illegible], abrasive pulverizing, ganister brick mixing [illegible] other such operations, can well be groupe[illegible] a limit of 5 million particles.

2. Dusts which come from the hard [illegible] used in the building and monumental trades which run 30 to 50 per cent quartz and the mixed foundry dusts, which started with [illegible] 90 per cent quartz in the sand but have been diluted by tremendous quantities of smok[illegible] and lime or phosphate parting so that the [illegible] breathed is often less than 50 per cent [illegible], a practical safe limit for them appears [illegible] 10 million particles.

3. For the whole great range of dusts such as talc or clay or emery, which contain either no quartz or only a 5 or 8 per cent impurity for which 100 million particles is a never-to-be-exceeded dead line, I doubt that we can afford to take chances and be satisfied with control which brings these dusts down [illegible] 100 million particles. I have often sugge[illegible] 15 million but have been accused of [illegible] ridiculous because that figure is certa[illegible] in arithmetical proportion to the silic[illegible] tent. Yet, we are faced with this dile[illegible] suppose we pick 50 or 60 million particles install a dust control procedure and find in the course of a number of years' operation that we still get disabling results. No dust control that I know of has actually demonstrated that 15, or 50 or 100 million residue is satisfactory. It may be necessary, therefore, to skip a tolerance for that type of dust except to say that when it is over 100 million it must be reduced. H[illegible]ver, get the dust down as low [illegible] is reasonably practicable, and 15 millio[illegible] [illegible] looks reasonable to me.

We now understand in general terms what dusts, how much, and of what sizes constitute health hazards. You have a plant in which you suspect a hazard. Let us examine what can be done about it to evaluate your particular conditions. Dust control is so expensive you should not guess at the hazard. If your dust has a lot of quartz in it, such as foundry molding sand, ganister, aggregate for fire brick, granite, sand stone for tool grinding, etc., there is a health hazard. If you can see the dust, you know it to be a terrific hazard. If there is settlement on ledges there is a hazard. You can save yourself the bother of finding out the exact quality of toxicity and proceed at once to put the dust under control. Your problem lies in the 5 or 10 million limit group.

If, on the other hand, you have [illegible] mixed dusts of low silica content of doubtful hazard, before buying dust control machinery you want to find out what the hazard is and how much. The first thought would be to take [illegible]

Dust Control

(Continued from page 18)

counts, make analyses and rely upon those findings. I have said that I doubt the value of analyses. They may prove to be the only practical methods, but they certainly are not as good criteria as to know whether the dust is harmful, and some moderate quantities under suspicion may be safe. We are, therefore, very anxious from a practical standpoint to determine whether our dust is really dangerous or not. This seems to me to be a tremendously important point, for if certain dusts are not dangerous, the atmospheres containing them should not require such clean sweeping as though the quartz content were there alone.

Our present knowledge of pneumoconiosis is so limited, and especially our knowledge of these minor dusts, that we do not know definitely which are bad and which are not. Good medical records of old employees, which records would show the incidence of pneumonia, tuberculosis, etc., would be helpful. X-ray of employees with 20 years or more exposure would be most useful, but the danger from inexpert diagnosis on the one hand, and misuse of the information on the other, makes examination of employees for this purpose something to be avoided. I urge that more satisfactory yardsticks for evaluating this hazard be found, and the recent and current toxicity studies hold some hope for an answer.

In the meantime, it is necessary to assume that all mineral dusts contain some health hazard and put them all under control, and rely upon the low quartz content of the material producing the dust to locate it in the third or least harmful bracket.

It may be well to consider medical examinations as a dust control measure. It is recommended that new employees for dusty places be found physically fit in order to avoid introducing men whose condition makes them liable to an early break down on account of defects or diseases already present, or who may infect others by spreading disease.

Proper diagnosis of such physical conditions can only be accomplished by having a medical examination with x-rays of the chest, including as complete a medical and employment history of [illegible] be made only by physicians who are qualified to interpret x-rays and who have training and wide experience in the diagnosis of respiratory ailments.

The periodic examination is an indispensable preventive measure which enables the physician to detect diseases of the lungs in their early stages and at a time when removal of the worker from the dust offers hope of recovery or improvement. In addition, the repeated routine medical examinations furnish a valuable means of determining the effectiveness of dust control measures.

While it would seem desirable to examine *present* employees to discover cases with active tuberculosis, in order to assure proper treatment and prevent their spreading infection, this procedure is likely to stir up claims or misunderstandings on the part of the workmen. Such examinations, if made, should be used only for rehabilitation purposes.

Equipment for Dust Counts

Our problem now is to suppress the dust to a safe limit. That implies its removal at the source by mechanical exhaust. That implies counting the dust to begin with in order to have some basis for designing the equipment, and recounting to know that the equipment is working satisfactorily. The impinger or standard method is complicated, slow, expensive and poor for routine checking although it must be used as a standard for calibration. We, therefore, want a simple method, one that somebody not an industrial health expert can use satisfactorily. Zeiss Konimeter is a satisfactory instrument in the hands of the man who has had some training. The instrument is imported, is rather difficult to obtain, and not too expensive, under $200, I believe.

Another instrument is the Owens Jet which has been modified by Mr. Hatch of Harvard and Mr. Thompson associated with me in the American Mutual to make its operation simpler and more satisfactory. This apparatus was built specifically for use in checking the dust control apparatus in a large granite shed, and is entirely satisfactory. Up to the present time I do not know that any instrument maker has undertaken to manufacture it, but certainly a demand [illegible] a reasonable price. There is also a very ingenious continuous dust sampling and counting apparatus for keeping a continuous count of the dust in a room under exhaust and it can be so arranged as to control the ventilating exhaust mechanism, turn on more as needed and turn it off when the satisfactory conditions have been reached. This has been designed and built by Mr. Hazard and Mr. Philip Drinker of Harvard and as far as I know, is still a laboratory piece. I see nothing impracticable about it, however, and for a large dust control installation I would expect it to be as useful as the automatic carbon monoxide detector and control mechanism in the Holland tunnel.

There are practical dust suppression mechanisms for sand blasting, tumbling, grinding, mixing, bagging, drilling, abrasive grinding, dry pan mixing and almost every type of localized [illegible] generating dusts. They are [illegible] unless well-designed. They are too often ineffective because, as I said before, they don't begin to touch the health hazard until they have got rid of most of the dust, which is the best they can do. They wear out due to the abrasive action of the dust. They cost a lot of money, and the cost usually cannot be justified on the grounds of improved work efficiency or quality of product. Occasional installations will be self-supporting. The Kelly trap on rock drilling has been demonstrated to increase the cost per foot drilled but has increased the drilling rate sufficiently to offset the cost. Also in the case of air-conditioned rooms in which porcelain enamel is sprayed, the expensive air conditioning system can be made to control the dust and at the same time be made economically sound by reason of an improved quality of enameled surface. No doubt there are many installations which have already demonstrated economy from other considerations than improvement to health. The point I wish to make is that the improvement to health is too important to waste time trying to justify dust exhaust equipment upon economic considerations. Where operations are spread out over a great area, as in the case of foundries, it is difficult to avoid raising dust in the shakeout operation, except by expensive mechanical installations. Most of those which have come to my attention have been installed for the economic purpose of sand handling and in most such cases were far from satisfactory [illegible]

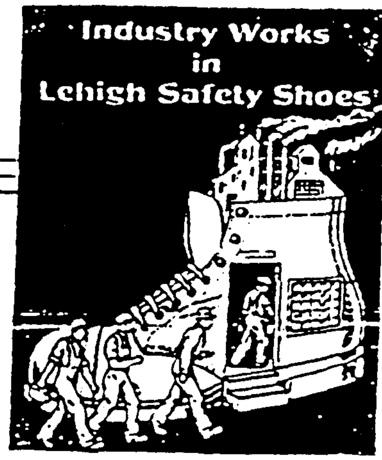
... the same tonnage all right but they do not touch the micrograms.

Let us now look further to see whether some other remedies will be satisfactory. Suppose we leave the hazard alone and put respirators on the men. It won't work, except for very short periods or for emergency work, such as cleaning out dust arresters or loading tumbling barrels. There should be no question about efficient respirators because the United States Bureau of Mines is now prepared to make tests and an employer can justifiably limit his purchase to respirators which meet these tests. Even though respirators may be efficient, they are uncomfortable, and while it is not a hardship for a man to wear a respirator temporarily, or even for a week perhaps during a period of breakdown in the dust exhaust system, I cannot conceive of workmen remaining contented if they have to wear respirators continuously for a long period. If they need to wear them and don't wear them properly they might just as well not have them on at all.

In operations which can be confined to a limited space, such as sand blasting and perhaps shaking out some types of castings, the workers can be enclosed in helmets provided with an adequate supply of clean air. The air-line helmet is practical for continuous use, while a filter respirator is practical for only limited periods. If the dust is extremely heavy, say 300 million particles of quartz, and a respirator is 98 per cent efficient, the worker is still breathing six million particles, which is too much. Think of respirators preferably to supplement exhaust systems.

What else can we do to get rid of the dust hazard? The first to suggest itself is to get rid of the silica content in the dust. I know of one group of foundries which is conducting extensive research involving the use of molding sands that are free of quartz. That may prove to be thoroughly practical and is a step in the right direction. Any plant can study its operations to see whether the quartz material that is being used can be eliminated. Castings in some cases can be cleaned with water. Blasting can be done frequently with steel grit instead of sand. Certainly foundries can use silica-free parting compound that is just as good as quartz dust. Silica packing should be replaced in annealing operations. Pulverized quartz is not needed as an abrasive. This is one avenue of control which should have thorough study in each individual case.

Even though you get rid of quartz



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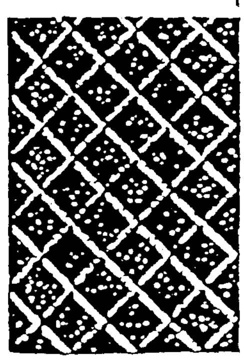

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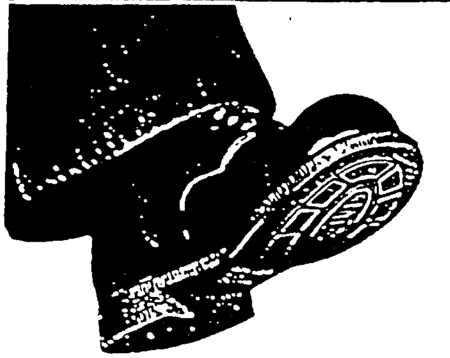

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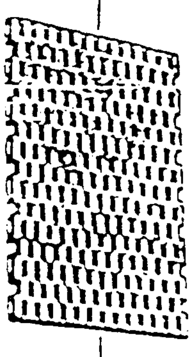

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but cannot get rid of all dust, see what you can do about getting rid of excesses of it by conducting operations in such a manner as to minimize the raising of dust. Explore your process, for instance, and see how much residual dust lies on the horizontal beams, ledges, etc. In some plants that have not been cleaned for a long time this dust has been found to lie at the angle of repose and the vibration of a passing truck would liberate enough dust in the air to be of itself a serious hazard. This can be got rid of by a thoroughly practical means, such as vacuum cleaning or blowing down with a jet of wet air or steam. Respirators are satisfactory for the protection of men doing the cleaning.

There is an economic value in this item. It has been reported by some plants which have improved their housekeeping by this method and have gone a step farther and brightened up their factory rooms with paint and adequate lighting that other accidents have been reduced and work efficiently increased. Certainly an extremely dusty place indicates sloppy housekeeping. Housecleaning must be put on a periodic routine.

Dry processes will sometimes admit of being changed to wet processes, or damp processes. While dampness will not lay dust, moisture in the process will prevent the generation of dust in many cases. Care must be exercised in interpreting this suggestion because water on a high speed grinding wheel does not prevent the dust. One of the most serious silica health hazards is wet grinding on natural sand stone wheels. The incidence to tuberculosis is high. Water on artificial emery and carborundum wheels may or may not be beneficial. It is permitted in lieu of dust exhaust in at least one state, but we are faced with the opinion that these dusts are harmless anyway, unless the volume is high. Its worth depends upon getting the dust well below 100 million particles.

Having done all the housekeeping and process improvement that can be devised in lieu of exhaust, we are confronted with the question of whether there still remains dust in sufficient quantity from some processes to make it necessary to remove it by mechanical exhaust. Dust counts will tell the answer. Hand operations, such as molding, can be done without raising much dust. Most mechanical operations which use or generate dust must be exhausted. It seems inevitable that exhaust be used on sand slingers, rock crushers, dry pans, etc.

Assuming that we have put in an exdust system that is well designed, what must be done to make it work? I have said that they wear out. You must put dust counts on a routine basis as a check of the efficiency of the system. Whether you use the Zeiss or the Owens' or the impinger doesn't matter. The system must be explored constantly for leaks, the dust traps must be cleaned regularly, and the dust disposed of so that it won't blow back into the building. If the design contemplates returning the cleaned air to the building, extremely careful checking of it must be done in order that the hazard may not be compounded. It is poor practice to return the air to the building because operation is so often badly maintained.

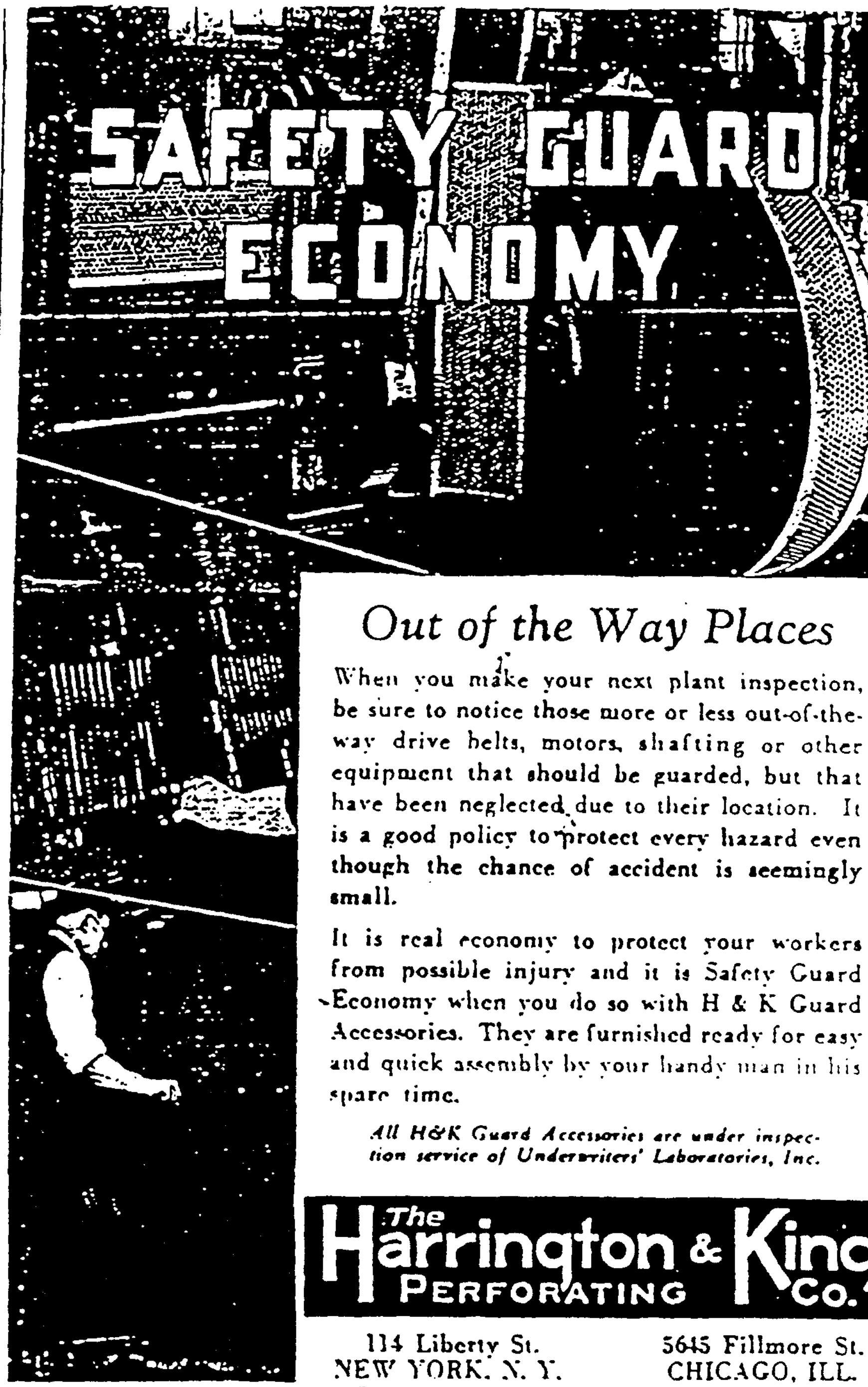
Who is responsible for a dust control program? The owners, through the management, are responsible for the provision of the equipment and the proper engineering to produce it. They have to spend the money and it is management's responsibility to see that it is spent properly. The initiative and the engineering necessary to control the dust rest entirely with the management. It is not a hazard which can be controlled by efficient supervision and safe practices alone.

The supervisory department is responsible for the housekeeping, safe practices and shop methods. Some assigned members of the supervisory department are responsible for the maintenance and operation of the dust removal equipment and for the dust counts used as a check on the system. If there ever was a nice machine requiring constant tuning, it is a dust removal system. It won't work without this attention.

The workers carry a responsibility too. They must use the safeguards provided, whether they be respirators or portable hoods to place behind hand tools. They must not stuff bags into ducts to stop drafts. Dust control is a cooperative thing—each division carrying its share of responsibility. Nobody can avoid his responsibility and make the thing work.

A Correction

Through an error in the caption accompanying the illustration on page 11 of the August National Safety News, Alfred P. Sloan, Jr., president of General Motors Corporation, was referred to as vice-president of the corporation.



Out of the Way Places

When you make your next plant inspection, be sure to notice those more or less out-of-the-way drive belts, motors, shafting or other equipment that should be guarded, but that have been neglected due to their location. It is a good policy to protect every hazard even though the chance of accident is seemingly small.

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