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MONTANA STATE BOARD OF HEALTH

Helena, Montana

DIVISION OF DISEASE CONTROL

A

REPORT ON AN INDUSTRIAL HYGIENE STUDY

OF THE

ZONOLITE COMPANY

OF

LIBBY, MONTANA

August 8-9, 1956

Conducted by:

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Distribution:

This report is confidential
and is not for distribution
except to the management of
the Zonolite Company.

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On August 8th and 9th, 1956, an industrial hygiene study was made of the Zenolite Company of Libby, Montana, to determine if any of the components of the operation of this company were detrimental to the health of the employees. The study was made after a discussion of industrial hygiene principles with Mr. R. A. Bleich, Division Manager, and Mr. D. Lovick, Assistant Manager. Mr. Walter Baker, Assistant Plant Manager, and Mr. Ted Wright, Repairman, acted as guides for the study.

The present study involved the conduction of an engineering investigation to evaluate the working environment and by making a determination of the environmental factors which might have a bearing on health. Consideration was also given to the ventilation and other protective measures already in use for the control of dust and other toxic materials.

The samples collected were analyzed and counted in accordance with accepted practice generally recommended by the U. S. Public Health Service, the American Conference of Governmental Industrial Hygienists, and other official agencies. Samples collected for dust counts were counted a few hours after they were collected and were analyzed for free silica in the U. S. Public Health Service Laboratory in Cincinnati, Ohio.

Description of Operations

The description of the operations of this company have been adequately discussed in previous reports, but, in general, they constitute an open cut mine, a transfer point from the mine to the mill, and various milling and sizing operations done on five floors of the company's mill, a short distance from the mine.

The operation, in general, is that of reducing in size the vermiculite ore which is mined in the open cut mine to various graded sizes which are best for the product which is ultimately an insulation material. In grading and sizing, various vibrating screens are employed to obtain the sizes necessary and to reduce the amount of extraneous material from the ore.

In the mining operations, approximately 17 men are employed per shift and, since the operation is almost wholly outdoor work, no samples for dust concentrations were collected in this area. At the transfer point from the mine to the mill, one man is employed and, although there is some dustiness, it was not felt to be significant and no samples were collected at this point.

In the mill proper, operations are divided into wet mill and dry mill production. In the wet mill, dustiness is quite low; however, in the dry mill the dust from the various sizing and grinding operations is quite high, as noted in the Table I.

The approximate population in the plant at the time of this study was 100 workers, as against 34 workers in 1944, when the last study of the plant was made. The population of the plant a few days before the study was considerably higher but, due to a reduction in the demand for the product, one shift was laid off.

TABLE I
DUST CONCENTRATIONS IN THE AIR

<u>Sample No.</u>	<u>Location</u>	<u>Description</u>	<u>Concentration in mppcf*</u>	<u>Percent Free Silica</u>
1	Wet mill	General air sample.	11.6	Not determined
2	Dry mill 5th floor	General air sample	37.9	1.8 (rafter sample)
3	Dry mill 4th floor	General air sample	51.8	Not determined
4	Dry mill 3rd floor	General air sample	26.7	1.0 (rafter sample)
5	Dry mill 2nd floor	General air sample	48.3	Not determined
6	Dry mill 1st floor	General air sample	83.0	1.2 (rafter sample)

Note: Composite air sample all floors provided free silica determination of 1.3%.

Maximum allowable concentration:

Silica: High -- (above 50% free SiO_2) -- 5 mppcf
Medium -- (5 to 50% free SiO_2) -- 20 mppcf
Low -- (below 5% free SiO_2) -- 50 mppcf

Dust (nuisance, no free silica -- 50 mppcf)

*millions of particles per cubic foot of air.

Concentrations

The concentrations of dust in the air, as determined in table I, vary considerably from a low of 11.6 to a high of 83 mppcf. These concentrations in relation to free silica are not excessive, although the concentrations on the fourth, second and first floor were at or above the maximum allowable concentration even for a nuisance dust with no free silica. On the basis of the asbestos content, no statement can be made, since at this time the asbestos content of the dust has not been determined. However, from visual observation and from information gained at the

plant, a small percentage increase in the asbestos content of the material being processed produces several times greater concentration of dust in the air. The maximum allowable concentration for asbestos is 5 mppcf, and when the concentration of asbestos in the dust samples collected has been determined, further comments on the concentrations will be made. At this time, however, and on the basis of the concentration of asbestos found in the dust, which varies from the company's records from 8 to 21%, it would appear that the maximum concentration of dust in the air should not be greater than 25 to 30 mppcf.

Toxicity

A review of the literature indicates that vermiculite or the dust from this material is not especially toxic and is generally included only as a nuisance dust. However, the asbestos dust in the dust in the air is of considerable toxicity, and is a factor in the consideration of reducing dustiness in this plant.

According to Drinker and Hatch⁽¹⁾, the pathologic changes produced by asbestos are not like those of silicosis. The asbestos fiber group about the neck of the small air sacs in the lungs, and stimulate the formation of a diffuse fibrosis. There is no definite migration or transportation of the dust particles to the lymph nodes and no formation of the fibris nodules. As the fibrosis increases, the reduction in lung area causes a serious decrease in lung capacity, or difficulty in breathing. Lanza⁽²⁾ suggested that enlarged hearts noted frequently in the cases of secondary asbestosis may be the result of the increased work with the heart resulting from this condition. It takes more work to pump the blood through the asbestotic than through the normal lung.

Maximum Allowable Concentrations

In the study of an environment from the standpoint of exposure to harmful materials, the use of maximum allowable concentrations is helpful. Maximum allowable concentrations is defined as that concentration of any harmful material in a working atmosphere below which a worker's health will not be affected adversely. Maximum allowable concentrations have been established upon many of the common industrial poisons and they have been based on the results of correlated engineering and medical studies in industries using these materials. Maximum allowable concentrations now in use as a criteria for the protection for the health of the workers are subject to change as additional information is accumulated. The concentrations used in this study are those recommended by the U. S. Public Health Service, the American Conference of Governmental Industrial Hygienists and the American Industrial Hygiene Association. All maximum allowable concentrations recorded are for prolonged exposures or these exposures for an eight-hour working day.

In the evaluation of the worker's exposure to any harmful material, cognizance of the amount of time spent by the worker in the contaminated atmosphere should be taken. For this reason an attempt was made to determine the amount of time a worker spent on all his jobs where they were not continuous. Weighted average exposures more nearly represent a workers actual exposure over an eight-hour day than

- (1) Drinker, P., and Hatch, T.: Industrial Dust, McGraw-Hill Book Co, New York, 1954
- (2) Lanza, A. J., McConnell, W. J. and Fehnel, J. W.: Effects of the inhalation of asbestos dust on the lungs of asbestos workers, "Public Health Reports", 50:1 of 1935.

does a single sample result representing an exposure for a short portion of an hour or a day.

Weighted Average = $\frac{\text{concentration of material} \times \text{hours exposed}}{\text{hours worked}}$

Conclusions and Recommendations

From observations made at the time of the study it would appear that the exhaust mechanism for allaying dust generated by the various vibrating machines and other moving parts in the dry mill, in particular, was well designed originally but under the handicap to which this exhaust mechanism is subjected it cannot and does not function properly. The following are several reasons why the dustiness in the dry mill is heavy and why the exhaust mechanism, as designed, does not function:

1. Dust vibrates almost continuously off the rafters which have become loaded and are continually loaded with dust generating from many sources.
2. Rubber connectors between the vibrating screens and the feed spouts are not tight, nor are they replaced when they vibrate off or they are worn out.
3. Rubber connectors between the vibrating screen and the exhaust ducts are either broken, missing, or are not placed on the ducts.
4. Exhaust from some of the vibrators is insufficient to control the dust generated, which, in all probability, is caused by an over-load of the system from other portions of the plant.
5. Backs are off many of the vibrators, making the exhaust mechanism provided ineffective and, in effect, making it wholly inoperative due to the large area from which the exhaust draws.
6. There are many holes in conveyor pipes in such places as stop gates, connections to vibrating screens, and dozens of other points where holes have been cut into the pipes at random locations, or where the pipes have broken by vibration or worn through by friction of the moving ore.
7. Hoods over many of the vibrators are broken, have not been replaced or are ineffective. It would appear that canvas or a resilient type cover over the vibrators would be more effective than rigid type hoods which have been provided.
8. Many of the transfer points from one belt to another are not exhausted and contribute a great deal of dust to the atmosphere.
9. Many of the dead ends in the exhaust system were left open permitting a large volume of air to be drawn in through openings where no control was necessary, thereby reducing the control velocity in volumes of air at more critical points.
10. In many locations it was obvious that the dust collection mechanism was full of dirt or dust and could not be expected to function satisfactorily because of many of the reasons already mentioned.
11. Many of the elevator housings and screw conveyor housings are open in

several places where holes have been cut for various reasons and the housing material removed and not replaced. These elevator housings and screw conveyor housings are particular offenders in production of dust.

12. It was noted during this study that holes were being cut in the exhaust ducts at random without any previous calculation as to the volume of air required, or the reduction of air volume to other locations. The junctions were often left exceedingly rough increasing the frictional resistance in the collection pipe.

13. In some of the locations, particularly on the vibrating screens on the top floor, it is obvious that a great deal of product is being withdrawn through the exhaust system by virtue of too much air being drawn through the system. It is quite probable that the reason for this pick-up of product is because of the imbalance created for the various reasons previously noted.

14. In summary, the foregoing points are illustrative of what would be poor policy in matters of maintenance and operation of this plant. The following recommendations are based on the observations presented and on the basis of the dust counts, silica content, and asbestos content of the dust. It will be recognized that the following recommendations are particularly broad and non-specific; until such a time as the general over-all maintenance and repair of existing dust work, both in the exhaust system and the ore feed pipes have been sufficiently repaired, no specific recommendations appear to be justified. General recommendations are as follows:

1. That all of the unnecessary openings in the entire exhaust system, both in the wet and dry mills be closed properly and a program of discriminatory cutting of pipes be initiated. All access doors, corners, etc., should be provided with tight seals and, of great practical importance, are so designed that they are easily closed and secured by quick-locking devices in place of the usual bolts and nuts. Access doors should be attached by hinges to avoid the frequent damage which occurs when ordinarily manhole plates are removed for inspection and maintenance work. An objective in designing the access should be to make it difficult to keep them open.

2. That all of the unnecessary openings in all of the ore transport ducts and in all the elevator housings and screw conveyors be tightly and completely closed and that all the broken portions of the system of the plant be adequately repaired.

3. That all of the covers on the backs of the vibrators be replaced and made as air tight as possible and that the hoods over the vibrators be repaired and replaced with a type material that will not disintegrate subject to vibration.

4. That all of the exhaust ventilation duct work be examined foot by foot and all holes plugged and unnecessary openings, particularly at dead ends, be adequately closed and the entire system be cleaned of dust which has deposited in any portion of any of the exhaust pipes.

5. That all of the transfer points and points where ore is being deposited into open containers be adequately enclosed and provided with exhaust ventilation.

6. That a system of vacuum cleaning or other cleaning of the rafters in the entire mill be instituted after the other measures have been adequately

accomplished so that the dust load contributed by that dust falling off rafters will be eliminated. Full recognition should be given to the fact that direct control measures alone are usually not enough to insure safe working conditions. The method of operations, proper maintenance of equipment and of housekeeping are equally essential to maintain healthful conditions.

7. That until such time as the repair and maintenance of both the exhaust and ore conveying systems have been complete, all the men in the dry mill be provided with and required to wear an adequate respirator, as indicated in the accompanying list.

8. That the operators of the spray painting equipment be provided with a respirator approved by the Bureau of Mines for such operation as indicated in the enclosed pamphlet.

9. That it be initiated as a policy of the company to be particularly discriminating in the provisions for any holes or outlets to be cut in any exhaust ventilation duct or any ore conveying duct or apparatus and that, if any ventilation must be provided for any process, the quantity of ventilation required be adequately determined before any exhaust capacity is taken from existing lines and that the result of such capacity will be ascertained on all subsequent units when such capacity has been involved.