SAFEGUARDING HEALTH IN CONSTRUCTION WORK*

By
M. F. Trice, Industrial Hygienist
Division of Industrial Hygiene
of the
N. C. State Board of Health
and the
N. C. Industrial Commission

There are several important approaches to the subject of safeguarding health in construction. One is that of the Safety Engineer who may limit his interpretation of health protection to the prevention of injury by accident; another is that of the industrial hygiene engineer who believes that health conservation may be influenced by almost everything under the sun. For this reason the concept of the latter is apt to be broader than that of the Safety Engineer. The subject is to be discussed from the view point of the industrial hygiene engineer; however, certain purely safety engineering practices will be considered.

The Industrial Hygiene Engineer is concerned primarily with the prevention of occupational diseases, which are maladies that are caused by the working environment. They may develope from a variety of exposures. Thus, there are many diseases caused by the inhalation of metal fumes, lead poisoning is one of them; others, by the inhalation of volitile solvents, a severe anemia and other applications, in the case of benzol poisoning; or severe irritation of the mucuous membranes of the respiratory tract, frequently resulting in the perforation of the nasal septum as a result of exposure to chromic acid mist produced in electroplating.(1)

Among the many hazards to health that are encountered in construction work, silica and its compounds are most important. Silica occurs abundantly in nature, being commonly knon as quartz and flint. In combination with other substances it is widel distributed as granite **??** gneiss, sand stone, shale and other minerals. The inhalation of fine particles of quartz. or other forms of free silica and certain silicate, or combined silica minerals will produce Silicosis, a disease of the lungs.

According to the late Dr. R. R. Jones, of the United States Public Health Service,(2) "The disease results from the tiny silica dust particles which penetrate the lungs of the workers. Constant exposure to silica dust first inflames the tissues of the lungs and then completely destroys them, leaving enlarged hardened scar tissues, instead. The victims of Silicosis suffer from infection of the lungs and are extremely susceptible to pulmonar tuberculosis. It has been estimated that three out of every four workers disabled b Silicosis also suffer from pulmonary tuberculosis. This combination usually leads to an early death." Some medical authorities have written(3) that early workers believed the effect of the mineral dusts to be the result of an abrasive action. More recent investigations, however, in which a variety of minerals and other hard substances with sharp edges and corners were used revealed that only silica produces a proliferative

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reaction. The toxicity of the siliceous dusts is due, therefore, to a chemical reaction, rather than to abrasion of the tissues. Silicosis is a serious potential occupational disease hazard to men employed in any construction work that involves the excavation, moving, or processing of minerals.

The construction of large hydro-electric projects in the mountains of Western North Carolina recently brought civil engineers face to face with the siliceous dust problem. Two projects that involved the daming of the Tuckasegee and Nantahala Rivers, respectively, and the deliveryt of impounded waters to power plants required the quarrying of stone and the driving of power tunnels. In both surface and underground occupations, **??** silica would be reduced to impalpably fine dust by the action of drills; by blasting; and by crushing and screening operations. In order to pre-prevent the creation of a serious occupational disease hazard, wet methods were employed for the control of dust. The use of wet type, jack hammer drill heads made possible the continuous application of water to the bottom of the drill hole. All stone piles were wet down before moving and water was applied to large aggregates as they were fed into crushers. Thus, the generation of dust was suppressed and the health of the workers safeguarded. Exhaust ventilation is sometimes utilized on heavy construction for the control of dust; thus, some four years ago in the construction of the Hiwassee ?? Dam, near Murphy, North Carolina, by the Tennessee Valley Authority this type of safeguard was applied to the stone crushing operations.(4)

In some types of construction, sand blast equipment is utilized to clean metal surfaces prior to painting. This is especially true of the giant penstocks that deliver water to the turbines in hydro-electric plants. Here, the health of the worker should be protected by the use of a positive pressure air helmet to which clean air should be delivered. A recognized substitute means of protecting the worker on such jobs is the use of steel shot as the abrasive, or alundum, neither of which are toxic. Even when substitute abrasives are employed for the dangerous quartz, the worker should be required to wear correctly a properly maintained respirator that has been approved by the U.S. Bureau of Mines for type A dusts. Substitution is one of the recognized means of health protection along with wet methods, exhaust ventilation, and personal respiratory protection, all of which have been mentioned.

The construction of the hydro-electric power tunnels involved exposure to gaseous substances that are inimical to health. The explosion of dynamite liberated toxic gases, chief of which are carbon monoxide and the oxides of nitrogen, all very deadly. Testing facilities were available for an evaluation of carbon monoxide, but not for oxides of nitrogen. In these tunnels the carbon monoxide hazard was acute during the early days of construction. This was evidenced both by the testing apparatus and by the physiological response of the investigators, all of whom developed splitting headaches. Carbon monoxide produces first a throbbing headache, later dizziness, and finally unconsciousness and death.(5)

While on the subject there are other potential sources of carbon monoxide that should be mentioned. The use of salamanders and charcoal pots in confined areas may result in the production of carbon monoxide with serious consequences. In this connection the potential danger attending the operation of internal combustion engines in tunnels, or other poorl

ventilated situations is obvious and should requie no admonition as to the necessity for safel disposing of the combustion products.

"Most investigators agree that the toxic effects of carbon monoxide are due to its great affinity for hemoglobin and that it acts mainly by interfereing with and finally inhibiting completely the oxygen metabolism."[5] In non-fatal cases of carbon monoxide poisoning there may result serious complications and even permanent damage to brain and heart tissue.[6]

The oxides of onitrogen have been mentioned as hazards that are encountered in tunnel construction, being combustion products resulting from the explosion of dynamite. They are also by-products of welding, which is a commonplace task on many construction jobs. Experiments have demonstrated that the use of bare rods, of low carbon steel, in electric arc welding will yield toxic gases capable of producing fatal, or severe pulmonary edema, occasionally accompanied b lung hemorrhages.[7] Specifically mentioned in this connection are nitrogen pero xide and ozone. A case of air acute fatal pneumonia following the electric welding of galvanized iron in a confined space is reported and the acute lung edema and cardiac dilation attributed to repeated exposures to nitrous gases.[8] The oxides of nitrogen are insidious poisons. It is possible for a workman to get a lethal dose of the oxides and not be aware of any acute symptoms until several hours afterwards, when it is too late for treatment to be successful. In 1936, for example, several workmen died at Balan, N. C., from exposure to nitrogen oxides in cleaning out the gay-Lucasse tower of a sulphuric acid plant operated in connection with a fertilizer plant. None of the men died until they got home, then they literally drowned in the exudations of body fluids. The coated welding rod is widely used at present and the decomposition products resulting from its use are potentially hazardous to health.[9]

In addition to the toxic gas hazards attending welding, frequently, there are poisonous metal fumes. The most commonly encountered are those emanating from lead, zinc, brass, bronze, nickle, and others. Finely divided iron oxide is a product of welding. When work is done in a confined space the concentration of this iron dust in the atmosphere may become quite high. When inspired much of it may be deposited, however, "Functional impairment of the lungs with such iron deposits appears to be entirely lacking."[10] Most of the metallic fumes produced in welding are quite toxic. The effects of these poisons are insidious in that some of the resulting symptoms are similar to those produced by the ordinary garden variety of afflictions. Thus, lead intoxication may produce an intestinal upset; an ashen pallor of the skin; anemia; partial paralysis; nervousness; or any one or combination of a great many other symptoms. Zinc ma produce chills and fever. Cadmium poisoning may produce weakness, vomiting, headache, generalized pneumonia and other disabilities.[11]

In order that the health of the welder may be properly safeguarded it is essential that the working area be well ventilated at all times. In the event satisfactory ventilation is difficult, then the welder should be supplied with U. S. Bureau of Mines approved personal respirator protection. A mechanical filter type respirator for fumes, or metallic dispersoids will suffice if properly worn and maintained, and air-supplied helmet is preferred. In this connection is well to point out that welding in a confined space may seriously deplete the oxygen content of the air and a supplied air respirator would prevent distress that might otherwise result.

A widely used constructin material is cement and the maladies that may be traced to it, or to concrete, are varied. Perhaps the most commonplace ailments are those result from burning, or

irritation of the skin. One bulletin [12] reveals that chemical analysis has shown some cements to contain as high as 10% caustic alkalie, although this may be higher than the average. Frequentl concrete, or cement gets on clothes, or in shoes, and the constrant rubbing of the stiffened wearing apparel abrade the skin and opens an avenue to infection. Some deafness, due to cement caking in the ears and eye injuries, limited usually to conjunctivitis, [12] are some of the occuptional health hazards associated with the use of cement and concrete. A recent stud involving 11 cement plants and 3278 (??) persons, over 55% of whom had been in the industr more than 10 years, disclosed that prolonged inhalation of dust from finished cement produces such slight anatonic **??** reaction that little or no abnormality is seen in the roentgenogram. Preventive measures are largely a matter of personal hygiene, that is, clean clothes and bathing goggles are indicated for the protection of the eyes.[12][14]

There are many other exposures in construction work that may result in ill-health, but time will permit reference to only a few of them. The sun's rays have caused cancer of the lips; [15][16] contact with tar has resulted in a so-called tar acne; [15] the handling of rock wool bats has produced a severe itching of the skin resulting in acute irritation due to scratching. Many skin ailments have been traced to frequent contact with oil and grease; and with friction tape. [17] Frequently dermatitis may be due to washing the hands and forearms in gasoline; such practice is emphatically condemned as it removes all the natural fats and waxes [18] and leaves the skin d and stiff, in which condition it readily cracks and becomes as susceptible to infection as any other open wound. There are detergents on the market that are better skin cleaners than gasoline and one of them should be used. Bruises and bone injuries due to constant pressure; or friction; or posture necessary to operate a machine; excessive heat; or wet conditions; all may constitute occupational disease hazards. The water bucket and the common drinking cup may constitute a serious occupational disease hazard; portable pressure tank fountains are recommended. Heat stroke due to excessive lss of minerals by excessive perspiration is a real hazard on many jobs: it may be controlled by the wise use of salt. [19]

In this connection it is possible for anything under the sun to become an occupational disease hazard, depending upon one, or all of the following factors: A. manner of contact; B. length of exposure; C. Concentration; and, D. individual susceptability.

The safeguards to employ for the protection of health have been discussed along with the hazards. In addition to the devices discussed, pre-employment examinations, to determine fitness for work are becoming more and more a routine procedure on construction jobs. Inasmuch as injury by accident may be the cause of ill health it is perhaps justifiable to mention some of the protective devices recommended by Safety Engineers. The hard hat, made of molded plastic, has saved many lives and its use is increasing on all types of construction. Goggles, or recentl developed face shields of transparent plastic should be worn wherever flying objects constitute an accident menace. [14] Steel capped shoes prevent many foot injuries, they look like the usual type work shoes and are worn on many jobs.

There are many reasons why the civil engineer shold be conscious of potential occupational disease health hazards. In design, an appreciation of potential occupational disease hazards is valuable. For example, there is at present under constructin in Western North Carolina, a plant for grinding siliceous minerals, that was designed by a young engineer. This man foresaw the development of a siliceous dust health hazard unless certain safeguards were provided, and as

a result an exhaust ventilation system is being installed and the plant has not been entirel completely. In addition, this engineer designed a dust collector which has some novel features.

Civil engineers should know that such maladies as occupational diseases may develope in construction work because of the compensation possibilities. All except one state, Mississippi, now have workmen's compensation laws that govern compensation payments in the event of disability or death by accident. And eighteen months ago (October, 1939)[sic] there were 23 states providing compensation to workers suffering from occupational diseases. [(20)] And the number will doubtless increase yearly as the occupational disease compensation problem is becoming increasingly imortant. The problem of occupational diseases cannot be ignored because of the many other agencies, both governmental and private that are now engage in industrial hygiene activities. At present there are bureaus of Industrial Hygiene in 32 state health and labor departments; 6 city healthd epartments; and the health departments of 1 county and 2 territories. The United States Public Health Service, the U.S. Bureau of Mines, and the Tennessee Valley Authority all engage in industrial hygiene activities. Large private enterprises like the Ford Motor Co., General Motors, the Chrysler Corp., the Pennsylvania Railroad, International Harvester Co., employe industrial hygiene personnel. Many life insurance companies, and casualty underwriters make industrial hygiene investigations and there are other organizations engaged in the work, not the least of which is the U. S. Longshoreman's Association.

Probably the foremost reason why civil engineers should be conscious of occupational disease hazards is humanitarian. Frequently, the supervision of all kinds of construction is the task of a civil engineer; and the man in charge should be able to recognize potential health hazards and know when to provide the necessary safeguards.

REFERENCES

1. Bloomfield, J. J., and Blum, William: Health Hazards in Chromium Plating. Rep. No. 1245. Public Health Rpts. 43, 2330 - (1928).
2. Jones, Roy R. Silicosis - An Occupational Hazard. Labor information Bul. 3, 1 - (1936).
3. Sayres, R. R. and Jones, R. R.: Silicosis and Similar Dust Diseases. Pub. health Rpts. 53, 1456 (1938).
4. Hatch, L. P. and Shaw, D. F.: Silica Dust Control at Hiwassee Dam. Civil Engineering. 10, 582 (1940).
5. Division of Industrial Hygiene, Nat'l Institute of Health: Carbon Monoxide: Its Toxicity and Potential Dangers. Pub. Health Rpts. 56, 421 (1941).
6. Van Oettingen, W. F.: Recent Studies and Theories on the Mechanism of the Action of Carbon Monoxide Poisoning. Trans. of the Third Annual Meeting, Nat'l Conf. Governmental Industrial Hygienist, Div. of Industrial Hygiene, Nat'l Institute of Health, Bethesda, Md.
7. Titus, A. C: Warren, Henry, and Drinker, Phillip: Electric Welding. 1. The Respirator Hazard. Jour. Industrial Hygiene and Toxicology, 17, 121 (1935).
8. Williman, Frank L.: Electric Welding. II. An Acute Fatal Pneumonia Following Electric Welding of Galvanized Iron in a Confined Space. Ibid. 17. 129 (1935).
9. Harold, Gordon C., Meek, Stuart F., and McCord, Carey P.: The Health of Electric Arc Welders in the Natinal Defense Program. Rep. Proceed. Fifth An. Meeting, Air Hyg.

Found. of America, Inc. November, 1940.
10. Enzer, Norbert, and Sander, A. O.: Chronic Lung Changes in Electric Arc Welders. Jour. Industrial Hygiene and Toxicology, 20.333 (1938).
11. Neal, P. A. and Jones, Roy R.: Industrial Toxicology of Heavy Metals. Syllabus of Industrial Hygiene. Division of Industrial Hygiene, Nat'l Institute of Health, Washington, 1937.
12. State of Illinois. Dept. of Pub. Health: Health Hazards from Cement Dust and Wet Concrete. Educational Health Circular, Industrial Health Series No. 1, Springfield.
13. Gardner, Leroy U.;Durkin, Thomas, N. Brumfiel, Daniel M., and Sampson, Homer L.: Survey in Seventeen Cement Plants of Atmospheric Dusts and Their Effects upon the Lungs of Twenty-two Hundred Employees. Jour. Industrial Hygiene & Toxicology. 21, 279 (1933).
14. U. S. Dept. of Labor. Protecting Eyes in Industry. Bul. No. 37, Government Printing Office, Washington, (1940).
15. Schwartz, Louis, and Warren, Leon, H.: Occupatioanl and Related Dermatoses. Abstracts from the Literature for the Years 1935 to 1939, inclusive. U. S. Pub. Health Ser. Bul. No. 266. (1941).
16. Blum, Harold Francis: Photo-Dynamic Action and Diseases caused by Light. Reinhold Pub. Co., New York.
17. Schwartz, Louis, and Abough, R. P.: Dermatitis in a Nut and Bolt Plant Due to the Use of Friction Tape. Pub. Health Rpts. 40. 1051 (1934).
18. Machle, Williard F., and Znick, Karl G.: Gasoline Dermatits: Rep. Medical Bulletin; University of Cincinnati.
19. Clark, W. Irving, and Drinker, Phillip., Industrial Medicine, National Medical Book Co., New York, 1935.
20. Bloomfield, J. J: Industrial Hygiene - Retrospect and Prospect. Amer. Journal & Public Health. 27, 1215 (1939).