

ILLUMINATION OF COAL MINES*

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In preparing this paper the object has been to set forth facts relating to illumination problems, which, judging from the results realized in the iron and steel and other industries somewhat similar to mining, will tend toward furthering safety, production, and contentment of employees, as well as economy of operation in mines. By applying the principles of illumination with the assistance of modern appliances, the full benefits in efficiency may be derived from improvements already made in other details of mine operation.

The lighting of a typical coal mine may be divided into four distinct parts: (1) The lighting of the buildings about the top; (2) the lighting of the working faces; (3) general illumination at the bottom; and (4) special applications of lighting.

The lighting of buildings about the top may be treated in the same manner as that of any other industrial plant, for we have a boiler room, an engine and generator room, a forge, a machine shop, and a hoist room. These can be well and efficiently lighted by the use of 100-watt tungsten-filament multiple lamps with proper reflectors so spaced and suspended that a power consumption of from $\frac{1}{4}$ watt per square foot in the boiler room to 1 watt per square foot in the machine shop is obtained. The methods that apply to this kind of lighting have been ably treated by a number of authors, and for this reason a detailed discussion is unnecessary.

The lighting of the working faces is usually done by means of portable lamps, of which there are four types in use: The oil torch, the acetylene lamp, and the oil and the electric safety lamps. The different types have been fully described in numerous papers and articles and will not be covered here, although a few figures on the cost of operation will no doubt be of interest. In attempting to obtain cost figures, one is impressed with the fact that apparently very few such data have been obtained in this country. It would seem that such data would be of particular benefit at this time, with the advent of the electric safety lamp.

The oil torch is without question the cheapest source of light. The acetylene lamp, at a cost of 6c. to 10c. per lamp per week, gives far superior illumination, but the characteristics of this source of light as well as any other open-flame lamp will bear careful consideration in view of the ever-present desire for industrial efficiency and safety. It is the opinion of many that the greater percentage of disastrous explosions in the United States have resulted from the use of open-flame lamps in the so-called non-gaseous mines. This question of safety, of course, merits serious consideration.

The oil safety lamp has a distinct advantage in that it gives an indication of the presence of gas. Its development marked one of the greatest advances in mine lighting, although in most cases at the present time it is not considered a guarantee against explosion when in the presence of gas. Figures obtained from foreign countries indicate the cost of using oil safety lamps is from 7c. to 9c. per lamp per week.

The electric lamp gives a steady and readily directed light, free from gases, soot, and large chances of outage. A large proportion of the generated light is directed on the working face. It is sometimes considered a disadvantage that the electric safety lamp does not give an indication of gas as does the oil safety lamp. The trend of opinion in England, however, is toward choosing a lamp for the light it gives and to use some other means for gas indication. There is no question that an electric lamp passing the

tests of the U. S. Bureau of Mines will give more light on the working face than any of the three previous illuminants, because it has been scientifically designed with that end in view.

Foreign practice has shown that electric light costs from 12c. to 17c. per lamp per week. This cost is about twice that of the oil safety lamp. The light on the "face," however, is materially increased by the use of the electric lamp. One foreign electric-lamp manufacturer places the cost of electric light at 2 $\frac{1}{2}$ c. per lamp per shift. This figure, though it seems low, can well be realized in this country with a large installation and proper care. In this connection, it is very necessary to have proper housing and proper attention for electric lamps, more so than with the oil safety lamps. It has been found in foreign practice that this care and attention is very little, if any, more expensive than the attention that is given to oil safety lamps even though more expensive help is needed, because fewer men are required to care for the electric outfits. This country has been slow in taking up the electric lamp. It has been said that in Belgium alone there are 12,000 outfits in use. The excellent work done by the U. S. Bureau of Mines to obtain the highest efficiency for this new source of illumination has accomplished what years of competition among electric mine-lamp manufacturers could hardly have brought about.

The application of the principles of industrial illumination to the general lighting of mines must be made in the face of conditions difficult to overcome. In fact, all the conditions the illuminating engineer considers most difficult are present: low ceilings, black walls, dust, smoke, and dampness but in spite of these, satisfactory results have been obtained.

An ordinary coal mine, from a lighting standpoint can be considered as composed of at least six parts: the bottom, the run-around, main entry, side entries, mule stables, and small rooms, such as offices, pump rooms, storage rooms and first-aid rooms. The bottom, being the entry and exit for both men and coal accommodates more traffic than any other part of the mine and should be especially considered from the standpoint of both convenience and safety. The lighting of the shaft in one well-lighted mine was accomplished by the use of 40-watt tungsten-filament lamps equipped with angle reflectors, placed above and across the shaft opening so as to direct the light on the cages. The maximum intensity is at the near edge of the cage, and the eyes of the workmen on the side of the shaft toward the observer are not subjected to the glare of the lamps.

That portion of the bottom leading into the mine, where cars are directed on to the cages, can be well lighted with 40-watt tungsten lamps in shallow dome reflectors placed above and between the tracks. These units, spaced at about 6 ft. intervals and hung about 8 ft. above the floor, will give satisfactory distribution of light. The car wheels are thus well illuminated and there is practically no glare. It would be well to design the lighting of this part of the mine on a basis of 4 to 5 foot-candles at the floor, not because the work demands this intensity, but because of the greater safety which results from ample illumination and because dust collecting on the lamps and reflectors decreases the amount of light delivered.

The run-around should require only sufficient light to make visible any obstructions in the path of the empties as they leave the cages. This part of the mine may be illuminated with 25-watt tungsten lamps equipped with shallow dome reflectors, spaced 15 ft. apart and suspended

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