RESPIRATOR REQUIREMENTS AND PRACTICES

by

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The purpose of this paper is to discuss the requirements of law with respect to nonemergency respirator use, the need for respirators in various situations that occur in coal mining, and the results of a study of the use or nonuse of respirators, together with some comments on the attitudes toward respirators and the reasons why they are or are not used. Based on this information, the solutions for some of these problems will be offered. These include the development of respirators which will meet the needs and the requirements of law and the development of programs, standards, and regulations which will provide for and require their use.

Section 202(h) of the Federal Coal Mine Health and Safety Act of 1969 states that "Respiratory equipment approved by the Secretary of the Interior and the Secretary of Health, Education, and Welfare shall be made available to all persons whenever exposed to concentrations of respirable dust in excess of the levels required to be maintained under this Act. Use of respirators shall not be substituted for environmental control measures in the active workings. Each operator shall maintain a supply of respiratory equipment adequate to deal with the occurrences of concentrations of respirable dust in the mine atmosphere in excess of the levels required to be maintained under this Act."

Section 204 states that "The dust resulting from drilling in rock shall be controlled by use of permissible dust collectors, or by water or water with a wetting agent, or by ventilation, or by any other method approved by the Secretary which is at least as effective in controlling such dust. Respiratory equipment approved by the Secretary and the Secretary of Health, Education, and Welfare shall be provided persons exposed for short periods to inhalation hazards from gas, dust, fumes, or mist. When the exposure is for prolonged periods, other measures to protect such persons or to reduce the hazards shall be taken."

It seems clear, therefore, that the use of respirators in certain instances is required in coal mining. These instances are, first, whenever respirable dust exceeds the limits prescribed by the standard, and secondly, for short periods, in the case of rock drilling, or other occasions when hazards of inhalation of gas, dust, fumes, or mist occur. With respect to the first instance (Section 202 h), it is obvious that at the times when a respirator is required, the mine operator will also be in violation of the standards. Since all violations of the standards must be abated sooner or later, or the mine will be closed, the question arises when would respirators be required? There are situations, however, when the mine operator knows that

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for some special reason he is in violation of the standard but that this violation has not yet been detected by the operator's sampling program or by a periodic inspection by Bureau of Mines inspectors. Similarly, when a violation of the respirable dust standard is detected, a period of abatement is generally permitted, during which time it is likely that, for at least part of the time, the standard will continue to be exceeded. During these periods, the law requires that respirators be used. Similarly, the law requires that respirators be used for short exposures to all air contaminants other than coal dust.

To interpret the various provisions of the Act with regard to respirator use and nonuse consistently, it would be necessary to say that respirators must be used for protection against respirable dust whenever the operator has reason to believe, either based upon his own experience or upon data or citations resulting from his own samples or samples collected by the Bureau of Mines, that he is exceeding the respirable dust standard. However, simultaneously he is required to develop and implement the engineering controls required to abate that respirable dust excess. It is not clear whether a combination of engineering controls and respiratory protection would be permitted. If, for example, it is possible for a mine operator, in special circumstances, to develop ventilation and other controls so as to reduce the dust from a level of perhaps 15 mg/m^3 down to a level of 5 mg/m^3, and if he could further reduce the exposure of the miner from 5 mg/m^3 to much less than 2 mg/m^3 by means of respiratory protection, does this meet the requirements of Section 202(h)? In other words, in this example, is respiratory protection being substituted for engineering control or is it being used in conjunction with engineering controls? At this time, this alternative has not been promoted for a variety of reasons.

It was our hypothesis that the respiratory practices in coal mines that existed at the time the law was passed and in the immediate aftermath were such that respirators would not be satisfactory for the protection of miners. To confirm or reject this hypothesis and to develop the engineering and psychological data base upon which a satisfactory respiratory program could be based, the National Institute for Occupational Safety and Health (NIOSH) contracted with the Eastern Associated Coal Corp. to study respirator practices in coal mines. Without going into the details of the rather lengthy reports resulting from this study, I would like to summarize a few of their findings. Virtually all mines made respirators available. Also, in virtually all mines their use was voluntary on the part of the miner. The miner's use of the respirator was related to his perception of the dust (and the risk from the dust) as modified by the attitude of the mine operator toward safety and health in general. Almost universally, respirators are worn on an intermittent basis.

The data from this survey is based on intensive interviews with 428 people in various job classifications, plus 17 section foremen, for a total of 445 men. It was found that 20 to 60 percent of the miners, as shown in table 1, used a respirator occasionally, depending upon the attitude and program of the mine operator, but almost no miner used a respirator continuously. Of those who used them occasionally, over 40 percent, as shown in table 2, used them as much as 3 hours per day.

TABLE 1. - Range of respirator possession and use (47 mines)

Respirator use	Approximate percent of underground work force
Possession of a respirator:	
High	90+
Low	40
Worn by work force:[1]	
High	60
Low	20

[1] Sometime during shift (see table 2 for duration of use).

TABLE 2. - Duration of respirator use

Hours per shift	Percent of underground work force interviewed
0-2	22
2-3	35
3-5	29
>5	14
Total	100

It is interesting to look at the question of what the miners thought should be done, as opposed to what they actually did. Fully 99 percent felt that respirators were needed for some occasions and should be worn when needed (table 3). Only 1 percent thought it possible to lower the dust concentrations so that respirators would not be needed at any time.

TABLE 3. - Need for use of respirators in coal mines

Category	Percent of underground work force
Generally needed	42
Used whenever dust is present	45
Used only when necessary	4
Needed, but are hard to wear	8
Prevent dust to make use unnecessary	1
Total	100

These results are not greatly different from what would be expected, except that the use of respirators was somewhat more extensive than anticipated, since it was expected that there would be almost no use. It was indeed surprising that most miners, although they did not wear respirators, felt that respirators should be worn.

Why don't miners wear respirators when they believe they should? The answer came, at least in part, from a series of questions that were asked with regard to respirator acceptability. About 35 percent of miners found respirators marginally acceptable or unacceptable and, in giving this response, they were thinking in terms of only intermittent, not continuous, use.

Reasons given for the unacceptability of respirators (table 4) were largely based on inconvenience and discomfort. The most frequently cited problems were breathing resistance (37 percent) and physical discomfort, meaning pressure on the face and head, sweat on the face, inability to chew tobacco, tightness of the harness (55 percent). A few (9 percent) of the miners stated that the respirator interfered with their work. Typical comments were: "It's hard to breathe. I feel smothered, especially when I'm doing hard work." Miners who, for one reason or another, suffered upper respiratory impairment were especially conscious of the need to wear a respirator, but unfortunately these individuals had the greatest difficulty wearing one.

TABLE 4. - Problems associated with respirator use

Category	Number of men	Percent of underground work force
Cause breathing difficulties	-	37
Physical discomfort	-	55
Generally cumbersome and uncomfortable	13	-
Cause perspiration	9	-
Interfere with tobacco chewing	9	-
Troublesome head harness	7	-
Respirator too large	6	-
Facepiece troublesome	5	-
Dust inside mask	5	-
Improper fit	1	-
Interference with work	-	9
Restricts vision or interferes with wearing glasses	5	-
Exhalation valve troublesome	2	-
Interferes with communications	1	-
Difficult to carry	1	-
Total	-	[1] 101

[1] Total adds to 101 percent because of rounding.

It can be concluded from all of the foregoing that, in a considerable number of instances, the use of respirators is required by law, that the miners themselves believe that respirators need to be worn, and that the miners are not wearing them principally because the respirators available to them are not satisfactory. Without exception, these respirators were of the quarter-face-mask type shown in figure 1. Respirators of this style provide very satisfactory protection in the dust levels, and for the kind of dust, encountered in a coal mine when properly used. In order for them to fit properly, it is necessary that they be tight and the pressure of the straps and facepiece can be painful. Also, the rubber facepiece traps sweat between it and the skin, the sweat mixes with dust and the resulting irritation becomes objectionable. The filters are not large, and the work of breathing is significant even when the filters are clean. It is apparent, therefore, that before we can effectively implement the provisions of the law to require the use of respirators in instances where the respirable dust and other dust, mist, and gases are temporarily exceeding the limits, and before we can even consider the use of respirators in conjunction with engineering controls as a means of reducing miner exposure to safe limits, better respirators are needed.

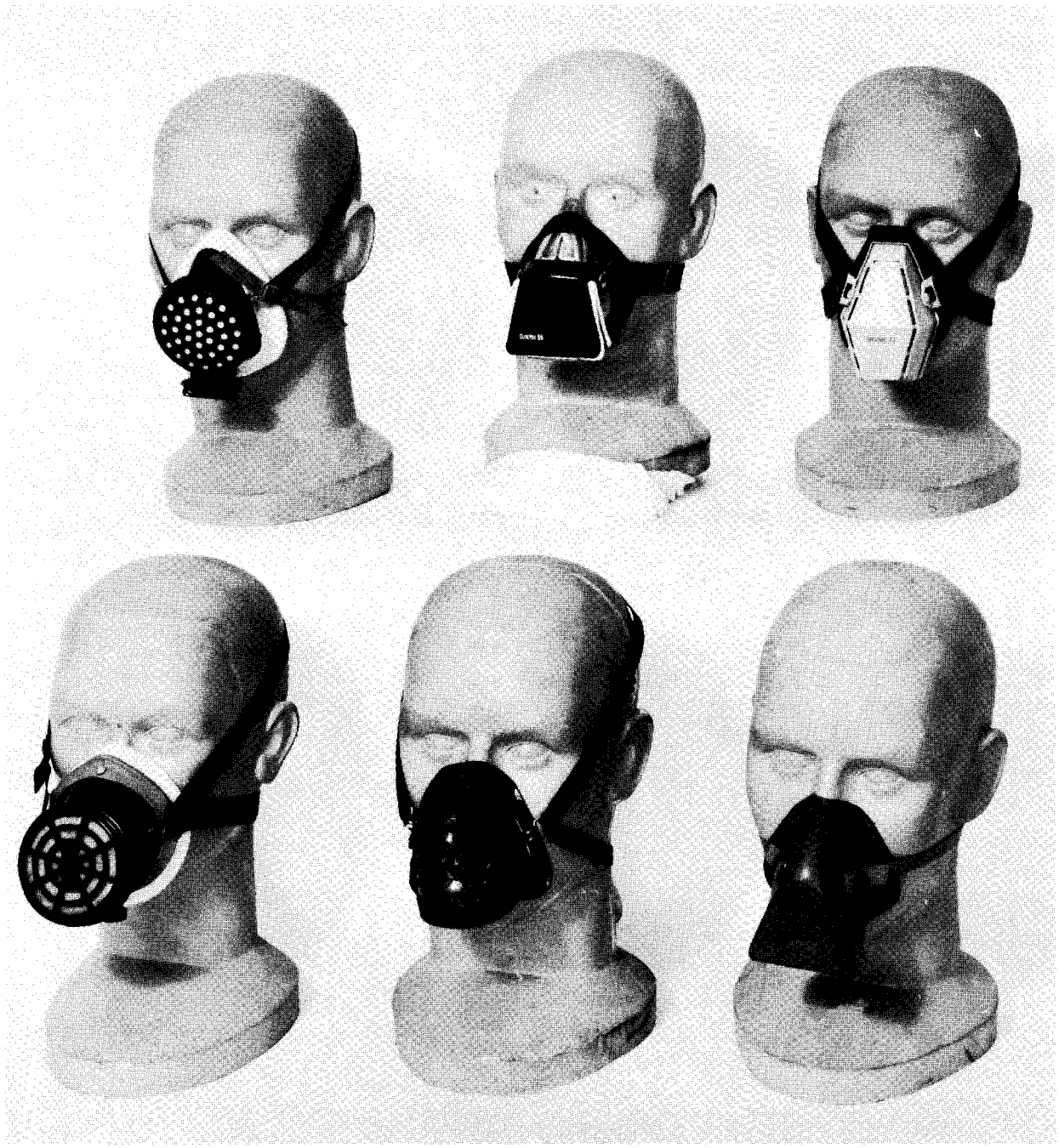

FIGURE 1. - Quarter Mask Dust Respirators. *(Courtesy, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.)*

NIOSH, the Bureau of Mines, and a number of other organizations are currently engaging in research and development activities aimed at providing respirators that will overcome the objections previously discussed and provide the worker with effective and acceptable protection. These activities are proceeding simultaneously in two directions. The first is the development,

testing, and certification of single-use respirators which, at least partially, solve the problem of facial irritation, harness tightness, and breathing burden (fig. 2). Respirators of this type provide a somewhat lower protection than the reusable quarter-face masks previously discussed, but they offer a number of advantages. They are lighter and do not require as strong a headband. The surface against the face is made of fabric or filter material which is less irritating than rubber and which does not trap sweat. Furthermore, the whole respirator is a filter; consequently, the filter is quite large and the breathing resistance is low. Since they are not used for more than one shift, they require no maintenance. An obvious difficulty is that the respirator has no exhalation valve and consequently the miner rebreathes his own exhaled breath to a slight extent. Since this was found objectionable in some instances, it is necessary to further evaluate the acceptability of devices of this sort. Although they are very inexpensive, since they may be used for only one workshift, the total expense may be greater than for conventional types of respirators. The new respirator testing and certification regulation, 30 CFR Part 11, dated March 25, 1972, provides for the approval of these new valveless single-use respirators. At least one model has already been approved.

The research direction in coal mine respirator development is toward the design of powered air-purifying respirators. Although the single-use respirator differed from the conventional half-face masks in that it was simpler,

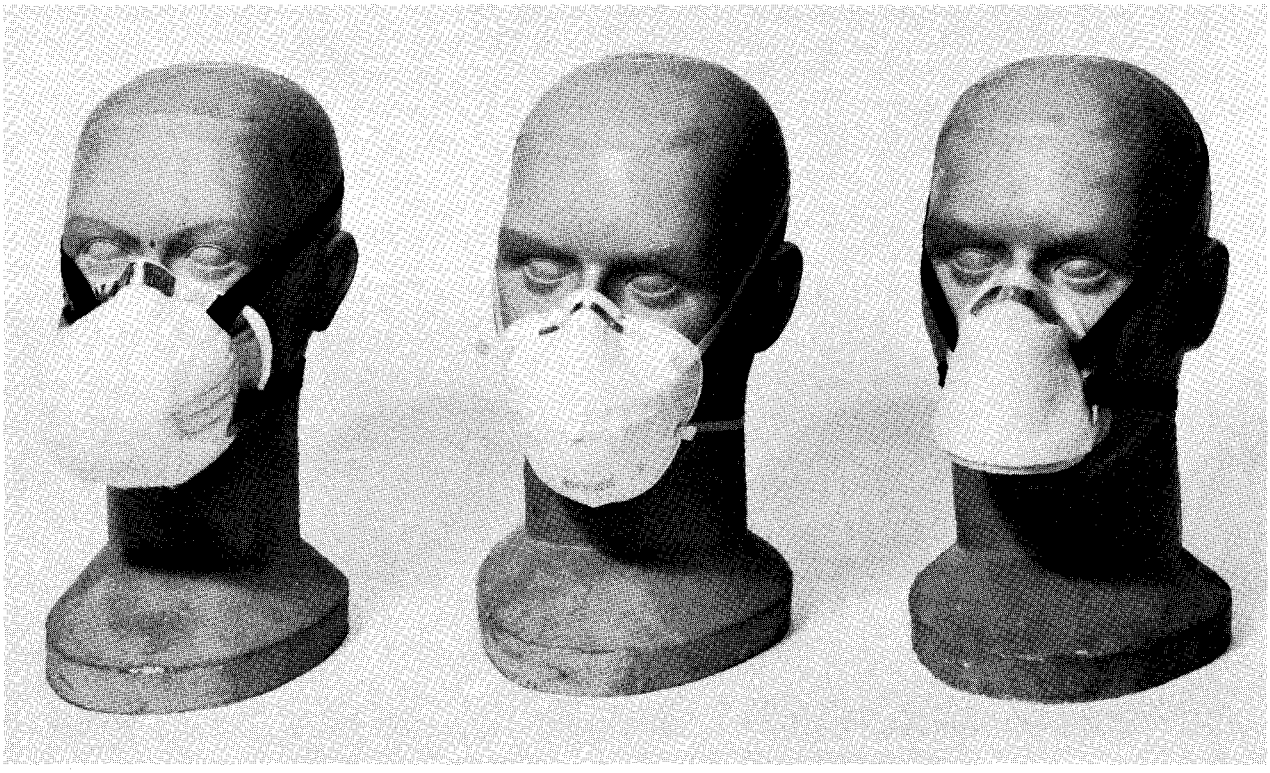

FIGURE 2. - Single-Use Dust Respirators. *(Courtesy, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.)*

FIGURE 3. - Powered Air-Purifying Respirator (C.S. Draper Laboratory).

these devices lie at the other end of the spectrum in terms of complexity. It is interesting to note that development of one type or another of these devices was instituted almost simultaneously, or at least within a short period of time, by the Bureau of Mines, NIOSH, Allegheny River Mining Co. (fig. 3), Harvard University, and several commercial firms, including 3M Co. (fig. 4),[2] Mine Safety Appliances Co., and others both in this country and abroad (figs 5-6). All of these devices have certain basic attributes. They all use an external power source other than the miner's lungs to overcome the filter resistance. The power sources range from battery packs to hydraulically operated prime movers connected to the mining machine. They all confront the problem of the fit of the face mask, although a variety of different approaches are used. The Bureau of Mines prototype, which is to be developed under contract with the Donaldson Co., provides a curtain of air blown down over the miner's face from beneath the rim of his hat. The Allegheny River Mining Co. device, under development by the Draper Laboratory of the Massachusetts Institute of Technology, is fundamentally similar, except that in addition to the hat, a helmet visor (face shield) which comes down almost to the chin and encloses the curtain of air, protects the clean airflow from interference by cross drafts. Environmental Systems uses basically the same approach as the Draper design, except that they use a hood rather than a helmet and face shield. Other designs

[2]Mention of specific manufacturers does not imply endorsement by the Bureau of Mines.

FIGURE 4. - Powered Air-Purifying Respirator (3M Co.).

FIGURE 5. - Powered Air-Purifying Respirator (Martindale).

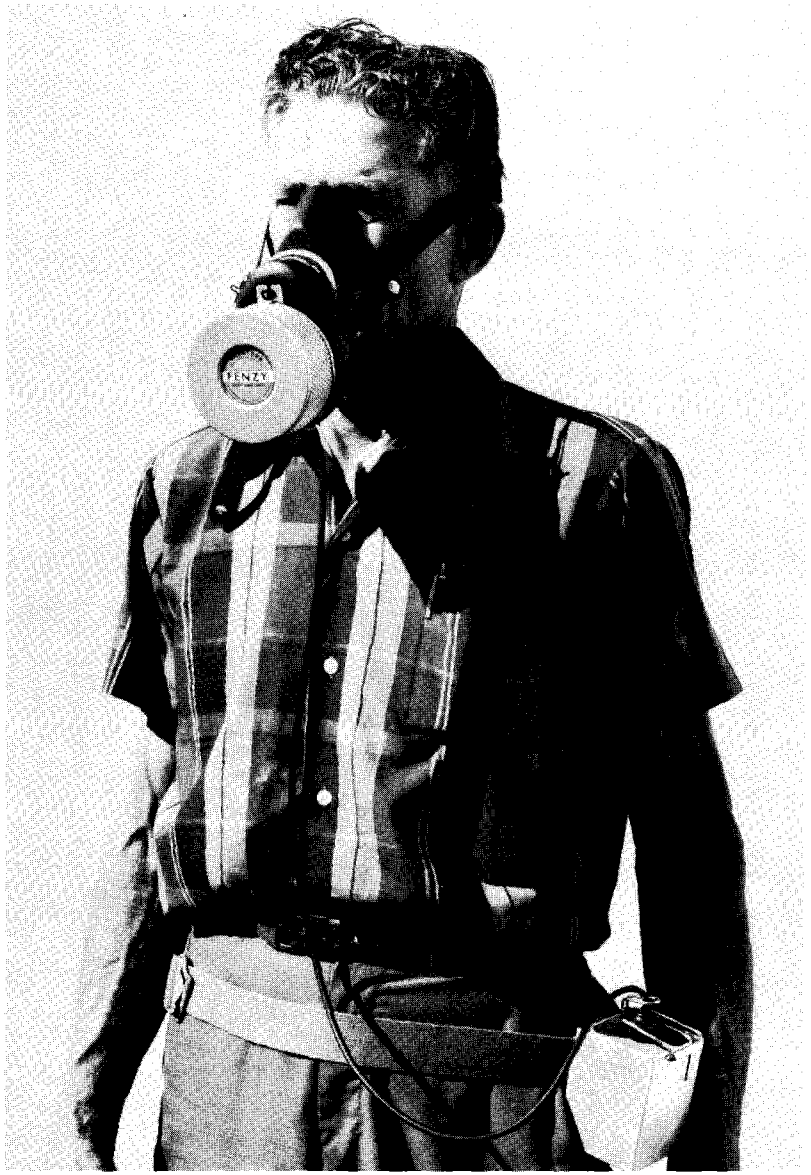

FIGURE 6. - Powered Air-Purifying Respirator (Fenzy).

use full-face masks and half-face masks. However, even though these masks are essentially identical to those used with previously unsatisfactory respirators, they can be made much more satisfactory in a powered air-purifying respirator. Since a tight fit is not required in the powered respirator because a positive pressure is being maintained in the respiratory inlet, any leakage from a loose fit will be outward. Again, since these are powered respirators, the filter resistance need not be overcome by lung power and the work of breathing is less. The obvious disadvantage is the increased weight (about 4 or 5 pounds) which the miner must carry.

We have every reason to believe that these dual developments will be at least partially successful. We are proceeding under contract to evaluate the 10 air-purifying devices currently available, either on the market or as prototypes. Each attribute will be evaluated so as to come up with a composite prototype design that will be as nearly satisfactory as the present state of the art can make it. Similar efforts will be undertaken to evaluate the single-use respirators.

Based on the outcome of these studies, NIOSH may recommend to the Bureau of Mines that the standards be modified to provide and encourage the use of these devices, at least in the intermittent exposure situation and perhaps even in those cases where the impact of conventional respirable dust abatement techniques is excessive and where it is possible to develop a program to protect the health of the miner using respiratory protection in conjunction with engineering controls.

INT.-BU.OF MINES,PGH.,PA. 18055

Information Circular 8568

Coal Mine Health Seminar

A Joint Staff Conference of the Bureau of Mines and the National Institute for Occupational Safety and Health

Compiled by Marilyn K. Hutchison, M.D.

UNITED STATES DEPARTMENT OF THE INTERIOR
Rogers C. B. Morton, Secretary

BUREAU OF MINES
Elburt F. Osborn, Director

This publication has been cataloged as follows:

U.S. Bureau of Mines

Coal Mine Health Seminar: A Joint Staff Conference of the Bureau of Mines and the National Institute for Occupational Safety and Health [Sept. 6, 1972. Washington] U.S. Dept. of the Interior, Bureau of Mines [1972]

44 p. illus., tables. (U.S. Bureau of Mines. Information circular 8568)

1. Coal mines and mining–Safety measures. 2. Coal mines and mining–Congresses. I. U.S. National Institute for Occupational Safety and Health. II. Title. (Series)

TN23.U71 no. 8568 622.06173

U.S. Dept. of the Int. Library