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REPORT NO 140
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January 1951

SAFETY IN JAPANESE COAL MINES

by

Major Charles S. Merriam

GENERAL HEADQUARTERS
SUPREME COMMANDER FOR THE ALLIED POWERS
Natural Resources Section

NATURAL RESOURCES SECTION
REPORT NUMBER 140
January 1951

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Distribution

NATURAL RESOURCES SECTION
REPORT NUMBER 140
January 1951

SAFETY IN JAPANESE COAL MINES

by
Major Charles S. Merriam 1/

SUMMARY

1. The accident rate in coal mines in Japan, when calculated as the rate per million tons of coal mined, is the highest of any country on record in the world. This rate was 24.5 fatalities per million metric tons during the 1948 fiscal year and has been as high as 48.3 fatalities per million tons.

2. The high accident rate in Japan may be attributed to several factors, the most important being the lack of a mine safety code which could be adequately enforced to insure the safety of the miners and the mines. Other reasons may be the reported unconcern of many mine managers for the safety of the miners, the lack of well-trained safety supervisory personnel, and a general lack of safety-mindedness on the part of all workers.

3. Since the beginning of the Occupation of Japan, American mining engineers and technologists have been stressing the need for an improvement in the mine safety laws and the enforcement thereof. The accident rate has continued to be high, but with the passage of new mine safety laws in 1949 an improvement can reasonably be expected in the near future. Only through good fortune has Japan been spared a truly major disaster.

INTRODUCTION

The high accident rate in Japanese coal mines has a direct bearing on the production of coal and is of great concern to everyone connected with the mining industry. This accident rate, in terms of accidents per million tons of coal mined, is the highest of any country on record in the world.

During the production of nearly 35,000,000 metric tons 2/ of coal in the 1948 fiscal year 3/, 860 men were killed and 144,409 were injured in Japanese coal mines. In comparison, in Great Britain where mining conditions are somewhat similar to those in Japan, 468 men were killed and 2,391 injured during the production of 208,470,000 tons of coal in the calendar year 1948. In the United States in the same period 870 fatalities occurred during production of more than 600 million tons of coal.

Japan's safety practices in the past have been so poor that only through good fortune has the nation been spared a truly major disaster such as the explosion at the Japanese-operated coal mine at Honkeiko, Manchuria, on 26 April 1942, when 1,527 miners were killed. 4/ Government, management, and workers all must bear a share of the responsibility for the poor safety record made in Japan's coal mines.

1/ Fuels Resources Branch, Mining and Geology Division.
2/ See glossary for conversion from metric to English units of measurement.
3/ Japanese fiscal year, 1 Apr 48-31 Mar 49. Throughout the report, fiscal year is meant unless otherwise specified.
4/ Cammack, Kirk V., The Honkeiko Colliery Disaster: Natural Resources Section Report No 29, Tokyo, Apr 1946.

In addition to the humanitarian aspects involved, a decrease in the accident rate would be of direct economic benefit to the mines and the mining industry. Not only would compensation rates be decreased but the efficiency of the miners would be increased, with a resulting increase in output.

This report presents information on general mine safety practices used in Japanese coal mines, statistics on accidents, the history of the mine safety program, measures now being taken to safeguard the lives of miners, and case histories of major accidents in recent years. 5/

Information contained in this report was obtained from personal visits to all of the major coal mines in Japan, during which physical inspections were made both underground and on the surface. On some of these visits the author was accompanied by Mr Russell G. Warncke, safety engineer from the United States Bureau of Mines, who was assigned to Natural Resources Section in 1948 to investigate and advise on safety practices in Japan.

Statistical data were obtained from the Mine Safety Bureau, Resources Agency, Ministry of International Trade and Industry, and from the heads of the safety departments in the major coal mining companies. Mr Shinobu Araki, chief of the Coal Mine Safety and Inspection Division, Mine Safety Bureau, was of invaluable assistance in obtaining background material for this report.

HISTORICAL BACKGROUND

The first mine safety ordinance of any scope in Japan was promulgated in 1916; the Ministry of Agriculture and Commerce (later the Ministry of Commerce and Industry, and now the Ministry of International Trade and Industry) was responsible for its enforcement. This ordinance was revised several times after 1916. 6/ These ordinances have been completely superseded by a new mine safety law passed by the Diet on 16 May 1949.

As far as can be determined there never has been a coordinated and planned mine safety program for Japanese mines. The author has interviewed several individuals who took an active interest in the problem; one of them, Mr Shintaro Ishiwata, has been working for safety for the past 30 years. However, owing to the complicated structure of the industry, the efforts of these individuals were futile. The safety departments of the mining companies were usually nominal only, and the safety employees were not specifically trained as such.

Recognizing the need for improved safety conditions in the coal mining industry, American mining engineers and technologists early in the Occupation encouraged the Japanese Government officials in the various safety agencies to consider methods of improving the conditions in the mines and reducing the accident rate. During the spring of 1948, Mr. Russell G. Warncke, mine safety engineer from the United States Bureau of Mines, was assigned to Natural Resources Section to study safety problems in the Japanese coal mines and to recommend improvements in safety practices. Following visits to the coal mining

5/ For discussions of mine safety at individual coal fields and mines, see the following: Merriam, C.S. and Rogers, C.L., Ishikari Coal Field, Hokkaido: Natural Resources Section Report No 99, Tokyo, Nov 1947; Cammack, Kirk V., et al, The Coal Fields of Kyushu: Natural Resources Section Report No 103, Tokyo, Feb 1948; Merriam, C.S., Coal Fields of Eastern Honshu, Japan: Natural Resources Section Report No 120, Tokyo, Apr 1949; MacAfee, Robert D., Coal Fields of Western Honshu, Japan: Natural Resources Section Report No 132, Tokyo, Jul 1950; Lewis, John B., Coal Fields of Hokkaido (Other than Ishikari): Natural Resources Section Report No 133, Tokyo, Aug 1950.

6/ Ministry of Agriculture and Commerce Ordinance No 22, Revision of Mining Police Regulations, August 1916; Ministry of Commerce and Industry Ordinance No 21, Revision of Mining Police Regulations, December 1928; Ministry of Commerce and Industry Ordinance No 29, Test Regulations of Explosives, Machinery and Instruments for the Use of Coal Mines, September 1940.

districts, Mr Warncke prepared a model for a new mine safety code along the lines of the Federal Mine Safety Code in the United States. This model, together with the codes prepared for the metal mines and for the petroleum industry, was submitted to the Japanese Government to be used as a guide in preparing its own safety regulations.

Owing to conflicting legislation passed by the Japanese Government in 1947, a jurisdictional dispute arose in November 1947 between the Minister of Commerce and Industry and the Minister of Labor as to which should have complete jurisdiction over mine safety. On 24 August 1948 the Supreme Commander for the Allied Powers directed the Japanese Government to prepare immediately and place in force adequate mine safety codes for the preservation of safety in mines, and concurrently to assign responsibility for the enforcement and the necessary surveillance thereof to a suitable government agency. Following receipt of this directive, and following many Cabinet meetings at which the directive was discussed, the Cabinet on 23 December 1948 gave full authority to the Ministry of Commerce and Industry to devise and implement laws providing for safety in all mines.

The Mine Safety Law was passed by the Diet and signed and promulgated on 16 May 1949 and was issued as Public Law No 70. The Mine Safety and Inspection Division (for metal mines) and the Coal Mine Safety and Inspection Division were established by Ministerial Ordinance, Ministry of Commerce and Industry, Ordinance No 21, 16 May 1949, and Ordinance No 47, 16 May 1949.

The new Mine Safety Law establishes the administrative details for organizing the necessary supervisory offices, provides general safety measures for all mines, and states the punitive measures for violations of or noncompliance with the Law. The Law also provides that the safety regulations prepared, following the model codes furnished earlier, were to be placed in effect 90 days after the passage of the Law. Accordingly the Mine Safety Regulations were issued by the Minister of International Trade and Industry on 12 August 1949.

The Mine Safety Bureau was established in the Ministry of Commerce and Industry (now the Ministry of International Trade and Industry) by the provisions of Articles 32-34 of the Mine Safety Law. Its main office is located in Tokyo, and branch offices are set up in Sapporo, Sendai, Hiroshima, Ube, and Fukuoka. Where there are local offices of the Coal Bureau or the Ministry of International Trade and Industry, the branch safety offices are attached to them. The mine inspectors work out of the branch offices.

CLASSIFICATION OF ACCIDENTS AND MANNER OF REPORTING

Accidents in coal mines are usually reported by causes as follows: gas and/or dust explosions, falls of roof and sides, haulage, explosives, electricity, flooding, handling materials, and the general classification "others". These causes are the same wherever coal is mined. Many mining men consider as an accident only some occurrence that results in injury to an individual. In its true meaning an accident is more than this; it is any occurrence that interrupts or interferes with the orderly process of the activity in question, whether or not it results in injury to a person. Hence, any unusual occurrence that might result in an injury to a workman should be considered an accident.

In the United States the two most widely used methods of recording accident statistics are by the accident frequency rate, which is the number of lost-time accidents per million man-hours of work, and by the rate of accidents per million tons of coal produced. A lost-time accident is one which results in disability or loss of working capacity of the injured employee for one or more days other than the day on which the injury occurred, regardless of whether a compensable case results from the accident. Such records are kept by the United States Bureau of Mines and are used to determine progress in accident prevention and to compare the accident rates of various mines and of the various states.

A knowledge of the severity rate at mines is of utmost importance to compensation insurance companies in establishing premium rates according to the accident experience at the mines. This severity rate often is stated in terms of the average loss in days per

thousand man-hours worked in a particular year. It is calculated by the following formula:

$$\text{Severity rate} = \frac{\text{Days lost time} \times 1{,}000}{\text{Man-hours worked}}$$

Another method of computing accident rates used at some mines which have kept accurate records of injuries and production is to translate these into tons per fatality or per nonfatal injury, or per lost-time injury. This basis for evaluating accident records is not highly satisfactory, however, because over a period of years the conditions of employment, man-hours of exposure, and changes in mining methods are not taken into consideration, whereas accident frequency rates per million man-hours of exposure can be obtained with reasonable accuracy.

In Japan until recently no standard system of reporting mine accidents seems to have been used. The most common definitions of injuries used at all mines are "fatalities", "heavy injury" (one which causes the injured person to lose more than four days of work), and "light injury" (one which causes the man to lose less than four days following the day of the injury). The system of reporting accidents by causes is the same as is used in the United States. Complete reports of all accidents are not usually made in Japanese coal mines. Fairly complete records of the number of accidents, injuries, and deaths resulting from injuries are maintained by the mining companies, but their accuracy is doubtful. A comparison of reports furnished by different government agencies for identical periods of time reveals many discrepancies. In such instances, in preparing information for this report the data which appeared to be most reliable have been selected.

The Japanese usually report the number of accidents, number of men killed or injured, number of men employed at the mines during the period covered by the reports, and production for the same period. Rates are then computed as the rate of accidents, fatal and nonfatal, per thousand men employed and the rate per million metric tons coal produced. The first is a type of accident frequency rate, differing from the system used in America because of the lack of accurate time records of Japanese employees. Under the new Mine Safety Law, the Mine Safety Bureau is attempting to obtain such records and now requires mines to make monthly reports of all types of accidents together with man-hour data and production data. Accident statistics for coal mines as they are usually reported in Japan are presented for 1932-48 in Table A.

TABLE A. - COAL MINE ACCIDENTS IN JAPAN, 1932-48

Year	Average Number of Miners per Day	Production (MT)	Mine Accidents	Fatal Injuries	Fatal Accidents per Million Tons of Coal Mined	Nonfatal Injuries
1932	137,975	28,053,375	58,572	635	22.7	58,562
1933	143,602	32,523,746	58,294	780	24.0	58,178
1934	168,524	35,924,989	64,456	825	22.9	64,474
1935	175,137	37,762,491	62,256	1,038	27.3	62,109
1936	198,346	41,802,711	61,207	1,051	25.1	60,964
1937	222,696	45,257,877	66,086	884	19.5	66,283
1938	263,632	48,683,689	68,874	1,165	24.0	69,178
1939	293,019	52,408,541	75,770	1,226	23.3	78,061
1940	335,997	57,318,222	83,941	1,354	23.5	85,513
1941	351,737	55,602,334	84,830	1,582	28.2	83,739
1942	387,757	54,178,544	84,195	1,488	27.4	84,247
1943	409,705	55,538,802	88,132	1,670	30.0	85,779
1944	403,477	49,335,008	56,031	1,966	39.8	98,738
1945	310,716	22,234,538	48,259	1,077	48.3	49,012
1946	341,987	22,523,336	70,857	917	40.6	61,009
1947	451,261	29,237,000	ND	816	27.8	93,079
1948	502,397	34,958,000	ND	860	24.5	144,409

ND: No data available
SOURCE: Mine Safety Bureau, Ministry of International Trade and Industry.

Falls of roof and sides always have accounted for the greatest percentage of accidents. During 1941-46 such accidents amounted to about 44 percent of all underground accidents, and haulage accounted for about 18 percent of the total. Explosions caused only 0.5 percent of the accidents although they caused 13 percent of the fatalities. In spite of the substantial number of undersea mines operating in Japan, floods have been negligible as a cause of accidents, the worst year having been 1941. Table B presents data showing coal mine accidents by causes during 1941-46.

TABLE B. - COAL MINE ACCIDENTS BY CAUSES, 1941-46 a/

Year	Type	Explosions b/	Roof Falls	Haulage	Floods	Others c/	Total
1941	Fatal	265	789	267	34	152	1,507
	Nonfatal	185	32,631	13,884	28	28,366	75,094
1942	Fatal	127	777	271	0	221	1,396
	Nonfatal	128	32,845	14,429	0	27,525	74,927
1943	Fatal	259	809	339	0	197	1,604
	Nonfatal	133	33,683	14,923	0	26,093	74,832
1944	Fatal	267	950	372	0	274	1,863
	Nonfatal	282	38,459	17,406	0	30,106	86,253
1945	Fatal	97	517	136	2	254	1,006
	Nonfatal	82	18,235	3,740	8	19,212	41,277
1946	Fatal	40	418	78	3	265	804
	Nonfatal	121	21,117	2,276	16	28,031	51,561

a/ Does not include surface accidents
b/ Occasionally the Japanese include accidents resulting from explosives under this heading, in addition to the gas and/or dust explosions.
c/ Includes accidents resulting from electricity, handling materials, and some of those resulting from use of explosives.
SOURCE: Mine Safety Bureau, Ministry of International Trade and Industry.

SAFETY PRACTICES IN JAPANESE COAL MINES

1. General

At most of the coal mines in Japan, the top supervisory personnel seem to have a thorough understanding of the need for strict safety measures, particularly with regard to ventilation. However, their understanding seldom is put into actual practice. The larger mining companies have safety directors in the main offices as well as at the mines. In most mines, however, the staffs are made up largely of clerks, and few, if any, safety engineers are employed.

Mines are classed as "A" or "B" depending on certain hazard factors. Class A mines are those known to liberate dangerous quantities of gas, or those in which large quantities of coal dust accumulate; these mines are required to use electrical machinery that has been tested and certified to be flameproof. Class B mines are those in which no dangerous amounts of methane gas have been found and which are not excessively dusty. These mines are not required to use equipment certified as permissible for use in gassy mines, and many of them use open flame lights for underground illumination. The new safety law provides that at any time that 0.25 percent or more inflammable gas is detected in the return airway of any Class B mine, or 0.50 percent of gas is found in any working place therefore, a report shall be made immediately to the chief of the District Coal Mine Safety and Inspection Division, and the mine will be reclassified as a Class A mine. Most of the safety regulations, except those pertaining to use of permissible equipment and open lights, are applicable to both classes of mines.

2. Ventilation Standards

Many gas and/or dust explosions have occurred in the coal mines of Japan (Table C), the most recent in June 1948. 7/ Some of these will be discussed in detail in another section of this report.

TABLE C. - GAS AND/OR DUST EXPLOSIONS IN COAL MINES, 1943-48

Region and Mine	Date of Explosion	Number Killed	Number Injured	Cause
Hokkaido				
Shin-Bibai	29 May 43	3	4	ND
Taiheiyo	13 Jun 43	7	35	ND
Mojiri	12 Jul 43	5	5	ND
Ashibetsu	22 Jul 43	10	0	ND
Mitsui-Bibai	22 Jul 43	1	3	ND
Nitto-Bibai	21 Aug 43	7	3	ND
Shin-Yubari	5 Sep 43	11	2	ND
Shakubetsu	17 Nov 43	12	0	ND
Sorachi-Kamui	19 Jan 44	17	10	Blasting
Akabira	21 Jan 44	1	0	ND
Sorachi-Kamui	25 Jan 44	0	32	ND
Kamiutashinai	20 May 44	4	0	Safety lamp
Mitsubishi-Bibai	26 May 44	19	14	ND
Oyubari	22 Jun 44	13	31	ND
Yayoi	13 Jul 44	3	3	Electric spark
Akama	8 Aug 44	2	0	Smoking
Utashinai	8 Sep 44	5	3	Safety lamp
Akabira	5 Nov 44	5	8	ND
Akabira	29 Jan 45	1	0	Gob fire
Mitsubishi-Bibai	16 Feb 45	9	1	Smoking
Toyosato	4 May 45	12	7	ND
Nitto-Bibai	5 May 45	0	2	ND
Sunagawa	13 May 45	9	0	ND
Asano-Uryu	29 Jan 46	16	15	Blasting
Manji	2 May 46	3	3	Electric spark
Mojiri	17 Mar 47	1	3	Blasting
Sunagawa	14 May 47	3	0	ND
Mitsubishi-Bibai	29 Jun 48	13	6	Electric spark
Kyushu				
Hoshu	26 Apr 43	4	9	ND
Karatsu	18 Jun 43	22	11	ND
Takashima	28 Oct 43	48	22	ND
Yoshino	15 Nov 43	0	15	ND
Tagawa	31 Jan 44	10	1	ND
Mineji	1 Feb 44	1	14	ND
Izuka	22 Mar 44	45	9	ND
Ozuru	17 Apr 44	1	5	Blasting
Yamano	1 May 44	10	3	Broken switch
Kasuya	22 Jun 44	23	1	ND
Ozuru	27 Aug 44	4	19	Electric spark
Shin-Shakanoo	10 Sep 44	6	20	Fuse
Tsunawake	20 Mar 45	11	1	Blasting
Kamiyama	19 May 45	29	6	ND
Tagawa	8 Jul 45	0	3	ND

(Cont'd)

7/ Statistical data for this report were closed as of June 1949. Since that time there have been three explosions in which five or more men were killed, but none on the scale of the Katsuda disaster in June 1948.

TABLE C. - GAS AND/OR DUST EXPLOSIONS IN COAL MINES, 1943-48 (CONT'D)

Region and Mine	Date of Explosion	Number Killed	Number Injured	Cause
Kyushu (Cont'd)				
Kitakata	12 Jul 45	0	6	Blasting
Tachikawa	17 Jul 45	1	1	Spark
Shinyashiki	11 Jan 46	2	17	Blasting
Miike	15 Jan 46	11	0	Safety lamp
Tagawa	19 Jun 46	12	37	Mine fire
Okawa	18 Oct 46	6	1	Cap lamp
Shinyashiki	30 Dec 46	4	4	Spark
Tagawa	20 Jan 47	4	6	ND
Tagawa	21 Mar 47	2	2	Spark
Hoshu	25 Jun 47	1	5	ND
Takamatsu	8 Sep 47	8	29	ND
Katsuda	18 Jun 48	62	8	Blasting
Chugoku (Western Honshu				
Sanyo-Muen	30 Apr 45	1	9	Safety lamp
Niga	18 Apr 46	4	0	Safety lamp
Niga	14 Aug 47	0	4	ND
Tohoku (Eastern Honshu)				
Joban-Iwasaki	6 Mar 46	11	18	ND
Joban-Iwasaki	20 Oct 47	12	13	ND
TOTAL	60	647	489	

ND: No data or cause not determined
SOURCE: Mine Safety Bureau, Ministry of International Trade and Industry.

Judging from information obtained by the author during personal visits to most of the mines at which explosions have occurred, and from investigations of more recent explosions, the basic cause was poor ventilation. Some of the explosions, as will be shown later, were caused by the stoppage of local or booster fans.

The old mine safety regulations, formulated in 1916 and known as the Mining Police Regulations, provided measures for the prevention of explosions, placing emphasis on ventilation of the mines. In the English translation, however, none of these regulations was very specific. For example, Article 2 of the "Rules and Regulations Concerning Control of Coal Mine Explosion" stated, "Ventilation (except local ventilation) shall be done by a fan. An autographic measurer, or autographic air-pressure measurer and autographic ammeter, or autographic air-speed measurer shall be attached to the fan,and if their readings are found abnormal, appropriate action shall be taken." The Article gave no indication of what an "abnormal" reading is considered to be, nor was the "appropriate action" specified. At no place in the Regulations were these statements clarified. Paragraph 4 of the same Regulations stated, "The volume of air at the mouth of the intake airway shall be three cubic meters per minute per head, taking the maximum number of laborers working at the same time in the pit per day as the standard." The amount of air passing the farthest working place was not specified in the regulations, nor was any limitation placed on the number of men working on one split of air, except that "the Director General of the Local Administration Office of Mines may, if he deems it necessary, restrict the number of coal faces or working laborers operated in one split". The Japanese consider that the longwall method of mining, which is in general use in Japan, in itself limits the number of men working on one air split. That system, however, also increases the difficulty of properly ventilating the mine and providing sufficient air at the farthest working places. In nearly every mine visited by the writer, the air velocity at the farthest working places was insufficient for obtaining an anemometer reading. This fact alone has brought about the development of

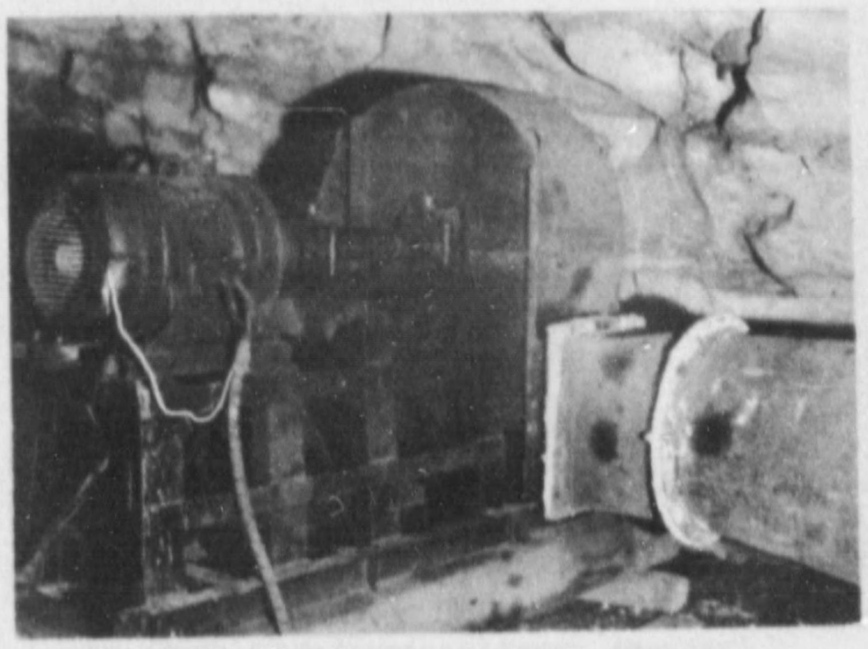


Figure 1. - Underground ventilating fan with 22-inch diameter pipe attached. Sunagawa coal mine, Hokkaido, 1947.

an electric anemometer which can register velocities as low as one meter per minute. 8/

The Mine Safety Regulations, published 12 August 1949 by authority of the Mine Safety Law of 16 May 1949, have considerably strengthened the ventilation standards for coal mines, but they still do not place a restriction on the number of men working on one air split nor do they specify the amount of air required at the farthest working places. A provision of the regulations which requires the appointment of certain safety officials prescribes that no boss shall supervise more than 50 men; however, this ruling only partly limits the number of men on one split of air because one split might serve more than one boss and group or more than one working face. The quantity of air specified per worker remains as three cubic meters per minute, which is adequate. However, the regulations state that this amount must be furnished at the intake to the mine and do not specify the amount of air to be furnished the workers at the working face. The new regulations provide that all Class A mines shall be ventilated by means of a main mechanically operated fan, located in a fireproof building, and offset from the main airway. The law further provides that fans shall be operated continuously and shall be either attended at all times by a competent person or equipped with an automatic device to give alarm when the fan stops or slows down.

Local or booster fans are used extensively in Japanese coal mines for conducting air to the working faces (Figure 1). The new regulations provide that such a fan shall be installed at a place where the return air will not be drawn into the intake air, and that the volume of air passing through that place shall be greater than the capacity of the fan in order to prevent recirculation of air. The regulations do not specify how much greater the volume should be; the United States Federal Code specifies that the volume should be two and one-half times the capacity of the fan. The statement should be made, in passing, that the use of auxiliary, local, or booster fans is not considered good practice in the United States, and the Federal Code prohibits their use except where special permission has been given.

Article 86 of the Coal Mine Safety Regulations provides that mine workers shall not work in mine air containing less than 19.0 percent oxygen or more than 1.0 percent carbon dioxide. Ventilation standards of the United States Bureau of Mines recommend that mine air contain at least 20.0 percent oxygen and not more than 0.5 percent carbon dioxide. However, the Japanese standards do meet the decision made by the Mine Safety Board in the United States regarding the quality of mine air. If other ventilation standards are maintained, the mines should experience little difficulty in meeting this requirement.

Most mines probably will find it very difficult to meet all the standards of ventilation contained in the new safety regulations, because most of the airways are congested and no attempts have been made to drive them straight or to provide for radius turnouts rather than for sharp angles. Much of the air is lost in the old workings and through inadequate stoppings between airways. No brattice cloth is used to conduct the air to the working faces even though the faces may be as far as 50 meters from the last open crosscut where headings or entries are being driven. Many mines will have to spend

8/ This anemometer is described in the section on "Anemometers" and is illustrated in Figure 16.

Figure 2. - Mine rescue team at Joban Coal Mine, Yumoto, Fukushima Prefecture, emerging from mine during practice demonstration. April 1949.

considerable amounts of money and do some major rearranging of their ventilation systems to come up to the new standards. Such expenditures, however, will be justified and ultimately will result in savings to the mines through decreased compensation rates and increased efficiency.

3. Mine Rescue Teams

Nearly all of the mines designated as Class A by the Mine Safety Bureau have mine rescue teams. These teams are required by law to practice mine rescue at least once each quarter year, and some of them have even more frequent practice sessions. Most of the mines pay the members of the rescue teams a small bonus each month as an incentive to remain on the team and to attend the practice sessions regularly. One of the best-trained teams observed in Japan was the team at the Joban Mining Co, Fukushima Prefecture (Figure 2). This team is well-equipped and drills with precision and quickness. It compares favorably with well-trained rescue teams in America. Not all of the mines, however, are equipped with oxygen-breathing apparatus as well maintained as that of the Joban mine. The apparatus in general use in Japan is the Draeger-1924-type, a German model similar to the Gibbs apparatus used in some mines in the United States. Figure 3 shows this apparatus open and closed; it is equipped with both a regular mouthpiece and nose clip, and the face mask. The rescue teams at the Joban mine do not use the mask because of the difficulty of obtaining a perfect air-tight fit.

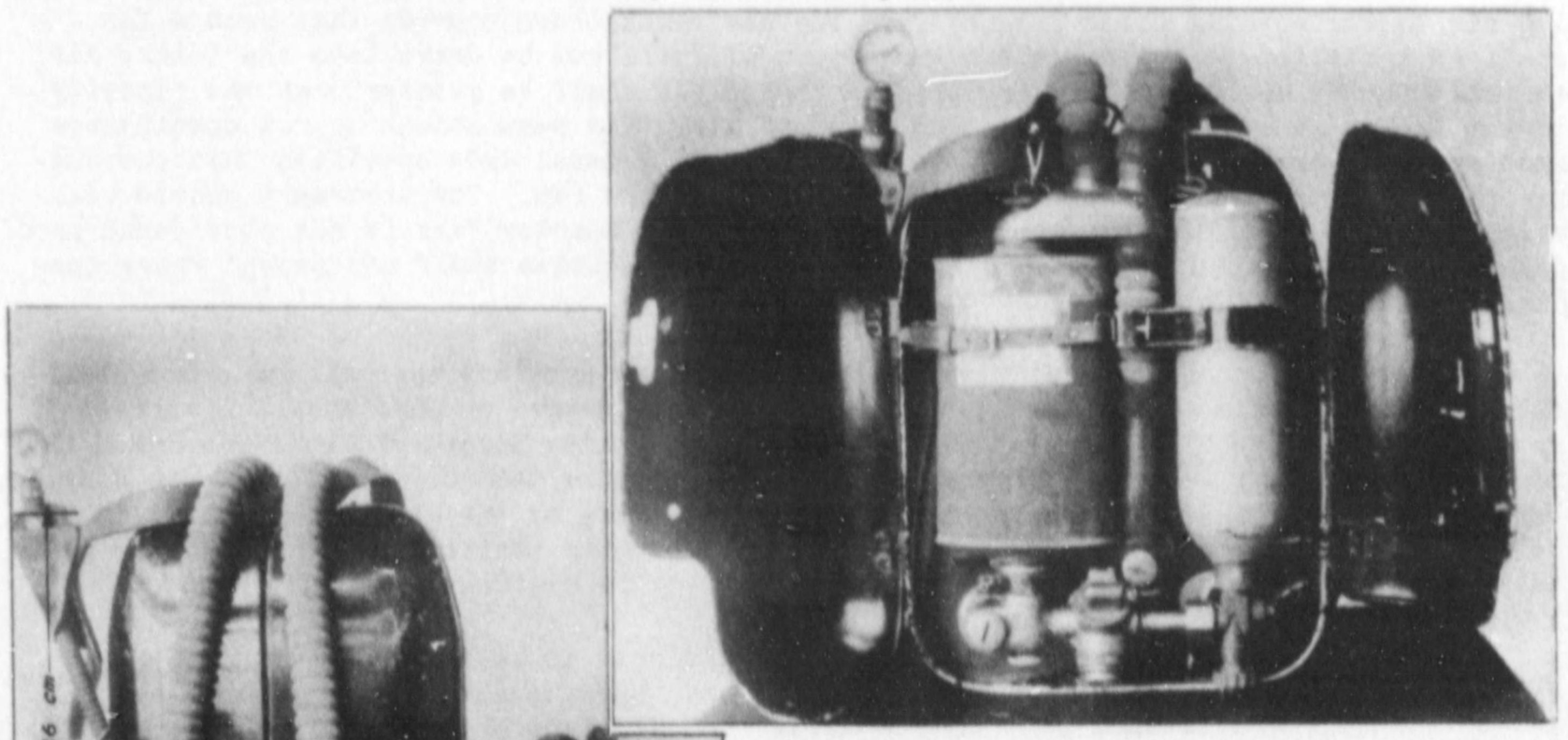


Figure 3. - Oxygen-breathing apparatus, A, closed, with face piece; B, open, Joban Coal Mining Co.

4. Use of Explosives and Blasting

Several serious accidents have occurred as a result of flagrant violation of the old rules on the handling of explosives. Japanese mining laws always have been strict regarding the use of explosives, and little strengthening was needed when the new codes were drafted. The principal objection had been to the manner of enforcement, and the new codes do attempt to correct that.

Methods of accounting for explosives prescribed in the new codes insure that the explosives supervisor will know at any time the quantity of explosives that has been taken into the mine, by whom, and the location of the explosives. Explosives are delivered to the shot boss or to specified qualified workmen only upon receipt of an application properly filled out. No more than the amount estimated for one shift's use may be applied for. All unused explosives must be turned in to the explosive delivery station by the user, and a receipt is issued. Explosives sufficient for no more than two days estimated requirements may be kept in underground delivery stations.

The construction and location of surface and underground explosives magazines, as required by the safety codes, are similar in all respects to accepted American practice. The Japanese code goes a step further than most American codes with respect to cleanliness and neatness of the powder magazines; the explosives boss is required to observe that the explosives delivery station be kept clean "and all outdoor footwear shall be taken off upon entrance".

The principal defect in the provisions of new codes pertaining to blasting concerns the length of time workmen are required to wait before returning to a working place in which a misfire has occurred. The subject of misfire is covered in Article 190 which states:

"When misfires occur, the shot-fire boss in charge shall observe the provisions of each of the following items: (1) When an electric firing system is used, the leading wire shall be disconnected from the blasting machine and short-circuited, and measures shall be taken to prevent firing. A waiting period of at least five minutes shall elapse before approaching the place where explosives have been charged and fired; (2) When delay electric detonators are used, the same measures as mentioned in the provisions of the preceding item shall be taken and at least 30 minutes shall elapse before approaching the place where explosives have been charged; (3) When fuses are used, a waiting period of at least 30 minutes shall elapse before approaching the place where explosives have been charged."

The first draft of the new regulations provided that when fuse blasting is done, a period of 15 minutes must elapse before miners return to a place in which a misfire has occurred. In commenting on this provision, the United States Bureau of Mines stated that this period does not provide a sufficient safety factor. In American mines the waiting period ranges from eight to 24 hours, and in some mines the places are closed off until the following shift. Under no circumstances, says the Bureau, should the waiting period be less than eight hours, preferably 12 hours. As a result of public hearing, technical discussions, and advice from mining engineers, the Japanese decided to lengthen the waiting time from 15 to 30 minutes, and the subject still is being considered. The principal objection of the Japanese to closing down a working place for a longer period of time is the great loss of production, as in some mines three or four longwall working faces may provide the greater part of the production; to close down one face for a whole shift would mean the loss of one-third or perhaps one-fourth of the production.

Methods of removal of misfired explosives are about the same as those used in American mines. Measures to be taken after completion of blasting are clearly outlined in the regulations, and positive means of inspecting each place in which blasting has been done and making an accurate accounting of all explosives used are provided.

5. Use of Electrical Equipment

Nearly all of the explosions and many of the fires that have occurred in Japanese coal mines are believed to have been caused by faulty or mishandled electrical equipment. This fact is recognized by the Japanese, and they have formulated many laws and rules pertaining to the use of electricity in mines. In the new regulations, Chapter II provides that all types of electrical equipment shall be of approved design, tested by one of the several testing laboratories. Chapter VIII, Articles 194-238, states the necessary safeguards for using electrical machinery and equipment. These articles are designed to correct existing deficiencies, a few of which are listed:

a. In the past, no protection has been provided against coming in contact with electric trolley wires at places where individuals habitually pass under them. Such protection is now required by Article 232 (7).

b. Many trolley wires are hung too low, and hangers are unevenly spaced, permitting the wire to sag. The wires frequently make electrical contact with doors and timbers, the roofs and sides. Article 232 requires proper maintenance of all electric and trolley wires.

c. At present, electric wiring and electrical machines are either not grounded or improperly grounded; rails on electric haulage systems are frequently not bonded or cross-bonded. Various articles of Chapter VIII provide that all wiring, machines, steel pipes, etc be grounded properly with soft copper wire of at least eight square millimeters in cross-section.

d. Many high-voltage transformers and high-voltage switchboards are not marked properly with danger signs and do not have insulated foot boards. Article 200 requires that such markings and the foot boards shall be placed on and around all high-voltage transformers and switchboards.

Most operators recognize the need for using "permissible" equipment in gassy mines. Such equipment can be tested at two experimental and research institutions, one at Nogata, Kyushu, and the other at Sapporo, Hokkaido. These laboratories conduct rigid tests on items of electrical equipment offered for use in coal mines, to determine whether or not they are explosion-proof. An identifying mark is placed on equipment which has passed the required tests. Observations in mines indicate, however, that in actual use much of this equipment is not maintained in a permissible manner. This neglect of course cancels the safety features of the equipment, and it is no longer safe to use in gassy coal mines. A notable example was the explosion at the Mitsubishi-Bibai coal mine in June 1948, the cause of which was found to be an arc from a broken switch on a "permissible" electric drill.

6. Haulage and Transportation

Haulage systems in Japanese coal mines are combinations of endless or main-and-tail ropes, gravity planes, and slopes. The use of electric or battery locomotives (Figures 4 and 5) is limited to very few mines. Many of the accidents charged to haulage are caused by breaking of ropes. Other accidents result from the miners practice of jumping on or off moving man-trips. This is now prohibited by Article 256 of the Mine Safety Regulations. The regulations also require that the machinery safety boss make more frequent inspections of all haulage ropes, track, mancars, hoists, and cages. Shelter holes have not been provided along haulageways as a usual practice, even where clearance between the cars and the sides of the entry was insufficient. Shelter holes are now required, and new developments must provide for sufficient clearance to enable men to walk safely on at least one side.

In nearly every mine visited observations have shown that track is poorly maintained. No evidence was seen of pre-planning of track layouts to provide radius curves, proper turnouts and switches, or cross-overs. In most places turnouts have poorly fitting stub switches; either the brakeman or a permanent switch attendant must be there to push

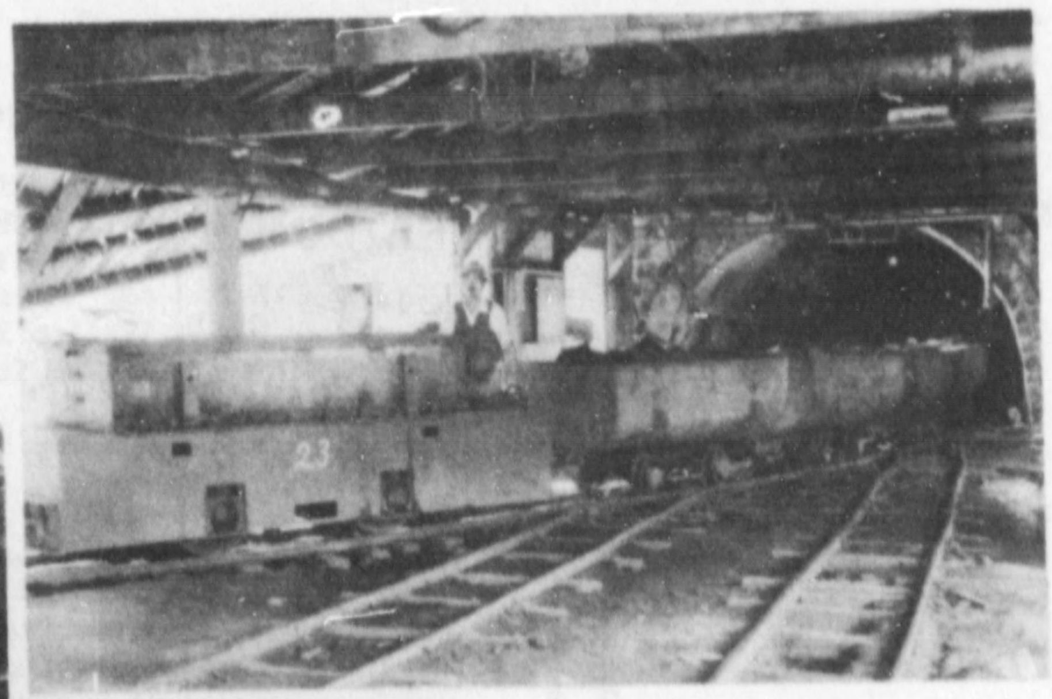


Figure 4. - Typical electric trolley locomotive, Mitsubishi-Bibai coal mine, Hokkaido, January 1946.

Figure 5. - Battery locomotive with trip of coal cars. Oyubari, Hokkaido, 1947

the cars around to prevent derailment. Poorly maintained track is a major cause of haulage accidents. The Mine Safety Bureau is attempting to emphasize this point in its safety posters and other safety literature.

Most of the larger mines have man-trips operating on the main entrance inclines. Some of these, such as at Miike mine in Kyushu, have steel or iron covers (Figure 6).

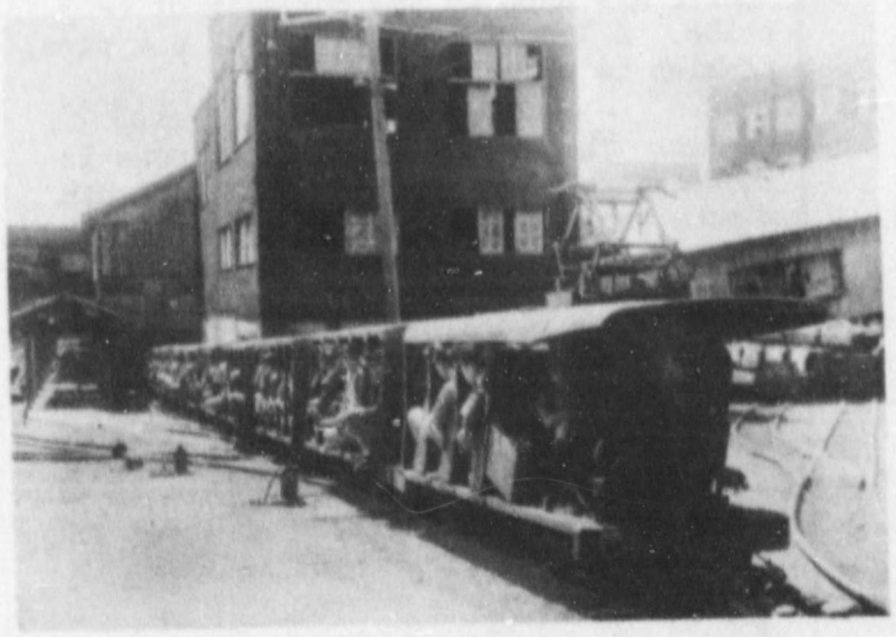


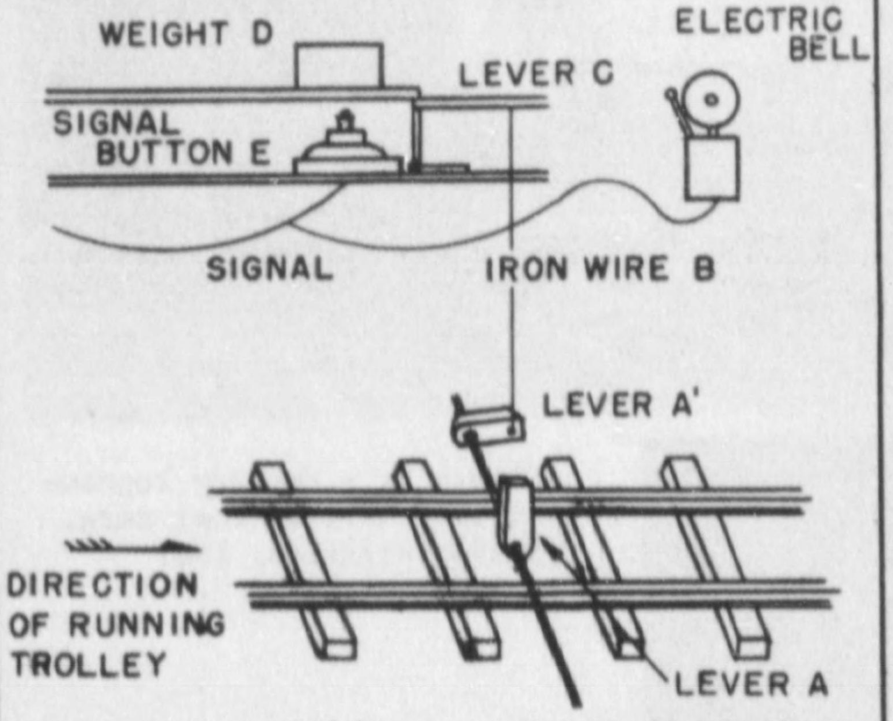
Figure 6. - Man trip cars on slope at Miike coal mine, Kumamoto Prefecture, Kyushu, 1947.

Numerous safety devices which local mine mechanics have designed for use on man-trips on slopes have been exceedingly successful in preventing accidents on man-trips. Other devices have been installed to give indication of a derailed car on endless rope haulage galleries and on some slopes. A simple device installed at the Bibai mine of the Mitsui Mining Co in Hokkaido and another device installed for the same purpose at Ikushunbetsu mine in Hokkaido are shown in Figure 7.

Where men are raised and lowered from the mine on cages in vertical shafts the rules are quite strict regarding safety factors for ropes; the factor for ropes in a shaft where men are hoisted must be at least 10 for the maximum static load and at least five for the

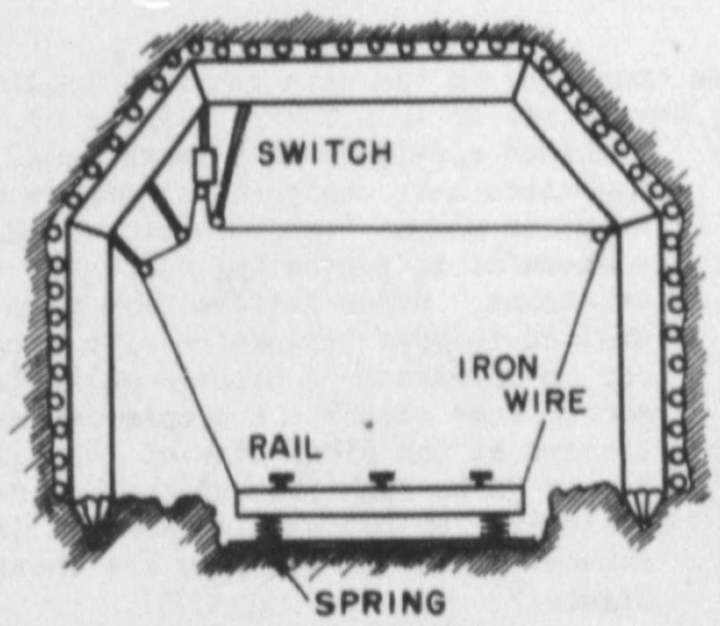
DERAIL WARNING DEVICES

MITSUI-BIBAI MINE, HOKKAIDO



THE TOP OF LEVER "A" HAS CLEARANCE OF ONE MILLIMETER FROM THE AXLE OF THE CARS ON THE TRACK. THE AXLE OF A DERAILED CAR PUSHES LEVER "A" DOWN, PULLING DOWN LEVER "C" WHICH IS CONNECTED TO "A" BY A STRONG WIRE. WEIGHT "D" THEN SETTLES ON THE PUSH BUTTON "E," CAUSING A BELL TO RING IN THE HOIST OPERATOR'S STATION.

IKUSHUNBETSU MINE, HOKKAIDO



TWO "FLOATING" TIES WITH COIL SPRINGS ATTACHED ARE MOUNTED IN A BOX UNDER THE TRACK. STEEL WIRES ARE ATTACHED TO THE ENDS OF THESE TIES. A DERAILED CAR RUSHES THE TIES DOWN, ACTIVATING THE SWITCH WHICH RINGS A BELL LOCATED AT THE HOISTING MACHINE.

NATURAL RESOURCES SECTION

Figure 7

maximum total load. The law requires that cages shall be provided with steel bonnets, safety chains on the front and rear, and hand holds or chains. Workmen have been observed to be very lax in using the safety chains on many occasions, and the companies have been urged to establish local safety rules providing penalties for failure to use the chains.

7. Timbering and Roof Control

About 44 percent of all underground accidents are caused by falls of roof and sides. How many of these accidents might have been prevented by better timbering plans or by better supervision of workmen at the face is difficult to determine. Certainly there is no lack of timber in the mines to indicate that insufficient timbers have been or are being placed. In recent years the rate of consumption of mine timbers has been 0.3 koku 9/ per metric ton of coal mined. The prewar consumption rate was reported by the Timber Bureau of the Ministry of Commerce and Industry to be only 0.2 koku per metric ton of coal.

Personal observation of the author indicates that the chief fault to be found with Japanese timbering methods is the lack of an engineered timbering plan. On longwall faces, the timbers are set helter-skelter with no regular interval between posts; in many places they are set "skin-to-skin". Often the workmen barely have room to move around near the working face. Old posts, ties, and scrap lumber are used in the building of many cribs. A long face timbered in a typical fashion is shown in Figure 8.

The use of steel mine props is increasing. Several companies in Japan manufacture a type similar to those in use in German coal mines. In calculating materials requirements of the coal mining industry for the 1949 fiscal year, the Machinery Bureau of the Ministry of International Trade and Industry estimated that 101,400 steel props could be used, effecting a saving of 386,000 koku of timber. A typical arrangement of steel props in a longwall working place is shown in Figure 9.

9/ One koku (timber) equals 9.827 cubic feet.

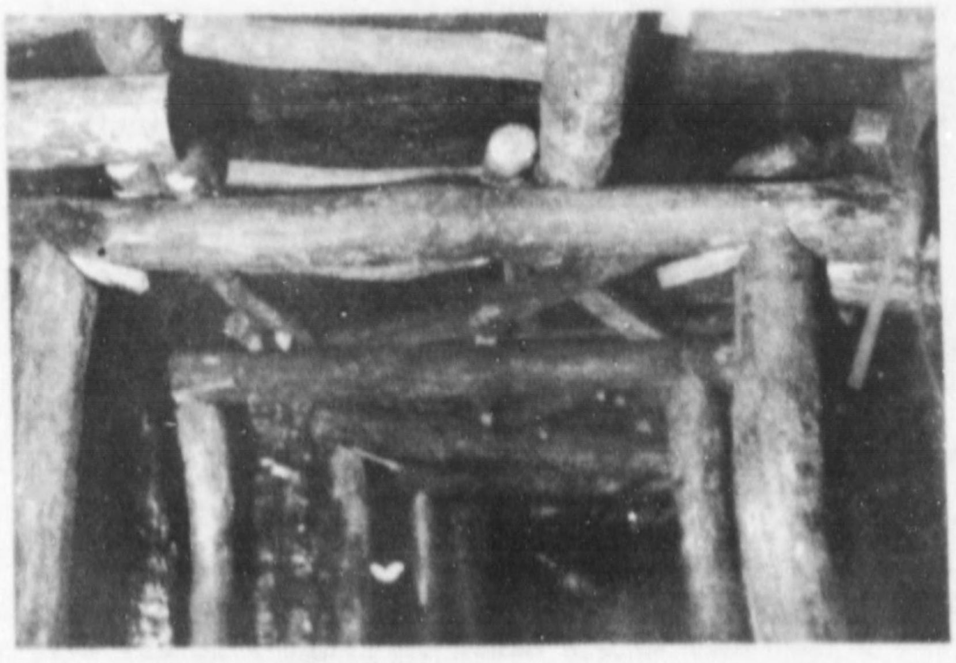


Figure 8. - Longwall timbering with wooden props in typical fashion

affected coal production. Strict control was exercised by the government over allocation of rubber and textiles. In 1947 a system of incentives for various industries, including coal mining, was established by the government at the instance of, and guided by, the Supreme Commander for the Allied Powers. Under this system critical items such as "tabi", gloves, work pants, towels, and soap were made available to the miners over and above the normal ration as an incentive to increase production.

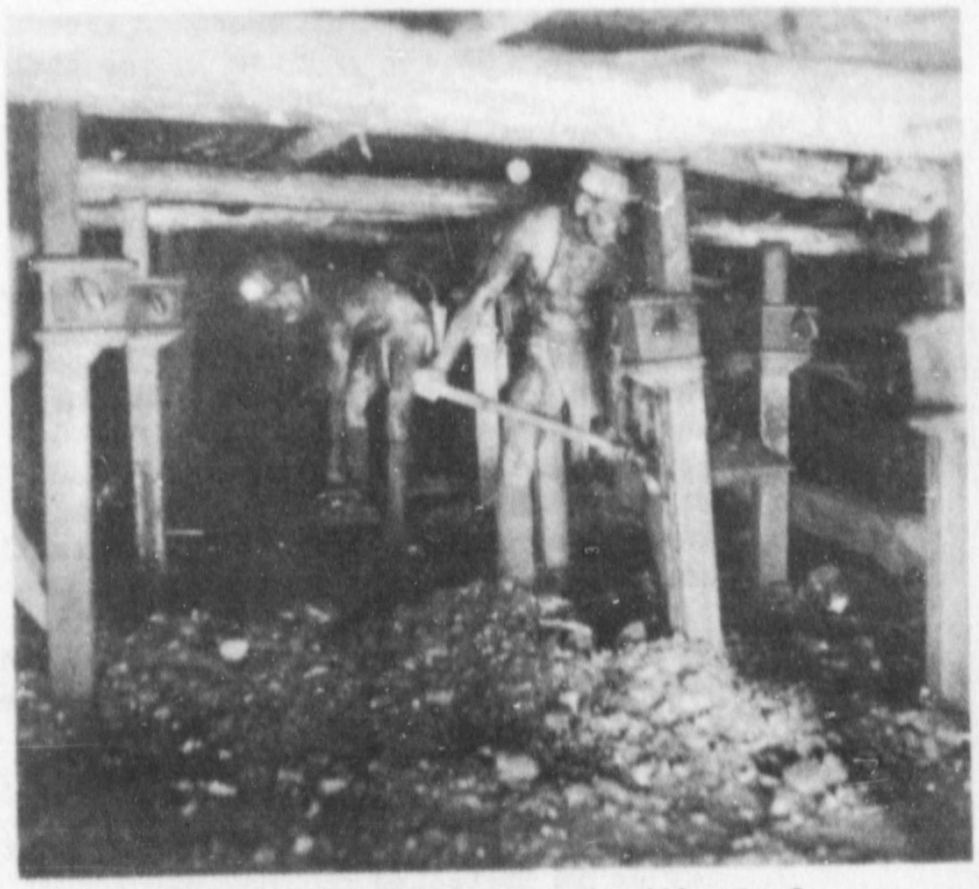


Figure 9. - Roof support with steel props in a longwall working place, Chikuho coal field, Fukuoka Prefecture, Kyushu. June 1947.

Prior to World War II, many mines were using arched steel rails to replace the wooden timber sets in the main haulageways. Shortage of steel since the outbreak of hostilities has limited this practice considerably. Upkeep of main entries is therefore a large item in the operating expense of the mine.

8. Protective Clothing

The clothing worn by Japanese coal miners is a nondescript uniform. Figure 10 shows a miner dressed for work. Particularly noteworthy are the split-toed rubber-soled "tabi" (shoes), the cloth cap, and the absence of gloves.

During the early stages of the Occupation, clothing and textiles were extremely scarce. This was one of the morale factors that seriously

Figure 10. - Japanese miner in typical working clothes, 1948.

Those miners who worked an established number of days and consistently met the quotas set for them were entitled to purchase these items at an official price set by the government. By the end of 1948, most shortages of such items were met, and following decontrol of nearly all industries in Japan during 1949 they are no longer considered as a factor in coal production.

At no time have the Japanese provided safety shoes for miners, and only a few safety hats are in use. Wearing of the split-toed rubber shoe is traditional for nearly all classes of labor. The few safety hats in use in coal mines are made of a hard, pressed fiber; although they do afford some protection to the wearer, they are not as satisfactory as the bakelite hats in use in American coal mines. Several manufacturers in Japan have developed a metal safety hat resembling the Mine Safety Appliance Co's "Skull-guard". These hats are sturdy and will prevent most injuries from falling materials, but they are conductors of electricity and hence are not safe for that reason. Another company, the Shibata Manufacturing Co of Tokyo, has developed a safety shoe. This waterproof shoe is made entirely of black rubber on a regular work shoe last and has a built-in steel cap over the toes. The only gloves observed in Japanese coal mines are light-weight, cotton knit gloves, which are not designed to give protection to the hands or fingers in any way. No leather, canvas, or insulated gloves have been seen.

A survey of accidents at the Joban coal mine, Yumoto, Fukushima Prefecture, for the calendar year 1948 reveals that 4.92 percent of all injuries were to the head and neck, 25.56 percent were to the hands, and 31.92 percent were foot injuries. Similar reports have been obtained from other coal mines throughout Japan. Many of these hand and foot injuries could have been avoided had the miners been wearing safety hats, safety shoes, and gloves. The use of the items described is being encouraged, and manufacturers of safety equipment for mines have been asked to contribute to the safety program by developing improved types of shoes, hats, and gloves.

Figure 11. - Japanese electric cap lamp, modeled after American Edison lamp.

SAFETY DEVICES AND EQUIPMENT

1. Electric Cap Lamps

Three types of electric cap lamps, one of which is shown in Figure 11, are in general use in the coal mines of Japan. All are modeled after the American Edison lamp, only a few of which were imported to Japan a number of years ago.

The Honda electric cap lamp, manufactured by Honda Electric Co Ltd, is typical of the electric cap lamps. The battery of this lamp is alkaline, having plates built up of nickeled steel pockets enclosed in a nickeled steel frame. The positive active material is nickel hydroxide with a small quantity of graphite added for conductivity. The negative active material is a mixture of finely divided iron and mercuric oxide. Insulation is furnished by strong ebonite plates. Both key locks and magnetic locks are available. The head piece is bakelite. Safety glass is used for the lens, and a safety device is installed on the bulb socket

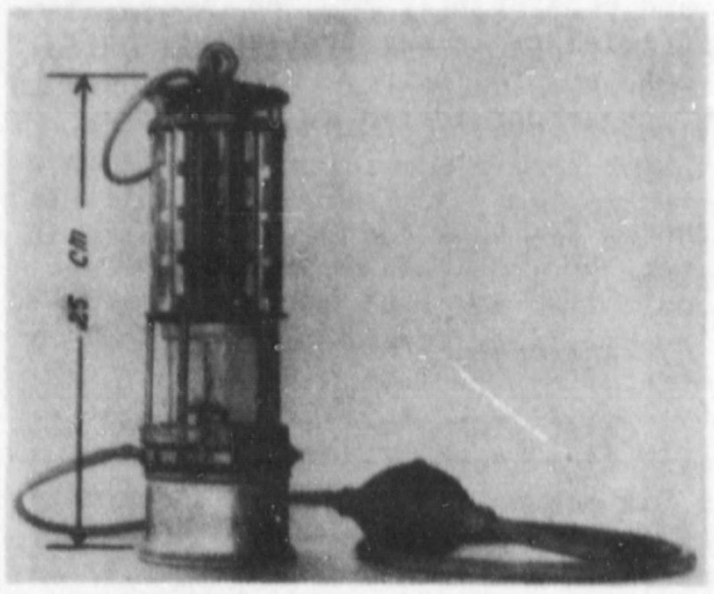


Figure 12. - Japanese flame safety lamp, Wolfe-type, showing tube and bulb attachment.

to cut off the electric current immediately if the lens is broken. The average voltage of this lamp is 2.5 volts, and it will furnish light for about 12 hours. It weighs 2.3 kilograms.

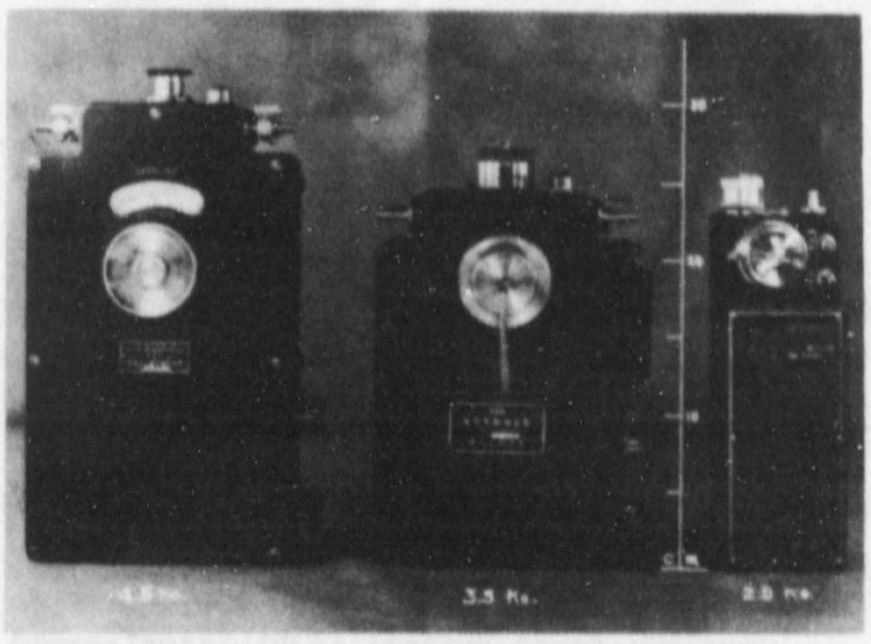
2. Flame Safety Lamps

The flame safety lamp used in Japanese coal mines to measure the amount of methane in the air is an adaptation of the Wolfe flame safety lamp made in the United States. The principal objection by users of the standard Wolfe model was the difficulty in getting the lamp into narrow places in the roof; they feel it is important that the test for methane be made directly against the roof. Accordingly, an air admission ring to which is attached a rubber hose with aspirating bulb was developed and placed on the lamp (Figure 12). This device eliminates the necessity for raising the lamp directly to the roof, where methane may have accumulated. By use of the rubber tube the air near the roof can be forced into the lamp in a normal carrying position.

The importance the Japanese place on testing for gas is indicated to some degree by the great number of flame safety lamps in use, together with more precise instruments described in the following section. In April 1946 a survey made of 71 coal mines in Hokkaido, Kyushu, and eastern Honshu showed that 6,670 flame safety lamps were on hand. The Sunagawa mine of the Mitsui Mining Co in Hokkaido alone had 466 lamps, followed by the Mitsubishi-Bibai mine, also in Hokkaido, with 223.

3. Precise Methane Indicators

The methane indicator most widely used in Japan is the Riken indicator manufactured by the Riken Measuring Instrument Mfg Co in Tokyo. This is a light-interference type detector similar to German types made by Karl Zeiss. After many serious explosions had occurred, detectors of this type were developed in Japan to detect gas vapors in oil tankers at the dock yards. Dr S. Sayama, Professor of Mining Engineering at Hokkaido University, and Mr S. Nakanishi, Director of the Government Institute for the Prevention of Explosions in Coal Mines, in Kyushu, both of whom had been studying the problem of methane in coal mines, made valuable suggestions for modifications of the detector to permit its use in coal mines. It was first tried in the Shinhoronai mine in Hokkaido. The various stages in the development of the detector during the past two decades are shown in Figure 13, and the latest Riken model is shown in Figure 14 and Figure 15. All have self-contained light units and a colored scale which indicates percentages of methane in mine air from 0.03-18.0 percent.



The Riken company reports that 4,712 of their detectors are in use in Japan's coal mines, with several thousand more on order. The company estimates that one Riken gas detector should be in use for each 3,000 tons of coal output.

Figure 13. - Development of Riken methane indicator earliest model shown at left.

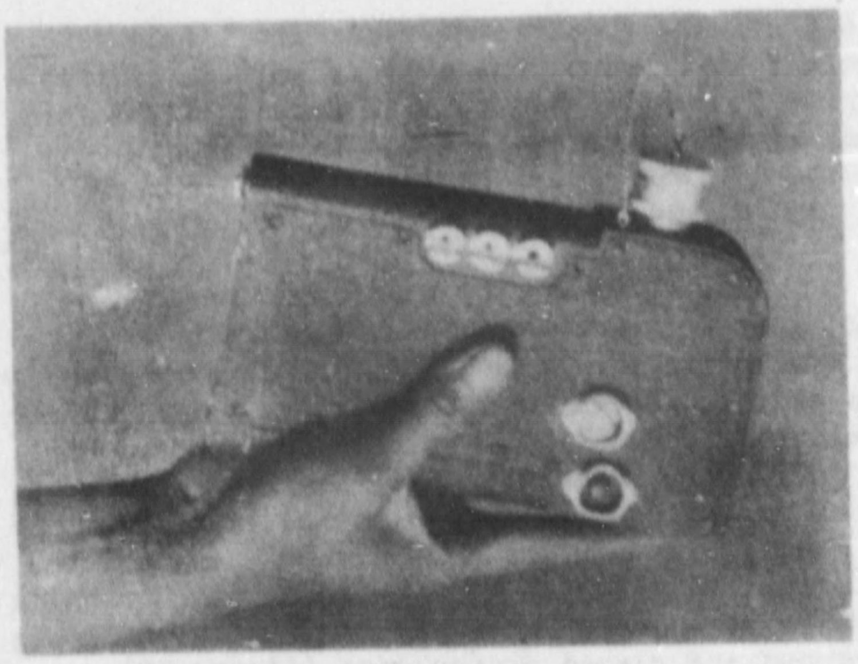


Figure 14. - Latest type Riken methane indicator for use in coal mines

To eliminate the need for having batteries enclosed in the case of the detector, the Tokyo Measuring Instrument Mfg Co developed a detector (Figure 15) which uses light from a special attachment on a miner's cap lamp to illuminate a built-in scale. As yet very few have been used in the mines.

4. Anemometers

Most mining men are familiar with the vane-type anemometer in general use in mines for measuring velocity and quantity of air in mine passages. Operations in Japanese mines have shown that such anemometers are usually reliable for velocities of from 70-500 meters per minute. As indicated in the foregoing discussion of ventilation, however, such velocities seldom exist in Japanese mines. It is often impossible to obtain an anemometer reading near the deep working faces. For this reason, an electric anemometer (Figure 16) was developed by the Electrotechnical Laboratory, Agency of Industrial Science and Technology, Ministry of International Trade and Industry. With this device, air currents of low velocity, from 0-60 meters per minute, can be measured. The device has a self-contained battery which is operated by the switch on the top right of the case. Temperature is compensated for by the resistor knob in the center. The device is operated by turning on the switch which heats a fine platinum wire in the thermocouple unit (shown mounted on the top left of the instrument and disassembled to the left of the instrument in Figure 16). It is finely calibrated to register velocities on the face of the dial in accordance with the degree to which the hot wire in the thermocouple is cooled by the air passing over it.

5. Coal Dust Measuring Instruments

Coal dust in mine atmosphere, in addition to being a nuisance factor affecting the health and comfort of the miners, presents a mine hazard owing to its explosive characteristics. The danger lies partly in that dust thrown into suspension in mine air by a gas explosion propagates the explosion by burning with explosive force, and partly in that very fine dust clouds may be ignited by a spark even without the presence of explosive gas. Many factors contribute to the explosibility of particular kinds of coal dust, and these are being studied constantly to determine means of suppressing the dust and rendering it non-explosible. One of the studies being conducted is the determination of the number of particles per gram of dust, and the number of grams per cubic meter of air, that may be exploded under normal mine atmosphere conditions.

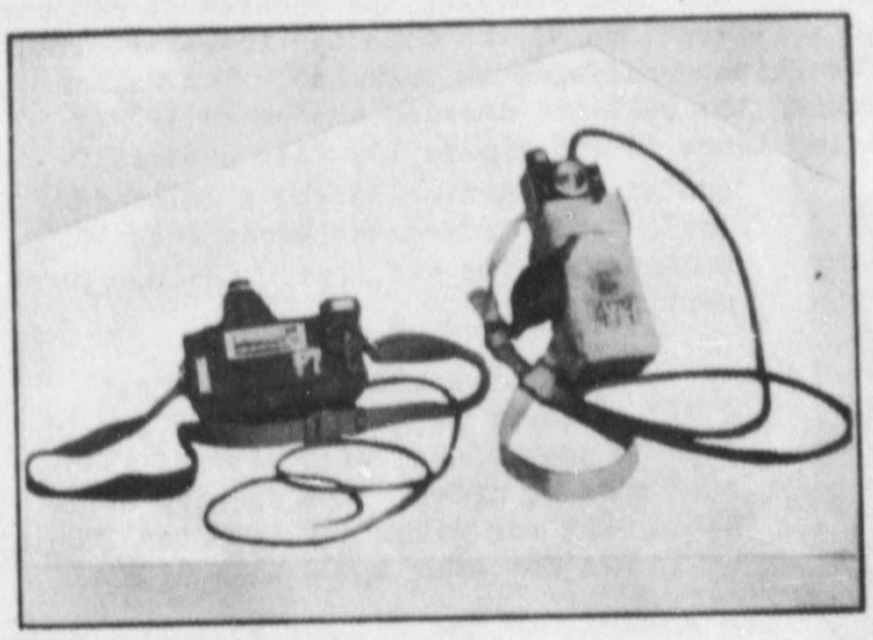


Figure 15. - On the left, a small and compact battery-less methane indicator which uses light from special attachment on miner's cap lamp. On the right, a Riken detector in its carrying case.

An instrument recently developed by the Electrotechnical Laboratory is designed to determine the quantity of coal dust in mine air. This instrument (Figure 17) is an optical light-interference

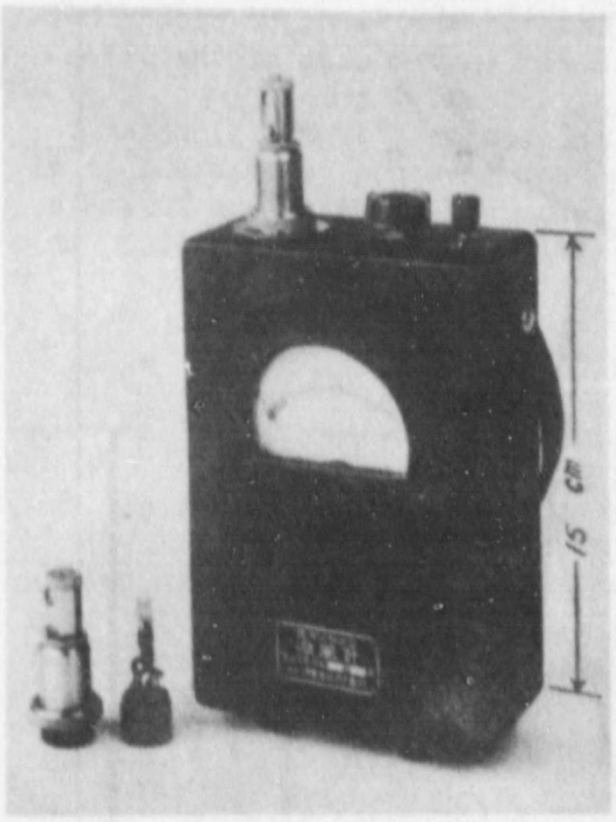


Figure 16. - Electric anemometer for low velocities, developed by Electrotechnical Laboratory, Agency of Industrial Science and Technology, Ministry of International Trade and Industry. Thermocouple is shown disassembled at lower left.

device capable of measuring coal dust in a range of 0.005 gram to 3.0 grams per cubic meter. It is still being developed and has been used in mines only on an experimental basis. However, mining engineers hope that such an instrument will prove valuable to the mines as an aid in preventing dust explosions.

The device utilizes a small light bulb, operated by a battery about the size of a battery for a cap lamp, used opposite a prism. The instrument is set at zero in clear atmosphere; looking through the eyepiece, the operator sees a clear, luminous dot. In a dusty atmosphere, the particles of dust interfering with the beam of light passing between B-B' (Figure 17) cause a dark spot to appear in the clear dot. This dark spot is extinguished by turning a dial, which causes a pointer to move across a graduated scale on the face of the instrument. By comparing the reading thus obtained with a previously calculated table, the quantity of dust per cubic meter in the mine atmosphere at the point is determined.

CASE HISTORIES

1. Katsuda Mine Disaster (62 Fatalities)

The Katsuda mine of the Mitsubishi Mining Co Ltd is located at Umi-machi, Fukuoka Prefecture, Kyushu. In June 1948 the average daily production was 1,128 metric tons; the registered number of workers was 3,148. The main opening of the mine is a vertical shaft near the center of the mine lot. All of the working places are northwest of the bottom of the shaft. The mine is classed as gassy by the Mine Safety Bureau of the Ministry of International Trade and Industry, and all usual precautions regarding the use of open lights and permissible-type machinery are taken.

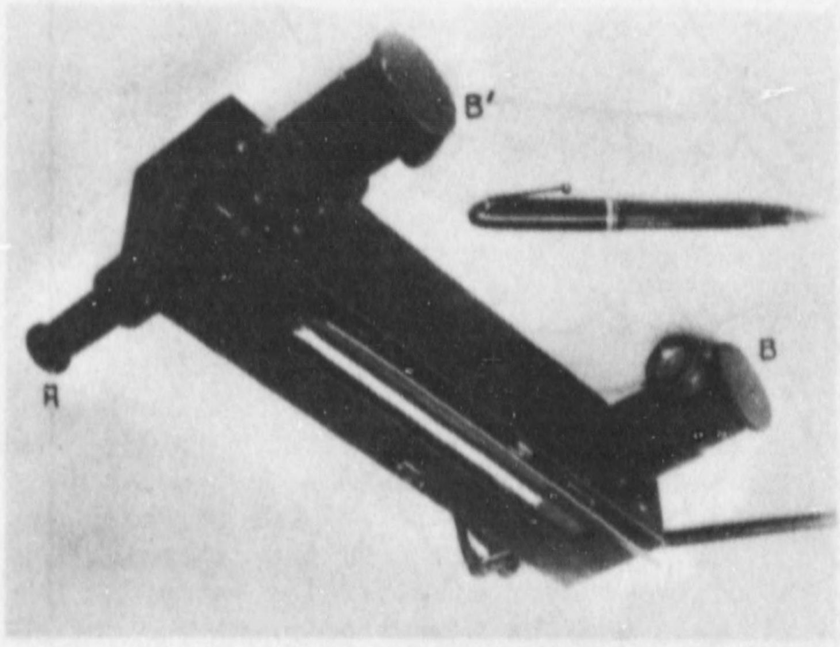
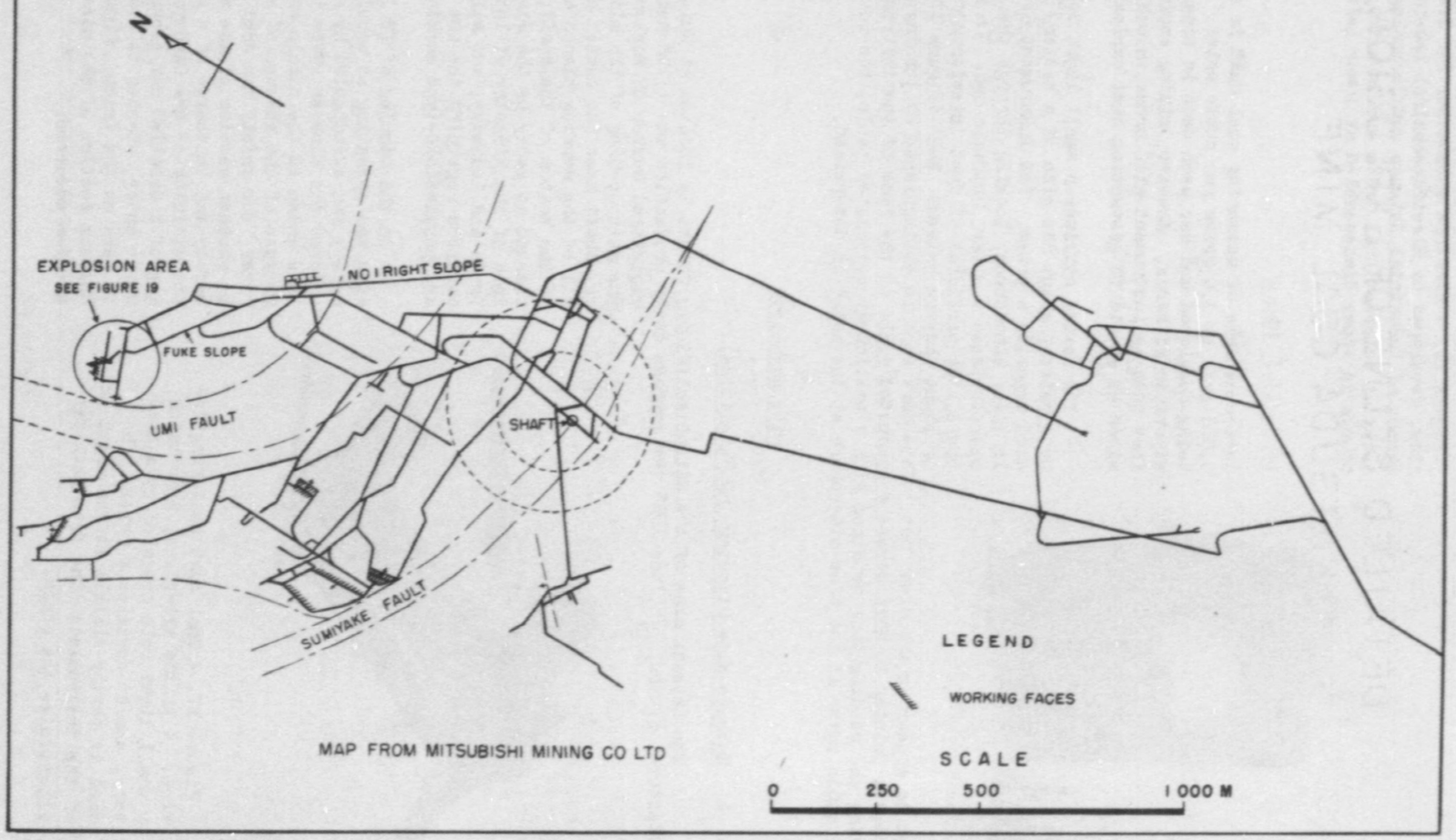


Figure 17. - Coal dust measuring device. A is the eye-piece, B contains a small light bulb operated by a battery, and B' contains a prism. The dial is partly visible at the right end of the instrument. The five-inch pen illustrates the scale.

On the morning of 18 June 1948 the mine was operating as usual. At 0630 a safety man accompanied by a shot-firer entered the mine en route to the Dandera face shown in the circle on Figure 18. Because of the absence of another shot-firer, the safety man sent his companion to another section of the mine. Another safety man in charge of a rock heading in the vicinity of the Dandera section, hearing of a derailed car along the main exhaust entry, started to assist in getting it back on the track. Figure 19 shows the Dandera section of the mine where the explosion occurred.

UNDERGROUND MAP OF KATSUDA COAL MINE



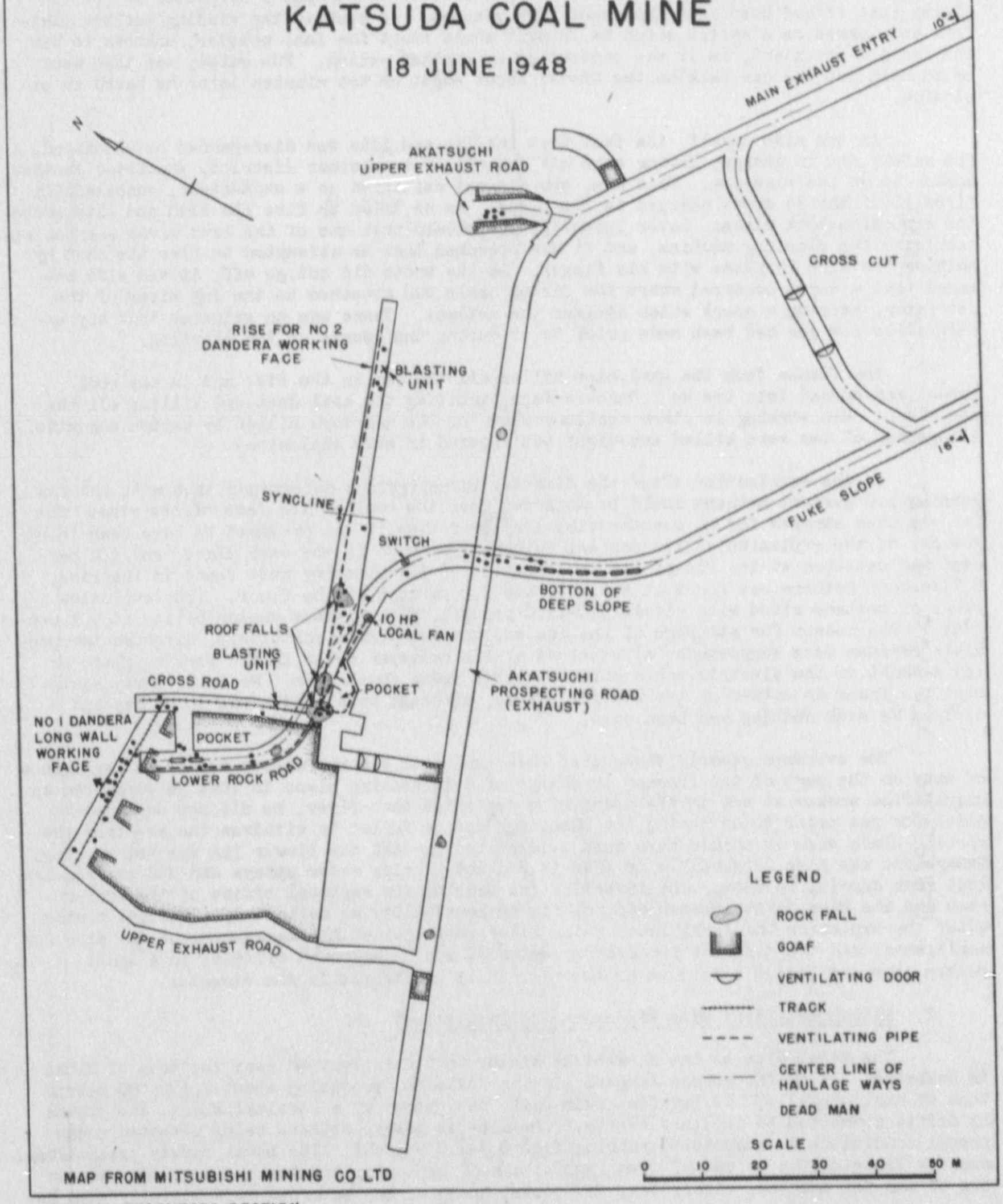
MAP FROM MITSUBISHI MINING CO LTD

NATURAL RESOURCES SECTION

Figure 18

DETAILED SCENE OF EXPLOSION, KATSUDA COAL MINE

18 JUNE 1948



NATURAL RESOURCES SECTION

Figure 19

The No 1 Dandera longwall face was 34 meters long, driving advancing. The rise being driven to establish the No 2 longwall face was advanced 73 meters. The rise was normally ventilated by a 10-horsepower local fan, as shown on the map, with steel tubing laid almost to the top of the rise. As the safety man on his way to help re-rail the car passed the fan he noticed it was not running and ascertained from a carpenter in the vicinity that it had been idle for about five minutes. He went to the winding machine platform and turned on a switch which he thought would start the fan; however, unknown to him, the fan did not start, as it was controlled by another switch. The safety man then went on to help get the car back on the track; about eight or ten minutes later he heard an explosion.

In the rise itself, the fact that the fan was idle was disregarded or unnoticed. The safety man in charge, having sent his shot-firer to another district, appointed another worker to do the blasting. This man, who was not certified as a shot-firer, successfully fired 10 of the 15 shots charged in the place. As he tried to fire the 11th and 12th shots the explosion took place. Later investigation showed that one of the lead wires was not attached to the blasting machine, and it was presumed that he attempted to fire the shot by holding the wire in place with his finger. As the shots did not go off, it was also assumed that a short occurred where the firing cable was attached to the leg wires of the detonator, causing a spark which ignited the methane. There was no evidence that any examinations for gas had been made prior to or during the course of the blasting.

The flames from the explosion killed all the men in the rise and in the rock tunnel and spread into the No 1 Dandera face, igniting the coal dust and killing all the men there. Men working in other sections shown on the map were killed by carbon monoxide. Altogether 62 men were killed and eight men injured in this explosion.

In the examination after the disaster investigators determined that with the fan running 1.0 percent methane could be detected near the roof at the face of the rise. The fan was then stopped for 20 minutes (the length of time it was presumed to have been idle the day of the explosion); 11.0 percent methane was found in the same place, and 4.0 percent was detected at the floor. At the location of the blasting unit found in the rise, 6.7 percent methane was found at the roof and 3.0 percent at the floor. (The explosive range of methane mixed with air is 5.0-15.0 percent, with maximum explosibility at 9.5 percent.) The reason for stoppage of the fan was not determined positively, although two possible reasons were suggested: (a) overload of the conveyor motor in the working place or (b) a short in the electric cable which supplied power to the fan. No water-spray equipment was found in either of the working places, although both were known to be dry and dusty. No rock dusting had been done.

The evidence clearly shows that this explosion was the direct result of negligence of duty on the part of the foreman in charge of this working place in that he permitted an unqualified worker to act in the place of a certified shot-firer, he did not examine the place for gas prior to or during the shooting, and he failed to withdraw the men from the working place when it should have been evident to him that the blower fan was not working. Management was also responsible in that it did not provide water sprays and did not require that rock dusting be done. The investigation made by the regional office of the Coal Bureau and the Mine Safety Bureau did not fix responsibility so definitely. Several months after the explosion the local labor union filed suit against the management of the mine for negligence, and the district procurator sentenced one underground official to a short prison term and levied a fine on another for their negligence in the disaster.

2. Mitsubishi-Bibai Mine Explosion (13 Fatalities)

The Bibai Mine of the Mitsubishi Mining Co Ltd is located near the town of Bibai in Hokkaido. It is the second largest mine in Hokkaido, producing about 1,500,000 metric tons of coal annually. It has five main pits, one opened by a vertical shaft, the others by drifts connected to inclined shafts. The mine is gassy, methane being detected under normal conditions in quantities ranging from 0.3-1.0 percent. The usual safety precautions, such as restrictions on use of open lights, use of explosion-proof machinery, and searching of men for matches, cigarettes, and pocket heaters, are enforced more strictly than has

been observed at other mines in Hokkaido. Two explosions had occurred in recent years prior to 1948. One in the Tateko (shaft) pit in May 1944, reported to have been ignited by a lighted cigarette, resulted in the death of 119 miners. A gas explosion in the Takinosawa pit, the cause of which was not determined, resulted in the death of nine miners.

Another explosion in the Takinosawa pit occurred 29 June 1948, killing 13 men and seriously injuring six. The explosion took place in the vicinity of the No 2 longwall working place of the Left No 6 Level of the Takinosawa No 1 pit. Figure 20 is a drawing of the general scene of the explosion and the conditions existing at the time. The belt haulage road was advanced about 19 meters ahead of the longwall face, driven on the strike of the seam which had changed from nearly level to a climbing slope of about 13 degrees. As shown on the sketch, the longwall face was inclined 20-30 degrees and was about 70 meters in length. Coal mined on the long face was carried by steel trough down the face, discharging onto a belt conveyor in the belt road.

Records of the mine showed that on the previous day the quantity of air at the longwall face was 100 cubic meters per minute; compressed air blown into the advanced heading through steel tubing provided 30 cubic meters of air per minute. The amount of methane recorded was 0.5-0.6 percent in the heading, 0.3 percent on the long face, and about 0.7 percent in the upcast. The working places were not equipped with water sprays but were reported to be damp.

Just prior to the explosion, the workers in the heading had completed drilling preparatory to blasting. Later investigation proved that the blower fan in the heading had been idle for about two hours. Considerable gas was issuing from a small fissure at the floor of the face of the heading. The electric drill found in the heading after the explosion had a broken operating switch. The drill was taken to the laboratory of the Sapporo testing office and tested in the explosion tunnel there. The test showed that an electrical short caused by this broken switch was capable of setting off an explosive quantity of methane in the testing tunnel. Investigators therefore decided that the explosion at the mine was caused by this defective drill.

Here again the basic cause of the explosion was poor ventilation. Had the drill in question been properly maintained the explosion probably would not have occurred, although a spark from any source was all that was necessary to explode the dangerous concentration of methane which had accumulated as a result of the stoppage of the fan. No action was taken against any of the mine officials in this case.

3. Takamatsu Mine Explosion (7 Fatalities)

The Takamatsu coal mine, owned by the Nihon Coal Mining Co Ltd, is located in the town of Mizumaki, Fukuoka Prefecture, Kyushu. Annual production of the mine prior to World War II was slightly more than 1,000,000 tons. Production in 1948 was 700,000 tons. The mine is classed as gassy by the Mine Safety Bureau. On 8 September 1947 an explosion at this mine took the lives of seven miners and severely injured 29 others. The location of the explosion in the mine is indicated on Figure 21.

The day preceding the explosion, 7 September, was a holiday. On that day, a Mr Kubo, in charge of the working place on the first shift, inspected the place and found that the explosion-proof switch on the remote control cable which operated the conveyor had been removed, leaving about three centimeters of bare wire exposed. On leaving, Mr Kubo pulled the electric switch which operated all the electrical equipment in the place, including the local fan.

The next morning, 8 September, a Mr Shinohara entered the mine without knowing of the conditions found by Mr Kubo the day before. One of the members of his crew examined for and found gas in the working place and observed that the local fan was not running. He reported this to Mr Shinohara who went to the main switch, which had been opened by Mr Kubo, and closed it. A short then occurred at the end of the remote control cable from which the switch had been removed, exploding the accumulated methane in the rise.

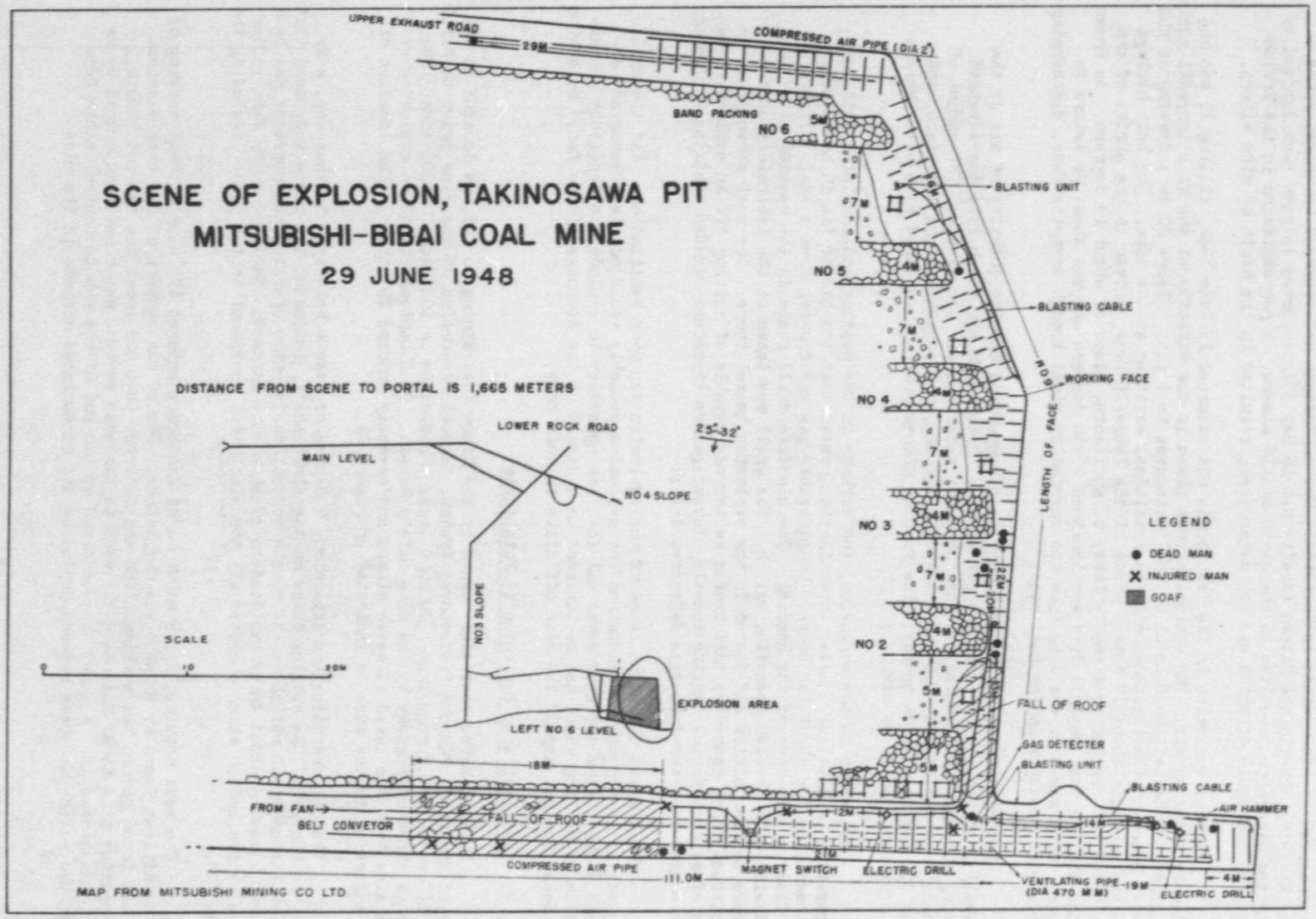


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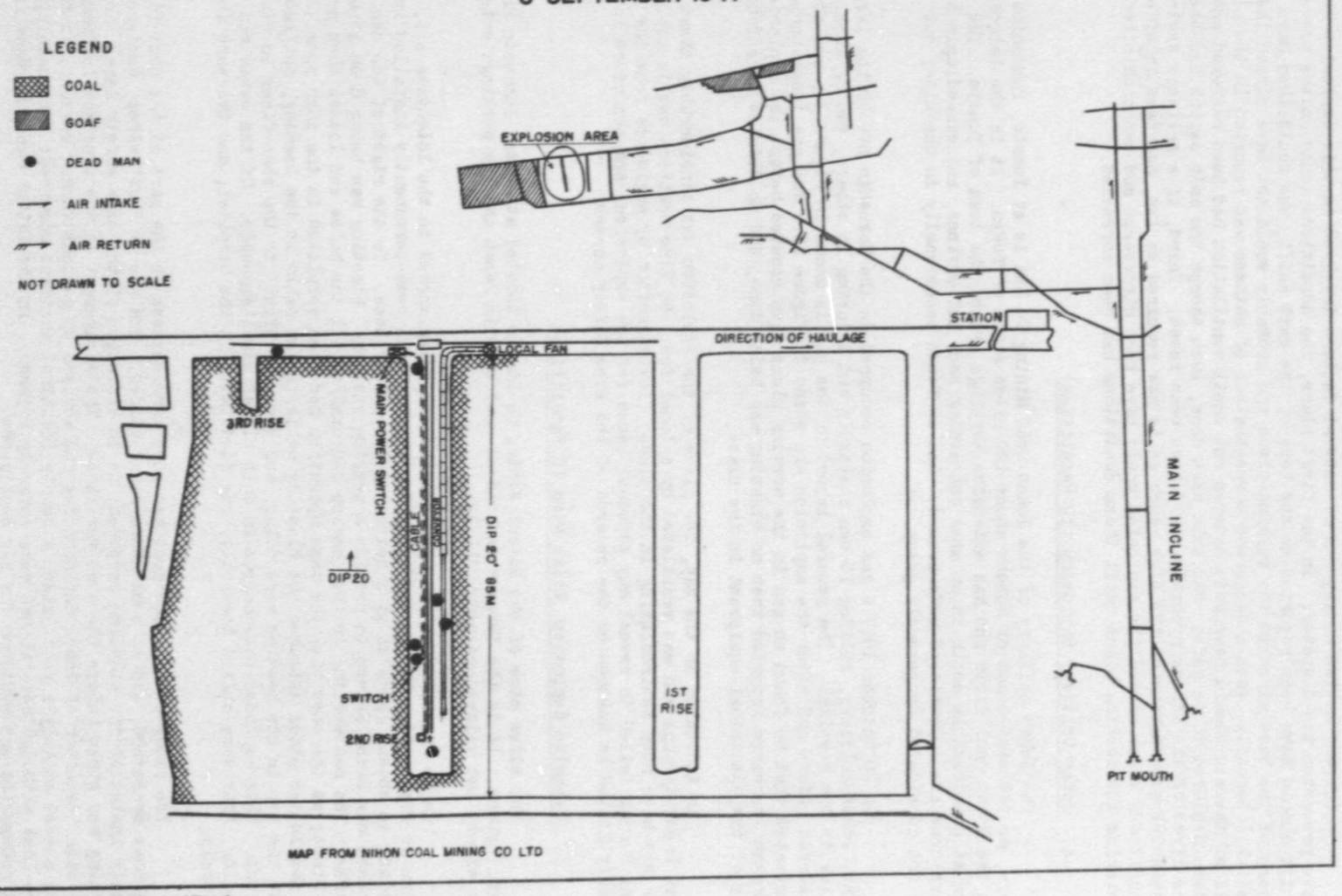
Figure 20

SCENE OF EXPLOSION, TAKAMATSU COAL MINE

8 SEPTEMBER 1947



MAP FROM NIHON COAL MINING CO LTD

Figure 21

Correct action on any one of several factors involved in this explosion could have prevented the disaster. In the first place, the conditions found on the preceding shift should have been reported to the boss of the next shift, who would then have been aware of the bare wires in the working place and probably would not have closed the main switch. Secondly, when a dangerous concentration of methane was reported in the place, all of the men should have been ordered out until ventilation had been restored and the place declared to be safe. Had this been done, even though the main switch had been closed the lives of the miners probably would have been saved. Third, if a reliable system of pre-shift examination of the mine, such as is now required by law, had been in effect, the conditions which caused the explosion would have been discovered and men prohibited from entering the working place until those conditions had been corrected.

4. Joban Colliery Explosion (12 Fatalities)

The Joban colliery of the Joban Coal Mining Co Ltd is at Yumoto, Fukushima Prefecture, on the east coast of Honshu about 120 miles north of Tokyo. It is the largest mine in the Joban coal field and has extensive workings around the town of Yumoto. The workings are at considerable depth in an area containing many hot springs, and exceedingly high temperatures are encountered underground. Gas is found occasionally in the mine, but the mine is not considered dangerously gassy.

On 20 October 1947 a gas explosion occurred in the Hokushin pit of the Iwasaki mine, Joban colliery, killing 10 men instantly and injuring 15 others, two of whom died later in the hospital. The general layout of the pit is shown in Figure 22, and conditions observed before and after the explosion are shown in Figure 23. The gas inspector's report indicated that he found no gas in the working place five minutes before the explosion. The foreman in charge reported that no blasting was being done, and no defects were found in any of the electrical equipment in the place.

As indicated on the map, the place of the explosion was considerably ahead of the last break-through and was ventilated by a local fan. No line brattice was in use. Some air may have been recirculating in the place. Investigation by engineers from the local Coal Bureau failed to reveal any physical cause for the explosion, and the cause is officially listed as unknown on the records of the Mine Safety Bureau.

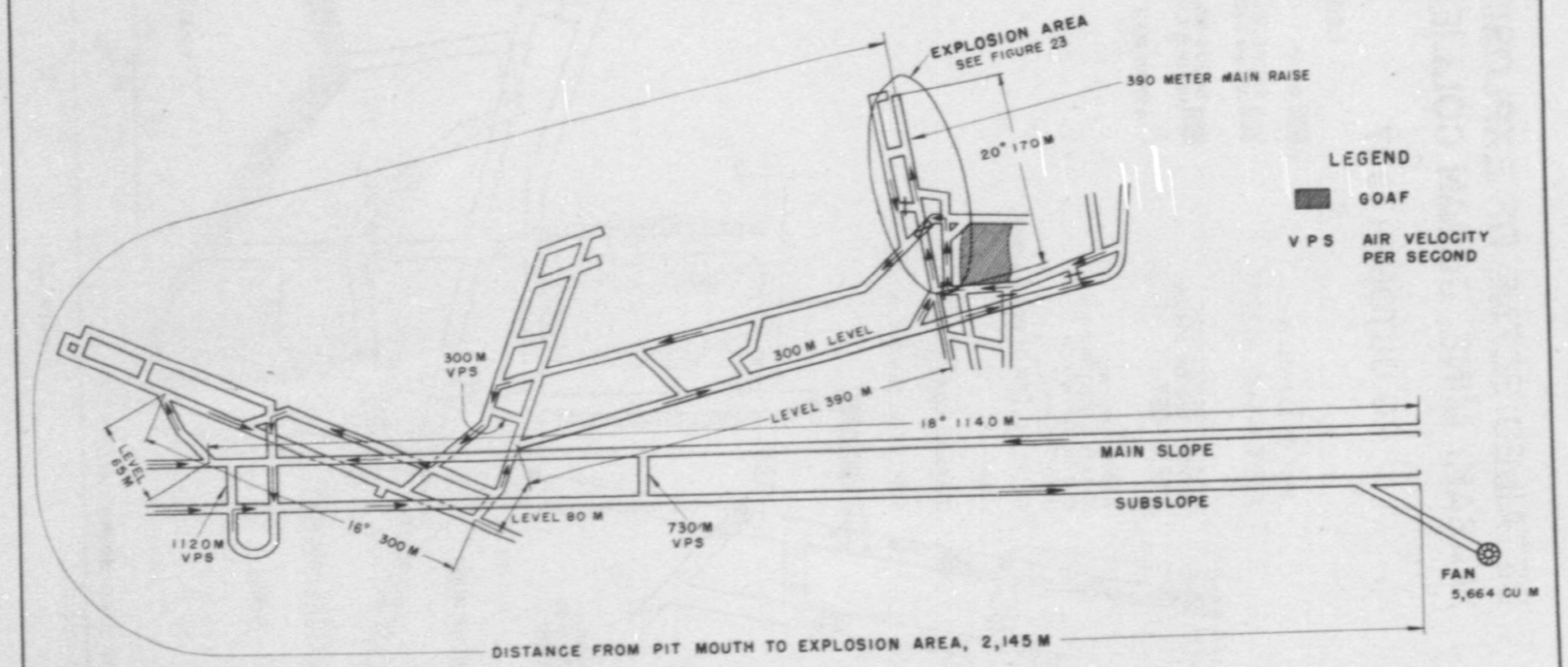
5. Dynamite Explosion, Miike Mine (5 Fatalities)

The Miike mine of the Mitsui Mining Co Ltd is located at Omuta, Kumamoto Prefecture, Kyushu. It is the largest and oldest coal mine in Japan and has workings extending for almost two kilometers under the sea.

On 26 June 1948, a new rock heading was being worked in the Yotsuyama pit, as shown on Figure 24. The firing cable for blasting was semi-permanently installed in the heading as shown, operated by a switch by the powder boss. To the right of the new heading, a place was being driven to provide a pumping station. Blasting was being done in both places. The men working in the heading had drilled all the holes and loaded them preparing to blast; at the same time the same operation had been completed in the pump room. The men in the latter place attached the blasting cable to the cable in the heading, not knowing what the men in the heading were doing, and gave the signal to the shot-firer to close the switch. This exploded the charges in both places simultaneously. Of the seven men in the heading, four were killed instantly, one died later in the hospital, and two were injured severely.

The cause of this accident was pure carelessness on the part of the shot-firer and the boss concerned, and it could have been avoided. The use of "hot" wires, semi-permanently installed for blasting purposes, is in violation of the mine safety laws. No proper warning was given before the shot was fired. The management of the mine was informed by the mine inspector of these deficiencies and advised to correct them. However, at the same mine almost exactly a year later, a nearly identical accident occurred; fortunately, no lives were lost although several men were severely injured. In the latter case the boss in charge was prosecuted and punished for his negligence.

UNDERGROUND MAP OF HOKUSHIN PIT, IWASAKI COAL MINE, JOBAN COLLIERY



MAP FROM JOBAN COAL MINING CO LTD

Figure 22

DETAILED SCENE OF EXPLOSION, IWASAKI MINE, JOBAN COLLIERY

20 OCTOBER 1947

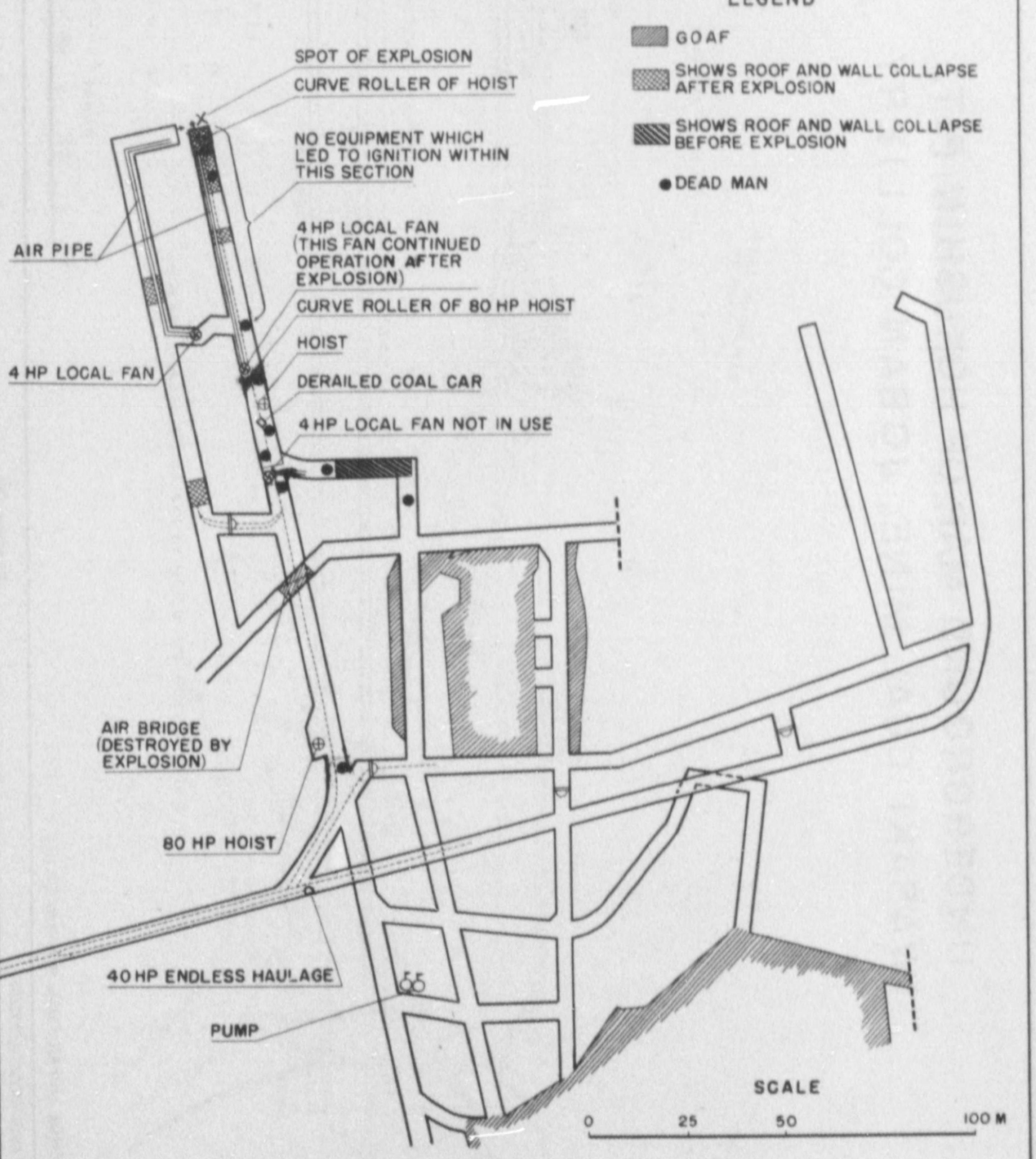


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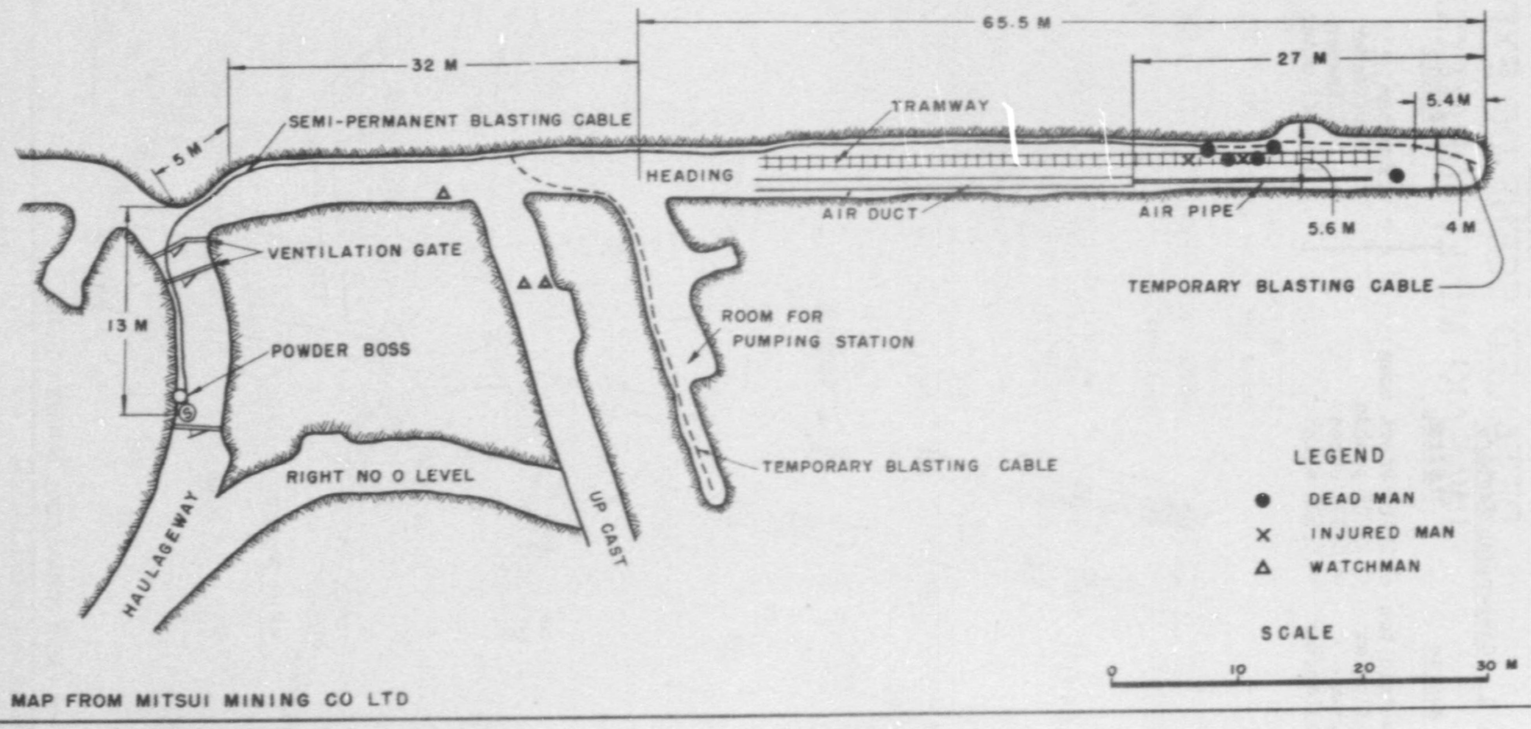
Figure 23

SCENE OF DYNAMITE EXPLOSION, MIIKE COAL MINE

26 JUNE 1948



MAP FROM MITSUI MINING CO LTD

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Figure 24

GLOSSARY

1. Conversion Factors

Metric		English
1 metric ton	=	1.102 short tons
1 kilogram	=	2.205 pounds
1 gram	=	0.035 ounce
1 kilometer	=	0.621 mile

Metric		English
1 meter	=	3.281 feet
1 centimeter	=	0.394 inch
1 millimeter	=	0.039 inch
1 cubic meter	=	35.313 cubic feet

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Government Section	1	Mining and Geology Division	25
Public Health and Welfare Section.	25	Administration Division	5
Public Information Section	24	Library	2
Civil Affairs Regions.	2	File.	100
Ryukyus Civil Administration Section	2		
Secretariat Allied Council for Japan	1		
Civil Affairs Officer, Fleet Activities.	1		

(subject to change)

PROCEDURE FOR OBTAINING COPIES OF NATURAL RESOURCES SECTION REPORTS

Government agencies, colleges, industrial organizations, and individuals in the United States may obtain a list of institutions where reports are available for reference purposes by addressing an inquiry to The Adjutant General, Attn: AGAO-X, Department of the Army, Washington 25, DC.

Reports may be purchased in photostat or microfilm from the Office of Technical Services, US Department of Commerce, Washington 25, DC. Orders should include the number and complete title of the report, and the issuing agency should be cited as Natural Resources Section, General Headquarters, Supreme Commander for the Allied Powers.

Foreign diplomatic missions should address requests to GHQ, SCAP, Attention Diplomatic Section.

Associate staff sections, civil affairs regions, and other military organizations in this command should address requests to GHQ, SCAP, Attention Natural Resources Section.

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