Coal Reserves in Areas of Critical Fuel Supplies

Exploration of the Coos Bay coal field in Oregon was completed. Fifteen holes, totaling 13,007 feet, to secure 2-1/8-inch minimum-diameter cores, were drilled in the area, which centers about 9 miles south of Coos Bay, a station on the Southern Pacific Railroad. The rough topography, heavy growth of timber and underbrush, and excessive rainfall in this area made access to drill sites difficult. The character of the overburden in the upper measures caused caving in many drill holes and delayed progress in drilling. The exploration proved a large reserve of minable coal, which can be developed as a source of fuel for both industrial and domestic use in the Pacific Northwest. The Beaver Hill bed is the most extensive in this area. A report is being prepared for publication on the results of this investigation.

The construction of Army camps and magnesium plants in Nevada resulted in large demands for coal. No coal is produced in Nevada, and the fuel used in the State is supplied by mines in Utah and other coal-producing States in the Rocky Mountain region. Increased demand for fuel placed an additional burden on the railroads transporting coal to the new Army camps and industrial plants. A deposit of coal near Coaldale, Esmeralda County, Nev., was explored to determine the extent of the coal beds and the character and physical properties of the coal. Abandoned mines and outcrops were examined, and diamond drilling was done. Figure 8 shows the outcrop of coal beds and sites of drill holes in the area of the exploration. The results of the investigation show that minable coal beds are not continuous over appreciable areas, and no estimate can be made of the reserves in these beds. Conditions as determined by the investigation are not favorable for successful development of coal mines in the Coaldale field. Washing tests of the raw coal indicated that there was no low-ash coal and that a product of high ash content can be obtained in only relatively low yield. The raw coal contained an average of 53 percent ash, the washed product an average of 35 percent ash and a yield of about 33 percent. The product could be used in industrial stokers of suitable design with satisfactory operation, if mechanical means are provided to handle the large amount of refuse produced; it would not be satisfactory as a domestic fuel because of its high ash content. Technically, it is feasible to use Coaldale coal as gas-producer fuel in producers properly designed to handle large volumes of ash. Although the Coaldale coal has limited possibilities as a fuel, both on industrial stokers and in gas producers, its suitability will depend largely on economics. A paper entitled "Exploration, Composition, and Washing, Burning, and Gas-Producer Tests of a Coal Occurring Near Coaldale, Esmeralda County, Nev.," Bureau of Mines Technical Paper 687, is in press.

Production of coal from underground mines in Washington has declined during the war due to manpower shortages, and coal had to be shipped into the Pacific Northwest from mines in the Rocky Mountain region. This movement of coal required the use of railroad equipment that otherwise could have been used for transportation of war supplies. The development of coal areas in the Pacific Northwest that could be mined by strip methods which use a minimum of manpower should increase coal production in this area and thus save long-haulage of coal. The development of a strip mine to supply coal demands at low cost requires a large investment in heavy equipment; to keep fixed charges due to large investment in the plant at a minimum, large reserves of coal must be proved. A reconnaissance of an area near Toledo, Lewis County, Wash., indicates a large reserve of lignite which could be mined by strip methods. This area is about midway between Portland, Oreg., and Seattle, Wash., and the opening of a large mine here would supply fuel to these centers. Explorations by diamond drilling in the Toledo area were still in progress at the end of the fiscal year. Work to date indicates the necessity for washing the coal. Preparation tests of this lignite will be discussed under Preparation of Coal on page 57.

Fuel requirements for industrial and domestic consumers in New England, in normal times, are supplied almost entirely by fuel oil, anthracite, and bituminous coal (a small amount of wood is burned in some localities). A shortage of these fuels occurred during the war. This shortage was caused by: (1) The diversion of oil to military uses; (2) the use of railroad and boat facilities for the transportation of war material; (3) the inability of coal mines to supply the increased demand for coal resulting from the conversion from oil to coal by domestic and industrial consumers; and (4) the increased demand of war industries for coal. Because of this critical fuel situation, an investigation was made of possible sources of fuel nearer the points of consumption in New England.

Meta-anthracite, which is a satisfactory fuel for some purposes, was mined in Massachusetts and Rhode Island many years ago. However, the introduction of better coal into New England markets resulted in the abandonment of these mines.

The coal from mines in the vicinity of Portsmouth on Aquidneck Island, Newport County, R. I., has been used successfully for smelting copper ore and for fuel. It is reported that this coal is less graphitic than the material mined at Cranston, near Providence, R. I. The coal is meta-anthracite and does not burn freely. However, improved equipment for burning coal has been developed and, should minable reserves of coal be found, methods of burning it probably could be devised.

The purpose of this investigation was to determine sources of additional fuel and as coal mined at Portsmouth had been used with some success, exploration was undertaken to determine the characteristics and continuity of the beds in this area.

Utilization investigations of the material mined at the Cranston mine of Graphite Mines, Inc., are being made by Rhode Island State College in cooperation with the Bureau of Mines.

The exploration, which was completed, did not disclose the presence of minable coal beds and the possibility of proving areas of coal that can be recovered by mining is not favorable. A report on the results of the investigation is being prepared.

Exploration by the Mining Branch

Of the 187 mineral deposits in the United States and Alaska explored by the Mining Branch of the Bureau of Mines during the fiscal years 1940-1944, 12 projects were concerned with explorations for coal.18/ The studies showed that the more important deposits of high-grade coals included estimated reserves of 2,500,000 tons of good coking coal near Fort Payne, Ala. (1,945,000 tons are considered recoverable); 15,345,000 tons of coking coal near Kemmerer, Wyo., (11,215,000 tons are considered recoverable), and a total of 3,332,200 tons of bituminous and subbituminous coals in three areas in Alaska. Subbituminous coal in two areas in Alaska - southwest of Fairbanks and in the Healy district - were being mined in 1944 under the supervision of the United States Army. The 3-million ton deposit of high-volatile B bituminous coal in the Moose Creek district, Alaska, was superior to any coal mined in the Matanuska field.19/ This is poorly coking coal but is in demand locally for domestic and commercial uses, particularly on stokers. The coal is amenable to open or closed storage, because it does not slack on exposure and its danger of spontaneous combustion is minimized by its low moisture and sulfur contents. The 1944 demand for coal in Alaska totaled 500,000 tons. By virtue of location, transportation advantages, and high quality of coal, the Matanuska field should supply 300,000 tons of the annual consumption. The activities of the lessees, together with the exploratory work by the Bureau of Mines, have made this production possible on the Buffalo Coal Co. leasehold for a minimum period of 10 years. Core drilling and trenching by the Bureau of Mines revealed a total of 2,375,500 tons of measured, indicated, and inferred coal in the Buffalo series, of which 1,656,700 tons are estimated as recoverable. Existence of deeper beds over the same length increased the estimated tonnage of coal of all categories to 3,259,300 tons. Exploration work on Alaskan coals is being continued by the Coal Mining Section of the Coal Division of the Bureau of Mines.

Mining Methods and Practices

Coal Strip Mining

The shortage of underground miners and the fact that more tonnage of coal can be produced per man by strip mining have stimulated increased activity in strip mining. Increased production of coal from strip mines in Kentucky, Maryland, Pennsylvania, and West Virginia has resulted largely from stripping operations in marginal deposits adjacent to outcrops in mountainous localities. Usually the reserves in these deposits are small and contractors' light equipment, such as tractor-scrapers and bulldozers, because of the comparatively small investment, is used instead of heavy equipment to remove the overburden in these areas. To determine the practicability of the methods in use and the economic limitations of this light equipment, studies were made of these operations. The studies are not yet complete and will be continued.

18/ Julihn, C. E., and Moon, L. B., Summary of Bureau of Mines Exploration Projects on Deposits of Raw Material Resources for Steel Production: Rept. of Investigations 3801, 1945, 35 pp., esp. pp. 33-35.

19/ Apell, G. A., Moose Creek District of Matanuska Coal Fields, Alaska: Bureau of Mines Rept. of Investigations 3784, 1944, 36 pp.

Hazards of Strip Mining

The rapid increase in the quantity of coal being mined by stripping methods has brought to attention the hazards connected with this type of mining. An important hazard exists in blasting in strippings adjacent to underground workings from the chance of carbon monoxide being drawn in. Where such conditions exist, blasting should be done only when all men are out of the workings and a thorough test should be made for dangerous gases underground before workers reenter.[20] Examples of the entrance of blasting gases into mines under these conditions are given, with the precautions instituted when the danger was recognized.

Mechanical Mining of Anthracite

To assist the anthracite industry to meet wartime demands for anthracite with a fixed manpower, investigations were made to increase the daily production per underground worker by two means: (1) Use of mechanical equipment and (2) application of mining methods previously untried in anthracite mining. Shortage of manpower, which has prevented the development of gangways in steeply pitching beds rapidly enough to provide sufficient working breasts, was relieved by a combination of a scraper slide with a shaker conveyor. This equipment enabled a complete cut of coal to be loaded by the conveyor into cars "spotted" on the track by a small winch without the usual transportation delays incident to normal loading practices. The company using this system believes that production can be increased appreciably, and contracts for making and testing the needed equipment were placed with manufacturers.

The traditional method of mining thick, steeply pitching anthracite beds by driving breasts straight up the pitch and back slicing fails to lend itself to increased output, (1) because only one cut per shift can be taken from the breasts and (2) because the usual recovery of pillar coal seldom exceeds 40 percent of the total coal left in the pillars. The first weakness was attacked by driving slant chutes in the bed at an angle of 30° with the horizontal and by cutting the coal mechanically. This 30° angle provides a less hazardous and more easily traveled floor on which the miner will work than the steeper angles, often as great as 85°. Moreover, the fact that the coal is cut requires less time for its removal and leaves more solid coal faces, thus increasing safety. The second weakness - the low extraction of pillar coal - was attacked by working the back ends of the pillars in a line advancing along the strike of the bed and by following this robbing line with backfill to support the walls and minimize rock falls. The largest anthracite reserves are found in thin, steeply pitching beds. Mechanical mining of this coal to increase production is being studied.

Realization of above-discussed objectives of mechanized mining will allow operators to produce anthracite more cheaply without reducing wages and thus enable them to be in a more advantageous position to market their product

20/ Forbes, J. J., and Weaver, H. J., Blasting Hazards in Strip Mines Adjacent to Underground Workings: Bureau of Mines Inf. Circ. 7296, 1944, 5 pp.

competitively. These improved practices will strengthen the economy of the anthracite industry and increse the living standards of the entire anthracite region.

Flood Prevention in Anthracite Mines

The flooding of active anthracite mines in certain areas of Pennsylvania is a constant menace to life and property, threatening to curtail the life of the anthracite industry and to decrease the present production of anthracite. This encroachment of mine water comes directly from the surface or from infiltration through inadequate barriers between active and abandoned mine workings. To obtain factual information on the many complexities of the anthracite mine-flood problem that will aid in minimizing the threat and disastrous consequences of a sudden inrush of water from nearby surface streams or from adjacent flooded abandoned mines, the Bureau of Mines conducted inquiries, made scientific and technologic investigations, and participated in the construction of mine flood-prevention projects. Recommendations on the projects completed were given to industry.

Permissibility Schedule for Diesel Mine Locomotives

Information obtained in studies of the hazards of operating Diesel engines in confined spaces was used in preparing a permissibility schedule for Diesel mine locomotives.[21] This schedule gives detailed information on the requirements that must be met by a permissible Diesel mine locomotive. A locomotive designed to meet these requirements can be submitted to the Bureau of Mines for tests, and if it meets all requirements and passes all tests it will be approved for underground use in coal mines or other confined spaces. Development of such locomotives has been retarded by the war because the facilities of locomotive and engine manufacturers were utilized full time in producing equipment for the armed forces. Nevertheless, interest in this development has continued as indicated by numerous requests for information from these manufacturers and from mining engineers. It is believed, therefore, that the development of permissible Diesel mine locomotives will proceed rapidly when the necessary production facilities become available.

Effect of Pressure on Exhaust Gases from Diesel Engines

Studies were completed on the effect of barometric pressure on the composition of exhaust gases from Diesel engines. Test conditions and results with one engine (engine B) were reported.[22] Similar tests were made during the fiscal year 1945 on two other engines (A and C). The results of these tests agreed with the previous data, which showed that the production of toxic exhaust gases at a given fuel:air ratio was not affected significantly by

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21/ Bureau of Mines, Procedure for Testing Diesel Mine Locomotive for Permissibility and Recommendations on the Use of Diesel Locomotives Underground: Sched. 22, approved September 2, 1944, 31 pp.

22/ Huff, W. J., Studies of Explosives and Explosions Fiscal Year 1944: Bureau of Mines Rept. of Investigations 3794, 1945, 35 pp., esp. pp. 20-21.

barometric pressure. However, it must be remembered that reduction in barometric pressure increases the fuel:air ratio at a given throttle setting or at a given rate of fuel consumption. Since, at the higher fuel:air ratios, the concentration of carbon monoxide increases markedly as the fuel:air ratio increases, it is necessary to limit the maximum quantity of fuel supplied to the engine to prevent production of dangerous quantitites of carbon monoxide at the lower barometric pressures.

The engine in a permissible Diesel mine locomotive will be equipped with a flame protective device and air cleaner in the intake system and with a flame protective device and exhaust-gas cooler in the exhaust system. Consequently, when the engine is operating there will be a pressure drop across any unit that offers resistance to flow of gas through it. If this pressure drop is excessive, combustion in the engine may be affected adversely, and production of toxic gases may increase. Studies were made with engines A and C of the effect on exhaust-gas composition (1) of reduced pressure in the intake system when the pressure in the exhaust system was held constant and (2) of back pressure in the exhaust system when the pressure in the intake system was held constant. Variations of concentration of carbon monoxide with fuel: air ratio at different reduced pressures and with fuel consumption were determined. The results showed that hazardous increases in carbon monoxide may occur from restrictions in the systems and attendant reduced absolute pressures in the intake manifold or excessive increased absolute pressures in the exhaust manifold. Removal and cleaning of the protective devices in the intake and exhaust systems to keep the engine in proper condition were recommended.

Relationship of Safety and Efficiency in Coal Mining

Accident records have an important bearing on the determination of the most effective methods for preventing accidents at coal mines and, hence, on the cost and rate of production. Analysis and interpretation of statistical data reveal the prevalent types of accidents and their causes, either on a national or local basis, and provide information necessary for accident-prevention work.[23] Data are given for the number of accidents from different causes in bituminous-coal mines, and trends of frequency or severity rates are discussed.

Roof Control

The greatest number of accidents from any cause in the bituminous-coal mines of the United States occur from falls of roof and coal; about half of all the fatalities and more than one-fourth of all the nonfatal injuries result from this cause. Control of mine roof has been a major study of the Bureau of Mines since its inception, and the information obtained established that many of these injuries are avoidable, if proper precautionary measures

23/ Bureau of Mines, Accident Statistics as an Aid to Prevention of Accidents in Bituminous-Coal Mines. Coal-Mine Accident-Prevention Course - Section 1: Miners' Circ. 47, 1945, 40 pp.

are taken. About four-fifths of these accidents result from some human failure.[24] Physical factors that affect falls of roof and coal are pointed out, and methods of overcoming or controlling these conditions are described. Safety instructions and supervision are treated as essentials, in addition to the proper methods of supporting mine roof. Methods of roof testing with recommended implements for testing and methods of mining and other underground activities affecting roof control are described.

Haulage Accidents

Accident records compiled by the Bureau show that about one-fifth of all lost-time injuries, fatal and nonfatal, are the result of accidents in transportation; they are exceeded only by accidents from falls of roof and coal. The upward trend of the number of injuries from haulage indicates that the increased application of mechanical loading devices and the speed-up in haulage to maintain production have not been accompanied, in many instances, by necessary improvements in haulage installations and maintenance. Haulage accidents are serious from the standpoint of safety and are costly economically. Haulage equipment everywhere in the mine should be handled solely by experienced haulage employees.[25] Various types of equipment with their unsafe aspects are discussed and methods for correction are suggested. Recommendations are included for the avoidance of human, mechanical, and physical failures in connection with bituminous-coal mine haulage.

Coal-Mine Hoisting

A uniform hoisting-signal code for coal and other mines that hoist from only one level has not been adopted by the coal-mining industry, and only a few States have promulgated adequate laws or regulations governing hoisting-signal codes. Accidents to men and property have been caused by confusion in meaning of signals used by men moving from one mine to another. Reliable mechanical and electrical signaling devices have been developed, and some attention has been given to the formation of safety rules. A uniform hoisting-signal code is suggested that might be adopted by the various coal-mining States and the coal-mining industry.[26]

Mining laws of coal-producing States differ widely with respect to safety catches on mine cages, and requirements for testing are generally indefinite in scope. To determine the effectiveness of safety catches, tests should be made under conditions similar to those existing when men are being handled.[27]

24/ Bureau of Mines, Prevention of Accidents from Falls of Roof and Coal. Coal-Mine Accident-Prevention Course - Section 2: Miners' Circ. 48, 1945, 114 pp.

25/ Bureau of Mines, Prevention of Haulage Accidents. Coal-Mine Accident-Prevention Course - Section 3.: Miners' Circ. 49, 1946, 58 pp.

26/ Harrington, D., and East, J. H., Jr., Suggested Hoisting-Signal Code for Slope Coal Mines and for Shaft Mines Having Only One Level: Bureau of Mines Inf. Circ. 7291, 1944, 9 pp.

27/ Sloman, H. J., Testing Safety Catches on Mine Cages at Some Eastern Bituminous Coal Mines: Bureau of Mines Inf. Circ. 7290, 1944, 20 pp.

Recommended methods of testing are described and their relative effectiveness is discussed.

Inspection Standards for Bituminous-Coal and Lignite Mines

To assist Federal coal-mine inspectors in their duties and to provide concise information to those in industry who are concerned with coal-mine safety, the numerous safety recommendations made by the Bureau of Mines relating to tentative bituminous- and lignite-mine inspection standards were summarized in one publication.28/ Numerous excerpts are included from Federal, State, and private publications relating to meritorious mining laws of several States, and to the experiences and writings of Bureau engineers, of other agencies, and of individuals. An extensive bibliography is given to enable Federal inspectors and other interested readers to find more detailed information on particular subjects.

The latest revision of inspection standards or recommendations for use in Federal inspection of bituminous-coal and lignite mines has been compiled.29/ These standards incorporate important alterations and additions made since 1943 (Information Circular 7268) because of changes in mining practices and temporary shortages of some safety equipment; several previous standards were found not generally applicable and have accordingly been deleted.

Inspection Standards for Anthracite Mines

Federal inspection of coal mines by the Coal Mine Inspection Division has required formulation of specific safety standards for the guidance of inspectors in making proper recommendations to correlate unsafe practices. Because the methods, practices, and conditions in anthracite mines differ greatly from those in bituminous mines, a different set of standards, based on practices that have been found safest and most practical by underground test and technical research, was prepared.30/ Each standard is explained, where the reason for it is not entirely obvious, and numerous excerpts from Federal, State, and private publications are included. The writings and experiences of authorities in the Bureau of Mines and other agencies are quoted for pertinent reference.

Coal-Mine Explosions and Fires During the Fiscal Year 1944

Although the explosion fatality record showed a considerable improvement over the preceding four fiscal years, 94 deaths resulting from 23 coal-mine explosions were reported for the fiscal year 1944.31/ Notwithstanding a long

28/ Bureau of Mines, Explanation and Justification of Tentative Inspection Standards for Bituminous-Coal Mines and Lignite Mines: Miners' Circ. 45, 1944, 139 pp.

29/ Bureau of Mines, Inspection Standards for Bituminous-Coal and Lignite Mines, Revised July 1945: Inf. Circ. 7333, 1945, 57 pp.

30/ Bureau of Mines, Explanation of Tentative Inspection Standards for Anthracite Mines: Miners' Circ. 46, 1945, 118 pp.

31/ Harrington, D., and Fene, W. J., Coal-Mine Explosions and Coal and Metal-Mine Fires in the United States During the Fiscal Year Ended June 30, 1944: Bureau of Mines Inf. Circ. 7330, 1945, 35 pp.

history of explosions and fires resulting from them, continued use of hazardous procedures in coal mines is revealed by the reports. An epidemic of disastrous mine fires of electrical origin during 1943 and 1944 emphasized the need of improved methods of protecting underground electrical circuits. Committees of mining-electrical engineers, electric manufacturers' representatives, and others are cooperating with the Bureau of Mines in seeking means to solve this problem.

Electrical Hazards of Fires and Explosions

In connection with the prevention of mine fires and explosions and with rescue and recovery work following coal-mine disasters, such as occurred in 1943 and 1944, special investigations were conducted by the Electrical-Mechanical Section of the Safety Division as follows: (1) Experiments to devise a means of communication with men trapped in a mine; (2) tests of flame-resisting qualities of trailing cables used with portable equipment in mines; (3) experiments to determine cause of explosions in enclosures for electric parts on approved machines in mines; and (4) tests of gas-ignition hazard connected with automatic controls for mine pumps. In 1943 and 1944 more than 40 serious fires occurred in the coal mines of the United States, and over 100 lives were lost in fires of electrical origin chargeable to the trolley-haulage system. Bare trolley wires and the entire trolley-haulage system are outstanding sources of electric arcs and sparks; but this equipment, which is efficient, even though hazardous, cannot be discarded at once and replaced by other equipment. Available equipment, therefore, must be carefully installed and maintained, and safely operated to minimize losses of life and property.32/ Other modes of transportation that will allow bare trolley wires to be eliminated are discussed, and suggestions are given for minimizing the hazards of arcs and sparks from trolley-wire systems. The ultimate solution of the basic problem is not immediately obvious and the cooperation of the industry and the Bureau of Mines must be continued to that end.

Fuel for Flame-Safety Lamps

Satisfactory operation of a flame-safety lamp depends upon the kind of fuel used as well as the design and the assembly of the lamp. Trouble experienced in operating permissible flame-safety lamps at mines is due to the common use as fuel of motor gasolines, none of which are suitable in these lamps.33/ Recommended fuels are listed with information as to where they may be procured.

Procedure for Investigating Explosion-Proof Mine Equipment

The arrangements and specifications under which tests are made for Bureau approval of electrical equipment used in gassy mines are modified from

32/ Griffith, F. E., Gleim, E. J., Artz, R. T., and Harrington, D., Prevention of Fires Caused by Electric Arcs and Sparks from Trolley Wires: Bureau of Mines Inf. Circ. 7302, 1944, 10 pp.
33/ Hooker, A. B., and Coggeshall, E. J., Fuel for Permissible Flame Safety Lamps (A Revision of Investigations 3389, 1938, 5 pp.): Bureau of Mines Inf. Circ. 7301, 1945, 6 pp.