EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. Environmental Protection Agency, have been grouped into series. These broad categories were established to facilitate further development and application of environmental technology. Elimination of traditional grouping was consciously planned to foster technology transfer and maximum interface in related fields. This series describes research performed to develop and demonstrate instrumentation, equipment and methodology to repair or prevent environmental degradation from point and non-point sources of pollution. This work provides the new or improved technology required for the control and treatment of pollution sources to meet environmental quality standards. This document is available to the public for sale through the National Technical Information Service, Springfield, Virginia. Detailed information is presented for coal occurrence, production, composition, and physical and chemical properties. Discussions and economic analyses are given as to the available mining techniques and transportation modes to bring these vast coal reserves to large fuel combustion markets. The effects of western coal properties on combustion equipment operation and emissions to the atmosphere are evaluated. The overall impact of increased western coal production on the environment is also analyzed and recommendations are made for further investigation of problematic areas. Conclusions and Recommendations 1 2. Western Coal Utilization 13 3. The western states considered in this report and having the greatest amount of demonstrated coal reserves in decreasing order of tonnage are: The lowest rank coal, lignite, is generally found in western North Dakota and part of eastern Montana. The highest rank surface coal is found in the Southwest portions of Arizona and New Mexico. The highest rank underground coal occurs in Utah and Colorado. Coal mining operations in the West are mechanized to a high degree due to the shortage of skilled labor. The operations are also very large and efficient and usually exceed U. Typical mining operations in the West use either underground or surface mining methods. Horizontal auger mining is less common but is gaining acceptance because it can recover the large amounts of coal left in strip mine high walls. Underground or deep mining is used in the West to extract the higher quality bituminous coals such as those used in coke manufacturing. The production of underground mines is executed in one of two ways: Of the two basic methods of surface mining practiced in the U. Area mining is the major strip mining method used on western coal lands. Flat open pits developed may range feet wide and 1 mile long. Underground coal mining costs usually center around labor issues because of the large number of persons required. Relatively large capital costs of underground pit development is eliminated by strip mining. Despite the high cost per ton of underground coal, the underground mines can be competitive with strip mines on a cost per Btu basis. Presently, the large transportation costs to deliver western coals to the major market areas are offset at the mine by low overburden-to-coal ratio. The mining becomes impractical technically if the overburden thickness is more than about feet. This precludes strip mining from a major role in the ultimate recovery of American coal. In the long range the re-emergence of underground mining methods may be expected. Significant factors inhibiting the development of new western coal mines today are legislative uncertainties, high cost of meeting stringent reclamation requirements, new mining equipment availability, long haul transportation economics, skilled manpower shortage, lack of new mining technology utilization, and high capital investment. A total of coal mines produced nearly 58 million tons of bituminous, sub-bituminous and lignite coals marketed in the West in Eighty-two percent of this production came from surface mines. Wyoming is the leading state in the western coal production followed by Montana and New Mexico. Almost 14 million tons were produced in the state of Wyoming in Montana produced almost 10 million and New
Mexico produced over 9 million tons in the same year. The western states coal production estimates indicate that the production will increase about 8. The scarcity of water in most portions of the West dictates that ground water be used to provide water for coal mining and transporting. The Westwide Water Study conducted by the Department of the Interior promises to generate a detailed information plan on future water requirements in the West. Considering overall ranges for coal properties, the western coals are in the medium range of volatile matter, in the lower range for fixed carbon, in the higher range for moisture content, in the lower range for caloric values, and the lower range of sulfur content. Western coal deposits contain coals with low as well as high ash contents. Comparison of ash compositions in western coals and eastern coals reveal that low sulfur-containing western coals are also low in iron. However, generally higher S03 content in the ash is observed with western coals Refer to Table. The western coals are also 2 to 4 times higher in average calcium and magnesium, and 2 to 8 times lower in average potassium content. Sodium content does not seem to follow any particular trend, with the exception of North Dakota and Montana coals which have relatively high sodium content of 4. Total trace element content in western coals is nearly the same as in other coals of the United States, but the distribution of each element differ. Cadmium and selenium are indigenous only to western coals. Rail methods comprising unit trains and common carriers are currently the prime movers of western coal. Rail rates up to 4. The coal slurry pipeline is a proven coal transport method. Additional pipeline projects are currently under study. In most instances firing western coals in these boilers designed for eastern or midwestern coals would result in an increased carbon loss. Some derating of the boiler capacity would also be needed for units presently operating at full capacity. Comparison of operation attributes rated the three most widely used stokers in the following descending order: spreader, chain and traveling grate, underfeed. The traveling grate type was preferred over the agitating grate type for all three stokers. Only water-tube boilers are used above this capacity. Boiler fouling rate increases rapidly with increasing sodium content of ash at low sodium contents. High calcium contents reduce the effect of sodium on the deposition mechanism. No effect on boiler fouling rate was observed with changes in the fuel moisture content and the percentage of excess air. Corrosion of the boiler tubes on the fire side is not fully understood, but several chemical reaction mechanisms have been proposed. Existing coal feeding mechanisms designed for more dense and higher quality coal were the reasons for this reduction. High coal moisture content will also reduce boiler efficiency. The fractions of state land areas that may potentially be disturbed by coal mining in the western states are generally orders of magnitude smaller than the fractions observed in non-western states. Pull reclamation of land in strip mined areas of the West is expensive and has been practiced to some extent with mixed success. Most serious problems include backfill of huge mined-out pits, topsoil replacement, and revegetation in these semi-arid and arid regions. Longwall stripping is a promising new surface mining concept resulting in minimum damage of the environment and the soil surface. Hazardous emissions of the particulates accompany coal mining operations. Additional airborne particulates and noxious gases are emitted from wind erosion and self-igniting refuse piles. Presently, these emissions are not well documented and technology for their control is not generally available. There is insufficient information to assess the effect of western coal trace element composition on the environment. Additional work to investigate the form and fate of these elements in the environment as well as their hazard potential is urgently needed. The low-sulfur emissions characteristics of western coals are penalized by their lower heating values. That is, more western coal must be burned to maintain the same boiler heat rate obtained with non-western coal. However, available data indicate that low-sulfur western coal burning plants in the small and intermediate boiler size range examined generally meet the Federal S02 regulation. None of the non-western coal burning plants examined which burned high-sulfur high heating value coals met the S02 emission regulation. As coal sulfur content decreases increased sulfur retention in the coal ash becomes important in reducing SO emissions. This is in part due to the higher alkalinity of western coal ash. Whether or not a specific coal meets the S02 emission standard depends on coal heating value, coal ash content, coal sulfur content and the previously mentioned sulfur content of the ash after combustion. A relationship comprised of the above variables which could be used to define the minimum
sulfur retention in the coal ash in order for the coal to meet the sulfur emission standard is proposed for verification. Vast reserves of coal with large portions containing permissible sulfur levels occur in western parts of the United States. These coal deposits are often easily accessible and subject to strip mining, but usually have low heat content, and high ash and water contents. Other properties such as ash fusion temperature, trace element contents and Hardgrove grindability index also have important effects on combustion processes, efficiency of combustion equipment, and properties of combustion gases emitted to the atmosphere. In order to better define the technical, economic, and environmental problems that may arise should an extensive utilization of western coal reserves occur, the Environmental Protection Agency contracted with Monsanto Research Corporation to conduct this study. The objectives of the study were to summarize present experience in the combustion of western coals, catalog their occurrence and properties, and identify potential problematic areas in bringing these coals to large markets. This report documents the results of the study. After the summary of findings and recommendations in the previous section, the report presents data on utilization of western coal in Section 3- This section includes information on western coal reserves and resources, mining technology, production and consumption, composition, factors influencing mining, and transportation. Section 4 evaluates western coal combustion and Section 5 presents information on the environmental effects associated with western coal mining and combustion. The following nine western states are not considered important for fundamental coal development due to a lack of resources, high sulfur content, or uneconomical distance of hauling to midwestern markets: Alaska Nebraska California Nevada Idaho Oklahoma Kansas Texas Missouri 13 Table 1 gives some indication of the relative merits of the considered states from a low sulfur standpoint. The arrows on Table 1 point to the ten states included in the study. A majority of sub-bituminous coal and lignite with 0. Figure 1 shows the major coal regions of the western states. The nomenclature of these coal regions is defined in Figure 2. Table 2 shows that over billion tons of potentially minable coal occur in the ten western states considered in this report. Of this quantity, 87 billion tons are considered surface minable and billion tons are considered minable by underground methods. The state-by-state ranking in decreasing order of demonstrated reserve tonnage in millions of short tons is as follows:


North Carolina December U. Environmental Protection Agency to report technical data of interest to a limited number of readers. Environmental Protection Agency, and approved for publication. Revisions will be accomplished through the issuance of AEROS Manual Updates, which may contain one or more separate revisions to a given volume. Responsibility for technical aspects of revisions is held by the groups in NADB responsible for the relevant system or operation, while compilation of revisions into Updates, and reproduction and distribution are overseen by the AEROS Manual Project Officer, Requests and Information Section. These recipients are responsible for reviewing each Update and inserting it in the appropriate Volume and removing outdated portions as directed. They should also notify persons in their organizations to whom specific revisions may be of importance, and provide copies of revisions to those persons requiring them. Three distinct types of revisions are foreseen: Urgent, Priority and Routine. Urgent revisions must be issued and entered into Manual Volumes as soon as possible to prevent adverse affects on operations. These drafts should be filed in the appropriate Manual Volumes immediately preceeding the portions to be replaced, pending issuance of the formal Update. Due to the importance of their timeliness, Urgent revisions will be issued by RIS as soon as complete, in Urgent Updates which will include any other revisions awaiting distribution at that time. It will also include a summary of dates and numbers of previous Updates to the subject Volume, for verification of currency of the Volume. Upon receipt of an Update, the changes should be made as indicated on the Update Notice and the Notice itself initialed and filed in Section 0, Chapter 2. Volume ,", is available to users by request: Any questions on the appropriate source of technical information and any questions, comments, or suggestions on the coverage, organization, and other such aspects of this Volume should be directed to: To improve the preparation, collection, storage, and utilization of this data, standardized codes must be used to store this data. The purpose of Volume V is to provide a complete compilation of codes required to prepare data for storage in A. Utilization of the codes in this volume and of the standardized methods and procedures in Volume II is extremely important to minimize data coding errors. The codes are also helpful to interpret the data from standard reports, which are explained in Volume III. Sections of this document have been arranged in a format that permits easy and convenient replacement of material as information concerning AEPDS is published and distributed. To speed dissemination of AEROS information, sections that contain new data will be issued - separate from the parent report - whenever they are revised. To facilitate the addition of future materials, the punched, looseleaf format was selected. This approach permits the document to be placed in a three-ring binder or to be secured by rings, rivets, or other fasteners; future supplements or revisions can then be easily inserted. The upper right-hand corner of each page of the document bears a notation that indicates the date the information was issued. Future supplements or revisions will be distributed in the same manner as this parent document. The codes contained in this volume are sufficient to enable the user to deal competently with normal AEROS data input preparation. Any questions which may arise on the codes or requests for new codes should be addressed to: T 5C 31C33 51C33 C3io: