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4967-F

THE IMPACT OF OVERMINING AND UNDERMINING ON THE EASTERN UNDERGROUND COAL RESERVE BASE

Prepared For: *United States Department of the Interior*
Bureau of Mines
Eastern Field Operation Center
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FINAL REPORT

Contract No. JO-357129

30 SEPTEMBER 1976

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BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No.

4. Title and Subtitle

THE IMPACT OF OVERMINING AND UNDERMINING ON THE EASTERN UNDERGROUND COAL RESERVE BASE

5. Report Date **30 June 1976**

6.

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8. Performing Organization Rept. No. **4967-F**

9. Performing Organization Name and Address

HRB-SINGER, INC.
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STATE COLLEGE, PA. 16801

10. Project/Task/Work Unit No.

11. Contract/Grant No.

J0357129

12. Sponsoring Organization Name and Address
U. S. BUREAU OF MINES
BRANCH OF CONTRACTS AND GRANTS
INTERIOR BUILDING
WASHINGTON, D. C. 20240

13. Type of Report & Period Covered
FINAL REPORT
1 JULY 1975 — 31 JULY 1976

14.

15. Supplementary Notes

ADDITIONAL VOLUME ENTITLED: USER'S MANUAL FOR THE COAL LOSS CALCULATION MODEL COMPUTER PROGRAM

16. Abstracts

This study undertook the development and implementation of a methodology for estimating the impact of coal seam interaction on the eastern bituminous underground reserve base as published in USBM Information Circular 8655. The effects of previous mining in multiple coal seam areas on currently mined and reserve seams are predicted as a percentage coal loss by an engineering assessment model called the Coal Loss Calculation Model. The model utilizes twelve input variables easily derivable from mine maps or other existing data sources and calculates the effects of subsidence and high-stress due to remnant pillars in the previously mined seam.

Extensive literature review resulted in the identification, definition, and quantification of the critical variables of seam interaction. Expert opinion surveys were made of mining experts, MESA mine inspectors, and coal mine operators. Statistical analysis was used to establish the redundancy of the critical variables and to develop a total coal loss prediction algorithm. A regional analysis resulted in the production of a series of thematic maps on coal characteristics and distribution. A derivative map showing the areas of commonality within the eastern bituminous coal region served as the basis for implementation of the coal loss calculation model. The model was developed and tested using data from four coal mines in western Pennsylvania and southern West Virginia.

17. Key Words and Document Analysis. 17a. Descriptors

SEAM INTERACTION, SUBSIDENCE, HIGH STRESS ZONE, MULTIPLE SEAM MINING, COAL RESERVE BASE, UNDERMINING, OVERMINING, COAL LOSS PREDICTION, BITUMINOUS COAL, MODELING

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 314
	20. Security Class (This Page) UNCLASSIFIED	22. Price

FOREWORD

This report was prepared by HRB-Singer, Inc., of State College, Pennsylvania under USBM Contract Number J0-357129. The contract was initiated under the 30 U.S.C.3 Act.

It was administered under the technical direction of the Eastern Field Operation Center, with Mr. Frank Doyle acting as the Technical Project Officer. Ms. Elizabeth Rexroad was the Contract Administrator for the Bureau of Mines.

This report is a summary of the work recently completed as a part of this contract during the period 1 July 1975 to 30 September 1976. This report was submitted by the authors on 30 September 1976.

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I. EXECUTIVE SUMMARY

The 1974 United States Bureau of Mines document "Information Circular 8655 - the Reserve Base of Bituminous Coal and Anthracite for Underground Mining in the Eastern United States" estimates the quantity of coal that is available for mining by underground methods in the eleven principal coal-producing states east of the Mississippi River at 169 billion tons. This represents coal in beds greater than 28 inches in thickness to a maximum depth of 1,000 feet and excludes all coal beds in reliability categories other than measured and indicated. Of the 169 billion tons of mineable coal reserves the U.S.B.M. estimates that only half would be physically recoverable depending upon the method of mining and such factors as (1) coal underlying urban areas; (2) deep-mineable reserves lying beneath airports, parks, recreation areas, public institutions, or major waterways; and (3) coal in areas of active mining where there are multiple coal beds, and beds overlying or underlying worked out beds that are hazardous and expensive to mine.

In an effort to establish the real impact of factor number 3 on recoverability of the coal reserve base, this study was awarded to HRB-Singer, Inc. in June 1975. The main objective was to develop and implement a methodology for estimating the impact of seam interaction in areas of multiple seam mining on the estimated underground bituminous coal reserve base of the eastern United States. To achieve this objective the technical work plan was formulated to direct all efforts to the final development of a coal loss predicting model based on a relatively small number of input variables derivable from existing data or easily derived from readily available empirical data sources.

The technical work plan can best be described as four basic work phases each consisting of a number of specific and related tasks:

- Phase I - Critical Variable Identification and Definition
- Phase II - Definition of the Study Area and Data Collection
- Phase III - Statistical Analysis
- Phase IV - Engineering Modeling

Both phases I and II eventually led to the establishment of a mine specific data base which provided the main input data for both Phase III and IV.

Critical Variable Identification and Definition consisted of a thorough review of the existing literature on seam interaction and subsidence from which the physical variables affecting adjacent seams were identified. Data sources were investigated in United States and Canadian libraries and a visit was made to the British National Coal Board in London to conduct a literature search and to consult with British coal mining experts. Following identification of variables of seam interaction, the critical variables were defined based on state-of-the-art knowledge and the opinions of seven mining experts in the Appalachian Region. A final list of twelve basic input variables was derived from which all critical calculations, such as subsidence and pillar strength, could be made. These twelve variables are:

1. Roof strength of currently mined seam.
2. Floor strength of currently mined seam.
3. Previously mined seam thickness.
4. Percent extraction in the previously mined seam.
5. Roof strength of the previously mined seam.
6. Floor strength of the previously mined seam.
7. Minimum pillar width in the previously mined seam.
8. Maximum width or span in the previously mined seam.
9. Distance between the seams.
10. Depth of the previously mined seam.
11. Time between mining.
12. Remnant pillar pattern.

The Definition of the Study Area and Data Collection Phase began with a regional analysis that produced eleven topical maps on the distribution and characteristics of the eastern underground coal reserve base. The main product was a derivative map showing "Areas of Commonality" based on coal characteristics and tectonic setting. The Areas of Commonality were then used to define the extent of the study area and to select six MESA district offices to interview for regional information and for candidate multiseam mines operating in their districts. Following these interviews specific mine operations were selected for preliminary interviews prior to selection of four mines for detailed data collection. Prior to mine specific data collection, the twelve input variables developed in Phase I were pre-tested in a Pennsylvania mine as a training exercise. As a result of this exercise, the problems associated with data collection were worked out and a data collection technique finalized.

Mine specific data collection followed for two mines experiencing previous undermining and for two mines experiencing previous overmining. One overmined situation was located in McDowell county, West Virginia and the three other mines in Cambria and Somerset counties, Pennsylvania.

Two parallel modeling efforts made use of the mine specific data and proceeded along completely independent lines. In Phase III a statistical analysis was run on the mine specific data to determine the validity of the variables. A principal components analysis grouped redundant variables, and factor loadings showed which variables were most significant. A multiple regression analysis was run to establish coefficients in a model using total extraction or total coal loss in the currently mined seam as the dependant variable.

In Phase IV an engineering assessment model was developed to predict the specific coal loss due to seam interaction. This was done based on the application of the twelve input variables into a model based on the state-of-the-art knowledge in the prediction of the ranges of the critical variables and their interaction in causing coal loss through subsidence and high stress. In comparing the variables used in this model to the results of the statistical principal components analysis it was shown that all variables were significant.

The engineering assessment model was called the coal loss calculation model (CLCM) and predicted coal losses of 16, 9, 8, and 7 percent for the four mines tested.

In order to validate the results of the coal loss calculation model, a comparison was made between the percentage extraction being achieved in a currently mined seam where previous mining in an adjacent seam existed, and the percentage extraction in the same currently mined seam where no previous mining had occurred in the same adjacent seam. This would theoretically give the coal loss due to the effects of the previous mining, all other factors being equal. In the first three mines which were used for model development, the estimated percentage extraction achieved by the mine operators was used in comparison to the CLCM predicted coal loss. This was done because the measured data was biased in that sampling was intentionally done in areas experiencing coal loss. The variation experienced between the two values was -1.6%, -1.4%, and +0.3%. In the fourth or validation mine, sampling was completely random and the variation between the measured value and the CLCM predicted value was -1.1%.

On the basis of the above results it is felt that the model is operating correctly, is perhaps consistently low in its coal loss predictions, and approximates the actual experienced coal loss. The model is useful in predicting on a seam-by-seam basis the losses to be expected from seam interaction. The model uses mine specific data but can be extended to predict on the county level. The model may be extendable to the sub-region level based on the Areas of Commonality distribution. Estimations above this level can only be generalizations. Caution is given that the model can only be exercised accurately when both seams being considered are present and the basic input variables are essentially the same.

II. BACKGROUND AND OBJECTIVES

A. BACKGROUND

The Department of Interior, U.S. Bureau of Mines is responsible for the appraisal of the quantity, quality, and distribution of the Nation's coal reserves. Historically, the state geologic surveys have provided the Bureau of Mines with the original estimates on the quantity and quality of coal for each state. This has led to the use of a variety of criteria which have resulted in wide discrepancies in tonnage values. Circular 8655, "The Reserve Base of Bituminous Coal and Anthracite for Underground Mining in the Eastern United States," was intended to partially solve the problems associated with estimating coal reserves by establishing uniform criteria.

Because of the importance of coal in providing near term solutions to the Nation's goal of achieving energy independence, accurate estimates of coal reserves are essential to the national welfare. Several factors impact on the planning associated with the use of the coal reserves. Coal quality, because of the air pollution standards established by the Clean Air Act of 1970, certainly impacts on the useable coal. Conflicting land use is still another factor which impacts on useable coal reserve estimates. Finally, portions of coal beds may not be mineable or may have a reduced percentage of extractable coal because they overlie or underlie mined-out coal beds. This latter consideration referred to as seam interaction as a result of multiple seam mining is the subject of this study.

The problems associated with multiple-seam mining are manifold and are generally described in terms of undermining,* overmining,** or a combination of the two. Both types of mining can result in a significant impact on coal reserve estimates.

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* Undermining - Extracting the underseam after the upper seam has been mined.

**Overmining - Extracting the upper seam after the underseam has been mined.

Historically, the selection of seam sequence in mining has been on the basis of optimizing the return on investment. For example, in southwest Pennsylvania, the Pittsburgh seam is the primary or pivot seam that has been mined. Recently, overmining operations in the Sewickley seam have begun. On the other hand, undermining operations are also being initiated by moving from the Pittsburgh to the underlying Freeport seam. In both cases the question of seam sequence was predicated on the extraction of the commerical seam first. The potential therefore exists for a major impact on the underground bituminous coal reserve base of eastern United States due to the effects of seam interaction.

B. OBJECTIVES AND SCOPE

The main objective of this study was to develop a methodology for estimating the impact of seam interaction in areas of multiple seam mining on the estimated underground bituminous coal reserve base of eastern United States as reported in United States Bureau of Mines Information Circular 8655.

Upon the development of such a methodology, the secondary objectives were to apply and to test what can be described as a coal loss predicting model in actual mine situations in Pennsylvania and West Virginia and to then document the results and recommendations into a final technical report and user's manual.

The scope of the study included:

1. A determination of the type and extent of problems associated with mining over and/or under a previously mined seam. This included the identification and definition of the critical variables and a regional analysis to define areas of commonality for physical variable data collection.
2. The development of methodology for predicting the effects of seam interaction on the coal reserve base estimates in terms of percentage coal loss. This included a statistical analysis to determine the validity of the physical variables used in an engineering assessment model and the implementation of the model using actual mine data.
3. An assessment of the utility of the engineering assessment model in predicting the impact on coal loss and the potential impact of undermining and overmining on the entire coal reserve base.

III. OVERVIEW OF THE TECHNICAL APPROACH

To ensure the satisfaction of the project objectives in an orderly and cost-effective manner, the initial proposal was expanded and after appropriate revision was used as the project implementation plan. Because the project work flow was slightly modified, the technical approach used is presented below and the flow depicted in Figure III-1.

Technically the project may be considered in terms of four basic work phases consisting of specific tasks as outlined below:

PHASE I

The identification of the critical variables of seam interaction and their definition and quantification.

1. A literature review and analysis from United States and foreign sources to identify the state-of-the-art knowledge on seam interaction.

2. The establishment of the relevance of the physical variables identified with seam interaction, selecting those that are critical to the performance of a coal loss predicting model, and establishing expert consensus on the critical values or limits under which these variables can be used.

PHASE II

The definition of the study area and the collection of the data needed for the subsequent predictive modeling efforts.

1. A regional analysis to classify the eastern bituminous coal fields into homogeneous regions based on coal characteristics and tectonic setting.

2. The selection of regions for predictive model development based on the physical characteristics of the regions and on information obtained from MESA inspectors through structured interviews.

3. The identification of mines to be used for possible mine specific data collection based on the data obtained from structured interviews of mine personnel.

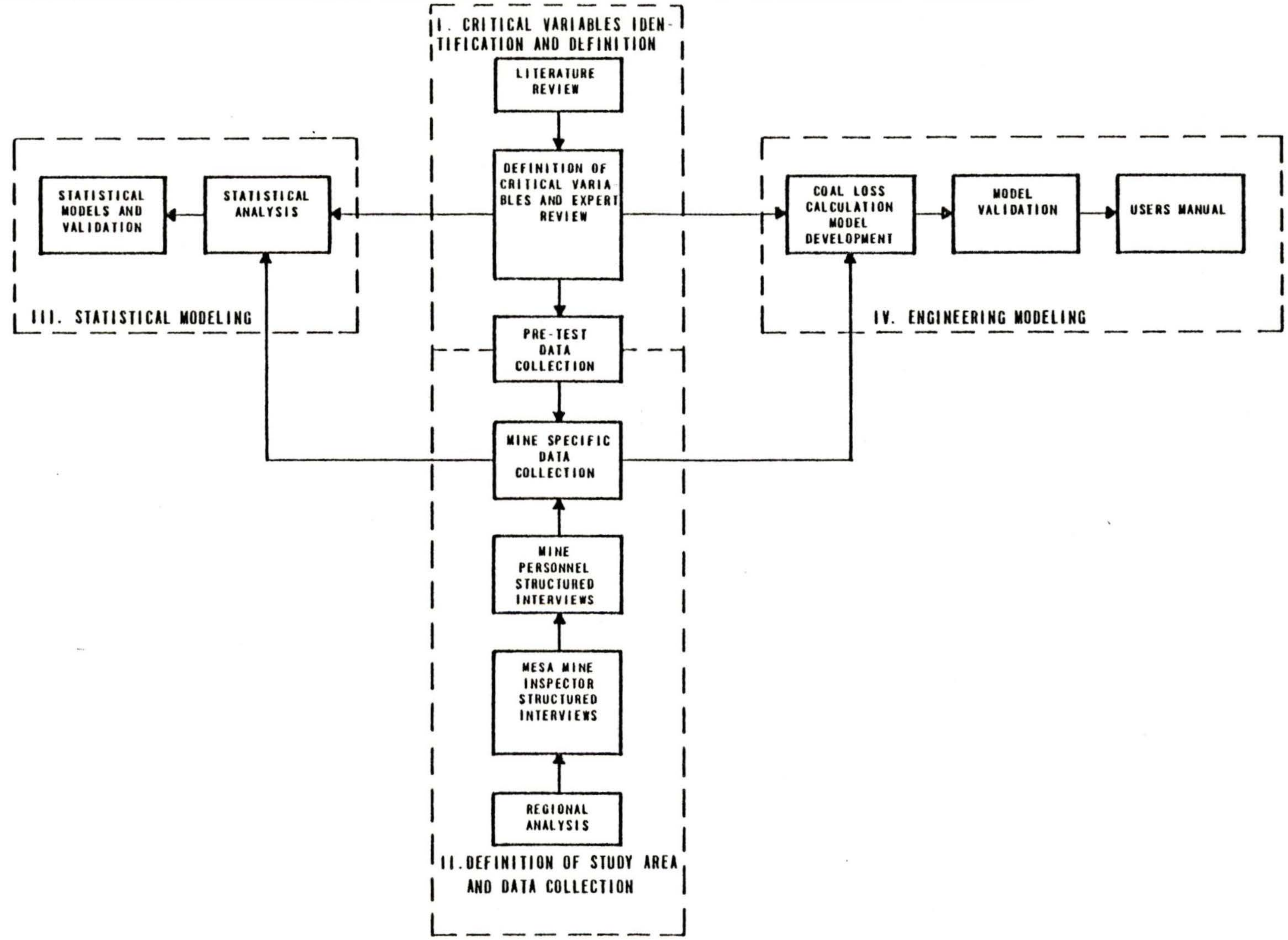

FIG. III-1 OVERVIEW OF THE TECHNICAL APPROACH

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4. A trial run on mine specific data collection to become acquainted with the problems that might arise in this type of data collection and to finalize the data collection process.

5. Mine specific data collection from mine maps and interviews at the mine sites.

PHASE III

A statistical analysis and modeling of the mine specific critical variables to establish the statistical validity of the critical variables identified and to formulate a predictive capability for estimated total coal loss for a given mining operation.

1. A statistical analysis using multivariate techniques to validate the theoretical concepts embodied in the undermining and overmining models using specific empirical mine data. Principal component analysis was used to distinguish redundant variables and factor loadings were calculated to show those of greatest significance.

2. Statistical modeling in the form of multiple regression analysis to establish the coefficients for the equations of coal loss and percentage extraction estimated for the currently mined seam.

PHASE IV

The development of an engineering assessment model to predict coal loss due to the specific effects of seam interaction.

1. The formulation of the basic logic of the model from the results of the state-of-the-art literature review, the definition and quantification of the critical variables of seam interaction, the opinions of experts in the field of multiple seam mining and seam interaction, and the use of geological engineering judgement where lack of reliable data existed.

2. The refinement of the model using the same mine specific data collected for use in the statistical modeling phase.

3. The testing of the model against data from a mine not used in the refinement process.

The products resulting from this study consist of this final technical report and appendices, and a separately bound document entitled User's Manual for the Coal Loss Calculation Model Computer Program.

IV. LITERATURE REVIEW

A. OBJECTIVES AND APPROACH

The objectives of the literature review task were to identify, review and, to a limited extent, analyze all of the important literature concerning the physical variables associated with undermining and overmining. All known literature related to the effects of multiple seam mining on coal extraction was identified and the pertinent titles collected and placed on file at HRB-Singer. The major archives where literature was sought were:

* The National Coal Board, Hobart House, London, England,
* The Pennsylvania State University Library System, including The Earth and Mineral Sciences Library, University Park, Pa.,
* Bituminous Coal Research, Inc., Monroeville, Pa.,
* U.S. Bureau of Mines, Pittsburgh Library, Pittsburgh, Pa.,
* CANMET Library, Ottawa, Canada, and
* HRB-Singer, subsidence research library collection.

To maximize the effectiveness of the literature search while minimizing the time involved to complete it, two parallel activities were conducted simultaneously. While available information was being retrieved from the American sources listed above with the assistance of Mr. Charles Manula, HRB-Singer mining consultant at Penn State, HRB-Singer's resident coal geologist, Dr. Ronald W. Stingelin, spent several days in August 1975 at the British National Coal Board in London to collect literature and to confer with Mr. R. J. Orchard, Chief Surveyor and Minerals Manager for the NCB. By prior arrangement with Mr. W.L.G. Nash, technical editor at Hobart House, a literature search was conducted and all titles pertinent to seam interaction were assembled for review by Dr. Stingelin. Each article of interest was marked by a slip sheet and a file card index was available. Dr. Stingelin reviewed each of the articles and selected those of primary interest for copying. Twenty-seven technical papers were copied and added to the HRB-Singer library.

The major points of information derived from discussions with Mr. R.J. Orchard, Mr. W.L.G. Nash, Mssrs. Allen and Slater, all of the NCB are outlined below.

1. When 100% extraction occurs in the previously mined seam, there are no pressure problems in the currently mined seam.

2. With proper room and pillaring, no subsidence problems should be expected if the distance between the seams is greater than sixty feet. This distance could be less than sixty feet if a massive sandstone roof is present in the previously mined seam to act as a beam.

3. Upper seam mining should be designed to align pillars with those of the previously mined lower seam.

4. In the overmining and undermining situation where 100% extraction has occurred in the previously mined seam, microfracturing is essentially non-existent after 120 feet above or below the previously mined seam.

5. Water problems are the result of microfracturing due to previous mining; therefore 120 feet is regarded as the limit of increased permeability.

6. Previous pillared workings do not appear to have any effect on surface subsidence when mining the second seam.

7. Faulting is the number one inhibition in long wall mining. Faults with displacements greater than the depth of the coal seam can sharply curtail the amount of recoverable coal.

Two publications of the NCB were reviewed during the discussion: (1) Design of Mine Layouts and (2) Subsidence Engineers Handbook. A brief review of the British GEOSYMPLAN approach to deep mining preplanning was also discussed.

Overall the British trip was very successful in providing, early in the study, a thorough discussion on seam interaction from the British viewpoint. British mining practices were contrasted with American techniques and the differences discussed. Although hundreds of titles were reviewed, it is significant that only twenty seven additional papers were of sufficient pertinence to warrant reproduction and inclusion in the HRB-Singer data base. This is partially due to the lack of profuse literature on the specific subject but, more so, to the thorough data collection performed in the United States.

B. RESULTS

A distillation of the American and British literature pertaining to multiple seam mining and subsidence revealed approximately one-hundred and forty articles. Of these, thirty-nine deal most directly with the identification and relative importance of the physical variables operating when a second or third seam is opened over or under the first mined seam. The Bibliography at the end of this report includes two listings entitled "Most Pertinent Articles" and "Other Articles". The two together comprise the articles identified and make up the Bibliography. The code in parenthesis at the end of each entry refers to one of six "summary factors" referred to in each article as follows:

1. Holdings dealing with undermining, overmining, and mine layout.
2. Holdings dealing with roof and pillar strength.
3. Holdings dealing with subsidence.
4. Holdings dealing with gas problems.
5. Holdings dealing with water problems.
6. Holdings dealing with roadway maintenance.

Further definition of the physical variables was carried out in the next task entitled "Definition, Quantification, and Application of Critical Physical Variables."

V. DEFINITION, QUANTIFICATION AND APPLICATION OF CRITICAL PHYSICAL VARIABLES

A. OBJECTIVES AND APPROACH

The purpose of this task was to extract from the literature and other sources, the variables most discussed in seam interaction and to identify as much as possible the range and importance of each. Further, it was to organize these variables into a structure permitting ready application to the models being generated.

B. DEFINITION OF CRITICAL VARIABLES

A series of formats were generated to permit grouping of reports and structuring of the information taken from each piece of literature or other sources such as questionnaire replies. Care was taken in the initial literature review to record the physical variables discussed in order to insure a smooth transition to this task. Those reports dealing most directly with seam interaction were grouped together (39 articles). A review sheet was prepared (Figure V-1) for each title identifying the problem areas discussed, contributing factors, quantities or ranges of values mentioned, whether current mining was over or under the previously mined seam and the comments made. It became apparent early in the task, from both U.S. and British National Coal Board sources, that two distinct groups of studies and reports were available concerning the critical physical variables being sought: (1) reports addressing all deep mining situations and (2) reports addressing problems associated specifically with multiple seam mining. The first group included such topics as roof and pillar strength, subsidence, gas, water, roadway maintenance, etc. To bring the rather voluminous amount of information into a workable size, an index card system was created, coded by topic, and including a brief summary of each article. An initial sort was made to identify those articles dealing specifically with multiple seam mining and those dealing with the topics noted above. Further analysis concentrated on the articles dealing with multiple seam mining.

TITLE: *A Study of Problems Encountered in Multiple Seam Coal Mining in the Eastern U.S.*

ANALYST *Fritz*

AUTHOR: *Stemple (24)*

DATE

SHEET *1* OF *1*

PROBLEM				CONTRIBUTING FACTORS	QUANTITY	CONDITIONS (CMS)		COMMENTS
SUB.	GAS	WATER	OTHER			OM	UM	
X				Distance between seams	>300'	X		No damage beyond 300' if the lower seam was less than 7' or 8' thick.
X				Thickness of previously mined seam	<7'-8' <5'-6'	X		No damage to upper seam if distance is>300. 30'-300', no damage in 5'-6' seam.
X				Distance between seams	<30'	X		Seams must be at least 30' apart.
X				Percent Extraction	100%	X		
		X		Drainage		X		Sometimes drainage problems in upper seam are alleviated by flow into lower seam.
X				Time lapse between mining	5-10 yr.	X		
X				Distance between seams	<100'		X	Weight disturbances can be expected at this distance (overburden >250')
X				Distance between seams	<60'		X	Weight disturbances are certain at this distance (overburden >250')
X				Amount of overburden over previously mined seam	>250'		X	Weight disturbances can occur when the overburden is >250' when the distance between seams is less than 100.'

SAMPLE

FIG. V-1 ARTICLE REVIEW SHEET

For articles addressing overmining, undermining, or mine layout, an extensive analysis to define and quantify the variables relating to coal loss resulted in the tabulation of variable frequency in the reviewed literature (Figure V-2). Fourteen variables constituted the sum total of those discussed in the thirty-nine papers reviewed. An X mark following each variable signifies its presence in a specific paper. This was done early in the analysis in order to arrive as some idea of the relative importance of the variables. This relative importance would be looked at again later in the study with interviews of mining experts and coal mine operators.

A matrix format was then designed to permit more detailed data on each variable to be recorded. Figure V-3 is an example of the format used for this literature summary by variable. The problem(s) addressed, the quantitative values specified, the currently mined seam situation (over or underminiing a previously mined seam), and pertinent comments were identified for each paper reviewed.

C. QUANTIFICATION OF CRITICAL VARIABLES AND EXPERT REVIEW

The major articles reviewed were used to begin a quantification of the variables. Table V-1 is a summary of the variables, comments, and sources. Two of the 14 variables are not included in this table, i.e., "Type of Roof in Previously Mined Seam" and "Gas Emission." No values for these were found in the literature.

A finalized list of critical variables in the multiple seam mining models was prepared for review by a number of selected experts on seam interaction within the eastern bituminous coal fields. The experts were contacted by phone to elicit their cooperation and the review package was then mailed. The cover letter and the finalized list of variables sent to the mining experts are shown in figures V-4 and V-5.

The responses to HRB-Singer's request were good. Much interest was expressed in the seam interaction problem and some additional articles were offered. However, no substantive changes in the list of variables or their relative importance were recommended. Compliments were made on the thoroughness of the literature review and the approach to predictive model development.

VARIABLE	FREQUENCY OF OCCURRENCE IN LITERATURE															
TYPE OF INTERVENING STRATA	X	X	X	X	X	X	X									
METHOD OF EXTRACTION FOR PREVIOUSLY MINED SEAM	X	X	X	X	X	X										
PERCENT EXTRACTION FOR PREVIOUSLY MINED SEAM	X	X	X	X	X	X	X	X								
RESIDUAL COAL PILLARS IN PREVIOUSLY MINED SEAM	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
TYPE OF FLOOR IN CURRENTLY MINED SEAM	X	X	X													
TYPE OF ROOF IN CURRENTLY MINED SEAM	X															
TYPE OF ROOF IN PREVIOUSLY MINED SEAM	X															
DISTANCE BETWEEN SEAMS	X	X	X	X	X	X	X	X	X	X	X	X				
DEPTH OF PREVIOUSLY MINED SEAM	X	X	X													
THICKNESS OF PREVIOUSLY MINED SEAM	X	X	X	X	X	X										
TIME LAPSE BETWEEN MINING TWO SEAMS	X	X	X	X	X	X	X	X								
ORDER OF MINING SEAMS (ASCENDING, DESCENDING)	X	X	X													
WATER DRAINAGE	X	X	X	X												
GAS EMISSION	X	X	X													

FIG. V-2 VARIABLE FREQUENCY DIAGRAM

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Dr. Larry Adler
Department of Mining Engineering
Virginia Polytechnic Institute
Blacksburg, VA. 24060

Dear Dr. Adler:

Recently we requested your assistance on a current research project that HRB-Singer, Inc., has been contracted to perform for the U.S. Bureau of Mines. To refresh your memory, our company is under contract to develop a method for estimating the impact of previous overmining and undermining on the underground bituminous coal reserve base in the eastern United States.

The problem with existing estimates, as you know, is that although coal may be present, portions of this coal reserve may not be extractable because of problems of water, gas, subsidence, and so on, resulting from earlier mining operations. Therefore, there is a need to increase the reliability of the estimates, and specifically, a need to develop a method for making reliable estimates of the amount of recoverable coal in areas that have been overmined or undermined.

In developing a method for estimating the impact of previous mining, it is important that all of the factors that affect over- and undermining conditions are identified and taken into account. As a recognized expert in the field, your judgments are critical to the success of this effort. Specifically, we would appreciate your opinions about the attached list of factors which, according to the technical literature, affect coal extraction in over- and undermining conditions.

Would you please evaluate the attached list of factors for completeness (e.g., are there additional factors that should be considered?), for accuracy (e.g., are there factors listed that do not, in fact, affect over- or undermining conditions?), and with respect to the units in which we propose to express the factor or condition?

In addition, we have enclosed a bibliography of sources we examined relating to factors affecting over- and undermining operations. Would you please examine this bibliography and list any additional work you feel should be examined?

Enclosed is a stamped self-addressed envelope for your reply. If you prefer to discuss these factors by telephone, simply mail back a card telling us when it would be most convenient for you to discuss the factors and the bibliography, and we will call you. As in most research projects, time is limited and we would especially appreciate an early response. Thank you very much for your cooperation.

Sincerely,

Ronald W. Stingelin

Ronald W. Stingelin, Ph.D.
Principal Geologist
Environmental Analysis Department

Enclosures: Bibliography
List of UM/OM factors
Self-addressed envelope
"Call me later" card

BOX 60, SCIENCE PARK, STATE COLLEGE, PA. 16801/814 238-4311

FIG. V-4 COVER LETTER SENT TO EXPERTS

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NOTE: VARIABLES ARE NOT LISTED IN ORDER OF IMPORTANCE. UM IS UNDERMINING MODEL; OM IS OVERMINING MODEL.

VARIABLE	UNIT	MODEL
DEPTH OF SEAM TO BE MINED BELOW SURFACE	FEET	UM OM
FULL THICKNESS OF THE SEAM	FEET	UM
VERTICAL DISTANCE BETWEEN SEAM TO BE MINED AND PREVIOUSLY MINED SEAM	FEET	UM OM
TIME BETWEEN MINING	DAYS, YEARS	UM
RELATIVE STRENGTH OF ROOF OF SEAM TO BE MINED	$LB/IN.^2$ (WEAK, MEDIUM, MEDIUM STRONG, STRONG)	UM OM
RELATIVE STRENGTH OF FLOOR OF SEAM TO BE MINED	$LB/IN.^2$ (WEAK, MEDIUM, MEDIUM STRONG, STRONG)	UM OM
LITHOLOGY OF INTERVENING STRATA	$LB/IN.^2$ (WEAK, MEDIUM, MEDIUM STRONG, STRONG)	UM OM
PERCENTAGE EXTRACTION DURING PREVIOUS MINING	PERCENT (%)	UM OM
REMNANT PILLAR HEIGHT TO WIDTH RATIO	Ph AND Pw EACH IN FEET	UM OM
SPAN (GREATEST UNSUPPORTED DISTANCE BETWEEN STABLE PILLARS IN A MINE)	FEET	UM
HIGH STRESS ZONES DUE TO PILLAR PRESSURES FROM PREVIOUS MINING AND WANT AREAS	FEET 0.3 X D+120	UM OM
DIP OR GRADIENT OF THE STRATA	DEGREES (IF LESS THAN 18 1/2, PRESSURE EXERTED VERTICALLY; IF GREATER THAN 18 1/2, PRESSURE EXERTED NORMAL TO STRATA	UM OM
MAXIMUM SUBSIDENCE	INCHES	UM
OTHER VARIABLES NOT YET FULLY DEFINED		
NATURAL AND INDUCED FRACTURES: FAULT ZONES FRACTURE TRACE DENSITIES MICROFRACTURING	---	UM OM
RELATIVE STRENGTH OF ROOF, FLOOR IN PREVIOUSLY MINED SEAM FOR THE CONDITIONS: ROOF AND SEAM STRONGER THAN FLOOR ROOF AND FLOOR STRONGER THAN SEAM SEAM AND FLOOR STRONGER THAN ROOF	$LB/IN.^2$ (WEAK, MEDIUM, MEDIUM STRONG, STRONG)	-- --
WATER	PSI OR GPM	OM
GAS (METHANE)	PSI OR CFM	UM

FIG. V-5 CRITICAL VARIABLES IN THE MULTIPLE SEAM MINING MODELS

76-65

The mining experts who cooperated in this review process were:

* Dr. Fred D. Wright, Professor of Mining Engineering
  University of Kentucky
  Lexington, Kentucky,

* Dr. Larry Adler, Professor Minerals Engineering
  Virginia Polytechnic Institute and State University
  Blacksburg, Virginia,

* Mr. Ben R. Auld, Chief Engineer, (Retired)
  Johnstown Coal and Coke Company
  Portage, Pennsylvania,

* Dr. H. Douglas Dahl, Manager of Mining Research Division
  Continental Oil Company
  Ponca City, Oklahoma,

* Mr. David T. Stemple, President
  Berwind Land Company
  Charleston, West Virginia,

* Mr. Charles B. Manula, Associate Professor of Mining Engineering
  The Pennsylvania State University
  University Park, Pennsylvania, and

* Dr. H. Beecher Charmbury, Assistant Dean Emeritus,
  Professor of Mineral Engineering (Retired)
  The Pennsylvania State University
  University Park, Pennsylvania.

D. APPLICATION OF PHYSICAL VARIABLES AND TECHNIQUE DEVELOPMENT

Having identified and agreed upon an initial list of critical variables, a trial effort was made to collect mine specific data prior to launching into the full scale data collection effort. This was done to develop and finalize the data collection format and to identify, early in the study, any potential problems and difficulties in data collection that might arise.

During this pre-test data collection effort, a number of field trips were made to a cooperating mine in central Pennsylvania. An overmining situation was chosen where the Lower Freeport seam (071) is currently being mined over a previously mined area of the Lower Kittaning seam (084).

Since each mining company has its own record keeping system, it was necessary to first identify the types of data available and then determine in what format these data would most likely occur from mine to mine. Most companies rely heavily on mine maps as a means of recording the physical data most needed for this research. Borehole logs and topographic maps added most of the required remaining data. A data collection form was devised to extract these data in a concise manner ready for entry into the computer.

To transform various information from a mine map into a set of data representing a specific area within a mine, a sampling system had to be devised that would be statistically valid and practical from the standpoint of taking measurements and be representative of the mine as a whole. After some attempts at sampling areas of varying sizes and configurations, it became apparent that each sample area would be square and equal in size and selected randomly from across the entire mine or that part of the mine under consideration for coal loss estimation due to previous over or undermining. A description of the data extraction process employed is given in Section VII Part C.

One advancement in technique development concerning coal loss in a mine was that the immediate area where trouble occurred may not be the only area of loss. Secondary effects throughout an advancing mine area include such loss as pillars left to support additional entries around a bad area. Since this coal will remain in the mine, it is lost even though no trouble occurred at that particular location. Occasionally coal is lost due to coal production expediency where economic pressure causes the overall mining plan to be temporarily abandoned. Because coal loss can occur for any number of reasons, a random selection of areas of equal size were used to collect the data.

VI. REGIONAL ANALYSIS

A. OBJECTIVE

The objective of the Regional Analysis was to develop and apply a methodology for classifying the coal fields of the eastern United States into homogeneous regions as they are specified in USBM Information Circular 8655 "The Reserve Base of Bituminous Coal and Anthracite for Underground Mining in Eastern United States." These homogeneous regions are characterized by a commonality in the physical parameters of the coal and in the general geological setting, and thereby, a similarity in past mining practices. A generalized "Areas of Commonality" map, based on county level resolution was derived from information contained on a series of thematic maps prepared during the task and in comparison with the Tectonic Map of the United States. These map products are discussed and included in part B, Technical Approach.

The major map product of this task, Map 1, "Areas of Commonality" was used in the selection of counties for empirical model development and validation and in conjunction with Map 6, "Coal Rank," in the initial selection of mines to visit for seam interaction variable data collection.

B. TECHNICAL APPROACH

Eleven states constitute the area of study. These eleven states are used as a map base for all topical areas to be illustrated. Map 2, "Study Area and County Names" is the key to the counties listed in I.C. 8655 as containing coal reserves and serves as the location map for this study. All map products are prepared on this base at a scale of 1:2,500,000 which is compatible with most published U.S.G.S. and USBM geologic maps. The thematic maps are prepared as overlays in order to facilitate comparison and analysis. Twelve maps were prepared with the topics listed below:

Map 1 - Eastern Underground Coal Reserve Base - Areas of Commonality.

Map 2 - Study Area and County Names.

Map 3 - Sulfur Content (Dry)

Map 4 - B T U (Dry)

Map 5 - Ash Content (Dry)

Map 6 - Coal Rank

Map 7 - Geologic Structure and Eastern Underground Coal Reserve Base.

Map 8 - Deep Mining Technique - 1974.

Map 9 - Number of Seams in the Eastern Underground Coal Reserve Base by County.

Map 10 - Number of Seams not Listed in the Eastern Underground Coal Reserve Base for which Sulfur Analyses are Available.

Map 11 - Eastern Underground Coal Reserve Base (tons/county)

Map 12 - Eastern Underground Coal Reserve Base (tons/sq. mile/county)

After the plotting of these data and the completion of the map overlays, a comparison of the maps was made to combine and match the subject topics into a final derivative map (Map 1). The regional analyses consist of a synthesis of the information contained on the topical maps and information developed and acquired from published maps. Maps 1 to 12 are printed in this report at a reduced scale.

C. RESULTS

The major product of Regional Analysis is Map 1, "Areas of Commonality." It is derived by combining the information contained in Maps 3 through 9 and Maps 11 and 12 with the purpose of deriving areas of common physical conditions.

As a result, ten major regions are developed based on coal properties. These regions are divided into twenty-one subregions or areas of commonality based on geologic setting.

The prime factors in the determination of the ten regions are sulfur content, BTU value, and ash content. Anthracite and semianthracite areas are given a separate region designation independent of these criteria and the Michigan Basin warrants a regional designation because of its isolation.

Differentiation of sub-regions is based on the tectonic parameters of degree of folding and faulting. Current underground mining practice (1974) by region is included in the sub-regional description.

The "Areas of Commonality" map follows predictable geologic lines of differentiation. These include decreasing coal rank westward together with decreasing tectonic activity.

Sulfur content is more variable and generally can be related to environmental conditions during coal formation. The low sulfur areas along the eastern perimeter of the coal regions represent deposition in a relatively narrow geosynclinal trough during early Pennsylvanian time (Lee and Kanawha). The geosyncline was restricted to the northeast, and was open to marine circulation to the southwest (Eardley, 1962). The major geosynclinal basins of deposition during this time were the Coosa, Cahaba, and Warrior Basins in Alabama and Tennessee, and the Pocohontas Trough in West Virginia and eastern Kentucky. Isolated coal deposition also existed in the Illinois, Indiana, and western Kentucky basin and in the Michigan basin. These basins represented the accumulation loci for Pottsville (Lee and Kanawha time) coal deposition. The eastern geosyncline was characterized by differential subsidence rates and close proximity to an orogenic belt to the southeast that supplied the source of the clastic sediments between the coals.

Pottsville deposition was occurring at a relatively rapid rate in these active differentially subsiding troughs east of a tectonic hinge line separating the troughs from the more stable cratonic platform to the west (Barlow, 1971). This hinge line was to act as a relatively positive area throughout the Pennsylvanian period. The hinge line is mapped in West Virginia trending northeast-southwest and is generally followed by the medium low/medium sulfur boundary line in Map 3. (The tectonic hinge line is drawn in its approximate position on Map 3.)

Toward the close of the Pottsville (in Kanawha time), the stable platform west of the hinge line began to experience relatively uniform subsidence while the eastern troughs were filling up. At the close of Pottsville time, platform deposition had spread to include Pennsylvania, eastern Ohio, and Kentucky.

This Pottsville/Allegheny time transition seems to be the key to sulfur distribution in the eastern coal fields. From the Pottsville/Allegheny transition to the end of the Pennsylvanian period, platform deposition prevailed throughout the eastern coal fields with the Michigan Basin remaining isolated. The climate was progressively becoming warmer and drier and the coal basin more and more restricted. Sediment supply was decreasing and at the end of the period, coal deposition was restricted to the current geographic distribution of Permian sediments in the eastern United States (Dunkard Series). The Pennsylvanian coals are buried deeply under the Dunkard Series and good data on the physical parameters of these coals is lacking, hence the obvious hole in western West Virginia on all of the maps.

D. MAP DESCRIPTIONS

Thematic maps presenting visual display of the physical parameters of coal, coal distribution, and geologic setting are presented in maps 3 through 12. Brief descriptions of these maps follow.

Map 3 - "Sulfur Content-Eastern Underground Coal Reserve Base." This represents a plot of the average sulfur content by county, listed on a moisture free basis in USBM I.C. 8655. Only seams included within this document in the reserve base tables for which sulfur analyses are available are represented in the county averages.

Map 4 - "BTU (Dry) by County-Eastern Underground Coal Reserve Base." The average BTU content, calculated on a moisture free basis, by county, is plotted. This includes only those seams listed in I.C. 8655 where analyses data are available.

Map 5 - "Ash Content-Eastern Underground Coal Reserve Base." The average ash content, calculated on a moisture free basis by county, is plotted. Average ash content includes only those seams listed in I.C. 8655 for which analyses data are available.

Map 6 - "Coal Rank-Eastern Underground Coal Reserve Base." The American Society for Testing Materials (ASTM) Standard Specification for Classification of Coal by Rank is used to categorize the eastern underground coal reserve base.

A variety of sources (USBM I.C. 8655, 1974 Keystone Coal Industry Manual, Luther, 1959, Culbertson 1964, PADER Map 11, Barlow, 1974, U.S.G.S. Prof. Paper 580) are used to develop this map. No differentiation of high volatile bituminous coal into A, B, & C ranks is made due to the inconsistancy of the available data, but rank generally decreases from A to C towards the west.

Map 7 - "Geologic Structure and Eastern Underground Coal Reserve Base." This is a derivative map compiled by comparing the tectonic map of the U.S. and maps 9 and 12. Regions of similar tectonic setting are divided into areas of high and low reserves. The tectonic setting was determined by the degree of major folding and major fault density. An asterisk denotes those counties with extremely high reserves or greater than 14 seams.

Map 8 - "Deep Mining Technique - 1974, Eastern Underground Coal Reserve Base." The active deep mining techniques used during 1974 are plotted on a countywide basis. The list of mining equipment in these mines, as reported in the 1974 Keystone Coal Industry Manual, determined the mining techniques. Active long-wall operations are present in Pennsylvania, West Virginia and eastern Kentucky.

Map 9 - "Number of Seams in the Eastern Underground Coal Reserve Base by County." The number of seams used in USBM I.C. 8655 to calculate the coal reserve base for each county is plotted. Uncorrelated seams and locations where the number of seams are not known are excluded. This map gives a visual representation of those counties where multiple seam mining is most likely to occur.

Map 10 - "Number of Seams Not Listed in the Eastern Underground Coal Reserve Base For Which Sulfur Analyses Are Available." This map is derived by determining the difference between the number of seams in the coal reserve base tables of USBM I.C. 8655 for a given county and the total number of seams listed in USBM I.C. 8655 for which sulfur analysis are available. This map gives a rough approximation of additional seams that may be encountered in a county in addition to those included in the underground coal reserve.

Map 11 - "Eastern Underground Coal Reserve Base (Millions of Short Tons/County)." The total amount of mineable underground coal reserves in each county as listed in USBM I.C. 8655 is plotted. This gives a direct visualization of this data presented therein in tabular form.

Map 12 - "Eastern Underground Coal Reserve Base (Millions of Short Tons/Sq. Mile/County)." This map was derived by dividing the millions of short tons of coal for each county by the square mile area in the county. This presents a better representation of the underground coal reserve base than in Map 11, although it would be much more accurate if the number of square miles of coal bearing strata in each county were used instead of total square miles.

E. CONCLUSIONS

The thematic maps prepared for this report may be used for rapid comprehension of regional distributions and trends of the various parameters they depict. In combination and comparison they may be used to explain or suggest solutions to problems other than that for which they were generated; namely, the identification of areas of commonality.

The twenty-one subregions derived from the regional analysis represent areas where the coal loss calculation model developed for predicting the effects of undermining and overmining may be run using mine specific data within each sub-region. Coal loss prediction within any sub-region is qualified by the restrictions discussed in chapter IX. These restrictions are also applicable to the possibilities of extending coal-loss predictions from one sub-region to another.

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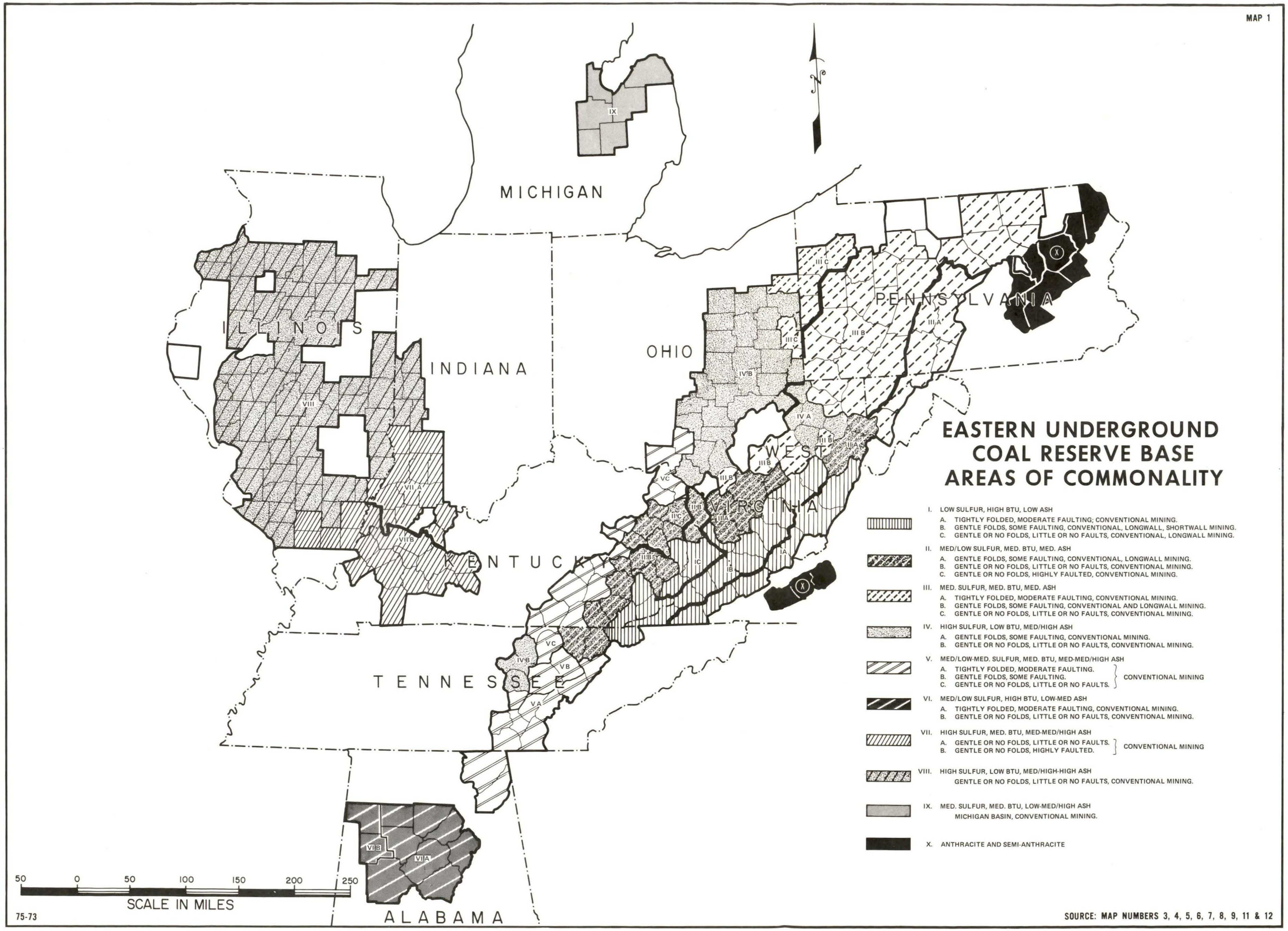
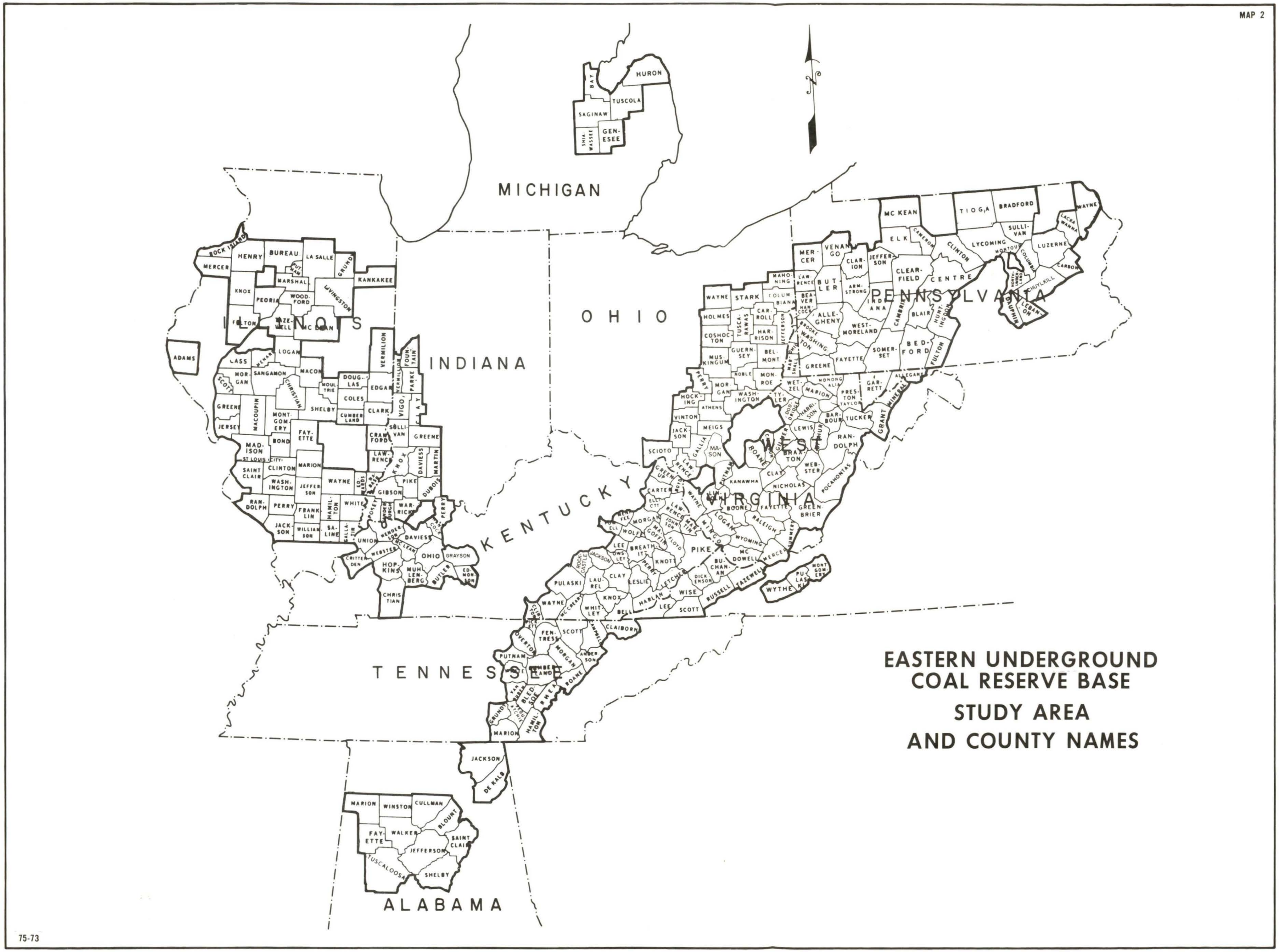
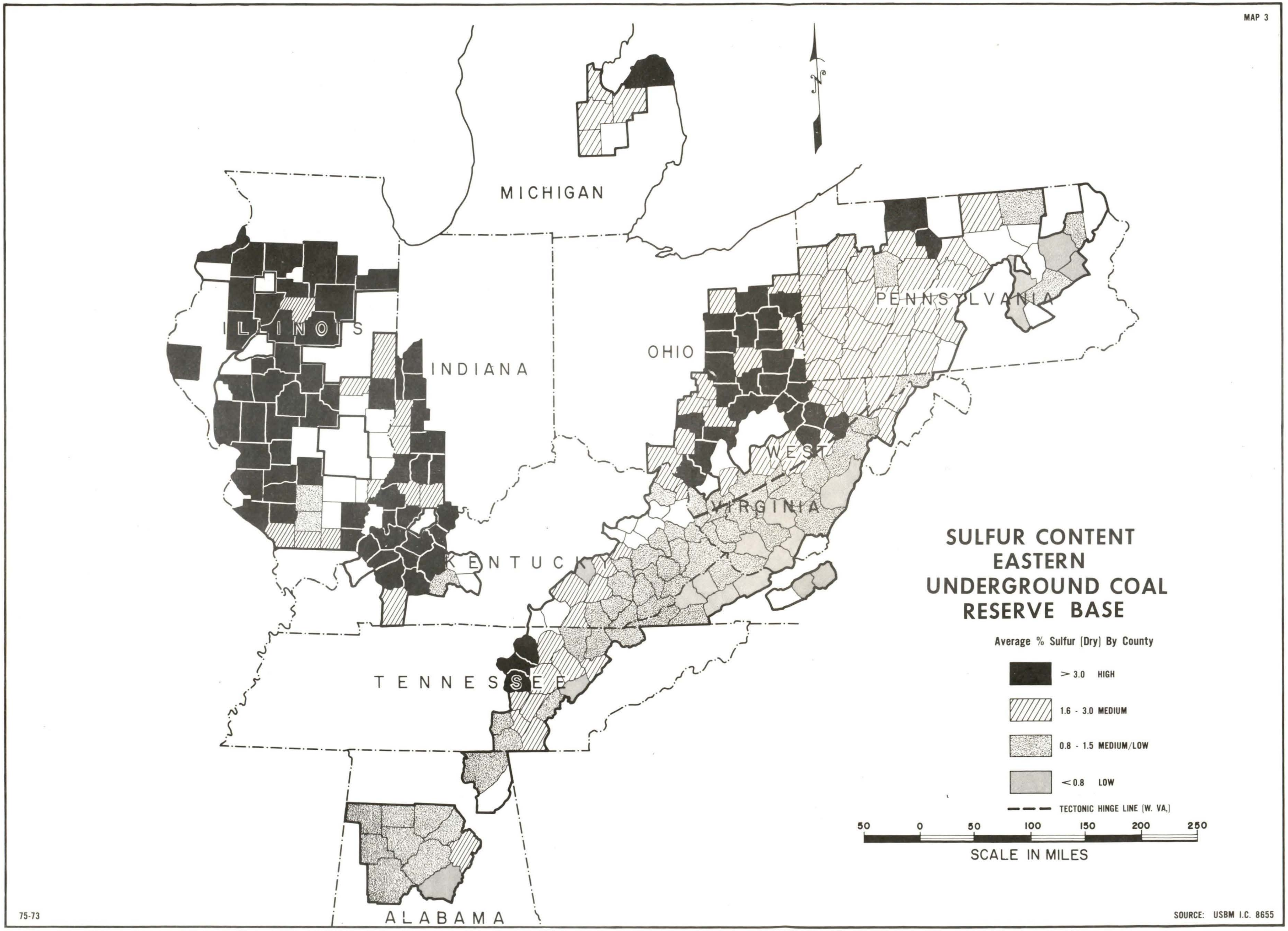
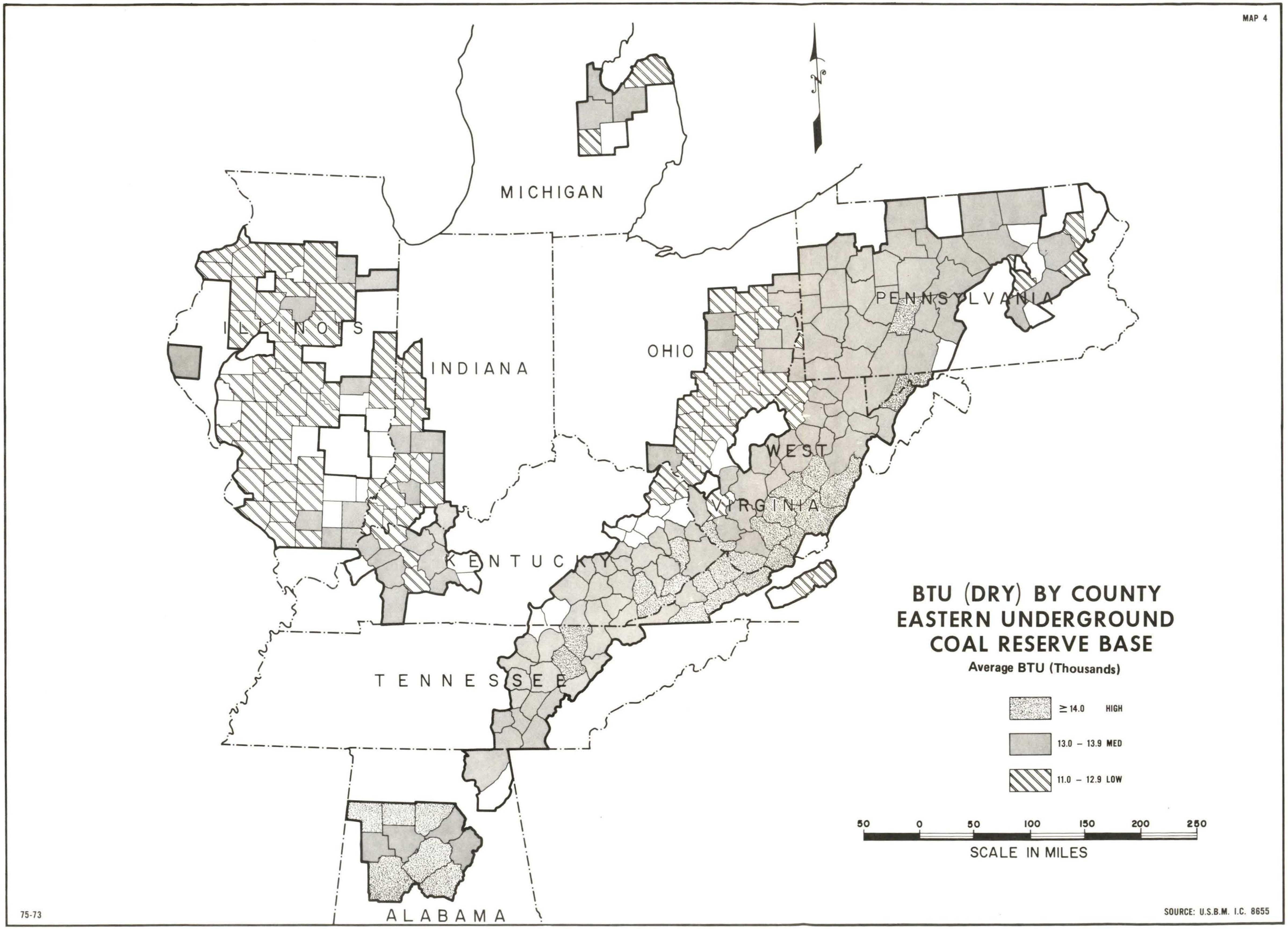
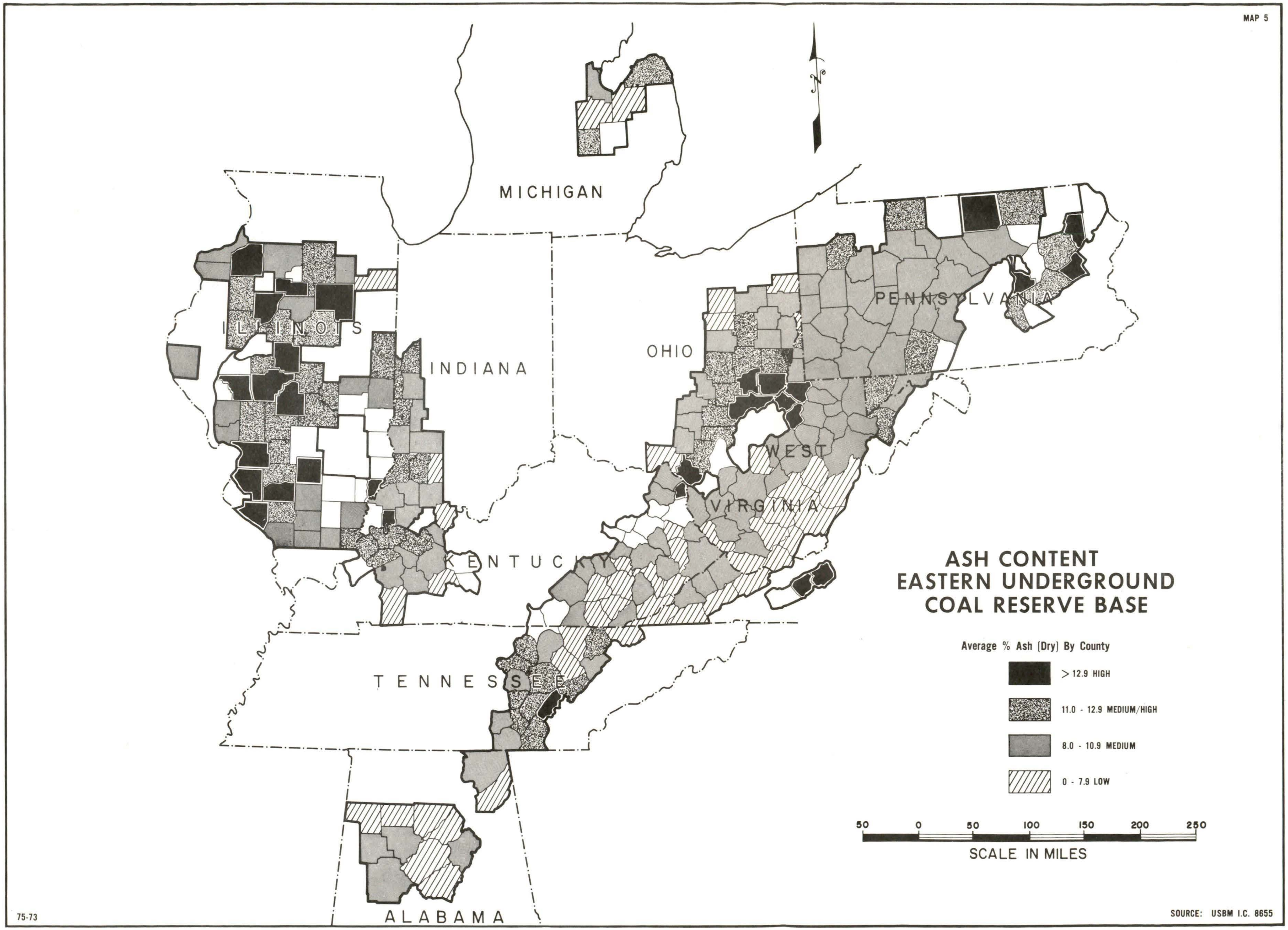

MAP 1
EASTERN UNDERGROUND COAL RESERVE BASE AREAS OF COMMONALITY
I. LOW SULFUR, HIGH BTU, LOW ASH
A. TIGHTLY FOLDED, MODERATE FAULTING; CONVENTIONAL MINING.
B. GENTLE FOLDS, SOME FAULTING, CONVENTIONAL, LONGWALL, SHORTWALL MINING.
C. GENTLE OR NO FOLDS, LITTLE OR NO FAULTS, CONVENTIONAL, LONGWALL MINING.
II. MED/LOW SULFUR, MED. BTU, MED. ASH
A. GENTLE FOLDS, SOME FAULTING, CONVENTIONAL, LONGWALL MINING.
B. GENTLE OR NO FOLDS, LITTLE OR NO FAULTS, CONVENTIONAL MINING.
C. GENTLE OR NO FOLDS, HIGHLY FAULTED, CONVENTIONAL MINING.
III. MED. SULFUR, MED. BTU, MED. ASH
A. TIGHTLY FOLDED, MODERATE FAULTING, CONVENTIONAL MINING.
B. GENTLE FOLDS, SOME FAULTING, CONVENTIONAL AND LONGWALL MINING.
C. GENTLE OR NO FOLDS, LITTLE OR NO FAULTS, CONVENTIONAL MINING.
IV. HIGH SULFUR, LOW BTU, MED/HIGH ASH
A. GENTLE FOLDS, SOME FAULTING, CONVENTIONAL MINING.
B. GENTLE OR NO FOLDS, LITTLE OR NO FAULTS, CONVENTIONAL MINING.
V. MED/LOW-MED. SULFUR, MED. BTU, MED-MED/HIGH ASH
A. TIGHTLY FOLDED, MODERATE FAULTING.
B. GENTLE FOLDS, SOME FAULTING.
C. GENTLE OR NO FOLDS, LITTLE OR NO FAULTS.
CONVENTIONAL MINING
VI. MED/LOW SULFUR, HIGH BTU, LOW-MED ASH
A. TIGHTLY FOLDED, MODERATE FAULTING, CONVENTIONAL MINING.
B. GENTLE OR NO FOLDS, LITTLE OR NO FAULTS, CONVENTIONAL MINING.
VII. HIGH SULFUR, MED. BTU, MED-MED/HIGH ASH
A. GENTLE OR NO FOLDS, LITTLE OR NO FAULTS.
B. GENTLE OR NO FOLDS, HIGHLY FAULTED.
CONVENTIONAL MINING
VIII. HIGH SULFUR, LOW BTU, MED/HIGH-HIGH ASH
GENTLE OR NO FOLDS, LITTLE OR NO FAULTS, CONVENTIONAL MINING.
IX. MED. SULFUR, MED. BTU, LOW-MED/HIGH ASH
MICHIGAN BASIN, CONVENTIONAL MINING.
X. ANTHRACITE AND SEMI-ANTHRACITE
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
50 0 50 100 150 200 250
SCALE IN MILES
75-73
SOURCE: MAP NUMBERS 3, 4, 5, 6, 7, 8, 9, 11 & 12

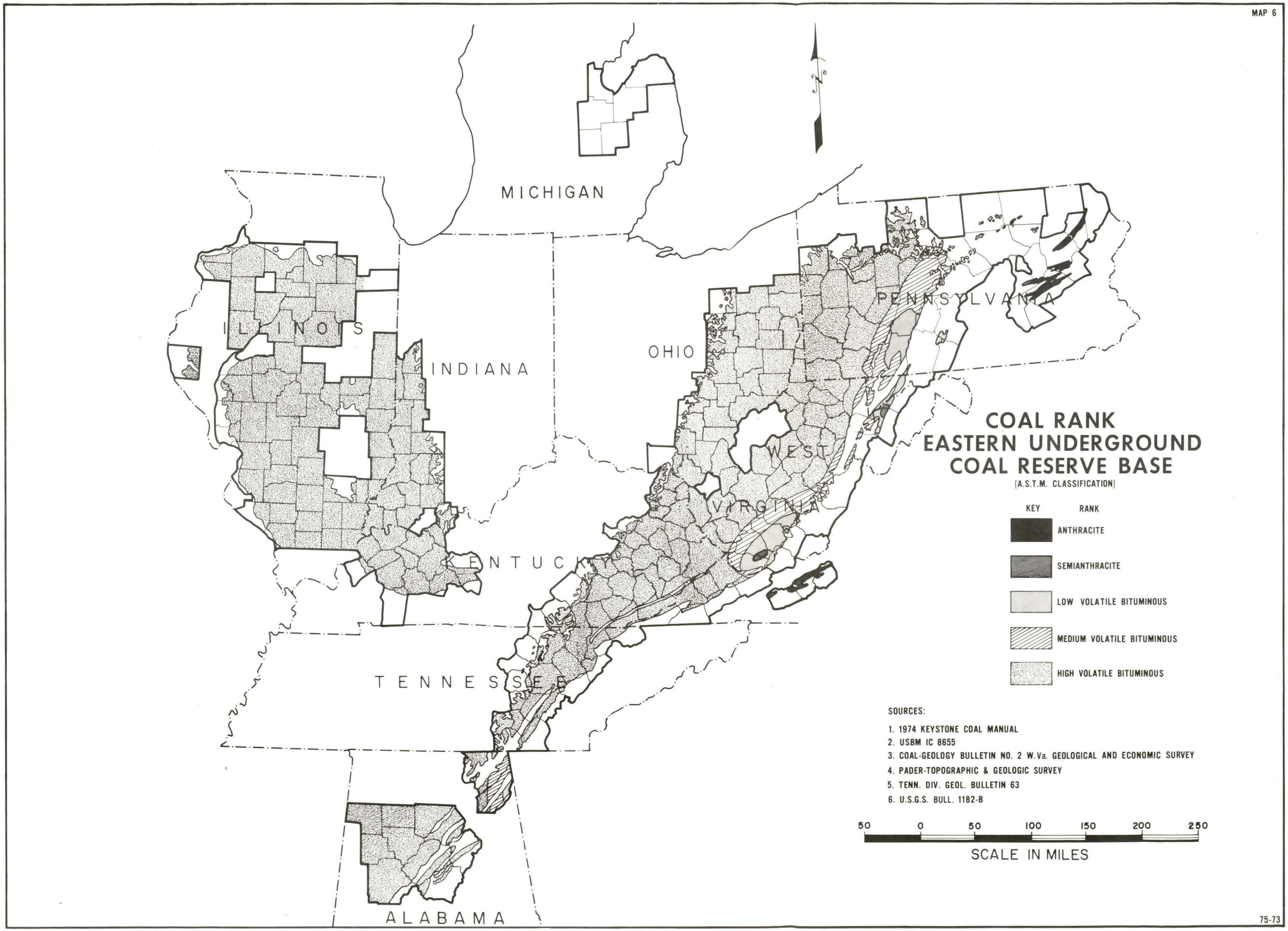


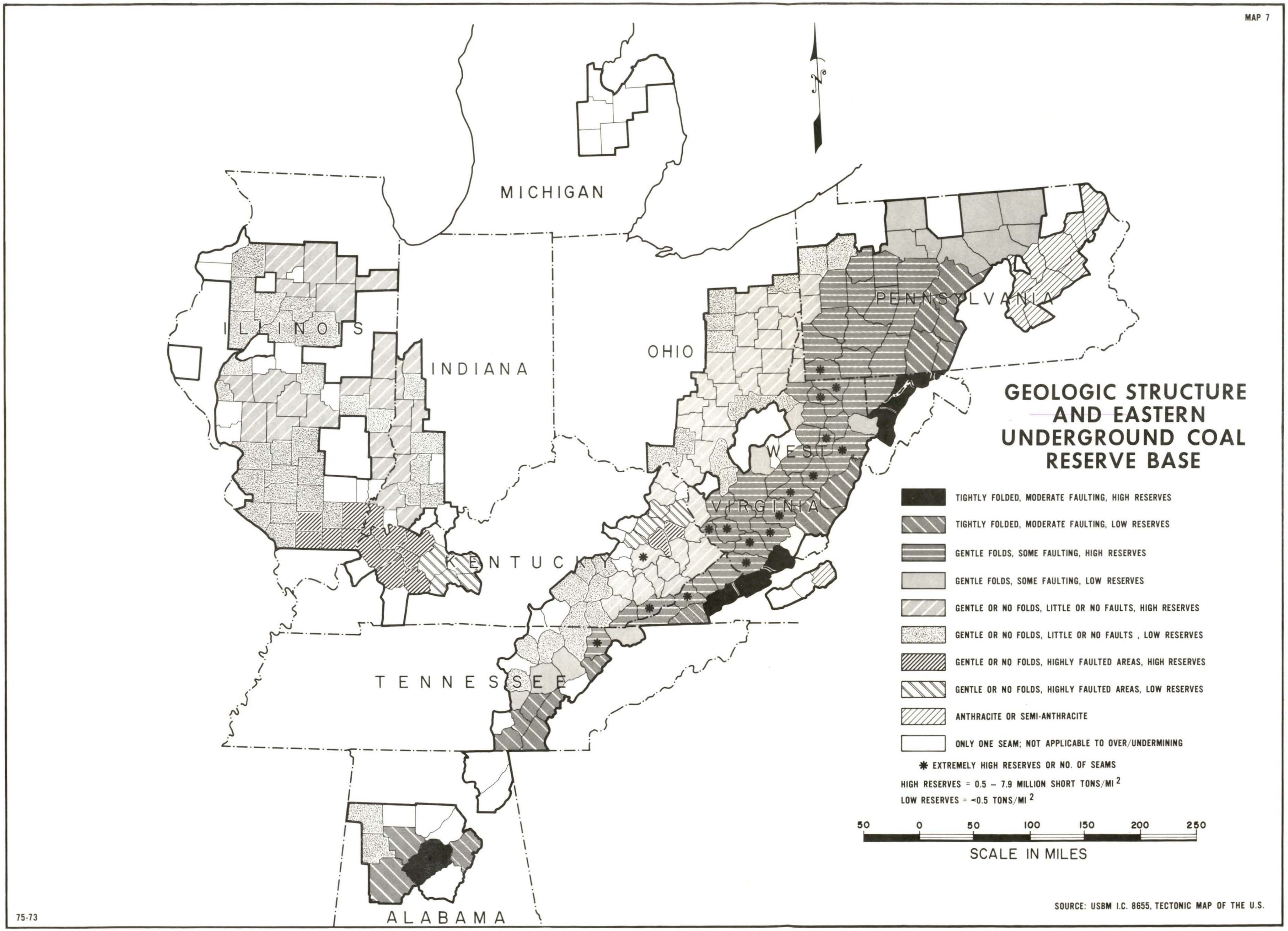
EASTERN UNDERGROUND COAL RESERVE BASE STUDY AREA AND COUNTY NAMES

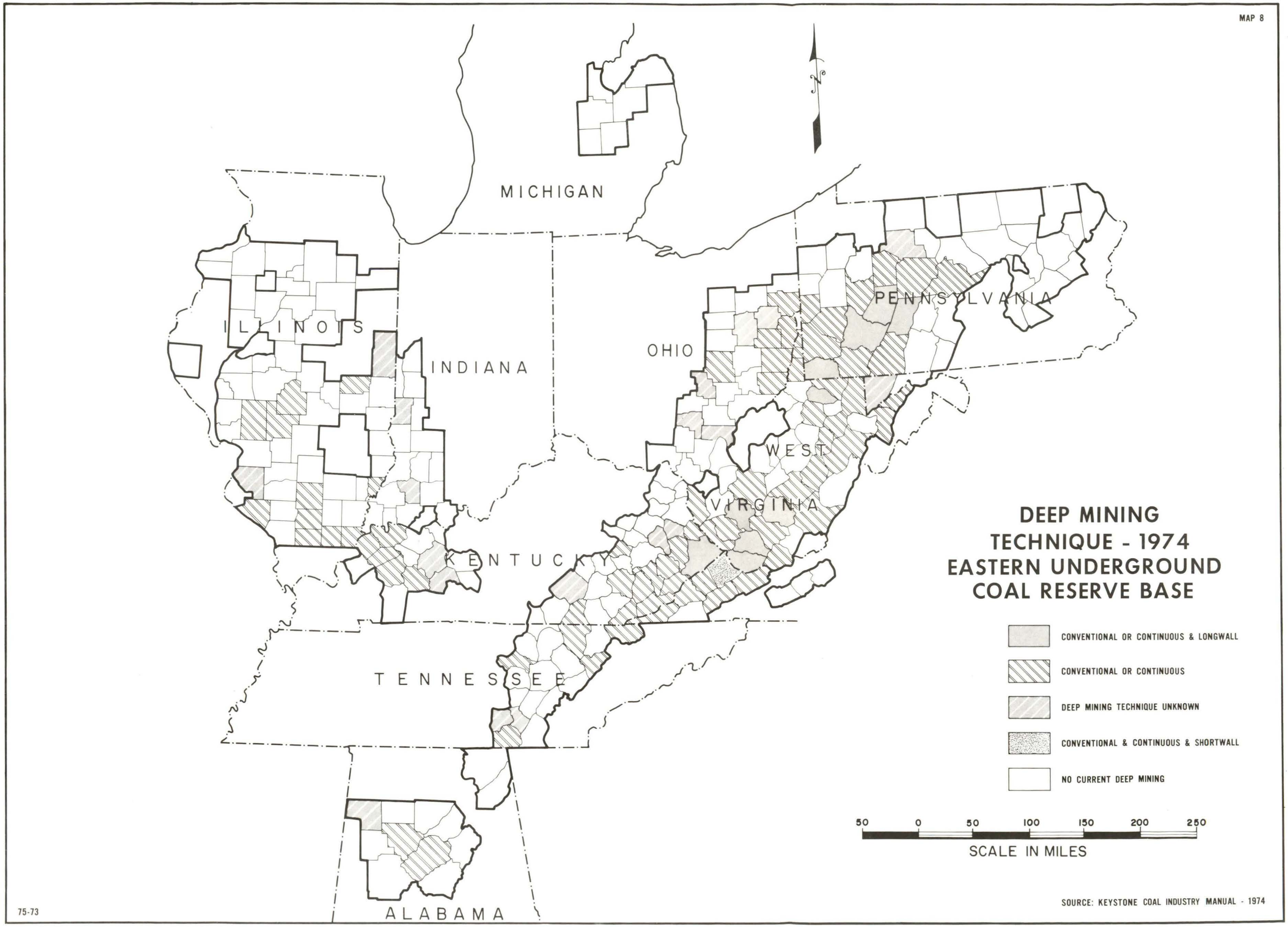

MAP 3
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST
VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
N
SULFUR CONTENT
EASTERN
UNDERGROUND COAL
RESERVE BASE
Average % Sulfur (Dry) By County
> 3.0 HIGH
1.6 - 3.0 MEDIUM
0.8 - 1.5 MEDIUM/LOW
< 0.8 LOW
TECTONIC HINGE LINE (W. VA.)
50 0 50 100 150 200 250
SCALE IN MILES
75-73
SOURCE: USBM I.C. 8655

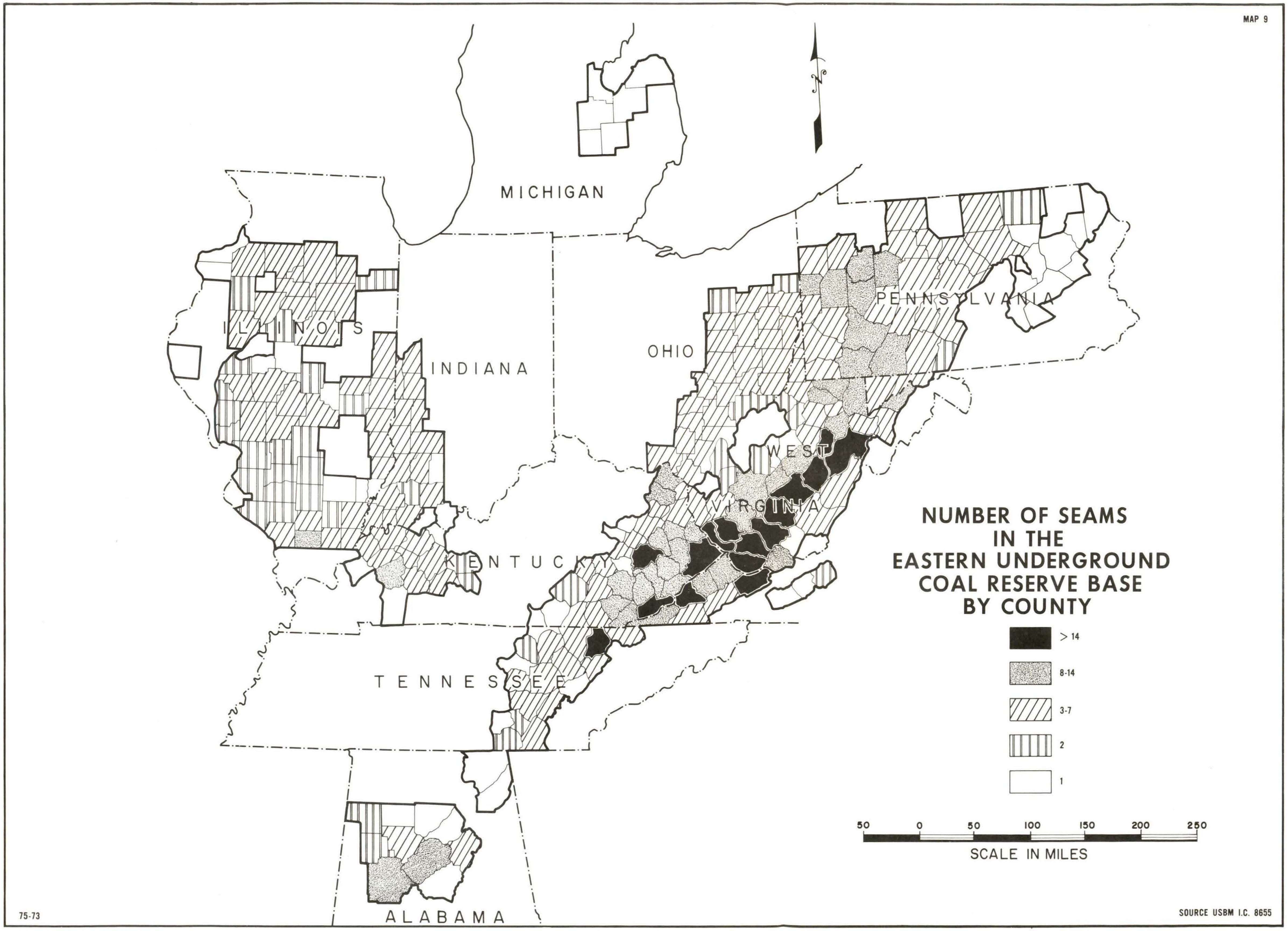

MAP 4
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST
VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
BTU (DRY) BY COUNTY
EASTERN UNDERGROUND
COAL RESERVE BASE
Average BTU (Thousands)
≥ 14.0 HIGH
13.0 – 13.9 MED
11.0 – 12.9 LOW
50 0 50 100 150 200 250
SCALE IN MILES
75-73
SOURCE: U.S.B.M. I.C. 8655

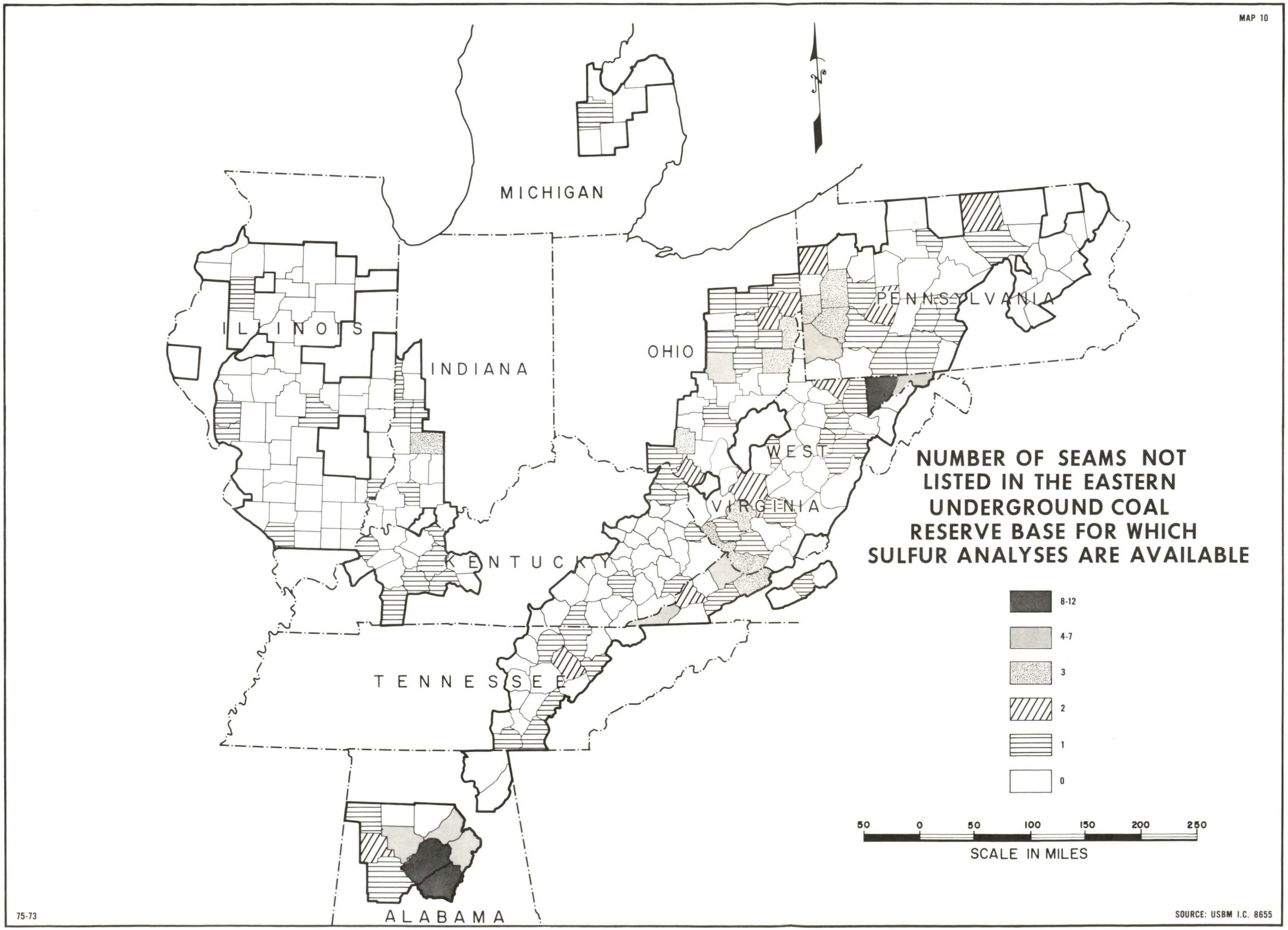

MAP 5
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST
VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
N
ASH CONTENT
EASTERN UNDERGROUND
COAL RESERVE BASE
Average % Ash (Dry) By County
> 12.9 HIGH
11.0 - 12.9 MEDIUM/HIGH
8.0 - 10.9 MEDIUM
0 - 7.9 LOW
50 0 50 100 150 200 250
SCALE IN MILES
75-73
SOURCE: USBM I.C. 8655

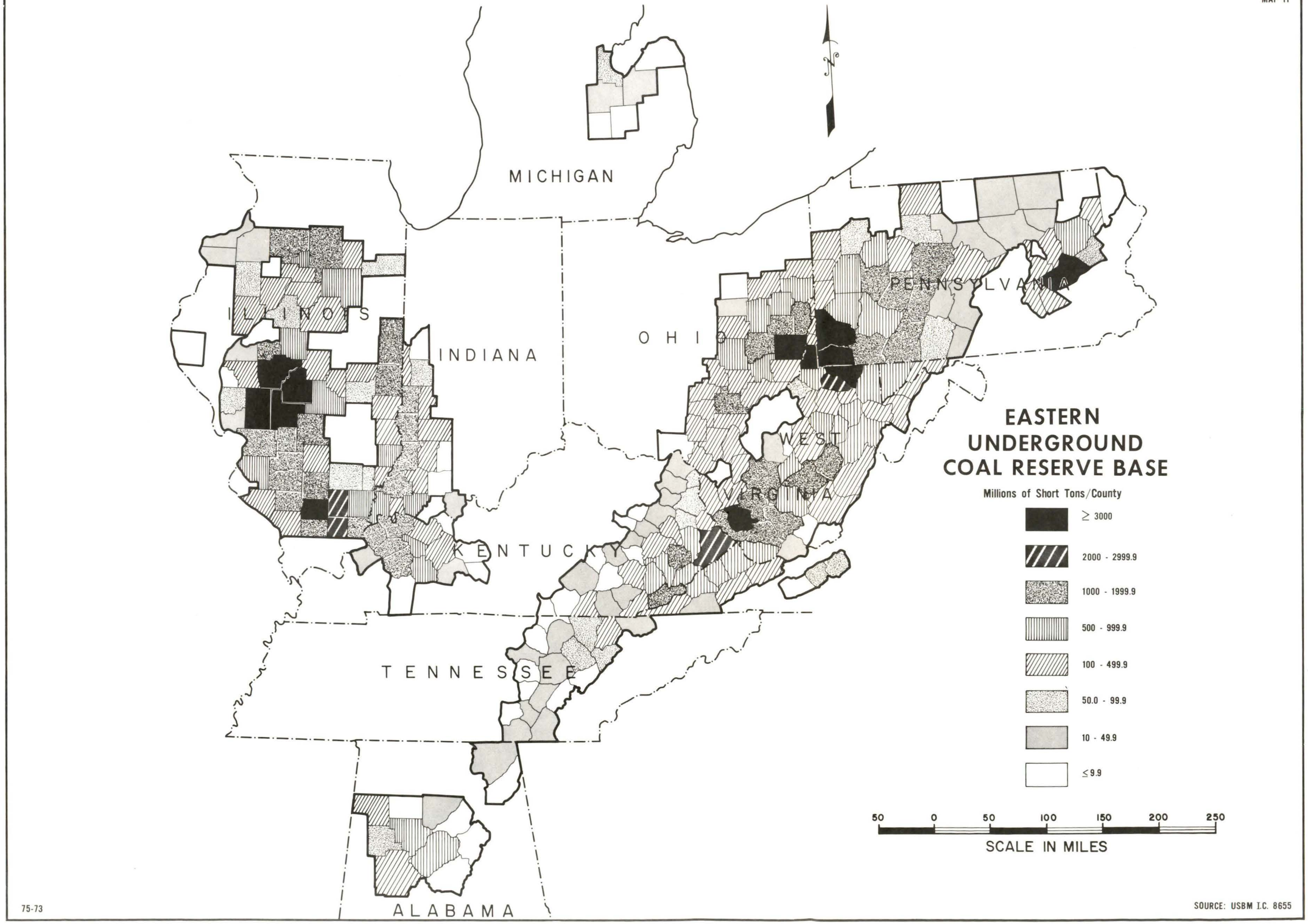

MAP 6
COAL RANK
EASTERN UNDERGROUND
COAL RESERVE BASE
(A.S.T.M. CLASSIFICATION)
KEY
RANK
ANTHRACITE
SEMIANTHRACITE
LOW VOLATILE BITUMINOUS
MEDIUM VOLATILE BITUMINOUS
HIGH VOLATILE BITUMINOUS
SOURCES:
1. 1974 KEYSTONE COAL MANUAL
2. USBM IC 8655
3. COAL-GEOLOGY BULLETIN NO. 2 W.Va. GEOLOGICAL AND ECONOMIC SURVEY
4. PADER-TOPOGRAPHIC & GEOLOGIC SURVEY
5. TENN. DIV. GEOL. BULLETIN 63
6. U.S.G.S. BULL. 1182-B
50 0 50 100 150 200 250
SCALE IN MILES
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST
VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
75-73


MAP 7
GEOLOGIC STRUCTURE AND EASTERN UNDERGROUND COAL RESERVE BASE
TIGHTLY FOLDED, MODERATE FAULTING, HIGH RESERVES
TIGHTLY FOLDED, MODERATE FAULTING, LOW RESERVES
GENTLE FOLDS, SOME FAULTING, HIGH RESERVES
GENTLE FOLDS, SOME FAULTING, LOW RESERVES
GENTLE OR NO FOLDS, LITTLE OR NO FAULTS, HIGH RESERVES
GENTLE OR NO FOLDS, LITTLE OR NO FAULTS , LOW RESERVES
GENTLE OR NO FOLDS, HIGHLY FAULTED AREAS, HIGH RESERVES
GENTLE OR NO FOLDS, HIGHLY FAULTED AREAS, LOW RESERVES
ANTHRACITE OR SEMI-ANTHRACITE
ONLY ONE SEAM; NOT APPLICABLE TO OVER/UNDERMINING
* EXTREMELY HIGH RESERVES OR NO. OF SEAMS
HIGH RESERVES = 0.5 – 7.9 MILLION SHORT TONS/MI 2
LOW RESERVES = <0.5 TONS/MI 2
50 0 50 100 150 200 250
SCALE IN MILES
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
N
SOURCE: USBM I.C. 8655, TECTONIC MAP OF THE U.S.
75-73


MAP 8
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST
VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
DEEP MINING TECHNIQUE - 1974 EASTERN UNDERGROUND COAL RESERVE BASE
CONVENTIONAL OR CONTINUOUS & LONGWALL
CONVENTIONAL OR CONTINUOUS
DEEP MINING TECHNIQUE UNKNOWN
CONVENTIONAL & CONTINUOUS & SHORTWALL
NO CURRENT DEEP MINING
50 0 50 100 150 200 250
SCALE IN MILES
SOURCE: KEYSTONE COAL INDUSTRY MANUAL - 1974
75-73


MAP 9
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST
VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
NUMBER OF SEAMS IN THE EASTERN UNDERGROUND COAL RESERVE BASE BY COUNTY
> 14
8-14
3-7
2
1
50 0 50 100 150 200 250
SCALE IN MILES
75-73
SOURCE USBM I.C. 8655


MAP 10
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST
VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
NUMBER OF SEAMS NOT LISTED IN THE EASTERN UNDERGROUND COAL RESERVE BASE FOR WHICH SULFUR ANALYSES ARE AVAILABLE
8-12
4-7
3
2
1
0
50 0 50 100 150 200 250
SCALE IN MILES
75-73
SOURCE: USBM I.C. 8655



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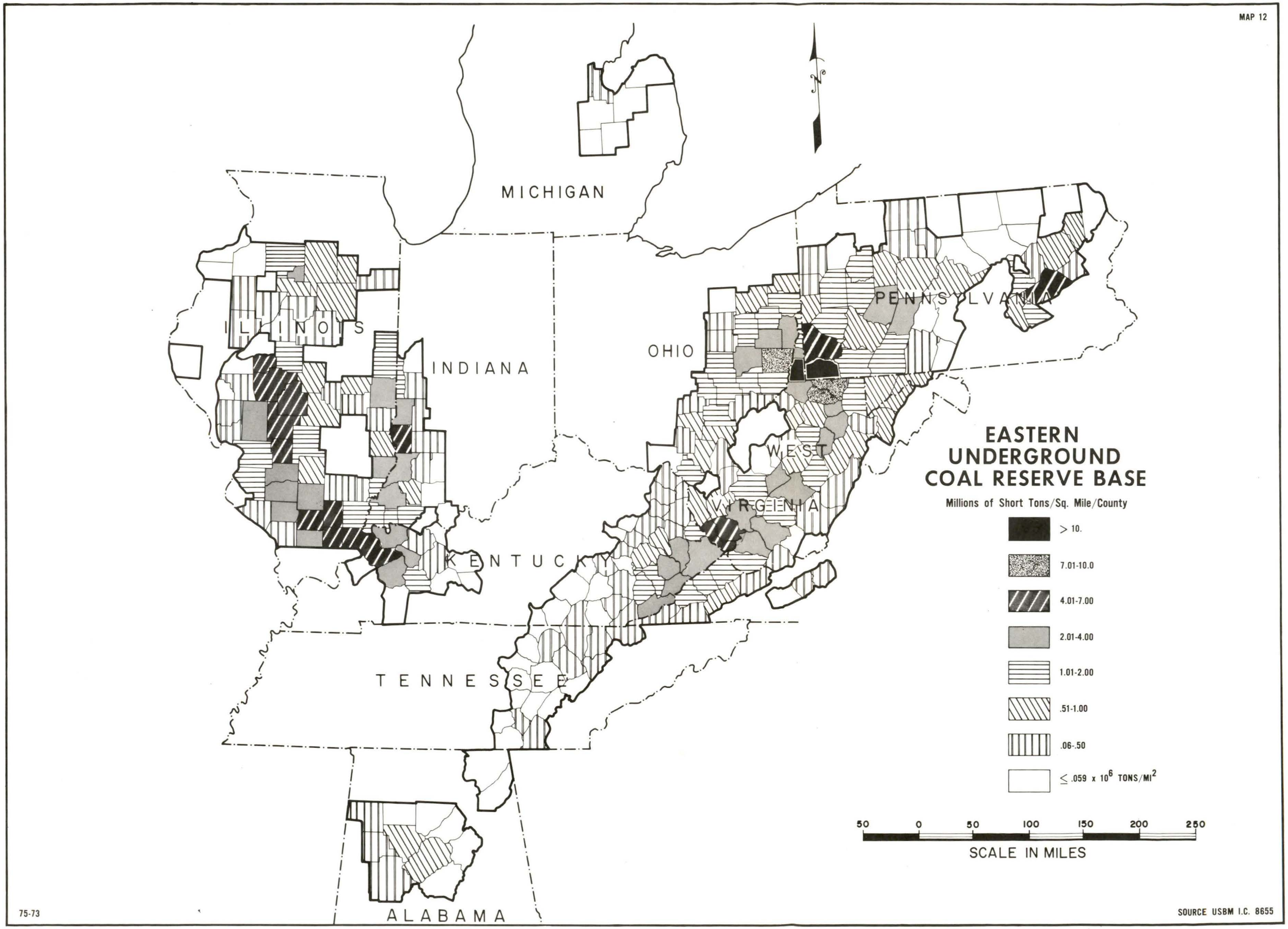
SOURCE: USBM I.C. 8655



MAP 12
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST
VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
EASTERN
UNDERGROUND
COAL RESERVE BASE
Millions of Short Tons/Sq. Mile/County
> 10.
7.01-10.0
4.01-7.00
2.01-4.00
1.01-2.00
.51-1.00
.06-.50
≤ .059 x 10^6 TONS/MI^2
50 0 50 100 150 200 250
SCALE IN MILES
75-73
SOURCE USBM I.C. 8655

VII. DATA COLLECTION

A. OBJECTIVES AND APPROACH

Following the definition of the study area through regional analysis, the main effort of the study turned to data collection. The overall objectives of data collection were to identify where the best data sources were located, to establish the most effective means for acquistion, and to implement such acquistion. Direct input from various groups within the mining community was used to satisfy the data requirements for the development, implementation, and validation of the coal loss calculation model. Three data collection activities led to the development of the final mine specific data base upon which subsequent project efforts would be dependent. These three activities were:

1. Structured interviews with Mine Enforcement and Safety Administration officials,
2. Structured interviews with mine superintendents and engineers and,
3. Mine specific data extraction from mine company maps, topographic maps, and borehole logs.

B. STRUCTURED INTERVIEWS

Structured interviews were conducted to obtain basic data and information concerning the character and results of mining activities associated with overmining and undermining. These data were used to substantiate the critical variables and their functional relationships.

To formulate specific questions to be addressed to mining personnel, the literature summary by variable matrix (Figure V-3) was used. Each appropriate article was inspected where mention was made of the variable in question and statements concerning that factor were converted into questions to be refined and presented to a number of selected mine inspectors and mine operators within the eastern bituminous coal fields.

Interviews were initiated with MESA officials in selected districts where multiple seam mining is being practiced. A major advantage of gaining information from this group was that their knowledge of geological conditions and mining practices throughout their districts is more general than that of mine personnel. Interviews were conducted in the following six locations representing

MESA districts or subdistricts: (1) Mt. Hope, W. Va., District 4-Southern West Virginia; (2) Norton, Virginia, District 5-Scott, Lee, Wise, Dickson, Russell, Tazewell, and Buchanan Counties, Virginia; (3) Pikeville, Kentucky, District 6-Mason, Lewis, Greenup, Fleming, Rowan, Carter, Boyd, Elliot, Lawrence, Menifee, Morgan, Johnson, Martin, MaGoffin, Floyd, Pike, and Letcher Counties, Kentucky; (4) Madisonville, Kentucky, Subdistrict of 7-Western Kentucky; (5) Jellico, Tennessee, Subdistrict of 7-Eastern Tennessee; (6) Pittsburgh, Pa. - Bituminous Region of Pennsylvania.

An interview format was designed to assist the interviewers in collecting information of a regional nature from individuals or groups in the districts listed above. The type of information included is shown in the form entitled "Interview Schedule-Mine Inspectors" included in Appendix A. The results of these interviews are summarized in Table VII-1 MESA District Data Tabulation.

Mine personnel interviews were conducted at mining locations in the eastern bituminous region of the U.S. Each of the persons interviewed was either a mine superintendent or foreman or a member of the engineering department of the mine. Each had a thorough knowledge of the mine where he was working.

The development of these interview forms began by delineating the information to be illicited and identifying the subjects who would be the best sources of the information required. Several refinements in the development of a workable form were made with the requirement that it not only cover all the necessary information, but that it be structured in such a way that a minimum of time be spent with the person to be interviewed. A satisfactory "Data Collection Form" resulted, a sample of which is included in Appendix B.

The procedure for successfully completing an interview with a mining official included several steps:

1. The candidate mining company was selected from a list of companies engaged in multiple seam mining compiled by HRB-Singer from the list of mines provided by the MESA interviews.

2. A telephone call was placed to the individual named and the research project and the need to gain data from him was explained. One of three types of responses usually followed this request: a) an appointment was scheduled; b) cooperation was refused; c) direction was given to initiate the request by mail at a higher level of management within the mining company.

TABLE VII-1 MESA DISTRICT DATA TABULATION

76-65

REGION		MESA DISTRICT	ATTEMPTS TO ALIGN PILLARS	GENERAL ROOF CONDITIONS	GENERAL FLOOR CONDITIONS	EFFECT OF PREVIOUS MINING ON COAL RECOVERY	NUMBER OF MINES	NUMBER OF MULTIPLE SEAM SITUATIONS	RANGE OF ESTIMATED % EXTRACTION	RANGE OF PILLAR DIMENSIONS	EFFECTS OF REMNANT PILLARS	GEOLOGIC FACTORS
III	A B C	PITTSBURGH	BETHLEHEM #33	DIFFICULT TO GENERALIZE --- ROOF WORSENS WITH DEPTH	FIRECLAY OR SHALE	NO REAL EFFECTS	155	~38	55-85	?	?	NONE
I II	A B A	SOUTHERN W. VA.-4	U.S. STEEL #1 POWELLTON VALLEY CAMP	EAGLE-BAD (SHALE) POCAHONTAS 3&4 GOOD (SAND-STONE)	GENERALLY AVERAGE TO GOOD EXCEPT FOR SEWELL	DEFINITE COAL LOSS	500-515	~386	AVG 60%	?	AT ELK MINING CO. THROUGH A DISTANCE OF 200 FEET BETWEEN SEAMS.	POCAHONTAS #4 BECKLEY POWELLTON HAVE FREQUENT WANT AREAS
I X	A	VIRGINIA-5	UNAWARE OF ANY	POOR TO EXCELLENT	POOR TO EXCELLENT	SOME EFFECTS BUT NOT VERY EXTENSIVE	310	230-250	AVG 60	?	NONE	PINE MOUNTAIN FAULT CLINCH RIVER VALLEY FAULT
I II V	C B C C	NE KENTUCKY -6	NONE	EXTREMELY VARIABLE --- ROOF WORSENS WITH DEPTH	MEDIUM GRADE SHALE	NO SIGNIFICANT EFFECT	313	200	65-90	30' x 30' TO 80' x 80' --- 45' x 45'	?	PINE MOUNTAIN FAULT
II IV V	B B A B C	EASTERN TENN-7 (JELLICO SUBDISTRICT)	ONLY ONE MINE-NOW CLOSED	GENERALLY GOOD IN JELLICO AREA. APPARENTLY AFFECTED BY JACKSBORO FAULT	NO GENERALIZATION COULD BE MADE	MINIMAL OR COULD NOT BE DETERMINED	80	80	60-70%	?	NONE	PINE MOUNTAIN FAULT JACKSBORO FAULT
VII	A B	W. KENTUCKY-SUBDISTRICT OF 7	NONE	GENERALLY BETTER WITH LIMESTONE THAN WITH SHALE	FIRECLAY BECOMES MUDDY WHEN WET	MINIMAL	30	6 OR 7	50-60%	?	PILLARS ARE NOT PULLED	MANY FAULTS BUT NO EFFECT ON MINING

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3. For those companies where letters of request were necessary, favorable responses were followed up and interviews were scheduled by telephone.

4. Two man teams of data collectors visited each company scheduled where one to three individuals familiar with the mine being discussed responded collectively to the questions asked from the "Data Collection Form".

5. Upon completion of the interview the two data collectors compared notes to establish one complete set of information for that mine.

A synthesis of information from the data collected in this manner from all the mine locations was then performed. A tabulation was made beginning with the region and mine represented as shown in Table VII-2, Mine Data Tabulation. It should be noted that six different subregions of the eastern bituminous field are represented with thirteen undermining and fifteen overmining situations.

C. MINE SPECIFIC DATA COLLECTION

A key step in the development of both the statistical analysis and the Coal Loss Calculation Model (CLCM) was the retrieval of data from four selected deep mines. A substantial amount of detailed information taken from mine maps, borehole logs, the interview "Data Collection Form," and additional inputs from the mine engineers and superintendents was processed for each mine to permit empirical data to be entered for each of the critical variables. The following is a step-by-step description of the procedure used to collect the raw data and reduce it to a point where the appropriate variables could be entered on computer punch cards.

Step 1 -- Selection of Mines Suitable for Model Development and Validation -- The mines selected as suitable for model validation were chosen because they conformed most closely to the following criteria:

1. They were in an overmining or undermining situation.

2. They were located in different "areas of commonality" in the eastern bituminous region, i.e., Pennsylvania and southern West Virginia.

3. The company was cooperative, i.e., they were willing to provide mine maps, borehole logs, and time for interviews.

TABLE VII-2 MINE DATA TABULATION

78-85

REGION		MINE NAME (PROPRIETARY)	COUNTY	PMS OVER OR UNDER MINING	DEPTH OF OVERBURDEN (PMS)	DISTANCE BETWEEN SEAMS	SEAM THICKNESS (PMS)	ROOF/FLOOR (PMS)	ROOF/FLOOR (CMS)	% EXTRAC. (PMS)	PILLAR INFORMATION (PMS)	TIME ELAPSED SINCE PREVIOUS MINING (YRS)	% EXTRAC. (CMS)	PROBLEMS	EFFECTS OF PREVIOUS MINING
III	A		CENTRE, PA.	O	149	81	5	SHALE(SH)/CLAY WET(W)	SH CLAY(W)	60-85%		28	80-85%	WATER	FLOODING
III	B		SOMERSET, PA.	O	100-150	103-110	3'8 -4	"SLATE" HARD	SH CLAY(W)	85		0- 8	85	WATER	NONE
III	B		SOMERSET, PA.	U	287-354	103-110	6	(SH)/CLAY(W)	S.S./S.S.	60		18-40	70	WATER	CRACKS IN FLOOR
III	B		SOMERSET, PA.	U	519	85	4	SH SH & LIMESTONE (L.S.)(W)	SH SH-L.S.(W)	80		30-85	85	WATER	HEAVING, FRACTURING, CRACKS IN FLOOR
III	B	UM (2)	CAMBRIA, PA.	U	512-664	160	3'10-4	?	S.S./CLAY(W)	?		7-45	?	GAS-FLOOR EMISSIONS	ROOF CRACKS-20% REDUCTION IN COAL RECOVERY. WET FLOOR HEAVES
III	B		WASHINGTON, PA.	U	108-768	100-110	6	?	S.S./MUDSTONE	?		29-35	30 (STILL DEVELOPING)	---	BREAKAGE OF COAL, DROPOFFS, SHALLOW BONDING
III	B		GREENE, PA.	U	198-893	90-135	8	SH/SH(W)	SH-L.S./SH	85		0-45	85	WATER	SUBSIDENCE OF SECTION ~4'
III	B	UM (1)	SOMERSET, PA.	U	443-504	90-100	3-4	SH & SANDSTONE(S.S.) CLAY(W)	SH & S.S./SH	85		27-78	75-85	WATER-SOME GAS	ROOF PROBLEMS WHERE MAIN HEADINGS CROSSED-SUBSIDENCE CRACKS
III	B	OM (2)	CAMBRIA, PA.	O	267	150	3½	SH/CLAY	SH CLAY(W)	75-77	LONGWALL 60x120 PANEL	0-20	70	WATER	FLOODING - SOME CAVING - BAD ROOF
II	A		BOONE, W.VA.	U	?	180-200	5-7	SH/SH	SH/SH	70		?	50	GAS	HEAVING, CRACKING, BAD ROOF
II	A		FAYETTE, W.VA.	O	1000	120	4-4½	SH/SH(W)	SH/SH(W)	65-80		12-22	65-75	WATER-GAS FROM COAL	BOTTOMS CRACKED AND HEAVED - PILLARS SINKING; ROOF FRACTURES
II	A		KANAWHA, W.VA.	U	70-544	18-40	3-4	SH/SH(W)	SH/CLAY(W)	70		0-10	50-55	WATER	SIGNIF., HEAVING; SUBSIDENCE-MINING IMPOSSIBLE W O ALIGNMENT OF PILLARS
II	A		BOONE, W.VA.	O	0-680	80	3'6	SH/CLAY(W)	SH/CLAY(W)	85		½	85	WATER	NONE-MINES ALIGNED
II	A		KANAWHA, W.VA.	O	308	85	3	?/SH	SILTSTONE/CLAY	80		31	65-70	POTENTIAL WATER	
II	A		KANAWHA, W.VA.	O	280	207	3'4	SH/?	SILTSTONE/CLAY	80		14-17	65-70	POTENTIAL WATER	
II	A		FAYETTE, W.VA.	U	154-514	100-110	3'8	SH/SH	SH/CLAY	65		40	10	SOME WATER	
II	A		FAYETTE, W.VA.	O	50-400	40- 50	6'8	SH/SH	SH/CLAY	+85		14-15	10	SOME WATER	ROOF FALLS, FRACTURES
I	B		McDOWELL, W.VA.	U	384	60	4'6-4'9	SH/SH	S.S./CLAY	65		17-18	70	SOME GAS	SOME STRESS ZONES
I	B		McDOWELL, W.VA.	U	800-1000	75	5½	S.S./CLAY	SH/SH	85		19	?	GAS	SQUEEZING, SPALLING OF RIBS 15% COAL LOSS
I	B	OM (1)	McDOWELL, W.VA.	O	60-1000	80-130	3½	SH/SH(W)	S.S. CLAY(W)	80-90	PULL ALL PILLARS	0-10	80-90	WATER, GAS	MAIN HAULAGEWAY & ALIGNED-PROBLEMS WERE POOR PILLAR ALIGNMENTS
I	B		WYOMING, W.VA.	O	400-1000	200-210	5'8	SH/CLAY(W)	SH/CLAY(W)	70		5-15	85	WATER	HEAVING-SINKING PILLARS
I	B		RALEIGH, W.VA.	O	50-800	280-320	4	SH/CLAY(W)	SH-S.S./CLAY(W)	70-75		30-40	70-75	WATER	HEAVING-SINKING PILLARS
I	A		MERCER, W.VA.	O	0-594	140-160	~4	S.S.&SH MUDSTONE	SH MUDSTONE(W)	90-95	ALL STUMPS PULLED	SEVERAL	75-80	WATER	NONE-EXCEPT NEAR BARRIER PILLAR ON LEASE BOUNDARIES
I	B		RALEIGH, W.VA.	O	300	100-300	4'8"	SH/SH(W)	ROTTEN SH/SHALE	85		0-SEVERAL	60-75	SOME WATER, VERY GASSY	SOME ROLLING & HEAVING
I	B		RALEIGH, W.VA.	O	0-390	103	3'2"-3'10"	SH/SH	SH/SH & S.S.	85		10	85		
VII	B		UNION, KY.	U	330	120-130	5	"SLATE"(HARD) CLAY	THIN GOB & L.S. (MASSIVE)/CLAY	50-55	PILLARS BROKEN	0-26	50	DRY	~5% COAL LOSS DUE TO CAUTION - SOME SQUEEZING - PILLARS BROKEN IN PMS
VII	B		HOPKINS, KY.	O	173	71-90	5'5"	THIN GOB & L.S./CLAY	HARD SHALE/CLAY	60		0- 4	60	WATER (SURFACE), SOME GAS	NONE
VII	B		HOPKINS, KY.	O	71	90	8	SH & L.S. CLAY	SH CLAY(W)	60	PILLARS ARE NOT PULLED	1-30	50	WATER, SOME GAS	PILLAR SINKING

(PMS) PREVIOUSLY MINED SEAM
(CMS) CURRENTLY MINED SEAM
(W) WET

4. They had sufficient overburden to cause the stresses resulting in coal loss (greater than 200').

5. They were experiencing coal loss attributable to the effects from the previously mined seam.

6. The mine was of sufficient size to permit random sampling of fifty square four acre blocks from a population greater than fifty. (Note: one mine was large enough to sample fifty sixteen acre blocks.)

7. The currently mined seams were in the completion stage of operation or already completed so that coal loss magnitude could be established accurately.

On this basis four mines were selected in the following counties:

Previously Overmined - Mine OM(1), McDowell County, West Virginia
- Mine OM(2), Cambria County, Pennsylvania

Previously Undermined - Mine UM(1), Somerset County, Pennsylvania
- Mine UM(2), Cambria County, Pennsylvania

Step 2 - Securing the Data -- At least two visits were made to each mine to secure all necessary material from which data would be collected. The first visit was the interview described in the previous section. Although the intention of this initial interview was not to screen mines for possible use as model development and validation mines, the information from the "Data Collection Form" proved useful in choosing mines for such cooperation. The second visit to a cooperating mine was to further isolate areas within the mine where coal loss has occurred, determine water table elevations, further definition of water, gas, roof and floor problems, and to retrieve records that could be brought back to HRB-Singer such as: (a) mine maps of the two seams (b) borehole data and (c) topographic maps.

Step 3 - Sampling Procedure -- Once the necessary information was available at HRB-Singer, a detailed data extraction process was employed for each mine. The areas of the mine where empirical data was to be extracted were divided into square grids of either sixteen or four acres depending upon the size of the mine and the scale of the mine maps in such a way that fifty blocks* could be selected at random from the total population. A portion of the previously mined seam with the sample blocks superimposed is shown in Figure VII-6. The total number of blocks in each mine represented the population of sample areas. These totals are as follows: UM(1)-287, OM(1)-162, OM(2)-168, and UM(2)-100.

Step 4 - Sample Measurements -- Each of the fifty sample blocks for each mine seam was planimetered to obtain the areas of coal extracted and left in place. For a sample block, the total coal reserve tonnage estimate was calculated using the following formula:

$$RT = A \times t \times D/2000$$

where

RT = Total Coal Reserve Estimate per Sample Block (Tons)

A = Area of Sample Block (Ft.^{2})

t = Thickness of Coal Seam

D = Density of Coal

2000 = Pounds Per Ton

Using the measurements of the area extracted in square feet, the number of tons of coal extracted and left in place was generated for each sample using the results of the above formula.

Step 5 - Data Collection from Mine Records -- Additional data from both the previously mined and currently mined seam for each sample block was collected using the data sheet shown in Figure VII-7. Below is a description of the procedure for collecting data.

* Number of Pillars -- all remaining pillars except barrier pillars and pillars nearly outside boundary of the sample block were counted.

---

* The sample size of N=50 for each mine was considered adequate for the purpose of this study. For further discussion of sample size determination, see Dixon, W. S. and Massey, F.J., 1969: Introduction to Statistical Analysis, pp. 80, 86, 270-275 and 346-354 and Tables A-12a to A-12e and A-21a.

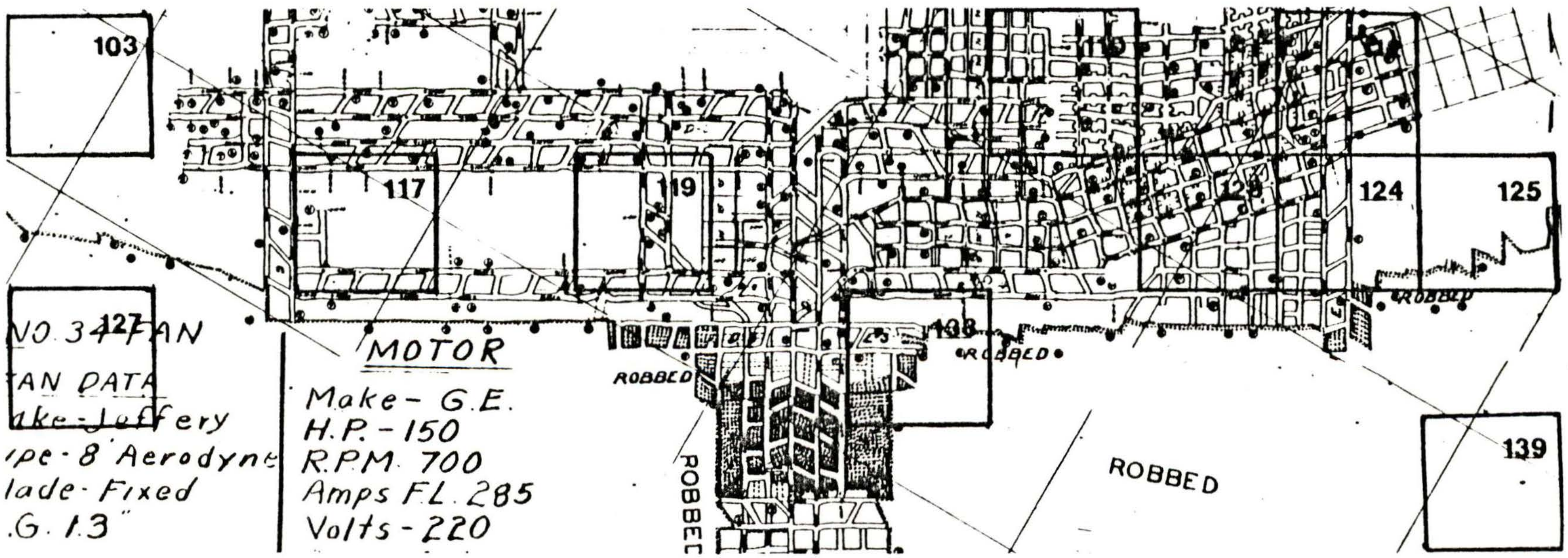

FIG. VII-6 SEGMENT OF MINE SEAM CONTAINING RANDOMLY SAMPLED BLOCKS

76-65

MINE OR

COLLIERY ______________ LOCATION ______________

SECTION # ______________ SURFACE ELEVATION __________ R

BLOCK # SQ. FOOT AREA: ______________ BEDROCK SURFACE ELEV. __________ R

NO. OF PILLARS ______________ WATER TABLE ELEVATION __________

COAL RANK ______________ DATE ______________

LITHOLOGY	ROOF & FLOOR PROBLEMS	PROBLEM SEVERITY
A-CLAY	H-NONE	1-NOTICEABLE
B-MUDSTONE	I-FALLS	2-SOMEWHAT TROUBLESOME
C-SHALE	J-SQUEEZE	3-IMPAIRS PRODUCTION
D-SILTSTONE	K-BUMPS	4-HALTS OPERATIONS
E-SANDSTONE	L-HEAVING	
F-CONGLOMERATE	M-CRACKS	
G-LIMESTONE		

ENGINEER ______________

FORM COMPLETED BY ______________

SEAM	USBM CODE	R ELEV. (FT.)	THICKNESS (FT.) R	DIP & DIRECTION AND STRIKE (DIR.)	DATE MINED R	% EXTRACTION A-ADVANCE, R-RETREAT	LITHOLOGY			RESERVE ESTIMATE (TONS)*	PRODUCTION/BLOCK (TONS)*	ENTRY WIDTH (FT.) R	CROSSCUT WIDTH R (FT.)	PILLAR CONDITION (MAKE COMMENTS)	PILLAR WIDTH R (FT.)	PILLAR LENGTH R	WANT AREAS (Y/N)	FLOODING (Y/N)	SPAN (FT.) R	WATER (GPM)	GAS (CFM)	ROOF PROBLEMS (Y/N)	FLOOR PROBLEMS	MINING METHOD (RP/L/S)
							ROOF	FLOOR	ROCK COVER															

COMMENTS: (GENERAL GEOLOGIC CONDITIONS OF BLOCK, FRACTURES, FAULT ZONES, LOCAL FOLDING, WANT AREAS, ETC. KEY TO SEAM CODE. FOR "WANT AREAS" INDICATE FREQUENCY OF OCCURRENCE AND SQUARE FOOTAGE.) R INDICATES RANGE; * INDICATES THAT ENTRY MUST BE CALCULATED.

FIG. VII-7 MINE SPECIFIC DATA COLLECTION FORM

76-65

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* Coal Rank -- Determined from the regional analysis (MAP 6) or from the engineer at the mine.

* Surface Elevation -- A topographic map from the mine company or a USGS topographic map was used to determine the maximum and minimum surface elevation in the sample block.

* Water Table Elevation -- Entered if the mine engineer supplied it, otherwise not used.

* Seam Name -- Supplied by the mining company.

* USBM Code -- The USBM number designation for the seam.

* Elevation -- The coal seam elevation taken from the floor of the mine. Structure contour lines on the mine maps indicated these elevations. Borehole data were used where boreholes were frequent.

* Thickness -- The average thickness in the sample block of the material extracted as recorded on the mine maps or from borehole data.

* Dip and Strike -- Determined from coal bed contour lines on the mine maps.

* Date Mined -- Dates were either taken directly from the mine map or a range was derived from two dates if the dates were recorded in only a few places on the maps.

* Percent Extraction -- Determined by planimetry of the mine map.

* Lithology -- Taken from borehole data. This includes the immediate roof, the floor, and the predominant lithology of the rock cover.

* Entry and Crosscut Widths -- No distinction was made between entry or crosscut dimensions. The maximum and minimum widths were recorded wherever they appeared.

* Maximum and Minimum Pillar Dimensions -- The width of the widest pillar and length of the longest pillar was recorded for maximum pillar dimensions. For minimum pillar dimensions, the pillar with the shortest width and the pillar with the shortest length was recorded.

* Span -- Considered to be the maximum unsupported distance of the roof. If only first mining occurred, the span is the maximum entry width.

If robbed, it is the greatest lateral distance across the unsupported area. Figure VII-8 illustrates a span width.

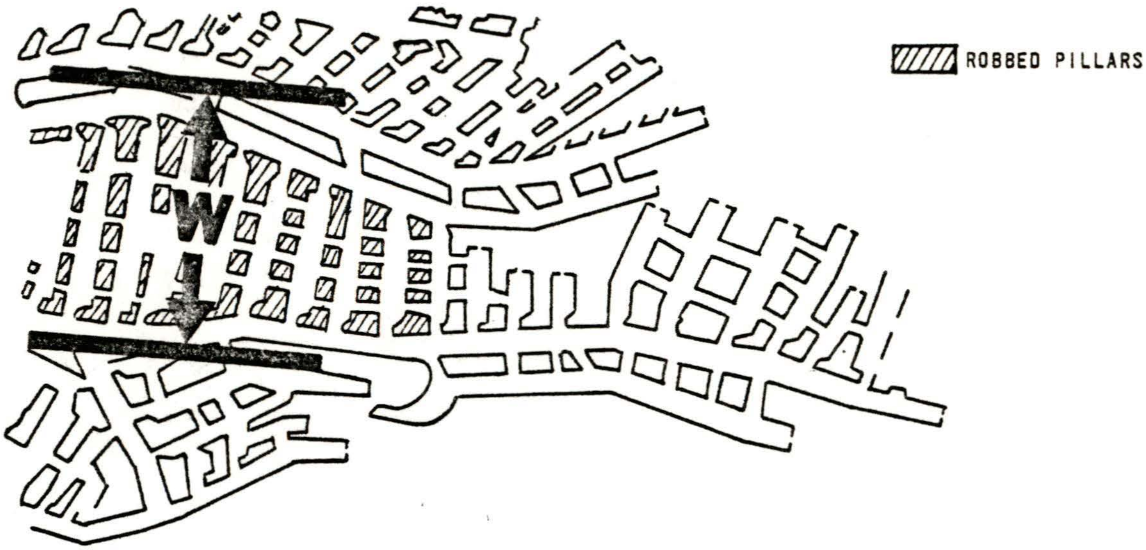

FIG. VII-8 MINE MAP SHOWING METHOD OF MEASURING WIDTH (SPAN) OF UNSUPPORTED OPEN DISTANCE. HATCHED LINES INDICATES ROBBED PILLARS.

76-65

* Mining Method -- The mine was recorded as a room and pillar, short wall, or long wall mine area in the block by mine map observation.

* Water, Gas, Roof, Floor Problems -- This information as well as coal density was taken from interview notes and other sources.

Step 6 - Keypunching -- Data for computer analysis was key punched from the specific mine data forms thus fulfilling the requirement of translating data from general mine and topographic map or borehole information into specific sample areas with specific critical variable values.

VIII. MODEL DEVELOPMENT AND VALIDATION -- STATISTICAL APPROACH

A. CONCEPTUAL FRAMEWORK OF THE STATISTICAL MODEL

In the original proposal submitted to the United States Bureau of Mines, a conceptual model was outlined which aimed at measuring the impact(s) or potential impact(s) of previous mining in adjacent seams on the recoverability of coal in a reserve seam. The model was conceived as the final product of a statistical analysis of the critical variables identified in the study through literature review and the opinions of experts. In the course of this study it became apparent that a statistical analysis alone would not provide the answer as to the specific impact on coal loss caused by a previously mined seam, but rather provided information on total coal loss to be expected in a current mining operation. To overcome this difficulty, it was decided early in the project to develop an engineering assessment model independently of the statistical activity that would predict coal loss due to the impact of previous mining in adjacent seams. This model is discussed in detail in Section IX and is the model used in the development of the computer program described in the User's Manual accompanying this report.

The statistical analysis was extremely useful in that it aided in the selection of the significant independent variables that should be used in the engineering assessment model and provided estimates of the total coal loss to be expected in current mining practices in areas where multiple seam mining has occurred.

The statistical model development incorporated all of our apriori knowledge of the mechanisms involved in seam interaction. To do this, two versions of the model were investigated; Model UM for the undermined case and Model OM for the overmined case. Each model specifies the functional relationship between the recoverability of coal in the reserve or currently mined seam and the physical variables attributed to previous mining of an adjacent seam. The variables considered are limited to the physical variables associated with the previously mined seam. The relationship embodied in each model was determined empirically. Principal Components Analysis and Multiple Regression were the statistical techniques applied to derive the empirical contents of both Models UM and OM.

The mathematics* behind both models are the same. However, their empirical content varies because of the differences in operational factors under each case. For example, subsidence is a major problem for undermined conditions, but does not exist for overmined conditions. Gas problems may be critical for undermined conditions, and water entry for overmined conditions. This also suggests some differences in the assumptions made under each case. The assumptions, and functional relations, behind each model are discussed below.

ASSUMPTIONS:

Model UM	Model OM
1. There are n seams of coal reserves in vertically adjacent areas (multiple seam).	1. Same as No. 1 under Model UM.
2. One or more lower seams had been previously mined and there remain n - 1 or n - k reserve seams above.	2. Same except upper seam had been mined previously and there remain n - 1 or n - k reserve seams below.
3. It is assumed that for an area, the recoverable coal from the overlying n - 1 or n - k reserve seams is less than the estimated (indicated and measured) reserve base. It is stated in USBM IC 8655 that coal can be lost to mining, especially in areas of active mining where there are multiple coal	3. Same except the condition is overmined, that is recoverable coal is from the underlying n - 1 or n - k reserve seams.

* In general, most introductory textbooks on "multivariate analysis" include the presentation of the mathematics behind principal components analysis and multiple regression technique.

Model UM (Cont'd)

beds and beds that are hazardous and expensive to mine overlying or underlying worked out beds. Several factors can account for the difference between the reserve base and the actual recoverable deposit. Model UM is capable of quantifying the influence of the various selected variables affecting the recoverability of coal from reserve seams overlying the undermined seam. The physical variables and related phenomena and problems associated with the undermined conditions are enumerated under Assumption 4.

4. According to established literature sources, the problems associated with undermined conditions are: (a) subsidence; (b) occurrence of high stress zones due to pillar pressures from old workings; (c) fracturing, either induced or natural, and gas emission. Each of these phenomenon is brought about by the interaction of the specific physical variable related to the characteristics of the undermined seams and the overlying reserve seams.

Model OM (Cont'd)

4. Occurrence of high stress zones and fracturing are problems resulting from overmined conditions. In addition, water entry and accumulation is also a problem.

Model UM (Cont'd)

5. Model UM assumes that the volume of coal that can be recovered from n - 1 or n - k reserve seams overlying the K undermined seam(s) is a function of the physical variables together with a random element.

Model OM (Cont'd)

5. Same except the condition is over-mined.

B. FUNCTIONAL RELATIONS

Equation (1) represents Model UM. It is an abstract representation of the functional relationships between recoverability of coal in the reserve seam(s) or currently mined seam and the operational physical factors in the previously undermined seam(s). Throughout the discussion model UM refers to the undermined condition.

Model UM

$$RCu_i = f_i(SMAX,\ R,\ \frac{LR}{LF},\ \frac{Ps}{PL},\ W,\ T,\ L,\ DT,\ D,\ f,\ G,\ g,\ U_i) \qquad (1)$$

Identify Conditions:

$$RCu_i \leq RTu_i;\ RTu_i - RCu_i \geq 0 = \Delta R$$

$$\sum_{i=1}^{n-k} RCu_i \leq \sum_{i=1}^{n-k} RTu_i;\ \sum_{i=1}^{n-k} RTu_i = RTA$$

where

RCu_i = quantity of bituminous coal recoverable (or actual raw coal extracted) from reserve seam i lying above a previously undermined seam(s) in a specific area.

RTu_i = reported quantity (estimated) of indicated and measured bituminous coal reserve in seam i lying above an undermined seam in a specific area.

ΔR = quantity of unmined coal in reserve seam i.

RTA = reported total size/quantity of indicated and measured bituminous coal reserve in the multiple seams for a specific area.

SMAX = maximum subsidence (ft.) (See Section IX C)

R = stress zones due to pillar pressure (ft) (See Section IX C)

LR = strength of roof (previously and currently mined seam) (lbs/in^2) (See Section IX C)

LF = strength of floor (previously and currently mined seam) (lbs/in^2) (See Section IX C)

Ps = pillar strength (previously mined seam) lbs/in^2 (See Section IX C)

PL = pillar load (previously mined seam) lbs/in^2 (See Section IX C)

W = span (greatest unsupported distance) or distance between major pillars (feet)

T = time elapsed between mining (years, months)

L = lithology of intervening strata (lbs/in^2)

DT = vertical distance between the seam to be mined (or currently mined seam) and previously mined seam (feet)

D = depth of the seam to be worked below the surface (feet)

f = natural/induced fracture

g = dip of the seam to be mined

G = gas emission rate

H = water emission rate

e = percent extraction

U_i = random error

Equation (2) represents Model OM. It is the general representation of the functional relationships between the recoverability of coal in the reserve seam(s) or currently mined seam and the operational physical factors in the previously overmined seam(s). Model OM then refers to the overmined condition.

Model OM

$$RCo_i = f_i\left(R, \frac{LR}{LF}, \frac{Ps}{PL}, W, L, DT, g, f, e, H, U_i\right) \quad (2)$$

Conditions

$$RCo_i \leq RTo_i;\ RTo_i - RCo_i \geq 0 = \Delta R$$

$$\sum_{i=1}^{n-k} RCo_i \leq \sum_{i=1}^{n-k} RTo_i;\ \sum_{i=1}^{n-k} RTo_i = RTA$$

where

RCo_i = quantity of bituminous coal recoverable (or actual raw coal extracted) from reserve seam i lying below a previously overmined seam.

RTo_i = reported quantity (estimated) of indicated and measured bituminous coal reserve in seam i lying below a previously mined seam.

RTA and all other variables in Equation (2) are identified under the section on Functional Relations of Model UM.

C. STATISTICAL ANALYSIS

This phase of the study presents a statistical analysis of the impact of previous mining on the recoverability* of the remaining coal reserve base in multiple seam areas. The empirical analyses include cases of both undermined and overmined conditions with respect to two vertically adjacent seams only. The empirical analysis also focuses on the determination of the inter-relationships of the physical variables associated with the previously mined seam. Independency between and among such variables are established. In addition, the structural relationships between the rate of recoverability of coal in the currently mined seam as a function of the operational physical variables in the previously mined seam are estimated.

Principal components analysis and the technique of multiple regression are the statistical tools used to determine the impact of previous mining on the recoverability of the remaining coal reserve base. The method of principal components is used in the classification and reduction of the number of variables (associated with the previously mined seam) into independent sets. Multiple regression of the least squares single equation method of estimation is employed to estimate the impact of the independent variables on the percentage of coal extraction from the currently mined seam. The impact of previous mining is analyzed statistically under two conditions. One is the undermined condition where overmining is the current operation and the other is the overmined condition, where the current operation is undermining.

The sequential steps employed in the statistical analyses are summarized below. The detailed steps of the methodology are presented in Appendix C. The presentation of results are emphasized in the sections that follow.

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* Inversely, it also implies the impact of previous mining on how much coal is left in place in multiple seam areas.

1. Data Processing

The data base consists of sixty-three variables (Appendix C) entered as values or codes into card punched data decks. The first forty-three variables (X_1 to X_{43}) were collected from the sources indicated and recorded on the data collection form (Figure VII-7). Some of the forty-three variables do not have any data or observations and are recorded as blanks or zeros. These forty-three variables were used for the generation of the data of the last twenty variables (X_{44} to X_{63}). These variables are differences, products, and ratios of the first forty-three. The formulas used to generate the last twenty variables are also listed in Appendix C.

2. Selection of Critical Variables

The statistical analyses conducted on each set of data from each of the three mines analyzed* represent pioneering attempts at the determination of the impacts of previous overmining or undermining to the recoverability of coal from the reserve base in multiple seam areas. The data from both mines currently operating under a previously overmined seam (OM(1)) and (OM(2)) were analyzed to validate empirically the concepts embodied in model OM (equation 2, Section VIII B). The data from the mine currently operating over a previously undermined seam (UM(1)) were also analyzed to validate empirically the concepts underlying Model UM (equation 1, Section VIII B). Each of the data sets was analyzed using principal components and multiple regression statistical techniques.

The selection of the variables included in the statistical and empirical analyses was based on two considerations:

a. theoretical formulations embodied in Models UM and OM as based on the results of the literature review, critical parameter definition, and the concurrence of selected recognized mining experts, and

* The complete (63 variables) data deck was not collected or statistically analyzed for the fourth validation mine. By the time mine company permission for data collection was granted for the fourth mine, statistical analysis was in its final stages. Twelve variables were collected from the fourth mine and used in validation of the coal loss calculation model.

b. availability of the data. Data were obtained for all of the variables included in the conceptual formulation of Models UM and OM except for gas and water emission rate and natural induced fractures. Room and pillar was the only method of mining employed in the three selected validation mines.

For the three mines as a whole, twenty-four variables were chosen for the statistical analysis based on the defined scope of models UM and OM and data availability. These variables and the mean values for the three mines are shown in table VIII-1.

With the same mining technique reported in each mine, it is interesting to note that the mean values of the CMS percent extraction (X_{15}) in the two previously overmined mines are approximately 12 percent higher than the mean value of the same variable for the previously undermined mine. Inversely, the CMS total coal loss (X_{47}) was higher in the previously undermined mine than in the two that had been previously overmined. On the other hand, PMS percent extraction (X_{37}) was 21 percent higher in the previously undermined mine than in the previously overmined mine. The differences in the averages of percent extraction in the currently mined seam and in the previously mined seam between the undermined and overmined conditions can be a reflection of many factors and problems surrounding each condition. Some of these factors associated with each condition impacting on CMS percent extraction have been established in this study.

In the analysis of the data from both the OM(1) and OM(2) mines maximum subsidence (X_{54}) and percent subsidence (X_{63}) were excluded. These two variables represent measures of subsidence which do not exist when the CMS underlies a previously overmined seam.

Complete data listings for the mines tested are included in Appendix D.

TABLE VIII-1 MEAN VALUES OF THE TWENTY FOUR VARIABLES INCLUDED IN THE STATISTICAL ANALYSIS

78-65

VARIABLES		UNITS	MINES		
NUMBER	NAME		UM(1) n=50	OM(1) n=47	OM(2) n=32
X_{15}	CMS % EXTRACTION	PERCENT	53.86	65.17	64.18
X_{19}	CMS MINIMUN PILLAR WIDTH	FEET	47.44	23.32	49.78
X_{20}	CMS SPAN	FEET	467.80	299.0	290.94
X_{25}	CMS WATER PROBLEM	NONE 1)	2) ---	2) ---	2) ---
X_{37}	PMS % EXTRACTION	PERCENT	75.10	54.57	48.16
X_{41}	PMS PILLAR WIDTH	FEET	39.44	37.62	40.84
X_{42}	PMS SPAN	FEET	576.60	269.00	269.53
X_{47}	CMS % COAL LOSS	PERCENT	46.24	34.74	35.87
X_{48}	CMS COAL EXTRACTED/PER ACRE	TONS	6223.38	7020.00	4628.59
X_{49}	CMS COAL LOSS PER ACRE	TONS	6613.27	3789.00	2617.78
X_{50}	CMS DEPTH BELOW THE SURFACE	FEET	388.52	830.00	531.16
X_{51}	PMS DEPTH BELOW THE SURFACE	FEET	478.52	718.95	379.78
X_{52}	VERTICAL DISTANCE BETWEEN THE SEAMS	FEET	90.00	111.70	151.37
X_{53}	VERTICAL EXTENT OF PRESSURE ARCH STRESS ZONES	FEET	263.58	335.80	233.91
X_{54}	MAXIMUM SUBSIDENCE	FEET	3.23	2) ---	2) ---
X_{55}	PMS PILLAR STRENGTH	LBS/IN^2	3) 1584.46	4) 3337.00	2870.72
X_{56}	PMS PILLAR LOAD	LBS/IN^2	3) 1600.22	4) 1734.00	1391.84
X_{57}	PMS RATIO OF PILLAR STRENGTH TO PILLAR LOAD	RATIO	1.44	2.47	3.73
X_{58}	CMS RATIO OF ROOF STRENGTH TO FLOOR STRENGTH	RATIO	1.95	4.00	4.58
X_{59}	CMS RATIO OF ROOF STRENGTH TO FLOOR STRENGTH	RATIO	4.79	4.00	4.75
X_{60}	PMS DEPTH OF OVERBURDEN	FEET	472.52	714.00	375.81
X_{61}	TIME ELAPSED BETWEEN MINING	YEAR OR FRACTION	25.22	10.84	25.27
X_{62}	CRITICAL EXCAVATION WIDTH LIMIT	FEET	131.92	167.80	117.00
X_{63}	PERCENT SUBSIDENCE	RATIO	0.56	2) ---	2) ---

1) VALUES FOR X_{25} ARE CODE ZERO OR 1

2) NOT APPLICABLE

3) BASED ON n = 31

4) BASED ON n = 29

CMS = CURRENTLY MINED SEAM

PMS = PREVIOUSLY MINED SEAM

3. Tests for Normality

In order to fulfill the statistical assumptions of principal components and multiple regression analysis the data were tested for normality. The NORMSTAT program algorithm* was used to analyze the distribution of observations for the selected variables in each data deck. The details of the tests for normality are included in "Tests for Normality" in Appendix C.

4. Principal Components Analysis and Results

a. Principal Components Analysis

The data outputs from the NORMSTAT analysis for each mine data deck were factor analyzed. The CORFAN (Correlation Factor Analysis) Program Algorithm** was used. The primary purpose of utilizing principal components analysis for analyzing the 24 selected variables was to classify them into independent sets and identify the redundant variables. The unrotated factor matrix was used in the classification. This classification technique also detects the existence of multicolinearity among the variables. The mechanics of the application of principal components analysis is discussed in Appendix C.

b. Results of Principal Components Analysis

(1) UM(1) Data, Somerset County, Pennsylvania

The matrix of factor loadings and the correlation coefficients matrix (See Appendix E) were utilized to produce three basic groups of variables significant at the 1% level (Table VIII-2). These groupings suggest that only one of the variables from each group can be used at a time. The degree

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* The algorithm was acquired from Dr. J. Griffith, Professor of Geostatistics at the Pennsylvania State University and consultant to HRB-Singer.

** Ondrick, C. W. and G. S. Srivastava. 1970, CORFAN-FORTRAN IV. Computer Program for Correlation Factor Analysis (R. and Q. Mode) and Varimax Rotation, Computer Contribution 42. State Geological Survey, The University of Kansas, Lawrence 92 pages.

TABLE VIII-2 REDUNDANT VARIABLES UM(1) MINE DATA (n = 31)

76-65

SIGNIFICANT CORRELATION COEFFICENTS

VARIATIONS NUMBER	GROUP A	X_{15}	X_{20}	X_{47}	X_{48}
X_{15}	CMS % EXTRACTION	1.00			
X_{20}	CMS SPAN	.73	1.00		
X_{47}	CMS % COAL LOSS	-1.00	-.732	1.00	
X_{48}	CMS COAL EXTRACTED/ACRE	.965	.766	-.963	1.00

VARIATIONS NUMBER	GROUP B	X_{37}	X_{42}	X_{54}	X_{57}	X_{63}
X_{37}	PMS PERCENT EXTRACTION	1.00				
X_{42}	PMS SPAN	.836	1.00			
X_{54}	MAXIMUM SUBSIDENCE	.979	.879	1.00		
X_{57}	PMS RATIO PILLAR STRENGTH/ PILLAR LOAD	-.767	-.787	-.819	1.00	
X_{63}	PERCENT SUBSIDENCE	.979	.879	1.00	.819	1.00

VARIABLES NUMBER	GROUP C	X_{50}	X_{51}	X_{53}	X_{57}	X_{58}	X_{59}	X_{60}	X_{62}
X_{50}	CMS DEPTH BELOW THE SURFACE	1.00							
X_{51}	PMS DEPTH BELOW THE SURFACE	.996	1.00						
X_{53}	VERTICAL EXTENT OF PRESSURE ARCH STRESS ZONE	.996	1.00	1.00					
X_{57}	PMS RATIO OF PILLAR STRENGTH/ PILLAR LOAD	-.518	-.530	-.529	1.00				
X_{58}	CMS RATIO OF ROOF STRENGTH TO FLOOR STRENGTH	.627	.630	.630	--	1.00			
X_{59}	PMS RATIO OF ROOF STRENGTH TO FLOOR STRENGTH	.664	.665	.665	--	.760	1.00		
X_{60}	PMS DEPTH OF OVERBURDEN	.996	1.00	1.00	.530	.630	.665	1.00	
X_{62}	CRITICAL EXCAVATION WIDTH LIMIT	.996	1.00	1.00	.533	.627	.665	1.00	1.00

CMS = CURRENTLY MINED SEAM PMS = PREVIOUSLY MINED SEAM

of substitutability of each variable in each group varies. Those variables with correlation coefficients of .99 or 1.00 are perfect substitutes. The degree of substitutability drops off as the value of the coefficient drops.

Based on the factor loadings presented in Appendix C and the variable groups (particularly B and C), one can conclude that X_{52} (vertical distance between the seams) and X_{61} (time elapsed between mining of CMS and PMS) are independent not only of each other but also with each of the variables in the B and C groups. Since X_{52} and X_{61} have the highest loadings on components 5 and 8 respectively, each of them was chosen as an independent set. Both of them are used as independent variables in the multiple regression analysis in addition to X_{37} (PMS percent extraction) and X_{60} (PMS depth of overburden).

The independent variables defined are then the best input variables to the multiple regression analysis. The variable with the highest loading from each group can be selected, or one can use its substitute. Logic and knowledge of the relationships between the dependent and independent variables must be considered during variable selection and substitution.* The utility and practical application of the results from the regression analysis must also enter into the decision of selection of the independent sets of variables. From the UM(1) data, X_{37}, X_{52}, X_{60} and X_{61} exemplify an independent set of variables.

More detail on the implications of correlation coefficients in relation to variables with high factor loadings is included in Appendix C.

(2) <u>OM(1) DATA, McDowell County, West Virginia and OM(2) Cambria County, Pennsylvania</u>

These two mines both represented the overmined condition. However, separate components analyses were done for the data from each mine for two reasons: (1) the OM(1) mine is in region IB and the OM(2) mine is in region IIIB; (2) variability was observed from the data on lithology of the CMS and PMS ratios of roof strength to floor strength for the OM(2) mine. (Variation occurred on roof strength for both PMS and CMS but there was none

* The correlation coefficient matrix will be very useful to the researchers in this regard.

in the OM(1) mine.) Hence, the variables relating to the ratio of roof to floor strength (X_{58} and X_{59}) were excluded in the statistical analysis of the OM(1) mine.

The complete results of the principal components analysis for both data sets are presented in Appendices E3, E4, and E5, respectively. The same variable groupings were observed from both mines. These variable groupings are presented in Tables VIII-3 and VIII-4. The analyses and interpretation of factor loadings from both mines together with the variable groupings showed about the same set of independent variables observed from the UM(1) mine data. However, variables representing maximum subsidence (X_{54}) and percent subsidence (X_{63}) are excluded from these analyses. These two variables do not have any effect on coal recoverability or coal loss from the seam underlying a previously overmined seam.

5. Multiple Regression Analysis

The results from the principal components analysis and the variable groupings suggest that four independent variables can be used simultaneously in the regression equation, representing both the undermined and overmined conditions.*

These variables are included in equation (3), where CMS % extraction (X_{15}) is the dependent variable and the previously mined seam percent extraction (X_{37}), the vertical distance between the seams (X_{52}), the previously mined seam depth of overburden (X_{60}), and the time elapsed between mining (X_{61}) are the independent variables.

$$X_{15} = \mathcal{L}_0 + \beta_1 X_{37} + \beta_2 X_{52} + \beta_3 X_{60} + \beta_4 X_{61} + U_i \quad (3)$$

The parameters $\mathcal{L}_0$, β_1, β_2, β_3, and β_4 are unknown and are calculated in the multiple regression analysis where $\mathcal{L}_0$ represents the intercept of the equation. Mathematically, $\mathcal{L}_0$ represents the level or magnitude of X_{15} when all the independent variables (X_{37}, X_{52}, X_{60} and X_{61}) have zero values. β_i's (i = 1 2 3 4) represent the regression coefficients (or slopes) for each of the respective independent variables. In statistical parlance, the β_i's or

*Only four non-redundant variables are considered to be independent. See Appendix C. The entire list of non-redundant variables were employed as modifications to Equation (4) (Appendix F).

TABLE VIII-3 REDUNDANT VARIABLES - OM(1) MINE DATA (n = 29)

76-65

SIGNIFICANT CORRELATION COEFFICIENT

NUMBER	GROUP A	X_{15}	X_{19}	X_{20}	X_{47}	X_{48}	X_{49}
X_{15}	CMS % EXTRACTION	1.00					
X_{19}	CMS PILLAR WIDTH	-.924	1.00				
X_{41}	CMS SPAN	.814	-.796	1.00			
X_{47}	CMS % COAL LOSS	-1.00	.924	-.813	1.00		
X_{48}	CMS COAL EXTRACTED/ACRE	.905	-.732	.680	-.905	1.00	
X_{49}	CMS COAL LOSS/ACRE	-.887	.864	-.698	.887	-.697	1.00

NUMBER	GROUP B	X_{37}	X_{42}	X_{56}	X_{57}
X_{37}	PMS PERCENT EXTRACTION	1.00			
X_{42}	PMS SPAN	.716	1.00		
X_{56}	PMS PILLAR LOAD	.791	.746	1.00	
X_{57}	PMS RATIO PILLAR STRENGTH/PILLAR LOAD	-.653	-.618	.453	1.00

NUMBER	GROUP C	X_{50}	X_{51}	X_{53}	X_{56}	X_{57}	X_{60}	X_{62}
X_{50}	CMS DEPTH BELOW THE SURFACE	1.00						
X_{51}	PMS DEPTH BELOW THE SURFACE	.999	1.00					
X_{53}	VERTICAL EXTENT OF PRESSURE ARCH STRESS ZONES	.999	1.00	1.00				
X_{56}	PMS PILLAR LOAD	.576	.574	.574	1.00			
X_{57}	PMS RATIO OF PILLAR STRENGTH/PILLAR LOAD	-.608	-.613	-.613	-.90	1.00		
X_{60}	PMS DEPTH OF OVERBURDEN	.999	1.00	1.00	.574	-.613	1.00	
X_{62}	CRITICAL EXCAVATION WIDTH LIMIT	.999	1.00	1.00	.572	-.611	1.00	1.00

CMS = CURRENTLY MINED SEAM PMS = PREVIOUSLY MINED SEAM

TABLE VIII-4 REDUNDANT VARIABLES - OM(2) MINE DATA (n = 32)

76-65

SIGNIFICANT CORRELATION COEFFICIENTS

NUMBER	GROUP A (VARIABLES)	X_{15}	X_{20}	X_{47}	X_{48}
X_{15}	CMS % EXTRACTION	1.00			
X_{20}	CMS SPAN	.726	1.00		
X_{47}	CMS % COAL LOSS	-1.00	-.725	1.00	
X_{48}	CMS COAL EXTRACTED PER ACRE	.963	.644	-.962	1.00

NUMBER	GROUP B (VARIABLES)	X_{37}	X_{41}	X_{42}	X_{56}	X_{57}
X_{37}	PMS % EXTRACTION	1.00				
X_{41}	PMS PILLAR MINIMUM WIDTH	-.547	1.00			
X_{42}	PMS SPAN	.788	-.507	1.00		
X_{56}	PMS PILLAR LOAD	.897	-.408	.618	1.00	
X_{57}	PMS RATIO OF PILLAR STRENGTH TO PILLAR LOAD	-.901	.684	-.735	-.869	1.00

NUMBER	GROUP C (VARIABLES)	X_{50}	X_{51}	X_{53}	X_{58}	X_{59}	X_{60}	X_{62}
X_{50}	CMS DEPTH BELOW THE SURFACE	1.00						
X_{51}	PMS DEPTH BELOW THE SURFACE	.998	1.00					
X_{53}	VERTICAL EXTENT OF PRESSURE ARCH STRESS ZONES	.998	1.00	1.00				
X_{58}	CMS RATIO OF ROOF STRENGTH TO FLOOR STRENGTH	.849	.861	.863	1.00			
X_{59}	PMS RATIO OF ROOF STRENGTH TO FLOOR STRENGTH	.849	.860	.862	1.00	1.00		
X_{60}	PMS DEPTH OF OVERBURDEN	.998	1.00	1.00	.860	-.860	1.00	
X_{62}	CRITICAL EXCAVATION WIDTH LIMIT	.996	1.00	.999	.863	-.863	1.00	1.00

CMS = CURRENTLY MINED SEAM PMS = PREVIOUSLY MINED SEAM

regression coefficients are the least-squares linear estimators that are unbiased and they possess a smaller variance than any other linear unbiased estimators. Because of these properties, the β_i's are known as the best linear unbiased estimators. The β_i's measure the change in the dependent variable when the independent variables change by a unit.

The symbol U_i included in equation (3) represents the residuals or random error terms. These are considered random elements and to some extent can represent the other independent variables that could have been included in the estimating equation but were not identified, as in the case of equation (3).

At this point, it is important to reiterate that in the estimation of equation (3) for the undermined condition, the subsidence variable, either maximum subsidence (X_{54}) or percent subsidence (X_{63}) can be used for X_{37}. However, this condition does not apply to the estimation of equation (3) for the overmined condition. Hence, it can be stated that the empirical content of equation (3) differs between Model UM and Model OM.

The multiple regression analysis emphasized the physical (independent) variables of the previously mined seam. This was done since the primary aim of the statistical analysis was to assess the impact or potential impact of previous mining on the recoverability of coal from the underlying or overlying reserve seams. The impact or potential impact in reality is measurable in terms of the reduction in percent recoverability (percent extraction) in the currently mined seam(s) in which vertically adjacent seams had been previously undermined or overmined. The reduction in percent extraction can be called percent coal loss* due to previous undermining or overmining as the case may be. The estimated equation from the multiple regression analysis has CMS percent extraction (X_{15}) as the dependent variable. Hence, X_{15} can be predicted by the

* The calculation of coal loss due specifically to over and undermining is presented in the Coal Loss Calculation Model, Section IX. The statistical analysis emphasized the selection of the significant independent variables input into the Coal Loss Calculation Model and addresses the total coal loss to be expected in the currently mined seam.

estimated equations for both the undermined and the overmined conditions.* When the CMS % extraction is known, then the CMS percent coal loss or percent coal left in place can be determined.

a. The Undermined Condition (Mine UM(1))

The multiple regression equation for the undermined condition (Model UM) is represented by Equation (3). In this equation, X_{15} (CMS percent extraction) is the dependent variable. The independent variables are X_{37}, (PMS percent extraction), X_{52} (vertical distance between the seams), X_{60} (PMS depth of overburden), and X_{61} (time elapsed between mining or the time difference between mining the two seams).

The estimated equations derived empirically from the UM(1) mine data are shown in equations (4) and (5). Equation (4) was estimated from the data set n = 31. Equation (5) was estimated using the data set n = 50.

$$X_{15} = \underset{(4.73)}{\overset{**}{146.824}} + \underset{(1.69)}{\overset{***}{0.2718}} X_{37} + \underset{(.90)}{\overset{****}{0.2562}} X_{52} + \underset{(.88)}{\overset{****}{0.0307}} X_{60} - \underset{(2.08)}{\overset{**}{105.5506}} \log X_{61} \qquad (4)$$

R = .668

$F_{(4,25)} = 3.83$

$$X_{15} = \underset{(4.26)}{\overset{**}{191.823}} + \underset{(1.82)}{\overset{***}{0.2266}} X_{37} - \underset{(.59)}{\overset{*****}{.1583}} X_{52} + \underset{(.55)}{\overset{*****}{0.0158}} X_{60} - \underset{(2.56)}{\overset{**}{105.8583}} \log X_{61} \qquad (5)$$

R = .50

$F_{(4,44)} = 3.67$

---

* Results obtained from this analysis must be used with caution. The data used are mine specific, and hence, the results apply to mine specific situations. However, generalizations can be made within the range of the data from which the coefficients are derived.

** significant at 2.5% level

*** significant at 5% level

**** significant at 20% level

***** significant at 30% level

The estimated (slope or regression) coefficients for each of the independent variables in equations (4) and (5) can be interpreted as the unit decrease or increase in the dependent variable when the independent variable is increased by a unit. It is a decrease when the coefficient is preceded by a negative sign and an increase if the coefficient has a positive sign. The numbers in parentheses below the coefficients are calculated t - values. These calculated t - values with 25 d.f. (n=30) were compared with tabular t - values to test the significance of the coefficients marked by asterisks. The R^2 value is the coefficient of multiple determination. It measures the variation in the dependent variable accounted for by the independent variables. The calculated value from equation (4) is R = .668 (R^2 = .446), and it is R = .5 (R^2 = .25) from equation (5). Although the R values are both significant at 2.5 percent level from both equations, equations (4) and (5) show low predictive ability. The low values calculated for R can be expected because the variables selected for purposes of this study were only those of the previously mined seam. This implies that seam interaction variables characterizing the currently mined seam impact on percent recoverability and should also be considered in future investigation. This aspect is beyond the scope of the problems addressed in the statistical analysis but is considered in the Coal Loss Calculation Model.

The implications of the results from the regression analysis of the undermined condition represented by equation 4 of the UM(1) mine data (n = 31) are summarized below:*

(1) PMS percent extraction (X_{37}) has a significant positive effect on CMS percent extraction (X_{15}). The regression coefficient shows that the CMS percent extraction increases by .2718 units when the PMS percent extraction increased by a unit. This coefficient (.2718) is derived with values for X_{37} ranging between 15% and 95%. The limits are obviously zero to 100%.

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* Additional equations were also estimated as modifications and further tests of equation 4. These are explained in Appendix C. The tests were pursued based on the list of non-redundant variables. Complete regression results for the mines tested are in Appendix F.

(2) The time elapsed between mining the two seams (X_{61}), expressed as a natural logarithm*, has a highly significant negative effect on CMS percent extraction (X_{15}). The magnitude of the coefficient calculated using log values for X_{61} was large (-105.55). This slope coefficient is about -0.7 when the data on X_{61} are in absolute years. What is interesting is that both slope coefficients have the negative sign. The negative sign of these coefficients reflected the real world as related by coal mining experiences in previously mined seams in northwestern Canada.**

(3) The vertical distance between the seams (X_{52}) and PMS depth of overburden (X_{60}) both have a positive effect on X_{15}. The sign of both coefficients appears to be logical, but the coefficients are small in magnitude and significant only at the 20% level. It implies that the increase in percent extraction in the currently mined seam resulting from the increase in the vertical distance between the seams and the depth of the overburden*** is not significant for this particular mine.

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* The observations on time elapsed between mining measured in years were transformed into natural logarithm because it is believed that this variable has monotonic declining slope (regression) coefficient on CMS percent extraction (X_{15}).

** Informal discussions with Dr. H. U. Bielenstein, Research Scientist, Mining Research Center, Western Office Department of Energy, Mines and Resources. Calgary, Alberta, Canada.

***This seems to hold true for the shallow mines sampled. In deeper room and pillar operations where the pillars will not be pulled, percent extraction will decrease with depth due to the necessity of leaving more support coal in place.

(4) The estimated coefficients in equation (4) must be used with caution. It only applies to the range of values from which they are derived. These ranges of values are given in Table VIII-5.

TABLE VIII-5 RANGES OF VALUES FOR THE INDICATED VARIABLES. UM(1) MINE DATA n = 31.

76-65

VARIABLES	UNITS	RANGE OF VALUES	MEAN
X_{15} CMS% EXTRACTION	PERCENT	21-95	51.96
X_{37} PMS% EXTRACTION	PERCENT	15-95	60.66
X_{52} VERTICAL DISTANCE BETWEEN SEAMS	FEET	30-120	88.66
X_{60} PMS DEPTH OF OVERBURDEN	FEET	177-674	474.69
X_{61} TIME ELASPED BETWEEN MINING	YEARS	15-35	1.408 (LOG)

It is important to note that the slope coefficients calculated for both equations (4) and (5) represented the average for the data from which they are derived. Thus, when one uses the mean values for the independent variables in the equation, the mean value CMS percent extraction (X_{15}) is predicted. This is illustrated below for equation (4).

$$X_{15} = 146.824 + (0.2718)\ (60.666) + (0.2562)\ (88.666) + (0.0307)\ (474.699) - (105.5506)\ (1.4084)$$

$$= 146.824 + 16.4891 + 22.7163 + 14.57 - 148.6574$$

$$= 51.94$$

The predicted value for CMS percent extraction (X_{15}), for each sample point is calculated in the same manner illustrated above.* The predicted values for X_{15} on the sample points included in the estimation of equation (4) are shown in Figure VIII-1. This graph portrays predicted CMS percent extraction on the X - axis and also CMS percent coal left in place. A similar graph (figure VIII-2) was made to show the observed values of CMS percent extraction for each sample point. When the two graphs are overlain on top of each other, about half of the predicted sample points coincide with the observed values. This clearly shows how the predicted values approximate reality and to what degree the estimation should be refined and improved in order for all the predicted points to closely approximate the observe values.

To further confirm the validity of the coefficients estimated in equation (4), CMS percent extraction (X_{15}) was calculated using available data from the scheduled interviews. Data from two mines were used. One is in McDowell County, W. Virginia, and the other is in Greene County, Pennsylvania. The mine in McDowell County has the Pocahontas #3 seam (USBM Code 344) as previously mined and the Pocahontas #5 seam (USBM Code 342) as currently being mined. The Greene County mine has the Pittsburgh seam (USBM Code 036) as previously mined and the Sewickley seam (USBM Code 029) as the currently mined seam. The reported average dimensions for the following variables for the two mines are given in table VIII-6.

With the given data in Table VIII-6, X_{15} was calculated for both mines by substituting the reported values of X_{37}, X_{52}, X_{60} and X_{61} into equation (4). The predicted value for CMS percent extraction was only nine percent lower than what the coal company reported as their percent recovery in McDowell County; on the other hand, the predicted value for CMS percent extraction was only 2 percent lower than what the Greene County coal company indicated as their estimated percent recovery.

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* The calculation of the predicted value for the dependent variable is an option in the algorithm and output printouts can be requested by the user if desired.

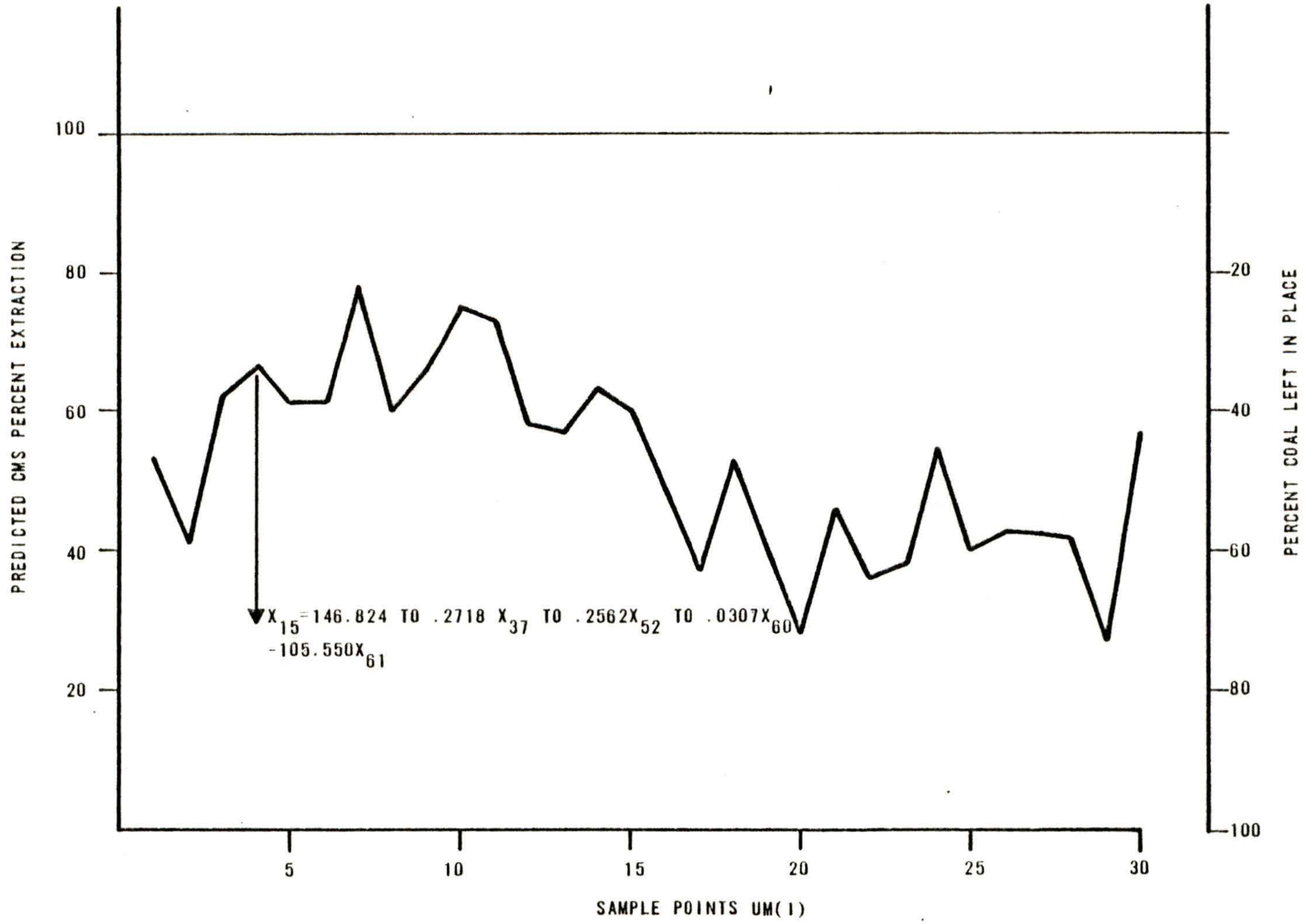

FIG. VIII-1 PREDICTED VALUES FOR CMS PERCENT EXTRACTION (BASED ON MODEL UM (UNDERMINED CONDITION) USING THE ESTIMATED EQUATION.)

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HRB-SINGER, INC.

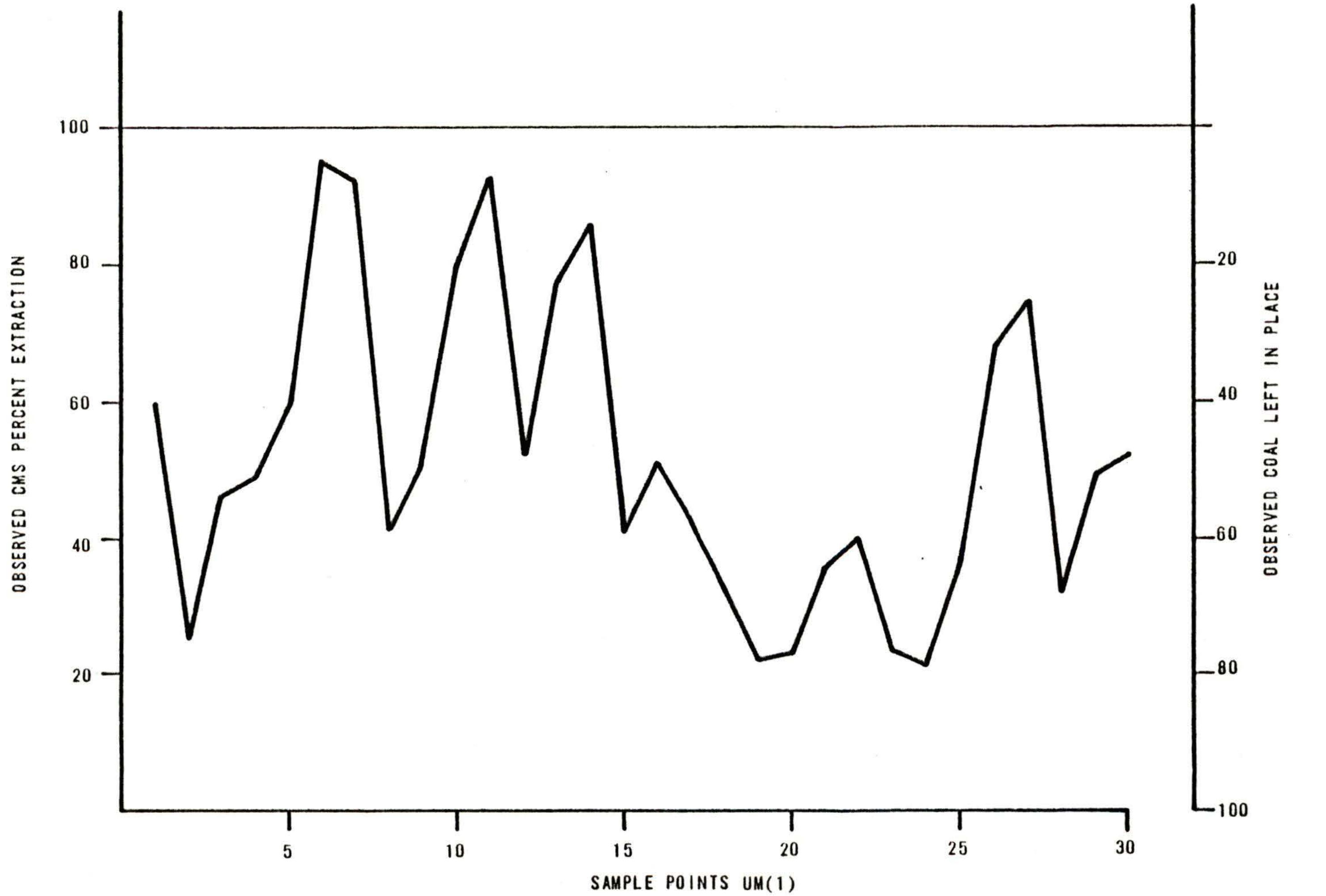

FIG. VIII-2 OBSERVED VALUES FOR CMS PERCENT EXTRACTION FOR MODEL UM (UNDERMINED CONDITION)

76-65

TABLE VIII-6 AVERAGE VALUES FOR VARIABLES FROM TWO MINES

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VARIABLES	UNITS	REPORTED AVERAGE VALUES	
		McDOWELL COUNTY MINE	GREENE COUNTY MINE
X_{15}, CMS PERCENT EXTRACTION	PERCENT	70	85
X_{37}, PMS PERCENT EXTRACTION	PERCENT	65	85
X_{52}, VERTICAL DISTANCE BETWEEN THE SEAMS	FEET	65	113
X_{60}, PMS DEPTH OF OVERBURDEN	FEET	384	546
X_{61}, TIME ELAPSED BETWEEN MINING THE TWO SEAMS	YEARS	17.5	22.5

These examples and illustrations simply show the utility and accuracy of the multiple regression results when caution is taken in the selection of the values for the independent variables to predict the dependent variable.

Although the coefficients derived from the statistical analyses of UM(1) data are highly significant for the variables indicated, these results cannot be considered highly conclusive because the data employed were obtained from only one mine. The statistical analyses must be expanded to include samples from a number of mines in order to derive more conclusive coefficients. Coefficients derived from samples obtained from a wider spectrum of mines will also lend credibility to subregion and regional applications. However, the results obtained from this statistical analysis must not go unnoticed. It represented the first case or micro study addressing a specific problem area on multiple seam mining in the United States. This study is a pioneering attempt to determine the relationships between recoverability of coal or coal left in place in overlying/underlying reserve seams as a function of the physical variables in the previously overmined/undermined seams.

b. The Overmined Conditions (Mine OM(1) and OM(2))

Multiple regression analysis was also conducted on the data from two mines representing the overmined condition. One mine has 47 observations, the other has 32. Regression runs were made on each data set for reasons previously indicated. In addition, equations were also estimated from the combination of both data sets. A combination of the data from each mine not only increases the sample size, but offers wider ranges of values for the selected variables in the estimating equation. Therefore, the estimates have broader applications.

With reference to tables VIII-3 and VIII-4 and the results of the respective principal components analyses for each data set, several equations were estimated. These are included in Appendices E2 - E4. Each equation uses CMS percent extraction (X_{15}) or CMS percent coal loss (X_{47}) (total percentage left in place) as the dependent variable. The independent variables used (considered independently) were PMS percent extraction (X_{37}), PMS depth below the surface (X_{51}), vertical distance between the seams (X_{52}), PMS ratio of pillar strength to pillar load (X_{57}) PMS depth of overburden (X_{60}), and time elapsed between mining the two seams (X_{61}).

The empirical estimates for both data sets showed that the coefficients for the vertical distance between the seams (X_{52}) are highly significant. The estimated coefficient was - 1.8340 for the 47 data set and between -.998 and -1.09 for the 32 data set. The variables representing time elapsed between mining, (X_{61}) and PMS percent extraction (X_{37}) both have negative coefficients which are significant at the 10% level for the 32 data set. The coefficients were positive, but insignificant for both variables (X_{37} and X_{61}) in the 47 data set. It appears that X_{52} is the most significant variable in the 47 data set. Variables X_{37}, X_{52}, and X_{61} were all significant in the 32 data set. This implies differences in the physical attributes of each mine.

IX. MODEL DEVELOPMENT AND VALIDATION -- ENGINEERING APPROACH

A. INTRODUCTION

The following is a description of the engineering assessment of potential coal loss due to previous mining of an adjacent seam. The results of the literature review, the definition of critical parameters affecting seam interaction, and the concurrence of recognized experts were used as the base to build an engineering assessment model. The basic theories of rock mechanics, subsidence, and seam interaction were reviewed and working rules adopted for the calculation and prediction of specific reactions, ratios, and limiting values. These were subsequently modified, where applicable, to meet Appalachian conditions and engineering judgment used in the absence of specific supporting data.

The model addresses the two basic effects of seam interaction; subsidence due to undermining a reserve seam, and high stress due to remnant pillars in previously mined under or overmined seams. A series of conditions are imposed by the model as it tests for these effects, and a relative scale is used to predict the impact of the probable intensity or magnitude of these effects on coal loss.

The greatest difficulty in the development of the engineering assessment model was to initially assign coal loss percentage values to the predictive step outputs. To do this the lower limit (0%) of coal loss was identified as was the upper or maximum limit. For maximum value outputs, the coal loss was arbitrarily set at > 30% therefore restricting the model to reporting this value as an upper limit. Coal loss, therefore, was calculated over the range of 0-30% with predicted values in excess of 30% being reported as >30%. It would be difficult to predict meaningful values >30%, and it was felt that these situations were probably unmineable by conventional underground mining techniques or economically unsound.

Following this initial step of defining the limits of coal loss, the process of refining the prediction values was carried out through a series of developmental versions of the engineering assessment model which, from hereon, will be called the Coal Loss Calculation Model (CLCM). During this developmental process, coal loss was related to the magnitude of the predicted seam interaction effects in a linear fashion and the seam interaction predictive techniques updated to reflect more complex situations. The coal loss calculation model was expanded in the later stages of development to include the effects of remnant pillar pattern, shallow overburden, and pillar alignment on the high stress calculation, and a coefficient change was made in the maximum subsidence prediction algorithm to fit actual subsidence experienced in western Pennsylvania.

The CLCM was completed to this point, using data from the UM(1) mine (Somerset County, Pennsylvania), completely independent of the statistical assessment of parameters. Comparison of the basic parameters being addressed by the CLCM and those determined to be statistically significant proved to be identical. All input parameters being used in the statistical analysis are represented in the CLCM. Furthermore, the statistical determination of redundancy of variables was compared to the use of combinations of variables in the CLCM, and it was found that all usage was statistically valid.

The CLCM can be used to calculate the approximate coal loss to be expected when mining a coal seam in an area where previous mining has occurred in an adjacent seam either above or below the reserve or currently mined seam. The model is designed to calculate the percentage of unmined coal resulting from conditions caused by previous mining of an adjacent seam. The model does not address combined effects of more than one previously mined seam. It will, if directed, calculate expected coal loss in the reserve seam caused by any previously mined seam. In this instance, in the absence of research data, it is suggested that the maximum reported coal loss calculated for the reserve seam as a result of an individual previously mined seam be taken as the estimate and the results of all previously mined seams <u>not</u> be added. For example, if three seams have been mined, one above and two below the reserve seam, and the coal loss is calculated as 11%, 15%, and 5%, take 15% as the estimated coal loss when mining the reserve seam and <u>not</u> 31% which is the sum of all calculated losses.

The more data points that can be input into the model for a given area, the more precise will be the coal loss calculation. Fifty data points are judged sufficient to adequately characterize a given mine.

B. CRITICAL VARIABLES AND CALCULATIONS

The following variables and calculations are necessary for the exercising of the CLCM (See Table IX-1 for variable name glossary):

Input Variables

1. Percent Extraction of Previously Mined Seam (PMS)
2. Distance between seams (feet)
3. PMS thickness = Pillar height (feet)
4. SPAN (PMS in feet)
5. Depth of overburden (PMS in feet)
6. Strength of immediate roof (top) (lbs/in^2 PMS, CMS)
7. Strength of floor (bottom) (lbs/in^2 PMS, CMS)
8. Minimum pillar width (PMS in feet)
9. Time since previous mining (years)
10. Distribution and Shape of Remaining Pillars

Critical Calculations

1. S_{max}; W/DT, Percentage Subsidence (PSUB)
2. Pillar strength/Pillar load ratio (PMS)
3. Roof strength/floor strength ratio (PMS, CMS)
4. Critical span (HORIZ)
5. Vertical stress (VERT)

1. Critical Input Variables

- PMS Percent Extraction

This is the percentage of extraction experienced in the previously mined seam as derived by planimetry from mine maps.

- Distance Between the Seams

This is the vertical distance measured in feet between the two seams being considered. It is equivalent to the difference in elevation of the two seams (measured from the seam floor) minus the seam thickness of the lower seam.

- PMS Thickness - Pillar Height

This is the maximum height of the mine opening as reported on mine maps measured in feet. It often includes some top rock and is generally a higher value than the actual coal thickness.

- SPAN (PMS)

This is the width in feet of unsupported distance. This could be the width of the chambers, the width of a gangway, the width between reserve pillars in a robbed area, or one of several combinations of situations depending on the type and extent of extraction. Where odd configurations appear, the figure recorded was measured across the cavity at the widest point.

- Depth of Overburden (PMS)

This is the difference in elevation between the previously mined seam and the surface elevation minus the thickness of the seam. This is expressed in feet and is independent of lithology.

- Strength of the Immediate Roof (Top)

This is the unconfined compressive strength of the roof lithology measured in Lbs/in^2. It is measured for both the currently mined and previously mined seams. In the absence of laboratory test data, the strength is approximated by equating the lithologies shown in Table IX-2 to Lbs/in^2 values. This is a relative scale of values and is designed to input workable values to the coal loss calculation model. It should not be used outside this context nor regarded as specific actual values for a given lithology.

- Strength of Floor (Bottom)

This is the unconfined compressive strength of the floor lithology measured in Lbs/in^2. It is measured for both the currently mined and previously mined seams. Comments made for Strength of Immediate Roof (Top) are applicable here also.

- Minimum Pillar Width

This is the minimum pillar dimension for rectangular and odd shaped pillars measured in feet.

TABLE IX-1 GLOSSARY OF VARIABLE NAMES FOR THE CLCM PROGRAM

ASTER	=	Asterisk Value
BLANK	=	Blank Value
BUMP(I)	=	Indication of Potential Bump due to Existing Conditions
CMS	=	Currently Mined Seam or Reserve Seam
CMSCL(I)	=	CMS Coal Loss
DMSDT	=	CMS Depth
DMSRAT(I)	=	CMS Roof to Floor Strength Ratio
D	=	PMS Depth
DATA (I,J)	=	Data Values
DT	=	Distance Between the Seams
E	=	PMS Percent Extraction
FUNC	=	Calculation to Determine Subsidence for a Given W/D Ratio
H	=	PMS Pillar Height
HORIZ(I)	=	Critical Span or Maximum Horizontal Extent of the Pressure Arch
HSTRES(I)	=	High Stress Coal Loss
ICOND	=	Overmined or Undermined Condition
ICURR	=	USBM Seam Code (Currently Mined or Reserve Seam)
ILINE	=	Pillar Alignment
IPREV	=	USBM Seam Code (Previously Mined Seam)
LMULT	=	Lithology Multiplier
NDECKS	=	Number of Data Sets or Reserve Seams
NO	=	Number of Sample Points
PILPAT(I)	=	Pillar Pattern and Uniformity Multiplier
PILRAT(I)	=	PMS Pillar Strength to Load Ratio
PMS	=	Previously Mined Seam
PMSRAT(I)	=	PMS Roof to Floor Strength Ratio
PSUB(I)	=	Maximum Subsidence Divided by Seam Thickness (SMAX/T)
RMULT	=	Regional Multiplier
SMAX	=	Maximum Subsidence
SNAME	=	Seam Name
SUB(I)	=	Maximum Subsidence
SUBCL(I)	=	Subsidence Coal Loss
T	=	PMS Seam Thickness
TIME	=	Time Since Previous Mining
TOTAL(I)	=	Average Value of Input Data Variables
VERT(I)	=	Maximum Vertical Extent of the Pressure Arch
W	=	PMS Span
WDRAT(I)	=	PMS Width to Depth Ratio
YES(I)	=	Indication of Subsidence

NOTE: (I) and (I,J) are subscripts of array variables.

TABLE IX-2 APPROXIMATE ROCK STRENGTH (LBS/IN^2)

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		DRY	WET
FLOOR	CLAY	4000	1500
	FLOOR SHALE	4000	1500
	MUDSTONE	6000	1500
	SANDSTONE	8000	4000
ROOF	FISSILE SHALE	5000	
	SHALE	6000	
	SILTY SHALE	8000	
	LIMESTONE		
	BEDDED	9000	
	MASSIVE	12000	
	SANDSTONE		
	SILTY OR ARGILLACEOUS	12000	
	THIN BEDDED	14000	
	MASSIVE	18000	
	CONGLOMERATE	18000	

- Time Since Previous Mining

This is the elapsed time between mining in the currently mined or reserve seam and cessation of mining in the previously mined seam measured in years or fraction thereof.

- Distribution and Shape of Remaining Pillars

This is the pillar pattern expressed in terms of pillar spacing and geometry and equated to a multiplier as shown in Figure IX-1. This is done to refine the high stress coal loss calculation (HSTRES) recognizing the effect that remnant pillar spacing and geometry has on vertical stress concentrations. Without this multiplier, the model calculates worst case conditions for all data points.

DISTRIBUTION AND SHAPE OF REMAINING PILLARS

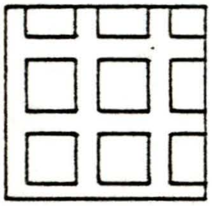
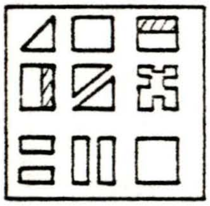
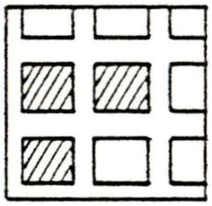
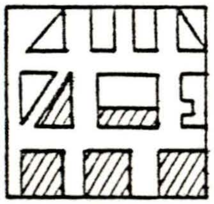
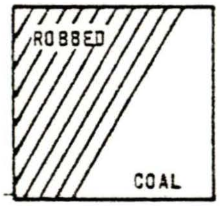
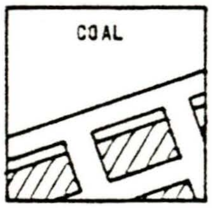
	SPACING	PILLAR GEOMETRY	HIGHSTRESS COAL LOSS (HSTRCL) MULTIPLIER)
	REGULAR	UNIFORM	.6
	REGULAR	NON-UNIFORM	.7
	RESULT OF CUTTING PILLARS IN RETREAT MINING.		
	IRREGULAR	UNIFORM	.8
	PULLING SOME PILLARS IN RETREAT MINING.		
	IRREGULAR	NON-UNIFORM	.9
	RESULT OF PULLING AND SLABBING PILLARS IN RETREAT MINING.		
	EXTREME CONDITIONS		1.0
			

FIG. IX-1 PILLAR SPACING AND GEOMETRY MULTIPLIER

76-65

2. Calculations

The CLCM performs the following calculations:

a. Maximum subsidence in feet expected in the overlying seam (SMAX)*

(1) SMAX = (.6) (t - .001)(DT)) f(W/DT)(E) for all values of SMAX $\geqq$ 0.01 feet

SMAX is set equal to 0.01 feet when 0.0 < SMAX < 0.01 and is set equal to 0.0 when SMAX $\leqq$ 0.0 feet.

t = Seam Thickness

DT = Distance Between Seams

W = Span (maximum unsupported distance (width))

E = % Extraction

(2) In order to calculate SMAX the W/DT ratio must first be calculated. These values are then used in the algorithm to calculate f(W/DT). f(W/DT) is set equal to 1.0 when W/DT $\geqq$ 1.2.

Otherwise f(W/DT) = ((((2.15909)(W/DT) - 6.26136) (W/DT) + 5.51136) (W/DT) - 0.469091 (W/DT)

f(W/DT)* calculates maximum subsidence in terms of percentage of seam thickness based on the mean subsidence curve developed by the British National Coal Board for conditions of full caving.

(3) Maximum subsidence as a percentage of PMS thickness (PSUB). PSUB is calculated by dividing SMAX by t

PSUB = SMAX/t

---

*This algorithm was developed by HRB-Singer, Inc. on ARC Contract 73-111-2552 "Overview of Subsidence Potential in Pennsylvania Coal Fields" 30 June 1975. It is modified to fit empirically derived subsidence in western Pennsylvania coal fields. Initial development of the algorithm came from British National Coal Board Data and the Subsidence Engineers Handbook. The packing factor .001 DT has been modified from .01D from the original formulas because of the shallow depths experienced in Appalachian mining and empirically derived data from western Pennsylvania. The 0.6 factor at the beginning of the formula which accounts for the incomplete packing of the cavity has been modified from the original 0.9 factor based on actual subsidence experienced in western Pennsylvania coal fields.

b. Pillar Strength, Pillar Load Ratio

(1) Pillar strength* (PMS)

$$S = 1320 \frac{W^{0.46}}{h^{0.66}} \quad (\text{Lbs/in}^2)$$

W = pillar width minimum

h = pillar height = t(seam thickness)

(2) Pillar Load* (PMS)

$$L = \frac{1.1\ D}{100 - E\ )\ (.01)} \quad (\text{Lbs/in}^2)$$

D = Depth to floor of seam

E = % Extraction

(3) Pillar strength to pillar load ratio (PMS PIL)

$$PS/PL = \frac{1320 \dfrac{W^{0.46}}{h^{0.66}}}{1.1\ \text{Depth}/(100 - \%\ \text{Extraction})\ (.01)}$$

c. Roof strength, Floor strength, Ratio (PMS ROOF, CMS ROOF)

$\frac{\text{Roof Strength}}{\text{Floor Strength}}$ = Ratio of unconfined compressive strength (UCS) of Roof and Floor (Lbs/in^2)

In the absence of specific data, equate lithologies to UCS (Table IX-2).

d. Critical Span (feet)**(HORIZ)

W = (0.15) (D) + 60

D = Depth to floor of seam

*Salamon (1967), Denkhaus (1962).

**Adler and Sun, (1968) This is the width of the maximum pressure arch. Theoretically a span in excess of this calculation will be unstable and will result in ultimate collapse of the cavity.

e. Vertical Extent of Pillar Pressure (PMS)* (VERT)

DT < (0.3) (D) + 120

Depth to floor of PMS

DT = Distance between seams

The Coal Loss Calculation Model was developed using generalized values and formulas obtained from the literature. The general list of criteria was circulated for discussion and critique among professional personnel knowledgeable in the field of seam interaction. The coefficients used were modified to fit conditions existing in coal Region IIIB, and the CLCM was tested against data in Region IIIB (UM(1) and OM(2) Mines) and IB (OM(1) Mine).

It is anticipated that if any adjustments are needed among the regions, a regional multiplier can be assigned to account for the variances. Any variances will probably be tectonic and due to such structural features as folding, faulting and fracturing.

The CLCM does not regard the total lithology existing between seams, but concentrates on the roof and floor lithologies of both seams. HRB-Singer's position is that the CLCM will perform in this manner regardless of the lithology of the total intervening mass. If variances are encountered in future tests where massive lithologies exist, a multiplier coefficient can be inserted to correct for the variation.

C. EXERCISING THE MODEL

- PART I - Overmining or Undermining

For all cases of overmining a previously mined seam (the undermined condition), the complete CLCM must be exercised.

For cases where only the undermining of a previously mined seam (the overmined condition) are to be considered, only the high stress portion of the CLCM is to be exercised.

*This is the theoretical vertical extent of the maximum pressure arch. This is generally regarded to be twice the width of the maximum pressure arch for seam depths between 400 and 2000 feet.

- PART II - Subsidence Effects

STEP 1: Test for Subsidence

Subsidence will occur in the overlying seam if the PSM has:

(1) 100% extraction

or

(2) Pillar strength/pillar load of any remaining pillars < 1.0

or

(3) Roof strength/floor strength > 2.4 or < 0.625

or

(4) Critical span > (0.15) (PMS depth) + 60

or

(5) Distance between the seams < 60 feet and roof strength/floor strength $\leq$ 3.3

or

(6) Span/DT $\geq$ 0.25. DT = distance between the seams

If any of these are true, continue. Otherwise go to PART IV.

STEP 2: Calculate Subsidence (SMAX) and Percent Subsidence (PSUB)

- PART III - Calculate Coal Loss in CMS (CMSCL)

STEP 1: Zero Coal Loss

If SMAX $\leq$ 0.1 feet, then

SUBCL = 0%. If true, go to PART IV, else continue.

STEP 2: DT $\leq$ 60 feet

If DT > 60 feet go to step 3, else continue.

(1) If PSUB > 0.5, then SUBCL > 30%. Go to PART IV

or

(2) If PSUB $\leq$ 0.5, then SUBCL = PSUB/1.667. Go to PART IV, else continue.

STEP 3: DT > 60 and < 120 feet

If DT ≥ 120 feet, go to STEP 4, else continue.

(1) If PSUB ≤ 0.2 then SUBCL = 0%. Go to PART IV.

or

(2) If PSUB > 0.2 then SUBCL = (PSUB -.2) (.5) GO to PART IV.

STEP 4: DT ≥ 120 feet

(1) If CMSRAT > 3.3

and

Time elapsed since previous mining > 0.25 years

and

PMS % extraction > 90%,

then SUBCL = 0%. Go to PART IV

or

(2) If PSUB > 0.5, then SUBCL = 5%.

- PART IV - High Stress Zone Effects

STEP 1: No Pillars

If PMS extraction = 100%, then High Stress Coal Loss (HSTRES) = 0%. If true, go to PART VI, else continue.

STEP 2: No Coal Loss

If DT > (0.3) (PMS Depth) + 120 feet then HSTRES = 0%.
If true, Go to PART VI, else continue.

STEP 3: DT ≤ 60 feet

If DT > 60 feet, Go to STEP 4.

(1) If CMSRAT ≤ 0.625 or ≥ 2.4, then HSTRES = >30%

or

(2) If CMSRAT > 0.625 and < 2.4, then HSTRES = 25%.

Go to PART V.

STEP 4: DT > 60 and < 90 feet

If DT ≥ 90 feet go to STEP 5, else continue.

(1) If CMSRAT ≤ 0.625 or ≥ 2.4, then HSTRES = 20%

or

(2) If CMSRAT > 0.625 and < 2.4, then HSTRES = 15%. If true, go to PART V, else continue.

STEP 5: DT ≥ 90 and < 120 feet

If DT ≥ 120 feet, go to STEP 6, else continue.

(1) If CMSRAT ≤ 0.625 or ≥ 2.4, then HSTRES = 15%

or

(2) If CMSRAT > 0.625 and < 2.4 then HSTRESS = 10%.

If true, go to PART V, else continue.

STEP 6: DT ≥ 120 feet

(1) If DT < VERT and (CMSRAT ≤ 0.625 or ≥ 2.4), then HSTRES = 10%

or

(2) If DT < VERT and (CMSRAT > 0.625 and < 2.4), then HSTRES = 5%.

- PART V - Coal Loss Adjustments

STEP 1: Pillar Pattern (PILPAT) Adjustment

If PILPAT ≠ 0 then (PILPAT) (HSTRES) = HSTRES (Adjusted).

STEP 2: PMS Shallow Depth Adjustment

If PMS Depth ≤ 400 feet, then

$$\text{HSTRES}\left(\frac{\text{PMS Depth}}{400}\right) = \text{HSTRES (Adjusted)}.$$

STEP 3: Pillar Alignment

If CMS mine layout is planned to align vertically with the PMS mine layout, then (HSTRES) (.25) = HSTRES (Adjusted).

- PART VI - Bump Warning

  If CMS depth below the surface ≥ 500 feet

  and

  CMSRAT > 0.625 and < 2.4, then potential bump conditions are present. Report by placing * after HSTRES value and writing message at the bottom of output page.

- PART VII - Coal Loss Comparison

  Compare SUBCL and HSTRES and report highest coal loss figure of either but not both as currently mined seam coal loss (CMSCL). If values are equal, report equal value in CMSCL.

- Repeat the CLCM program for each seam being considered. The model will calculate coal loss for N seams above or below a previously mined seam.

A sample printout from the computer program designed to implement this model is shown in Figures IX-2, IX-3, and IX-4. These figures represent the title page, input variables, and output of the CLCM as run for mine UM(1). A detailed description of the model implementation is provided in the User's Manual provided under separate cover.

D. MODEL VALIDATION

Proper validation of the CLCM logically entails a comparison of predicted coal loss with actual experienced coal loss. This, however, is a hard number to determine accurately. To arrive at the actual experienced coal loss due to the effects of previous mining, a comparison is made between the percentage extraction in the currently mined seam (where previous mining has occured in an adjacent seam) and the percentage extraction in the currently mined seam where previous mining in the same adjacent seam has not occurred. If any difference exists, this should be due to the effects, if any, of previous mining providing the mining technique was identical.*

Working on this premise, Table IX-3 was constructed and summarizes the data for four mines used to test the CLCM. The eight columns contain the following information:

*This approach was not used in the statistical analysis because we purposefully chose mines which were largely completed so that the effects of the previously mined seam would be borne out further. As a result, there were very few sample points which could be used for in-depth analysis.

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CLCM...VALIDATION RUN

UNDERMINED CONDITION
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076  C'  UPPER KITTANNING        CURRENTLY MINED OR RESERVE SEAM

004  A   LOWER KITTANNING        PREVIOUSLY MINED SEAM
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FIG. IX-2 CLCM PRINTOUT TITLE PAGE

76-85

H R B - S I N G E R . I N C .

THE INPUT DATA CARDS

NO	1 CMS ROOF STRENGTH	2 CMS FLOOR STRENGTH	3 PMS SEAM THICKNESS	4 PMS PERCENT EXTRACT	5 PMS ROOF STRENGTH	6 PMS FLOOR STRENGTH	7 PMS PILLAR WIDTH	8 PMS SPAN	9 DISTANCE BETWEEN SEAMS	10 PMS DEPTH	11 TIME BETWEEN MINING	12 PILLAR PATTERN
1	5000.00	4000.00	5.75	50.00	5000.00	4000.00	50.00	160.00	110.00	195.00	22.00	0.70
2	5000.00	4000.00	5.75	45.00	5000.00	4000.00	45.00	40.00	100.00	183.00	26.00	0.70
3	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	100.00	175.00	22.00	1.00
4	5000.00	4000.00	5.75	60.00	5000.00	4000.00	50.00	160.00	90.00	190.00	17.00	0.70
5	5000.00	4000.00	5.75	50.00	5000.00	4000.00	45.00	200.00	90.00	223.00	15.00	0.80
6	5000.00	4000.00	5.75	60.00	5000.00	4000.00	45.00	140.00	90.00	350.00	19.00	0.80
7	5000.00	4000.00	5.75	70.00	5000.00	4000.00	40.00	360.00	100.00	220.00	20.00	0.80
8	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	100.00	260.00	21.00	1.00
9	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	110.00	280.00	28.00	1.00
10	5000.00	4000.00	5.75	95.00	5000.00	4000.00	40.00	840.00	100.00	320.00	17.00	1.00
11	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	90.00	340.00	24.00	1.00
12	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	90.00	370.00	23.00	1.00
13	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	100.00	390.00	18.00	1.00
14	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	100.00	400.00	26.00	1.00
15	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	90.00	390.00	15.00	1.00
16	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	110.00	480.00	17.00	1.00
17	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	100.00	500.00	20.00	1.00
18	5000.00	4000.00	5.75	100.00	5000.00	4000.00	0.0	840.00	80.00	460.00	25.00	1.00
19	5000.00	4000.00	5.75	95.00	5000.00	4000.00	40.00	840.00	80.00	560.00	26.00	1.00
20	5000.00	4000.00	5.75	100.00	5000.00	1500.00	0.0	840.00	80.00	590.00	26.00	1.00
21	5000.00	4000.00	5.75	65.00	5000.00	4000.00	80.00	580.00	80.00	550.00	19.00	0.80
22	5000.00	4000.00	5.75	90.00	5000.00	4000.00	80.00	780.00	90.00	500.00	19.00	1.00
23	5000.00	4000.00	5.75	95.00	5000.00	1500.00	30.00	840.00	90.00	530.00	21.00	1.00
24	5000.00	4000.00	5.75	55.00	5000.00	1500.00	45.00	400.00	90.00	620.00	24.00	0.90
25	5000.00	4000.00	5.75	100.00	5000.00	1500.00	0.0	840.00	90.00	540.00	26.00	1.00
26	5000.00	4000.00	5.75	100.00	12000.00	1500.00	0.0	840.00	90.00	640.00	27.00	1.00
27	5000.00	4000.00	5.75	100.00	12000.00	1500.00	0.0	840.00	90.00	660.00	27.00	1.00
28	5000.00	4000.00	5.75	100.00	12000.00	1500.00	0.0	840.00	90.00	540.00	30.00	1.00
29	5000.00	4000.00	5.75	100.00	12000.00	1500.00	0.0	840.00	60.00	570.00	36.00	1.00
30	5000.00	4000.00	5.75	100.00	12000.00	1500.00	80.00	840.00	80.00	570.00	29.00	1.00
31	5000.00	1500.00	5.75	90.00	12000.00	1500.00	160.00	840.00	90.00	630.00	27.00	1.00
32	5000.00	4000.00	5.75	100.00	12000.00	1500.00	60.00	840.00	90.00	430.00	26.00	1.00
33	5000.00	1500.00	5.75	40.00	12000.00	1500.00	70.00	120.00	80.00	580.00	25.00	1.00
34	5000.00	1500.00	5.75	70.00	12000.00	1500.00	90.00	650.00	90.00	640.00	0.0	1.00
35	5000.00	1500.00	5.75	100.00	12000.00	1500.00	0.0	840.00	90.00	600.00	27.00	1.00
36	5000.00	1500.00	5.75	20.00	12000.00	1500.00	125.00	40.00	70.00	620.00	28.00	0.70
37	5000.00	1500.00	5.75	65.00	12000.00	1500.00	0.0	680.00	90.00	680.00	29.00	0.90
38	5000.00	4000.00	5.75	75.00	12000.00	1500.00	60.00	540.00	90.00	400.00	26.00	1.00
39	5000.00	1500.00	5.75	40.00	12000.00	1500.00	70.00	160.00	90.00	650.00	33.00	0.80
40	5000.00	1500.00	5.75	30.00	12000.00	1500.00	45.00	40.00	30.00	600.00	28.00	0.90
41	5000.00	1500.00	5.75	50.00	12000.00	1500.00	70.00	400.00	80.00	490.00	26.00	0.90
42	5000.00	1500.00	5.75	45.00	12000.00	1500.00	80.00	340.00	90.00	500.00	31.00	0.70
43	5000.00	1500.00	5.75	35.00	12000.00	1500.00	80.00	320.00	100.00	520.00	32.00	0.80
44	5000.00	1500.00	5.75	90.00	12000.00	1500.00	55.00	440.00	100.00	560.00	32.00	1.00
45	5000.00	1500.00	5.75	45.00	12000.00	1500.00	100.00	280.00	90.00	630.00	33.00	0.90
46	5000.00	1500.00	5.75	50.00	12000.00	1500.00	40.00	400.00	90.00	650.00	34.00	1.00
47	5000.00	4000.00	5.75	65.00	12000.00	1500.00	70.00	540.00	90.00	470.00	32.00	0.90
48	5000.00	1500.00	5.75	15.00	12000.00	1500.00	70.00	120.00	90.00	540.00	32.00	0.70
49	5000.00	1500.00	5.75	15.00	12000.00	1500.00	45.00	40.00	80.00	480.00	33.00	0.70
50	5000.00	1500.00	5.75	85.00	12000.00	1500.00	12.00	740.00	120.00	660.00	35.00	1.00
AVERAGE	5000.00	3150.00	5.75	75.10	8500.00	2550.00	63.61	576.60	90.00	478.52	25.80	0.92

FIG. IX-3 CLCM INPUT VARIABLE PRINTOUT

076 C' UPPER KITTANNING

*********** COAL LOSS FOR CURRENT OR RESERVE SEAM ***********

SAMPLE	PMS STREN/LOAD RATIO	PMS ROOF/FLR RATIO	CMS ROOF/FLR RATIO	MAX VERT EXTENT PR. ARCH	MAX HORIZ EXTENT PR. ARCH	PMS WID/DEPTH RATIO	PERCENT SUBSIDENCE	MAXIMUM SUBSIDENCE	SUB-SIDENCE COAL LOSS	HIGH STRESS COAL LOSS	ANTICIPATED COAL LOSS
1	5.86	1.25	1.25	178.50	89.25	1.45	0.29	1.69	0.05	0.03	0.05
2	6.55	1.25	1.25	174.90	87.45	0.40	0.09	0.53	0.0	0.03	0.03
3	0.0	1.25	1.25	0.0	0.0	8.40	0.59	3.39	0.19	0.0	0.19
4	4.82	1.25	1.25	177.00	88.50	1.78	0.35	2.04	0.08	0.03	0.08
5	4.89	1.25	1.25	186.90	93.45	2.22	0.30	1.70	0.05	0.04	0.05
6	2.49	1.25	1.25	225.00	112.50	1.56	0.35	2.04	0.08	0.07	0.08
7	2.81	1.25	1.25	186.00	93.00	3.60	0.41	2.37	0.11	0.04	0.11
8	0.0	1.25	1.25	0.0	0.0	8.40	0.59	3.39	0.19	0.0	0.19
9	0.0	1.25	1.25	0.0	0.0	7.64	0.59	3.38	0.19	0.0	0.19
10	0.32	1.25	1.25	216.00	108.00	8.40	0.56	3.22	0.18	0.08	0.18
11	0.0	1.25	1.25	0.0	0.0	9.33	0.59	3.40	0.20	0.0	0.20
12	0.0	1.25	1.25	0.0	0.0	9.33	0.59	3.40	0.20	0.0	0.20
13	0.0	1.25	1.25	0.0	0.0	8.40	0.59	3.39	0.19	0.0	0.19
14	0.0	1.25	1.25	0.0	0.0	8.40	0.59	3.39	0.19	0.0	0.19
15	0.0	1.25	1.25	0.0	0.0	9.33	0.59	3.40	0.20	0.0	0.20
16	0.0	1.25	1.25	0.0	0.0	7.64	0.59	3.38	0.19	0.0	0.19
17	0.0	1.25	1.25	0.0	0.0	8.40	0.59	3.39	0.19	0.0	0.19
18	0.0	1.25	1.25	0.0	0.0	10.50	0.59	3.40	0.20	0.0	0.20
19	0.18	1.25	1.25	288.00	144.00	10.50	0.56	3.23	0.18	0.15	0.18
20	0.0	3.33	1.25	0.0	0.0	10.50	0.59	3.40	0.20	0.0 *	0.20
21	1.81	1.25	1.25	285.00	142.50	7.25	0.38	2.21	0.09	0.12	0.12
22	0.57	1.25	1.25	270.00	135.00	8.67	0.53	3.06	0.17	0.10	0.17
23	0.17	3.33	1.25	279.00	139.50	9.33	0.56	3.23	0.18	0.10	0.18
24	1.58	3.33	1.25	306.00	153.00	4.44	0.32	1.87	0.06	0.09*	0.09
25	0.0	3.33	1.25	0.0	0.0	9.33	0.59	3.40	0.20	0.0	0.20
26	0.0	8.00	1.25	0.0	0.0	9.33	0.59	3.40	0.20	0.0 *	0.20
27	0.0	8.00	1.25	0.0	0.0	9.33	0.59	3.40	0.20	0.0 *	0.20
28	0.0	8.00	1.25	0.0	0.0	9.33	0.59	3.40	0.20	0.0	0.20
29	0.0	8.00	1.25	0.0	0.0	14.00	0.59	3.41	0.30	0.0 *	GT 30 PER
30	0.0	8.00	1.25	0.0	0.0	10.50	0.59	3.40	0.20	0.0	0.20
31	0.62	8.00	3.33	309.00	154.50	9.33	0.53	3.06	0.17	0.15	0.17
32	0.0	8.00	1.25	0.0	0.0	9.33	0.59	3.40	0.20	0.0	0.20
33	2.76	8.00	3.33	294.00	147.00	1.50	0.24	1.36	0.02	0.20	0.20
34	1.41	8.00	3.33	312.00	156.00	7.22	0.41	2.38	0.11	0.15	0.15
35	0.0	8.00	3.33	0.0	0.0	9.33	0.59	3.40	0.20	0.0	0.20
36	4.50	8.00	3.33	306.00	153.00	0.57	0.07	0.40	0.0	0.14	0.14
37	0.0	8.00	3.33	324.00	162.00	7.56	0.38	2.21	0.09	0.13	0.13
38	1.55	8.00	1.25	240.00	120.00	6.00	0.44	2.55	0.12	0.10	0.12
39	2.46	8.00	3.33	315.00	157.50	1.78	0.24	1.36	0.02	0.12	0.12
40	2.54	8.00	3.33	300.00	150.00	1.33	0.18	1.03	0.11	0.27	0.27
41	2.72	8.00	3.33	267.00	133.50	5.00	0.30	1.70	0.05	0.18	0.18
42	3.12	8.00	3.33	270.00	135.00	3.78	0.27	1.53	0.03	0.10	0.10
43	3.55	8.00	3.33	276.00	138.00	3.20	0.21	1.19	0.00	0.12	0.12
44	0.43	8.00	3.33	288.00	144.00	4.40	0.53	3.05	0.17	0.15	0.17
45	2.75	9.00	3.33	309.00	154.50	3.11	0.27	1.53	0.03	0.13	0.13
46	1.59	8.00	3.33	315.00	157.50	4.44	0.30	1.70	0.05	0.15	0.15
47	1.99	8.00	1.25	261.00	130.50	6.00	0.38	2.21	0.09	0.09	0.09
48	4.20	8.00	3.33	282.00	141.00	1.33	0.09	0.51	0.0	0.10	0.10
49	3.86	8.00	3.33	264.00	132.00	0.50	0.04	0.25	0.0	0.14	0.14
50	0.27	8.00	3.33	318.00	159.00	6.17	0.50	2.87	0.0	0.10	0.10
AVERAGE	2.50	4.79	1.96	267.41	133.70	6.39	0.44	2.52	0.13	0.07	0.16

* CONDITIONS ARE PRESENT WHICH MAY RESULT IN A BUMP IN THE CURRENTLY MINED OR RESERVE SEAM

FIG. IX-4 CLCM OUTPUT PRINTOUT

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HRB-SINGER, INC.

TABLE IX-3 COMPARISON OF ESTIMATED, MEASURED, AND PREDICTED EXTRACTION VALUES

76-65

MINE	1 PMS CALCULATED % EXTRACTION PMS	2 ESTIMATED % EXTRACTION PMS FROM INTERVIEWS	3 MEASURED % EXTRACTION CMS	4 ESTIMATED % EXTRACTION CMS FROM INTERVIEWS	5 % EXTRACTION CMS WHEN 0% EXTRACTION IN PMS	6 5-3	7 5-4	8 CLCM PREDICTED COAL LOSS	9 VARIANCE 8-7	10 VARIANCE 8-6
UM(1) [50]	75	85	53.9*	75-85 AVG. 80	97.6 [2]	43.7	12.6 TO 22.6 AVG. 17.6	16	-1.6	(-27.7)
OM(1) [47]	55	80-90	65.1*	80-90 AVG. 85	95.4 [3]	30.3	5.4 TO 15.4 AVG. 10.4	9	-1.4	(-21.3)
OM(2) [32]	48	75-77	64.0*	70	77.7 [20]	13.7	7.7	8	+0.3	(-5.7)
UM(2) [20]	79.9	?	74.1	66 (OVERALL)	82.2 [7]	8.1	16.2	7	-9.2	-1.1

* SAMPLES WERE SELECTED FROM AREAS WITHIN THE MINE WHERE COAL LOSS WAS EXPERIENCED.

[ ] NUMBER OF SAMPLES USED TO ESTABLISH DATA

1. Calculated Percentage Extraction in the Previously Mined Seam (PMS). These are the averages of the values input into the CLCM.

2. Estimated Percentage Extraction of the previously mined seam from interviews. These are the values given by the coal companies for the percentage extraction they believe have been achieved.

3. Measured percentage extraction for the currently mined seam (CMS). These are the actual planimetered values measured from mine maps. For mines UM(1), OM(1), and OM(2) these values are intentionally low because a conscious effort was made, in the selection of data blocks, to pick those areas where coal loss was being experienced.

4. Estimated percentage extraction of the currently mined seam from interviews. These are the values given by the coal companies for the percentage extraction they are currently experiencing based on production figures.

5. Percentage extraction experienced in the currently mined seam when the adjacent seam (PMS) has not been mined (0% Extraction). This gives the extraction percentage when no previous mining has occurred.

6. Difference between the extraction achieved in the currently mined seam when the adjacent seam has and has not been mined (Item 5 minus Item 3). This is theoretically the coal loss, if any, due to previous mining based on mine map data.

7. Difference between the extraction achieved in the currently mined seam (estimated) when the adjacent seam has and has not been mined (Item 5 minus Item 2). This is theoretically the coal loss, if any, due to previous mining based on mine map and interview data.

8. Coal Loss Calculation Model (CLCM) predicted coal loss. This is the average coal loss for a given mine predicted by the CLCM.

9,10. Variance. These are the variances obtained by subtracting Item 8 from 7 and 8 from 6.

Because of the biased data for the first three mines, the measured percentage extraction for the currently mined seam (Item 3) are all low. This is to be expected since a deliberate effort was made to choose data points where coal was being lost.* When contrasted with the estimated percentage extraction for the currently mined seam (Item 4), this disparity is even more evident. The predicted coal loss (Item 8), therefore, can not be readily compared for these mines to the coal loss experienced by subtracting Item 3 from Item 5, but it compares favorably with the coal loss experienced by subtracting Item 4 from Item 5.

In contrast to the above, Mine UM(2) was sampled randomly without any conscious effort to choose sample points where coal loss was being experienced in the CMS. The currently mined seam also had some longwall as well as room and pillar mining operations.

When the predicted coal loss (Item 8) is compared to the measured coal loss (Item 6), a variance of only - 1.1 is achieved. Using the estimated extraction values, however, a variance of -9.2 is reported.

In the case of the first three test mines, the estimated percentage extraction in the currently mined seam (from interviews) had to be used for comparison since the measured data was biased. In the fourth or validation mine, the measured values can now be used since the data is random. Care should be exercised in using the estimated values since estimates will vary according to the estimator. In the fourth mine the figure estimated (66%) takes into account the overall percentage recovery for the mine property even though the company is experiencing 80% recovery in room and pillar and 100% in it's longwall operations.

Although only four mines were used in this study, the results of the coal loss calculation model are within acceptable limits. Admittedly, many more samples and many more mines must eventually be used to fully validate and update the model. From the interpretation of Table IX-2 it is concluded that the model is operating correctly, is perhaps consistently low in its coal loss prediction, and approximates the actual experienced coal loss.

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*This was done because, in the development of the CLCM (independently from the statistical exercises) actual situations of mine experienced coal loss were needed to help quantify and establish the physical variable relationships.

X. CONCLUSIONS

A. THE TYPE AND EXTENT OF PROBLEMS ASSOCIATED WITH UNDERMINING AND OVERMINING

On the basis of the results obtained from the literature review and from the interviews with six MESA district inspectors and 28 mine operators, it was concluded that the major problems associated with previous mining can be summarized under the following four categories:

1. Water Problems
2. Gas Problems
3. Roof and Rib Problems
4. Floor Problems

Water Problems - Water seems to be a ubiquitous problem regardless of the position of the previously mined seam. In the overmined condition, however, the severity of the water problem is usually greater and can cause flooding. Water, however, does not directly cause coal loss as it is pumped out in operating mines. Water does contribute to coal loss by indirectly helping to create floor and roof problems.

Gas Problems - Gas seems to be seam specific and occurs regardless of the position of the previously mined seam. Gas does not cause coal loss as it is vented prior to and during mining.

Roof and Rib Problems - In overmining a previously mined seam, the following roof and rib problems were encountered: roof cracks, fracturing, breakage of coal, subsidence cracks, bad roof, roof falls, and squeezing.

Subsidence is usually manifested by cracking of the roof, fracturing in the overburden, squeezing, and roof falls and is widespread in occurrence.

In undermining a previously mined seam, the following roof and rib problems were encountered: caving, roof fracturing, roof falls, and spalling of ribs.

Pressure effects are more evident and troublesome at the greater depths (in the 400-2000 foot range). A fifteen percent coal loss was reported by one mine in Region IB with 800 - 1000 feet of overburden and seventy-five feet between seams.

Floor Problems - In overmining a previously mined seam, the following floor problems were encountered: cracks in floor, heaving, drop offs, shallow bending, subsidence, squeezing, and floor caving.

In undermining a previously mined seam, the following floor problems were encountered: cracks in floor, squeezing, heaving, sinking pillars, and rolling.

Floor problems are universally worsened by water. Significant heaving and pillar sinking is experienced in mines at greater depths (>400 feet).

B. THE UTILITY OF THE MODEL IN PREDICTING THE IMPACT OF COAL LOSS

The coal loss calculated by the CLCM is more representative of a mine's actual experienced coal loss with an increasing number of sample data points. Experience has shown that a sample size of approximately 50 data points will closely approximate coal loss calculated for higher sample populations. It is therefore specific in the prediction of coal loss in the reserve seam as a result of conditions caused by factors originating in a specified previously mined seam. The CLCM may theoretically be extended to predict the general effects on the same reserve seam by the same previously mined seam within the county supplying the original mine prediction data. For example, the question might be asked, "How does previous mining in the 084 seam affect the tonnage totals listed in the coal reserve base for seam 076 in a given county?" Using, for example, a mine located in Cambria County, Pennsylvania to calculate the coal loss in bed 076 resulting from previous undermining in coal bed 084, a value of 13% coal loss is predicted by the CLCM for bed 076. The total underground reserve base listed for Cambria County in IC 8655 is 354.04 million short tons. Applying the calculated predicted 13% coal loss (if all of coal bed 084 is assumed to have been previously mined or will be mined prior to extraction of bed 076), then the actual tonnage listed in Cambria County for coal bed 076 should be reduced to 308.01 million short tons. This represents a simplified and qualified situation. If, in fact, reserve bed 076 was also previously overmined (seam 071) then the CLCM must be exercised on specific mine data to determine the coal loss expected as a result of seam 071. If the CLCM predicts a 4% loss in seam 076 due to factors originating from seam 071, then a recalculation of mineable tonnage in the reserve seam would now read 339.9 million short tons. In actuality, in any given county, some undermining and some overmining of the reserve seam may have occurred. It may be difficult to project, for a given county, exactly how much of each type of mining has or will occur and what the combined effect will be on the reserve seam. The CLCM, however, can be used to provide maximum or worst case effects of each type of mining on the coal reserve tonnages. The possibilities for handling the data are many. A few suggestions are:

1. Use only the data from the previously mined seam showing the largest coal loss.

2. Calculate coal loss resulting in the reserve seam from both previously mined seams and then average the results.

3. Determine the approximate percentage each of over and undermining occuring in a given county and use these percentages to calculate separately the effects on reserve tonnage.

In the absence of mine specific data for another specific county, the CLCM may be extended to other counties within the same sub-region. For example, the predicted percentage coal loss for Cambria County which lies within sub-region IIIA may be applied to Somerset County which lies within the same sub-region and contains the identical two seams. It is, therefore, theoretically possible to predict, by county, the general coal loss for a specific reserve seam caused by a specific previously mined seam over an entire sub-region if the assumption is made of complete prior extraction occurring in the non-reserve seam(s).

Because individual coal beds are finite in their geographic distribution, they will naturally fall into sub-regional distributions and are also expected to extend into adjacent sub-regions. Specific mine data should be used to characterize each natural sub-region. Extending predicted coal losses from one sub-region to another, even though the identical seams are represented, would be stretching the acceptability of the model beyond researched results. Theoretically, this can be done by applying a regional multiplier based on the expected reaction of the varying lithologic and tectonic parameters from one sub-region to another, provided, again, that the two identical coal seams being considered are present and that basic input parameters are relatively the same.

Since this is highly unlikely between certain sub-regions and even within certain sub-regions, the uncertainties involved outweigh the probabilities for successful predictions. HRB-Singer's position is that specific mine data should be used to characterize each of the twenty sub-regions in the eastern bituminous underground coal reserve base, and that, where possible, this should be done county by county. Where this is not possible or deemed unfeasible, data from a specific mine can be used to project to other counties in the same sub-region containing the identical seams being considered. In all cases if existing local data exists on some, if not all, input variables, these should be substituted in the model where applicable. This is particularly true for the input variables of distance between the seams, overburden over the previously mined seam, and percentage extraction in the previously mined seam. This is of utmost importance in those areas of the eastern underground coal reserve base where the coal seams do not lie parallel but diverge or converge depending on distance and direction.

For those cases where two coal seams being analyzed transgress sub-regional boundaries, it may be possible to apply the results of one sub-region to the next based on a regional adjustment. This is suggested only for generalized calculations and is based on the theoretical effects of differing tectonic settings. A regional multiplier (see Table X-1) is offered using calculations made in Area IIIB as a standard of 1.0. Calculations made in one sub-region may be adjusted to predict coal loss in another sub-region using the appropriate multiplier for that region. The user is cautioned that this is to be done only for general approximations and only if:

1. The same two seams are being considered and are present in both sub-regions (determined on a county-by-county basis).

2. The basic input parameters are essentially the same.

The regional multiplier is based on the tectonic classification of each region into sub-regions. (See Map of Areas of Commonality in Chapter VI, Regional Analysis). The more disturbed sub-regions received a 1.2 rating and the less distrubed sub-regions a 0.8 rating. Region IIIB which naturally falls into a median tectonic area is rated 1.0.

TABLE X-1 REGIONAL MULTIPLIERS AREA IIIB = 1.0			
AREA	MULTIPLIER	AREA	MULTIPLIER
IA	1.2	VA	1.2
B	1.0	B	1.0
C	0.8	C	0.8
IIA	1.0	VIA	1.2
B	0.8	B	0.8
C	1.2	VIIA	0.8
IIIA	1.2	B	1.0
B	1.0	VIII	0.8
C	0.8	IX	0.8
IVA	1.0	X	1.2
B	0.8		

C. THE POTENTIAL IMPACT OF UNDERMINING AND OVERMINING ON THE COAL RESERVE BASE

On the basis of the results obtained and the mines investigated, it is concluded that previous mining has and will have a significant effect on the underground coal reserve base. Where previous mining has occurred below a reserve seam, the impact on the reserve seam will be greater than when mining has occurred above the reserve seam. These impact values can be calculated seam by seam and county by county to arrive at an overall reduced tonnage for the coal reserve base. By following this procedure in an orderly and methodical manner, an estimate of the potential impact of previous mining on the remaining coal reserve base can be made.

From the results of this study, however, one could hazard a rough estimate on the range of potential impact of seam interaction on the coal reserve base. Generally, overall coal loss should be in the five to twenty percent range for previously undermined situations and in the one to ten percent range for previously overmined situations although occasional mines will fall outside these limits. Looking at the reserve base as a whole, it would not be overly pessimistic to estimate an average reduction of ten percent in the reported tonnage. This reduction, it is to be remembered, is due solely to the impact of previous mining and does not take into consideration potential coal loss from other sources.

XI. RECOMMENDATIONS

Based on the results obtained in this study, the following recommendations are made:

1. Implementation, by the USBM, of the Coal Loss Calculation Model on a county by county basis using available mine data to determine the percentage coal loss expected in the principal reserve seam(s) as a result of previous mining above or below this seam.

2. Reported figures for coal reserve tonnages in IC 8655 should be considered as high by approximately 10% as an estimate in lieu of complete recalculation using the CLCM.

3. Further validation of the Coal Loss Calculation Model over a wider range of mines both areally and in the range of parameters tested. Validation and testing of the regional capability of the coal loss calculation model should be effected in both overmining and under-mining situations throughout the Eastern Bituminous Region. This can be accomplished by collecting mine specific data and implementing the model for each of the sub-regions where multiple seam mining is being practiced.

4. Investigate and determine the effect, if any, of massive lithologies on subsidence and subsidence induced coal loss. It is important to determine if massive sandstones, for example, actually provide a "beam" effect over room and pillar workings that is sufficient to eliminate or dampen subsidence effects in overlying seams or even at the surface.

5. Further sophistication of the model to permit additional predictions. These could be:

   a. Expected subsidence at the surface.

   b. Probability that subsidence has occurred, is occurring, or may occur in the future.

   c. Maximum surface area affected by subsidence, and,

   d. Combined effect of coal loss experienced in a reserve seam from any number of previously mined seams above and below the reserve seam.

6. Additional research to further test the empirical validity of the estimated statistical relationships between the significant physical variables by expanding the number of mines providing input data. By the random selection of mines from different areas of commonality, an increase in the variability among the physical variables can be achieved.

7. Further statistical analysis to consider the interaction between the physical variables in the selection of the significant independent variables.

8. Research into the effect of economics on the recovery of coal. The economics and social aspects of mining in multiple seam areas were not included in the present study.

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APPENDIX A

INTERVIEW SCHEDULE: MINE INSPECTORS

INTERVIEW SCHEDULE: MINE INSPECTORS

Respondent's Name: ______________________ Address: ______________________

Form completed by: ______________________ ______________________

Date: ______________________ ______________ ZIP Code: ______

Telephone No.: ( ) ____________

1. Region. (Official designation; key place names that define boundaries of jurisdiction.)

____

____

2. Number of underground mines over which the inspector has jurisdiction:

____

3. Number of mines engaged in multiple seam mining: ______________

4. Production of mines in this region. The primary concern is with multiple seam mines. However, two or three single seam mines should also be included in the "sample" below. A "sample" should include a "large," "medium," and "small" mine at a minimum. "Largeness" and "smallness" will be relative to each region.

Mine	Mining Method	Est. Production, Tons per Year	Est. Percent of Extraction

____

____

____

*Single seam mines:

____

____

If unable to get mine-specific data, request "averages" for the overall region, e.g., most common type of mining, ___________; average production, ___________, average percent of extraction, _____________.

5. Characteristics of coal seams mined in this area. List seams in descending order from the surface.

Seam Name	USBM Code	Average Thickness	Distance Between Mineable Seams	Type of Intervening Strata

HRB-SINGER, INC.

6. Amount of overburden to first seam that is mined in this region.

Range: __________ft. to __________ft. Mean (average): ____________ft.

7. Time elapsed between mining, multiple seam mines. If possible, identify specific mines, dates. Code to mine identification used in production estimates.

Mine	Upper Seam (USBM#)	Years Mined	Lower Seam (USBM#)	Years Mined

If not possible to get mine-specific data, then request "average" time that elapsed between mining for the overall region. __________________

8. Pillar dimensions, this region.

Range: _________' x _________' to _________' x _________'

Average dimensions: ________' x _________'

(Variation: ____________ft. centers to __________ft. centers

Average: ____________ft. centers.

9. Discuss attempts to align pillars in current seam with those in previously mined seams. Consider effectiveness, problems encountered. Identify mines, if possible.

____

____

____

10. Prevailing roof conditions, this region. (Consider notable exceptions, too.)

Seam	Composition	Condition/Effect	Mines Noted

11. Prevailing floor conditions, this region. (Consider notable exceptions, too.)

Seam	Composition	Condition/Effect	Mines Noted

12. Presence of any geologic condition which might affect coal production in the overall region. (E.g., faults, synclines, etc.) Describe condition and effects.

13. Inspector's opinion of the effects of under/overmining practices in this region on the amoung of coal recovered.

14. Specific mines in the region in which effects were noted.

15. Discuss effects of remnant pillars in multiple seam mines in the region. Identify mines, if possible.

* Explore possibility of coordinating visits to mines. It would be desirable to visit at least one mine that was not mining multiple seams as well as one mine that was mining multiple seams.

Our concern is for identifying a mine that is either completely mined out, or which has a large section that is completely mined out and is no longer used for any purpose.

APPENDIX B

DATA COLLECTION FORM

DATA COLLECTION FORM

Date: ______________________

Mining Company: ______________________ Address: ____________________

Other names by which the company is known: ____________________

______________________ ____________________

Company Respondents: _________________ Telephone No.: ( ) __________

____

____

Form completed by: __________________

Type of Operation: Overmining _______ Undermining _______

Specific mine name or identifier: ________________________________

Location of mine: ____

____

____

(Get sufficient data to pinpoint the location on a topographical map.)

Mine Surface Elevation: _____________

( ) Current Seam Name: _______ USBM Code: _______ Elevation: _______

Mined from _______ to _______. Mining Method: _____________

( ) Previous Seam Name: _______ USBM Code: _______ Elevation: _______

Mined from _______ to _______. Mining Method: _____________

( ) Previous Seam Name: _______ USBM Code: _______ Elevation: _______

Mined from _______ to _______. Mining Method: _____________

If any seams are or were mined by a company <u>other</u> than the company named above, so indicate.

( )

( )

DISCUSSION GUIDE

1. Distance between current seam and next seam(s) above/below. __________ft.

__________ft.

2. Thickness, current seam. ____" ____'

3. Thickness, previous seam(s). (Identify seam: ______) ____" ____'
(Identify seam: ______) ____" ____'

4. Amount of overburden, current seam. __________ft.

5. Time elapsed between minings. We need the time between mining only for the sections of a seam that have been under- or over-mined.

____mos. ____yrs.

6. Types of intervening strata. (Use miner's terminology.)

7. Opinion of mine personnel as to the effects of previous mining on the amount of coal recoverable in the current seam. Try to get specifics.

8. Estimate of percentage of coal recovered or recoverable:

Current seam - __________%

Previous seam-(___)__________%

Previous seam-(___)__________%

9. Effects of subsidence on current operations.

10. Pillar dimensions - Current seam: ____________- ft. centers

Previous seam: ____________- ft. centers

Previous seam: ____________- ft. centers

11. Discuss attempts (if any) to align pillars.

12. Remnant pillars. Discuss problems (if any) attributable to remnant pillars in previous seam(s).

13. Pillar condition. Indicate condition of pillars in current and previous seam(s) (if possible). Describe severity of problem. Type of problem conditions include spalling, crushing, sinking, etc. Get opinion as to probable cause.

Current Seam	Previous Seam	Previous Seam

14. Floor, current seam.

Composition

Conditions: e.g., rolling, heaving, hard/soft, wet/dry

15. Floor, previous seam(s).

Composition

Condition

16. Roof, current seam.

Composition

Conditions: e.g., falls, fractures, etc. Pay particular attention to conditions that affect the amoung of coal recoverable.

17. Roof, previous seam.

Composition

Conditions

18. Water. (Current Seam) (Previous Seam)

Presence

Amount (e.g., damp, shallow pooling, more than one foot of standing water, etc.)

Source

Effects on Production

19. Gas. (Current Seam) (Previous Seam)

Presence

Kind

Source (e.g., floor emissions, gas spills, etc.)

Effects on Production

20. Comparable mines with OM/UM conditions, and adequate records; other possible respondents. . .

APPENDIX C

STATISTICAL ANALYSIS PROCEDURE

STATISTICAL ANALYSIS PROCEDURE

The following sequential steps are employed in the statistical analysis.

1. Planning and Actual Data Collection
2. Data Processing
3. Tests for Normality
4. Principal Components Analysis
5. Multiple Regression Analysis

The first step is not presented in this Appendix because it is discussed in detail in Section VII. The discussions included in this Appendix are the mechanics of the last four steps. Some interpretations of results are also included under steps 4 and 5.

DATA PROCESSING

A key of alphanumeric codes entitled Data Deck Variable Identification and Codes (DDVIC) was prepared to facilitate data processing. These data and related information are listed in Table C-1. The data for each mine were key punched on standard 80 column IBM cards. The first 8 columns on the data card were code names for the (a) state, (b) name of the mine, (c) sample number, (d) range of values, and (e) card number. The first three items (a to c) each have two digit codes while (d) and (e) each have a one digit code. All of the data that corresponds to the sixty-three variables are entered as actual values or codes as identified in the DDVIC list.

The data for the first forty-three variables (X_1 to X_{43}) were originally key punched. (These data were collected from the sources indicated and recorded on the Data Collection Form, Figure VII-7). Some of the forty-three variables do not have any data or observations, hence their columns are blanks that produce zeros on the data listing printouts. The first forty-three variables were used for the generation of the data for the last twenty variables (X_{44} to X_{63}). These variables are differences, products and ratios of the first 43 variables. The formulas used to generate the values for variables

X_{44} to X_{63} are included in Table C-1. The collected and generated data on the sixty-three variables provided the data base input deck for the empirical and statistical analyses to validate models UM and OM. The data deck of 63 variables had 7 cards for each of 50 samples. Nine variables were punched on each card. The data listing for the 50 sample blocks for 63 variables from each mine are included in Appendix D-1 through D-4.

The 50 random sample data points from each mine were separated into two decks for the following reasons:

(1) For the UM(1) mine, 19 samples with one hundred percent extraction in the previously mined seam (X_{37}) were pulled out. This was done to derive a more homogeneous sample of data points for the 24 variables selected. For instance, zero values were generated for pillar strength (X_{55}) and pillar strength/pillar load ratio (X_{57}) from the sample blocks with 100 percent extraction in the PMS. Zero values are not meaningful at all in measuring the impact of these variables on percent coal extraction or on percent coal loss. However, even though sample partitioning was done, no information was disregarded. Both the data deck sets of 50 and 31 sample points were analyzed. Twenty-one variables were included in the analyses of the 50 sample points and the 31 sample points included all of the 24 variables.

(2) For the same reasons explained in (1) above, the 50 random sample points for the OM(1) mine were separated into two decks of 50 and 29 each. The set of 50 was reduced to 47 because of no previous mining on two of the samples and no current mining on one. Hence, the statistical analysis for the OM(1) mine data was done on 47 sample deck sets that includes sixteen variables and 29 sample deck sets with 19 variables.*

(3) For the OM(2) mine, 56 random sample data points were included. This data set was divided again into two decks of 32 and 24 samples for a reason different from (1) and (2) above. In this mine, 24 of the 56 random sample blocks in the currently mined seam had no previous mining on the overlying seam, while 32 of the sample blocks in the CMS were mined previously on the overlying seam. With the same mining method used in the CMS and PMS, the data

*For reason of data availability only 19 variables were included in the statistical analysis of the data from the OM(1) mine.

TABLE C-1 DATA DECK VARIABLE IDENTIFICATION AND CODES			
VARIABLE NAME	ITEMS	CODE/ENTRY	UNITS
	State	01 - 50 01 - Pennsylvania 02 - W. Virginia	
	Name of Mine	01 - 99 01 - UM(1) 02 - OM(1) 03 - OM(2)	
	Sample Block Number	01 - 99	
	Range of Values	1 - High 2 - Low	
	Card Number	1 - 9	
X_1	Sample Block Area	Actual Value	square feet
X_2	Extracted Area in Sample Block	Actual Value	square feet
X_3	Remaining Coal Area in Sample Block	Actual Value	square feet
X_4	Surface Elevation	Actual Value	feet
X_5	Water Table Elevation	Actual Value	feet
X_6	Coal Rank	1 - Low Volatile 2 - Medium Volatile 3 - High Volatile	
X_7	Coal Density	Actual Value	lbs/cubic feet
X_8	Currently Mined Seam (CMS) Name	1 - A 2 - A' 3 - B 4 - C 5 - C' 6 - D	

TABLE C-1 DATA DECK VARIABLE IDENTIFICATION AND CODES (Cont'd)			
VARIABLE NAME	ITEMS	CODE/ENTRY	UNITS
		7 - E 8 - 9 - 10 - 11 - 12 - 13 - no. 5 seam 14 - no. 3 seam	
X_9	CMS USBM Code	Numerical Code	
X_{10}	CMS Elevation	Actual Value	feet
X_{11}	CMS Thickness	Actual Value	feet
X_{12}	CMS Dip	Actual Value	degrees
X_{13}	CMS Dip Direction	1 - N 2 - S 3 - W 4 - E 5 - NE 6 - NW 7 - SE 8 - SW	
X_{14}	CMS Date of Mining	Actual Data	years
X_{15}	CMS Percent Extraction	Actual Value	percent
X_{16}	CMS Roof Strength	Actual Value	$lbs/inches^2$
X_{17}	CMS Floor Strength	Actual Value	$lbs/inches^2$
X_{18}	CMS Intervening Strata Strength	Actual Value	$lbs/inches^2$
X_{19}	CMS Pillar Width	Actual Value	feet
X_{20}	CMS Span	Actual Value	feet
X_{21}	CMS Roof Problems	1 - YES 0 - NO	

TABLE C-1 DATA DECK VARIABLE IDENTIFICATION AND CODES (Cont'd)

VARIABLE NAME	ITEMS	CODE/ENTRY	UNITS
X_{22}	CMS Severity of Roof Problems	1 - Noticeable 2 - Somewhat Troublesome 3 - Impairs Production 4 - Halts Operation	
X_{23}	CMS Floor Problems	1 - YES 0 - NO	
X_{24}	CMS Severity of Floor Problems	1 - Noticeable 2 - Somewhat Troublesome 3 - Impairs Production 4 - Halts Operation	
X_{25}	CMS Water Problems	1 - YES 0 - NO	
X_{26}	CMS Severity of Water Problems	1 - Noticeable 2 - Somewhat Troublesome 3 - Impairs Production 4 - Halts Operation	
X_{27}	CMS Gas Problems	1 - YES 0 - NO	
X_{28}	CMS Severity of Gas Problems	1 - Noticeable 2 - Somewhat Troublesome 3 - Impairs Production 4 - Halts Operation	
X_{29}	CMS Mining Method	1 - Room and Pillar 2 - Longwall 3 - Shortwall	
X_{30}	Previously Mined Seam (PMS) Name	1 - A 2 - A' 3 - B 4 - C 5 - C' 6 - D 7 - E 8 - 9 - 10 - 13 - 14 -	

TABLE C-1 DATA DECK VARIABLE IDENTIFICATION AND CODES (Cont'd)			
VARIABLE NAME	ITEMS	CODE/ENTRY	UNITS
X_{31}	PMS USBM Code	Numerical Code	
X_{32}	PMS Elevation	Actual Value	feet
X_{33}	PMS Thickness	Actual Value	feet
X_{34}	PMS Dip	Actual Value	degrees
X_{35}	PMS Dip Direction	1 - N 2 - S 3 - W 4 - E 5 - NE 6 - NW 7 - SE 8 - SW	
X_{36}	PMS Date of Mining	Actual Date	year
X_{37}	PMS Percent Extraction	Actual Value	percent
X_{38}	PMS Roof Strength	Actual Value	$lbs/inches^2$
X_{39}	PMS Floor Strength	Actual Value	$lbs/inches^2$
X_{40}	PMS Intervening Strata Strength	Actual Value	$lbs/inches^2$
X_{41}	PMS Pillar Width	Actual Value	feet
X_{42}	PMS Span	Actual Value	feet
X_{43}	CMS Area Per Sample	Actual Value	acres
X_{44}	CMS Coal Reserve Per Sample	Actual Value	tons
X_{45}	CMS Coal Extracted Per Sample	Actual Value	tons
X_{46}	CMS Coal Loss Per Sample	Actual Value	tons
X_{47}	CMS Percent Coal Loss Per Sample	Actual Value	percent
X_{48}	CMS Coal Extracted Per Acre	Actual Value	tons/acre
X_{49}	CMS Coal Loss Per Acre	Actual Value	tons/acre
X_{50}	CMS Depth Below the Surface	Actual Value	feet

TABLE C-1 DATA DECK VARIABLE IDENTIFICATION AND CODES (Cont'd)

VARIABLE NAME	ITEMS	CODE/ENTRY	UNITS
X_{51}	PMS Depth Below the Surface	Actual Value	feet
X_{52}	Vertical Distance Between the Seams	Actual Value	feet
X_{53}	Stress Zones	Actual Value	feet
X_{54}	Subsidence	Actual Value	feet
X_{55}	PMS Pillar Strength	Actual Value	$lbs/inches^2$
X_{56}	PMS Pillar Load	Actual Value	$lbs/inches^2$
X_{57}	PMS Ratio of Pillar Strength to Load	Actual Value	
X_{58}	CMS Ratio of Roof Strength to Floor Strength	Actual Value	
X_{59}	PMS Ratio of Roof Strength to Floor Strength	Actual Value	
X_{60}	PMS Depth of Overburden	Actual Value	feet
X_{61}	Time Elapsed Between Mining	Actual Value	years
X_{62}	Critical Excavation Width	Actual Value	feet
X_{63}	Percent Subsidence	Actual Value	percent

FORMULAS FOR VARIABLES 44 TO 63

$$X_{44} = \frac{(X_1)(X_{11})(X_7)}{2,000}$$

$$X_{45} = \frac{(X_2)(X_{11})(X_7)}{2,000}$$

$$X_{46} = \frac{(X_3)(X_{11})(X_7)}{2,000} \quad \text{or } X_{44} - X_{45}$$

$$X_{47} = \frac{X_{46}}{X_{44}} \times 100$$

$$X_{48} = \frac{X_{45}}{X_{43}}$$

$$X_{49} = \frac{X_{46}}{X_{43}}$$

$$X_{50} = X_4 - X_{10}$$

$$X_{51} = X_4 - X_{32}$$

$X_{52} = X_{10} - X_{32}$ or $X_{32} - X_{10}$ (subtrahend is seam on higher elevation)

$$X_{53} = 6\left(\frac{X_{51}}{20} + 20\right) \quad \text{or } (0.3)\ (X_{51}) + 120$$

FORMULAS FOR VARIABLES 44 TO 63 (Cont'd)

$$X_{54} = .9\ (X_{33} - .10X_{52})\ f(X_{42}/X_{52})(X_{37})$$

$$X_{55} = (1320)\left(\frac{X_{41}^{0.46}}{X_{33}^{0.66}}\right)$$

$$X_{56} = (1.1)\ (X_{51}/(100 - X_{37}))\ (.01)$$

$$X_{57} = X_{55}/X_{56}$$

$$X_{58} = X_{16}/X_{17}$$

$$X_{59} = X_{38}/X_{39}$$

$$X_{60} = (X_4 - X_{32}) - X_{33}$$

$$X_{61} = X_{14} - X_{36}$$

$$X_{62} = 3\ (\frac{X_{51}}{20} + 20) \text{ or } (0.15)\ (X_{51}) + 60$$

$$X_{63} = \frac{X_{54}}{X_{33}}$$

from this mine represent a case where definite comparison can be made on the percentage of coal loss from the CMS attributable to previous mining. In this case the average percentage of coal loss attributable to previous mining is 13%.

TESTS FOR NORMALITY

The distribution of the observations for the selected variable in each deck was tested for normality. The test was conducted through the use of the NORMSTAT Program Algorithm.* Tests for normality included in the NORMSTAT program are: (1) tests for skewness and kurtosis calculated by the use of the third and fourth moments and (2) Chi-square goodness of fit test. The NORMSTAT algorithm outputs histograms or distributions in the form of line charts, sample mean, standard deviation, variance, sample size, and values to conduct the tests for skewness and kurtosis and Chi-square. The output histograms give indications of which distribution approximate a normal distribution and which variables are skewed either to the right or to the left. The skewed distributions or histograms require data transformation. The NORMSTAT algorithm allows thirteen types of data transformations. For practical applications only two options were used in this study**. These are the log to the base 10 and the arc sine transformations. Log to the base 10 was used when the observed distribution or histograms of the variable was skewed to the right. The arc sine was used when the observed distribution was skewed to the left. The transformation of the data for the variable with skewed distribution is suggested when the coefficient of variation of the data for a particular variable, say X_i is above twenty or thirty percent. The coefficient of variation (C.V.) is calculated as

$$C.V. = \left(\frac{\bar{X}}{S}\right) (100)$$

where

* The algorithm was acquired from Dr. J. Griffith, Professor of Geostatistics at The Pennsylvania State University and consultant to HRB-Singer.

**Suggested by Dr. J. Griffith during a consultation session.

$\overline{X}$ = Sample Mean

S = Standard deviation of the sample

The test for normality was included as a data cleaning step preparatory to principal components and multiple regression analyses. This step was done to insure that the data do not violate the statistical assumptions of the analytical techniques.

Of the 24 variables selected, the ones where data transformations were made are shown in Table C-2.

PRINCIPAL COMPONENTS ANALYSIS

The data outputs from the NORMSTAT analysis for each deck for each mine were factor analyzed. The CORFAN (Correlation Factor Analysis) program algorithm was used. The primary purpose of utilizing principal components analysis for analyzing the 24 selected variables was to classify them into independent sets and identify the redundant variables. This classification technique also detects the existence of multi-colinearity among the variables.

The CORFAN program algorithm with its current limitations has several output options. The options used in this analysis are (1) correlation matrix (2) means and standard deviations (3) number of components or factors (4) matrix of loadings both unrotated and rotated and (5) communalities and (6) eigenvalues. Brief explanations of items (3) to (6) are presented below:

Item (3) The number of factors (columns) are the number of substantively meaningful independent (uncorrelated) patterns of relationships between the variables.

Item (4) Factor loadings measure which variables are involved in what factor pattern and to what degree. They can be interpreted as correlation coefficients. The square of the loading multiplied by one-hundred equals the percent variation that a variable has in common with an unrotated pattern. The percent figure is the reliability of prediction of a variable from the pattern or the other variables in the pattern. By comparing the factor loadings for all factors and variables those particular variables involved in an independent pattern can be defined and those variables most highly related to a pattern can be seen.

TABLE C-2 SELECTED VARIABLES IN EACH MINE AND THE TRANSFORMATION USED.

Mine and Variable	Transformation
OM(1)	
X_{19}	log
X_{20}	log
X_{41}	log
X_{42}	log
X_{48}	log
X_{49}	log
X_{55}	log
X_{56}	log
OM(2)	
X_{20}	log
X_{42}	log
X_{48}	log
X_{49}	arc sine
X_{56}	log
UM(1)	
X_{20}	log
X_{41}	log
X_{42}	arc sine
X_{48}	log
X_{49}	arc sine
X_{55}	log
X_{56}	log

Item (5) Communality is the proportion of the total variation in which a variable is involved in the pattern. This also gives the percent of variation of a variable in common with the pattern. This communality may also be looked at as a measure of uniqueness. By subtracting the percent variation in common with the patterns from one-hundred, the uniqueness of a variable is determined. This indicates to what degree a variable is unrelated to the others; i.e., to what degree the data on a variable cannot be predicted (derived) from the data on the other variables.

Item (6) Eigenvalues equal the sum of the column of squared loadings for each factor. They measure the amount of variation accounted for by a pattern. Dividing the eigenvalues by the number of variables and multiplying by one-hundred determines the percent of total or common variance.

In the classification of the selected variables into independent sets, the matrix of unrotated factor loadings was used in this study. The factor by factor comparison between the unrotated and rotated matrix of loadings showed that the cumulative percentage variation contributed by each factor is higher in the unrotated matrix than in the rotated matrix. The cumulative percent variation in both, however, converge at some number of factors. The convergence point signals the number of independent sets.

RESULTS OF PRINCIPAL COMPONENTS ANALYSIS

The results obtained from the principal components analysis of the UM(1) mine data are interpreted and summarized below. (See also Appendix E).

The correlation coefficients calculated for the 24 variables express the degree of relationship between the row and column variables of the matrix. The closer to zero the coefficient, the less the relationship; the closer to one, the greater the relationship. A negative sign indicates the variables are inversely related. For $n = 50$ and $n = 31$, the values of $\underline{r}$ (correlation coefficient) higher than .366 and .328 are significant at the 1% level, respectively.

At the 1% level of significance, three basic groups of variables (Groups A, B, C in Table VIII-3) were observed from the matrix of correlation coefficients. Group A suggests that one can select either X_{15} or X_{47} or X_{48} or X_{49} as the dependent variable for this study.

These groupings (A, B, and C) also suggest that only one of the variables from each group can be used at a time. The degree of substitutability of each variable in each group varies. The degree of substitutability suggests that those variables with correlation coefficients of .99 or 1.00 are perfect substitutes. The variables with correlation coefficients between .90 and .98 are highly substitutable. Those variables with coefficients between .50 and .89 must be substituted for each other with care and possibly derive a new variable in terms of their interaction. It is important to recognize the degree of intercorrelation between the row and column variables included in the matrix to minimize redundancy and multicolinearity. Intercorrelations among the independent variables in multiple regression analysis tend to destabilize the regression coefficients and in extreme cases the mathematical calculations break down when the matrix of the independent variables is singular.

The variables in each group (particularly Groups B and C) have significant implications in relation to the variables with high factor loadings. The factor loadings on each variable under each factor or component are summarized in Table C-3. Nine components are calculated from the data set of 24 variables. These nine components are generated from the data by setting the eigen coefficient to .5.* The first component of the unrotated (original) factor pattern delineates the most general pattern of relationships in the data; the second delineates the next most general pattern that is independent of (uncorrelated with) the first; the third component delineates the third most general pattern independent of the first and the second, etc. Thus, the amount of variation in the data each pattern describes decreases successively with each factor. Hence, the first component is the most powerful, the last component least powerful.

The results showed that the loadings on component 1, F_1, are highest on the variables representing PMS and CMS lithologies of the immediate roofs and floors (X_{58} and X_{59}). Loadings on the PMS and CMS overburden characteristics

*This is an option in the CORFAN program. The researcher sets the limit of the eigenvalue coefficient and the program automatically calculates the number of components until that coefficient limit is reached.

TABLE C-3

THE ORIGINAL MATRIX OF FACTOR LOADINGS UM(1)

	F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
1	-0.67372	-0.42372	0.50743	0.21199	-0.04825	-0.13424	-0.03489	-0.07240	-0.13944	0.0
2	-0.27075	-0.00059	-0.39114	-0.48140	0.34424	-0.31001	0.13189	-0.41848	-0.17759	0.0
3	-0.37841	-0.51879	0.48368	0.35145	-0.06328	0.19131	0.03229	-0.20996	0.08438	0.0
4	0.86914	-0.10705	0.16656	-0.07096	-0.13935	-0.23870	-0.16004	0.15084	-0.20022	0.0
5	-0.64153	-0.63371	-0.29923	-0.19247	-0.02143	0.02805	-0.03549	0.12026	-0.02649	0.0
6	0.29298	-0.06306	-0.02533	0.26743	0.62261	-0.48692	-0.30465	-0.10261	0.18345	0.0
7	-0.44358	-0.74827	-0.19071	-0.28145	-0.02777	-0.13199	-0.17740	-0.01596	0.08221	0.0
8	0.67664	0.41569	-0.51182	-0.20610	0.04953	0.13798	0.03943	0.07254	0.13471	0.0
9	-0.64336	-0.45105	0.49419	0.24773	-0.02027	-0.09493	-0.13163	-0.09624	-0.09717	0.0
10	0.25902	0.17390	-0.17869	-0.04576	0.08902	0.56125	-0.67546	-0.23880	-0.17477	0.0
11	0.70343	-0.68265	0.06749	0.00962	0.09725	0.10226	0.07056	-0.04474	0.06214	0.0
12	0.68785	-0.70301	0.07001	-0.02471	0.04374	0.08021	0.03762	-0.05300	0.09760	0.0
13	-0.39919	0.01661	0.00266	-0.36314	-0.59227	-0.25835	-0.37824	-0.07629	0.34570	0.0
14	0.68758	-0.70312	0.07099	-0.02441	0.04264	0.07366	0.04641	-0.04829	0.10258	0.0
15	-0.59652	-0.69792	-0.28710	-0.18472	0.03813	0.02136	-0.03853	0.12109	-0.07496	0.0
16	0.22584	0.31894	0.65962	-0.60983	0.11751	0.00931	0.00050	0.00192	0.00194	0.0
17	0.13317	0.04738	0.62914	-0.73617	0.08270	0.06980	0.04750	0.01010	-0.03974	0.0
18	0.14629	0.92218	0.18337	0.14200	0.01164	-0.10169	-0.09559	-0.06753	0.09556	0.0
19	0.86925	-0.10697	0.16632	-0.07106	-0.13905	-0.23666	-0.16301	0.14927	-0.20171	0.0
20	0.74876	-0.32708	-0.18718	0.20607	-0.19439	-0.25750	-0.14698	0.10077	-0.16419	0.0
21	0.68787	-0.70300	0.06997	-0.02473	0.04378	0.08054	0.03716	-0.05323	0.09736	0.0
22	0.52415	-0.02404	-0.24631	0.01477	-0.51931	-0.10404	0.22604	-0.44071	-0.10626	0.0
23	0.68496	-0.70631	0.06861	-0.02211	0.04365	0.07379	0.04409	-0.04965	0.10019	0.0
24	-0.59657	-0.69845	-0.28655	-0.18420	0.03749	0.01639	-0.03112	0.12441	-0.07107	0.0
SUM SQ.	7.99419	6.32836	2.51337	1.88301	1.26216	1.05621	0.91400	0.62372	0.46069	0.0
VAREXP	33.30913	26.36815,	10.47239	7.84586	5.25900	4.40087	3.80831	2.59882	1.91953	0.0
CUMPER	33.30913	59.67728	70.14966	77.99551	83.25452	87.65538	91.46368	94.06250	95.98203	95.98203

are also significantly very high (X_{50}, X_{51}, and X_{60}). The loadings on X_{15}, X_{47} X_{48}, and X_{49} can also be noted from F_1; X_{15}, and X_{47} load higher than X_{48} and X_{49}. The comparison of the loadings on X_{15}, X_{47}, and X_{49} implies that it is more meaningful to use X_{15} and X_{47} than X_{48} and X_{49} as dependent variables.*

From component 2, F_2, the loading is highest on variable X_{57} (PMS ratio of pillar strength to pillar load). However, the loadings were also significantly high on X_{37} (PMS percent extraction), X_{42} (PMS span), X_{54} and X_{63} (maximum subsidence and percent subsidence), respectively.

The loadings on components 3 and 4, F_3 amd F_4, are all high for X_{55} (PMS pillar strength), X_{56} (PMS pillar load). From Component 5, F_5, X_{52} (vertical distance between the seams) and X_{41} (PMS minimum pillar width) are the variables with highest loadings. These two variables surfaced again in components F_6 and F_7 but their loadings are lower than in F_5.

Component 8, F_8, showed the highest loading on X_{61} (time elapsed between mining). This variable has significant loadings also under F_1, F_3, and F_5.

Based on the factor loadings noted above and the variable groups (particulary B and C), one can conclude that X_{52} (vertical distance between the seams) and X_{61} (time elapsed between mining of CMS and PMS) are independent not only of each other but also with each of the variables in the B and C groups. Since X_{52} and X_{61} have the highest loadings on components 5 and 8 respectively, each of them was chosen as an independent set. Both of them are used as independent variables in the multiple regression analysis.

The independent variables defined are then the best input variables to the multiple regression analysis. The variable with the highest loading from each group can be selected, or one can use its substitute. Logic and knowledge of the relationships between the dependent and independent variables must be considered during variable selection and substitution.** The utility and practical application of the results from the regression analysis must also enter into the decision of selection of the independent sets of variables.

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* The selection of the dependent variable based on the factor loadings is the primary purpose of including X_{15}, X_{47}, X_{48}, and X_{49} in the component analysis.

**The correlation coefficient matrix will be very useful to the researcher in this regard.

MULTIPLE REGRESSION ANALYSIS

This step in the statistical analysis is focused on the estimation of parameters or coefficients that measure the impact of the physical variables in the previously mined seam to the percent recovery of coal or coal left in place in the reserve or currently mined seam. To obtain unbiased estimates for the parameters, classical least squares regression was used. This method of estimation starts with the assumption that a linear relationship exists between a variable y and k explanatory variables, X_1, X_2, ... X_k and a disturbance term μ.

In the analysis the regression model was represented by the equation that follows.

$$X_{15} = \pounds_0 + \beta_1 X_{37} + \beta_2 X_{52} + \beta_3 X_{60} + \beta_4 X_{61} + \mu_i.$$

The β coefficients are the unknown parameters. These coefficients were estimated from mine specific empirical data that represented both the undermined and over-mined conditions. The results of the estimation for both conditions are discussed in detail in Section VIII of the report. The interpretation and discussion of results on multiple regression in this Appendix are extensions and modifications made to the estimating equation.

Additional equations were estimated as modifications to equation (4) in Section VIII. The modifications were in terms of (1) dropping the PMS percent extraction (X_{37}) and PMS depth of overburden (X_{60}) variables and (2) including the following variables one at a time in the estimating equation. These variables are: (a) subsidence variables (X_{54} and X_{63}); (b) PMS ratio of pillar strength to pillar load (X_{57}), (c) PMS ratio of immediate roof strength to floor strength (X_{59}) and (d) PMS depth below the surface (X_{51}). These estimations were pursued in order to determine the degree of the relationships existing between CMS percent extraction (X_{15}) and the variables that are highly inter-related with X_{37} and X_{60}.

The results given on page 251, Appendix F-1 showed that maximum subsidence (X_{54}) has a highly significant positive coefficient in the order of 7.8471. The coefficient for percent subsidence (X_{63}) (page 255) is also positive and highly significant with a magnitude of 45.1610. The magnitudes of the coefficients of these two variables are indicative of their respective impacts on percent extraction and percent coal left in place in the seams being currently mined. It also implies, obviously, that percent subsidence is more meaningful variable in terms of its weight (coefficient) than maximum subsidence.

For PMS ratio of pillar strength to pillar load (X_{57}) the estimated coefficient is negative (-6.3079) and also highly significant. This variable X_{57}, is a ratio of two variables derived functionally and the explanation of the coefficient must be related to the pillar strength and pillar load formulas.*

The estimated coefficient for X_{59}, is also negative (-5.3947) and significant at 10%. Again X_{59} is a ratio variable of the immediate roof strength to floor strength of the previously mined seam.

Several equations were also estimated using CMS percent coal loss (X_{47}) with the same set of independent variables used when CMS percent extraction (X_{15}) is the dependent variable. These results are shown in Appendix F-1. With X_{47} as the dependent variable, the results showed that the magnitude of the calculated coefficients are almost equal to the magnitude of the estimated coefficients when X_{15} is the dependent variable. However, the signs of the coefficients are opposite and their intercept values are different. This is expected since percent coal loss or coal left in place is the inverse of percent extraction. It should be pointed out that the intercept of the equation where CMS percent extraction (X_{15}) is the dependent variable plus the intercept of the equation where CMS percent coal loss (X_{47}) is the dependent variable equals 100% all the time.

*These formulas are explained in Section IX-C.

APPENDIX D-1

DATA LISTING

UM(1) FIFTY SAMPLE BLOCKS PREVIOUSLY UNDERMINED

101011	696000.000	414400.000	281600.000	1925.000	0.0	1.000	82.600	5.000	76.000	1840.000
101021	696000.000	179200.000	516800.000	1873.000	0.0	1.000	82.600	5.000	76.000	1790.000
101031	696000.000	280000.000	416000.000	1925.000	0.0	1.000	82.600	5.000	76.000	1850.000
101041	696000.000	318400.000	377600.000	1940.000	0.0	1.000	82.600	5.000	76.000	1840.000
101051	696000.000	409600.000	286400.000	1973.000	0.0	1.000	82.600	5.000	76.000	1840.000
101061	696000.000	416000.000	280000.000	2100.000	0.0	1.000	82.600	5.000	76.000	1840.000
101071	696000.000	659200.000	36800.000	1960.000	0.0	1.000	82.600	5.000	76.000	1840.000
101081	696000.000	273600.000	422400.000	1990.000	0.0	1.000	82.600	5.000	76.000	1830.000
101091	696000.000	206400.000	489600.000	2000.000	0.0	1.000	82.600	5.000	76.000	1830.000
101101	696000.000	641600.000	54400.000	2040.000	0.0	1.000	82.600	5.000	76.000	1820.000
101111	696000.000	632000.000	64000.000	2050.000	0.0	1.000	82.600	5.000	76.000	1800.000
101121	696000.000	696000.000	0.0	2050.000	0.0	1.000	82.600	5.000	76.000	1770.000
101131	696000.000	526400.000	169600.000	2060.000	0.0	1.000	82.600	5.000	76.000	1770.000
101141	696000.000	228800.000	467200.000	2070.000	0.0	1.000	82.600	5.000	76.000	1770.000
101151	696000.000	692800.000	3200.000	2070.000	0.0	1.000	82.600	5.000	76.000	1770.000
101161	696000.000	408000.000	288000.000	2100.000	0.0	1.000	82.600	5.000	76.000	1730.000
101171	696000.000	145600.000	550400.000	2110.000	0.0	1.000	82.600	5.000	76.000	1710.000
101181	696000.000	280000.000	416000.000	2130.000	0.0	1.000	82.600	5.000	76.000	1750.000
101191	696000.000	281600.000	414400.000	2180.000	0.0	1.000	82.600	5.000	76.000	1700.000
101201	696000.000	692800.000	3200.000	2190.000	0.0	1.000	82.600	5.000	76.000	1680.000
101211	696000.000	347200.000	348800.000	2190.000	0.0	1.000	82.600	5.000	76.000	1720.000
101221	696000.000	555200.000	140800.000	2120.000	0.0	1.000	82.600	5.000	76.000	1710.000
101231	696000.000	641600.000	54400.000	2130.000	0.0	1.000	82.600	5.000	76.000	1690.000
101241	696000.000	356800.000	339200.000	2170.000	0.0	1.000	82.600	5.000	76.000	1640.000
101251	696000.000	497600.000	198400.000	2120.000	0.0	1.000	82.600	5.000	76.000	1670.000
101261	696000.000	163200.000	532800.000	2180.000	0.0	1.000	82.600	5.000	76.000	1630.000
101271	696000.000	280000.000	416000.000	2180.000	0.0	1.000	82.600	5.000	76.000	1610.000
101281	696000.000	377600.000	318400.000	2110.000	0.0	1.000	82.600	5.000	76.000	1660.000
101291	696000.000	508000.000	187200.000	2120.000	0.0	1.000	82.600	5.000	76.000	1610.000
101301	696000.000	529600.000	166400.000	2120.000	0.0	1.000	82.600	5.000	76.000	1630.000
101311	696000.000	598400.000	97600.000	2140.000	0.0	1.000	82.600	5.000	76.000	1600.000
101321	696000.000	280000.000	416000.000	1980.000	0.0	1.000	82.600	5.000	76.000	1640.000
101331	696000.000	348800.000	347200.000	2100.000	0.0	1.000	82.600	5.000	76.000	1600.000
101341	696000.000	422400.000	273600.000	2110.000	0.0	1.000	82.600	5.000	76.000	1560.000
101351	696000.000	161600.000	534400.000	2110.000	0.0	1.000	82.600	5.000	76.000	1600.000
101361	696000.000	299200.000	396800.000	2090.000	0.0	1.000	82.600	5.000	76.000	1540.000
101371	696000.000	235200.000	460800.000	2100.000	0.0	1.000	82.600	5.000	76.000	1510.000
101381	696000.000	224000.000	472000.000	1920.000	0.0	1.000	82.600	5.000	76.000	1610.000
101391	696000.000	152000.000	544000.000	2090.000	0.0	1.000	82.600	5.000	76.000	1530.000
101401	696000.000	154000.000	542400.000	2090.000	0.0	1.000	82.600	5.000	76.000	1520.000
101411	696000.000	238400.000	457600.000	1990.000	0.0	1.000	82.600	5.000	76.000	1580.000
101421	696000.000	276000.000	420800.000	1990.000	0.0	1.000	82.600	5.000	76.000	1580.000
101431	696000.000	153600.000	542400.000	2000.000	0.0	1.000	82.600	5.000	76.000	1580.000
101441	696000.000	144000.000	552000.000	2020.000	0.0	1.000	82.600	5.000	76.000	1560.000
101451	696000.000	248000.000	448000.000	2040.000	0.0	1.000	82.600	5.000	76.000	1500.000
101461	696000.000	472000.000	224000.000	2040.000	0.0	1.000	82.600	5.000	76.000	1480.000
101471	696000.000	512000.000	184000.000	1990.000	0.0	1.000	82.600	5.000	76.000	1610.000
101481	696000.000	219200.000	476800.000	2020.000	0.0	1.000	82.600	5.000	76.000	1570.000
101491	696000.000	336000.000	360000.000	2000.000	0.0	1.000	82.600	5.000	76.000	1600.000
101501	696000.000	361600.000	334400.000	2060.000	0.0	1.000	82.600	5.000	76.000	1520.000

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101011	5.830	2.000	5.000	1944.000	60.000	5000.000	4000.000	5000.000	45.000	50.000
101021	4.080	2.000	5.000	1949.000	25.000	5000.000	4000.000	5000.000	50.000	50.000
101031	5.670	2.000	5.000	1946.000	40.000	5000.000	4000.000	5000.000	50.000	450.000
101041	5.420	2.000	5.000	1941.000	46.000	5000.000	4000.000	5000.000	60.000	60.000
101051	5.580	2.000	5.000	1939.000	59.000	5000.000	4000.000	5000.000	60.000	600.000
101061	5.250	2.000	5.000	1943.000	60.000	5000.000	4000.000	5000.000	30.000	360.000
101071	5.670	2.000	5.000	1944.000	95.000	5000.000	4000.000	5000.000	45.000	480.000
101081	5.750	2.000	5.000	1945.000	40.000	5000.000	4000.000	5000.000	80.000	480.000
101091	4.500	2.000	5.000	1952.000	30.000	5000.000	4000.000	5000.000	50.000	40.000
101101	5.500	2.000	5.000	1941.000	92.000	5000.000	4000.000	5000.000	100.000	840.000
101111	4.670	2.000	5.000	1949.000	91.000	5000.000	4000.000	5000.000	0.0	840.000
101121	5.750	2.000	5.000	1947.000	100.000	5000.000	4000.000	5000.000	0.0	840.000
101131	4.500	2.000	5.000	1942.000	86.000	5000.000	4000.000	5000.000	30.000	680.000
101141	4.580	2.000	5.000	1950.000	33.000	5000.000	4000.000	5000.000	30.000	40.000
101151	5.000	2.000	5.000	1940.000	99.000	5000.000	4000.000	5000.000	0.0	840.000
101161	5.660	2.000	5.000	1942.000	59.000	5000.000	4000.000	5000.000	80.000	840.000
101171	4.330	2.000	5.000	1953.000	21.000	5000.000	4000.000	5000.000	60.000	50.000
101181	5.580	2.000	5.000	1950.000	41.000	5000.000	4000.000	5000.000	45.000	600.000
101191	5.670	2.000	5.000	1951.000	41.000	5000.000	4000.000	5000.000	60.000	440.000
101201	4.670	2.000	5.000	1951.000	99.000	5000.000	4000.000	5000.000	35.000	840.000
101211	5.170	2.000	5.000	1944.000	50.000	5000.000	4000.000	5000.000	60.000	840.000
101221	5.670	2.000	5.000	1944.000	80.000	5000.000	4000.000	5000.000	50.000	700.000
101231	5.920	2.000	5.000	1946.000	93.000	5000.000	4000.000	5000.000	50.000	840.000
101241	5.750	2.000	5.000	1949.000	52.000	5000.000	4000.000	5000.000	50.000	800.000
101251	5.580	2.000	5.000	1951.000	72.000	5000.000	4000.000	5000.000	50.000	840.000
101261	5.850	2.000	5.000	1952.000	24.000	5000.000	4000.000	5000.000	40.000	40.000
101271	6.000	2.000	5.000	1952.000	41.000	5000.000	4000.000	5000.000	40.000	840.000
101281	5.830	2.000	5.000	1955.000	55.000	5000.000	4000.000	5000.000	92.000	240.000
101291	5.500	2.000	5.000	1961.000	74.000	5000.000	4000.000	5000.000	40.000	800.000
101301	5.580	2.000	5.000	1954.000	77.000	5000.000	4000.000	5000.000	45.000	840.000
101311	5.750	2.000	5.000	1952.000	86.000	5000.000	1500.000	5000.000	45.000	840.000
101321	5.920	2.000	5.000	1952.000	41.000	5000.000	4000.000	5000.000	60.000	320.000
101331	6.000	2.000	5.000	1951.000	51.000	5000.000	1500.000	5000.000	45.000	840.000
101341	5.670	2.000	5.000	1923.000	61.000	5000.000	1500.000	5000.000	30.000	440.000
101351	5.920	2.000	5.000	1953.000	24.000	5000.000	1500.000	5000.000	45.000	45.000
101361	5.420	2.000	5.000	1954.000	43.000	5000.000	1500.000	5000.000	55.000	720.000
101371	5.670	2.000	5.000	1955.000	44.000	5000.000	1500.000	5000.000	45.000	480.000
101381	5.750	2.000	5.000	1952.000	33.000	5000.000	4000.000	5000.000	60.000	30.000
101391	5.250	2.000	5.000	1959.000	22.000	5000.000	1500.000	5000.000	55.000	30.000
101401	5.250	2.000	5.000	1954.000	23.000	5000.000	1500.000	5000.000	45.000	30.000
101411	5.850	2.000	5.000	1952.000	35.000	5000.000	1500.000	5000.000	55.000	30.000
101421	5.750	2.000	5.000	1960.000	40.000	5000.000	1500.000	5000.000	55.000	180.000
101431	5.750	2.000	5.000	1959.000	23.000	5000.000	1500.000	5000.000	60.000	35.000
101441	5.550	2.000	5.000	1959.000	21.000	5000.000	1500.000	5000.000	60.000	35.000
101451	5.750	2.000	5.000	1960.000	36.000	5000.000	1500.000	5000.000	50.000	35.000
101461	5.400	2.000	5.000	1961.000	68.000	5000.000	1500.000	5000.000	40.000	640.000
101471	5.350	2.000	5.000	1959.000	74.000	5000.000	4000.000	5000.000	40.000	840.000
101481	5.600	2.000	5.000	1959.000	32.000	5000.000	1500.000	5000.000	60.000	40.000
101491	4.900	2.000	5.000	1960.000	49.000	5000.000	1500.000	5000.000	0.0	840.000
101501	5.200	2.000	5.000	1962.000	52.000	5000.000	1500.000	5000.000	40.000	740.000

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101011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101031	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101041	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101051	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101061	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101071	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101081	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101091	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101121	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101131	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101141	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101151	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101161	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101171	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101181	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101191	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101201	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101211	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101221	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101231	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101241	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101251	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101261	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101271	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101281	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101291	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101301	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101311	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101321	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101331	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101341	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101351	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101361	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101371	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101381	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101391	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101401	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101411	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101421	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101431	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101441	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101451	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101461	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101471	0.0	0.0	1.000	0.0	0.0	0.0	0.0	0.0	1.000	3.000
101481	1.000	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101491	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000
101501	0.0	0.0	0.0	0.0	1.000	0.0	0.0	0.0	1.000	3.000

101011	84.000	1730.000	5.750	2.000	5.000	1922.000	50.000	5000.000	4000.000	5000.000
101021	84.000	1690.000	5.750	2.000	5.000	1923.000	45.000	5000.000	4000.000	5000.000
101031	84.000	1750.000	5.750	2.000	5.000	1924.000	100.000	5000.000	4000.000	5000.000
101041	84.000	1750.000	5.750	2.000	5.000	1924.000	60.000	5000.000	4000.000	5000.000
101051	84.000	1750.000	5.750	2.000	5.000	1924.000	50.000	5000.000	4000.000	5000.000
101061	84.000	1750.000	5.750	0.0	0.0	1924.000	60.000	5000.000	4000.000	5000.000
101071	84.000	1740.000	5.750	0.0	0.0	1924.000	70.000	5000.000	4000.000	5000.000
101081	84.000	1730.000	5.750	0.0	0.0	1924.000	100.000	5000.000	4000.000	5000.000
101091	84.000	1720.000	5.750	0.0	0.0	1924.000	100.000	5000.000	4000.000	5000.000
101101	84.000	1720.000	5.750	0.0	0.0	1924.000	95.000	5000.000	4000.000	5000.000
101111	84.000	1710.000	5.750	2.000	5.000	1924.000	100.000	5000.000	4000.000	5000.000
101121	84.000	1680.000	5.750	2.000	5.000	1924.000	100.000	5000.000	4000.000	5000.000
101131	84.000	1670.000	5.750	2.000	5.000	1924.000	100.000	5000.000	4000.000	5000.000
101141	84.000	1670.000	5.750	2.000	5.000	1924.000	100.000	5000.000	4000.000	5000.000
101151	84.000	1680.000	5.750	2.000	5.000	1925.000	100.000	5000.000	4000.000	5000.000
101161	84.000	1620.000	5.750	2.000	5.000	1925.000	100.000	5000.000	4000.000	5000.000
101171	84.000	1610.000	5.750	2.000	5.000	1925.000	100.000	5000.000	4000.000	5000.000
101181	84.000	1670.000	5.750	2.000	5.000	1925.000	100.000	5000.000	4000.000	5000.000
101191	84.000	1620.000	5.750	2.000	5.000	1925.000	95.000	5000.000	4000.000	5000.000
101201	84.000	1600.000	5.750	2.000	5.000	1925.000	100.000	5000.000	1500.000	5000.000
101211	84.000	1640.000	5.750	2.000	5.000	1925.000	65.000	5000.000	4000.000	5000.000
101221	84.000	1620.000	5.750	2.000	5.000	1925.000	90.000	5000.000	4000.000	5000.000
101231	84.000	1600.000	5.750	2.000	5.000	1925.000	95.000	5000.000	1500.000	5000.000
101241	84.000	1550.000	5.750	2.000	5.000	1925.000	55.000	5000.000	1500.000	5000.000
101251	84.000	1580.000	5.750	2.000	5.000	1925.000	100.000	5000.000	1500.000	5000.000
101261	84.000	1540.000	5.750	2.000	5.000	1925.000	100.000	12000.000	1500.000	5000.000
101271	84.000	1520.000	5.750	2.000	5.000	1925.000	100.000	12000.000	1500.000	5000.000
101281	84.000	1570.000	5.750	2.000	5.000	1925.000	100.000	12000.000	1500.000	5000.000
101291	84.000	1550.000	5.750	2.000	5.000	1925.000	100.000	12000.000	1500.000	5000.000
101301	84.000	1550.000	5.750	2.000	5.000	1925.000	100.000	12000.000	1500.000	5000.000
101311	84.000	1510.000	5.750	2.000	5.000	1925.000	90.000	12000.000	1500.000	5000.000
101321	84.000	1550.000	5.750	2.000	5.000	1926.000	100.000	12000.000	1500.000	5000.000
101331	84.000	1520.000	5.750	2.000	5.000	1926.000	40.000	12000.000	1500.000	5000.000
101341	84.000	1470.000	5.750	2.000	5.000	1926.000	70.000	12000.000	1500.000	5000.000
101351	84.000	1510.000	5.750	2.000	5.000	1926.000	100.000	12000.000	1500.000	5000.000
101361	84.000	1470.000	5.750	2.000	5.000	1926.000	20.000	12000.000	1500.000	5000.000
101371	84.000	1420.000	5.750	2.000	5.000	1926.000	65.000	12000.000	1500.000	5000.000
101381	84.000	1520.000	5.750	2.000	5.000	1926.000	75.000	12000.000	1500.000	5000.000
101391	84.000	1440.000	5.750	2.000	5.000	1926.000	40.000	12000.000	1500.000	5000.000
101401	84.000	1490.000	5.750	2.000	5.000	1926.000	30.000	12000.000	1500.000	5000.000
101411	84.000	1500.000	5.750	2.000	5.000	1926.000	50.000	12000.000	1500.000	5000.000
101421	84.000	1490.000	5.750	2.000	5.000	1927.000	45.000	12000.000	1500.000	5000.000
101431	84.000	1480.000	5.750	2.000	5.000	1927.000	35.000	12000.000	1500.000	5000.000
101441	84.000	1460.000	5.750	2.000	5.000	1927.000	90.000	12000.000	1500.000	5000.000
101451	84.000	1410.000	5.750	2.000	5.000	1927.000	45.000	12000.000	1500.000	5000.000
101461	84.000	1390.000	5.750	2.000	5.000	1927.000	50.000	12000.000	1500.000	5000.000
101471	84.000	1520.000	5.750	2.000	5.000	1927.000	65.000	12000.000	1500.000	5000.000
101481	84.000	1480.000	5.750	2.000	5.000	1927.000	15.000	12000.000	1500.000	5000.000
101491	84.000	1520.000	5.750	2.000	5.000	1927.000	15.000	12000.000	1500.000	5000.000
101501	84.000	1400.000	5.750	2.000	5.000	1927.000	85.000	12000.000	1500.000	5000.000

HRB-SINGER, INC

101011	50.000	160.000	16.000	167582.063	99778.750	67803.313	40.460	6236.172	4237.707	85.000
101021	45.000	40.000	16.000	117278.688	30195.902	87082.750	74.253	1887.244	5442.672	83.000
101031	0.0	840.000	16.000	162982.875	65567.813	97415.063	59.770	4097.988	6088.441	75.000
101041	50.000	160.000	16.000	155796.688	71272.500	84524.188	54.253	4454.531	5282.762	100.000
101051	45.000	200.000	16.000	160395.875	94393.875	66002.000	41.149	5899.617	4125.125	133.000
101061	45.000	140.000	16.000	150910.063	90199.125	60710.938	40.230	5637.445	3794.434	260.000
101071	40.000	360.000	16.000	162982.875	154365.439	8617.438	5.287	9647.840	538.590	120.000
101081	0.0	840.000	16.000	165282.500	64973.148	100309.313	60.690	4060.822	6269.332	160.000
101091	0.0	840.000	16.000	129351.563	38359.430	90992.125	70.345	2397.464	5687.008	170.000
101101	40.000	840.000	16.000	158096.250	145739.375	12356.875	7.816	9108.711	772.305	220.000
101111	0.0	840.000	16.000	134238.063	121894.375	12343.688	9.195	7618.398	771.480	250.000
101121	0.0	840.000	16.000	165282.500	165282.500	0.0	0.0	10330.156	0.0	280.000
101131	0.0	840.000	16.000	129351.563	97831.375	31520.188	24.368	6114.461	1970.012	290.000
101141	0.0	840.000	16.000	131651.125	43278.422	88372.688	67.126	2704.901	5523.293	300.000
101151	0.0	840.000	16.000	143723.875	143063.125	660.750	0.460	8941.445	41.297	300.000
101161	0.0	840.000	16.000	162695.375	95373.188	67322.188	41.379	5960.824	4207.637	370.000
101171	0.0	840.000	16.000	124464.875	26037.492	98427.375	79.080	1627.343	6151.711	400.000
101181	0.0	840.000	16.000	160395.875	64527.063	95868.813	59.770	4032.941	5991.801	380.000
101191	40.000	840.000	16.000	162982.875	65942.500	97040.375	59.540	4121.406	6065.023	480.000
101201	0.0	840.000	16.000	134238.063	133620.938	617.125	0.460	8351.309	38.570	510.000
101211	80.000	580.000	16.000	148610.375	74134.438	74475.938	50.115	4633.402	4654.746	470.000
101221	80.000	780.000	16.000	162982.875	130011.625	32971.250	20.230	8125.727	2060.703	410.000
101231	30.000	840.000	16.000	170169.063	156868.438	13300.625	7.816	9804.277	831.289	440.000
101241	45.000	400.000	16.000	165282.500	84731.063	80551.438	48.736	5295.691	5034.465	530.000
101251	0.0	840.000	16.000	160395.875	114673.813	45722.063	28.506	7167.113	2857.629	450.000
101261	0.0	840.000	16.000	168156.875	39429.918	128726.938	76.552	2464.370	8045.434	550.000
101271	0.0	840.000	16.000	172468.688	69383.938	103084.750	59.770	4336.496	6442.797	570.000
101281	0.0	840.000	16.000	167582.063	90918.063	76664.000	45.747	5682.379	4791.500	450.000
101291	0.0	840.000	16.000	158096.250	115392.125	42704.125	27.011	7212.008	2669.008	510.000
101301	80.000	840.000	16.000	160395.875	122048.375	38347.500	23.908	7628.023	2396.719	490.000
101311	160.000	840.000	16.000	165282.500	142104.938	23177.563	14.023	8881.559	1448.598	540.000
101321	60.000	840.000	16.000	170169.063	68458.813	101710.250	59.770	4278.676	6356.891	340.000
101331	70.000	120.000	16.000	172468.688	86432.563	86036.125	49.885	5402.035	5377.258	500.000
101341	90.000	650.000	16.000	162982.875	98913.750	64069.125	39.310	6182.109	4004.320	550.000
101351	0.0	840.000	16.000	170169.063	39510.535	130658.500	76.782	2469.408	8166.156	510.000
101361	125.000	40.000	16.000	155796.688	66974.625	88822.063	57.012	4185.914	5551.379	550.000
101371	0.0	680.000	0.0	162982.875	55076.965	107905.875	66.207	55076.965	107905.875	590.000
101381	60.000	540.000	16.000	165282.500	53194.391	112088.063	67.816	3324.649	7005.504	310.000
101391	70.000	160.000	16.000	150910.063	32957.391	117952.625	78.161	2059.837	7372.039	560.000
101401	45.000	40.000	16.000	150910.063	33391.039	117519.000	77.874	2086.940	7344.938	570.000
101411	70.000	400.000	16.000	168156.875	57598.582	110558.250	65.747	3599.911	6909.891	410.000
101421	80.000	340.000	16.000	165282.500	65543.063	99739.438	60.345	4096.441	6233.715	410.000
101431	80.000	320.000	16.000	165282.500	36476.148	128806.313	77.931	2279.759	8050.395	420.000
101441	55.000	440.000	16.000	159533.563	33006.941	126526.563	79.310	2062.934	7907.910	460.000
101451	100.000	280.000	16.000	165282.500	58893.789	106388.688	64.368	3680.862	6649.293	540.000
101461	40.000	400.000	16.000	155221.750	105265.375	49956.375	32.184	6579.096	3122.273	560.000
101471	70.000	540.000	16.000	153784.563	113128.875	40655.688	26.437	7070.555	2540.980	380.000
101481	70.000	120.000	16.000	160970.750	50696.527	110274.188	68.506	3168.533	6892.137	450.000
101491	45.000	40.000	16.000	140849.375	67996.250	72853.125	51.724	4249.766	4553.320	400.000
101501	12.000	740.000	16.000	149472.875	77657.125	71815.750	48.046	4853.570	4488.484	540.000

101011	195.000	110.000	178.500	2.092	2516.050	429.000	5.865	1.250	1.250	199.250
101021	183.000	100.000	174.900	0.671	2397.015	366.000	6.549	1.250	1.250	177.250
101031	175.000	100.000	172.500	4.275	0.0	0.0	0.0	1.250	1.250	169.250
101041	190.000	90.000	177.000	2.619	2516.050	522.500	4.815	1.250	1.250	184.250
101051	223.000	90.000	186.900	2.182	2397.015	490.600	4.886	1.250	1.250	217.250
101061	350.000	90.000	225.000	2.619	2397.015	962.500	2.490	1.250	1.250	344.250
101071	220.000	100.000	186.000	2.992	2270.600	806.666	2.815	1.250	1.250	214.250
101081	260.000	100.000	198.000	4.275	0.0	0.0	0.0	1.250	1.250	254.250
101091	280.000	110.000	204.000	4.185	0.0	0.0	0.0	1.250	1.250	274.250
101101	320.000	100.000	216.000	4.061	2270.600	7039.996	0.323	1.250	1.250	314.250
101111	340.000	90.000	222.000	4.365	0.0	0.0	0.0	1.250	1.250	334.250
101121	370.000	90.000	231.000	4.365	0.0	0.0	0.0	1.250	1.250	364.250
101131	390.000	100.000	237.000	4.275	0.0	0.0	0.0	1.250	1.250	384.250
101141	400.000	100.000	240.000	4.275	0.0	0.0	0.0	1.250	1.250	394.250
101151	390.000	90.000	237.000	4.365	0.0	0.0	0.0	1.250	1.250	384.250
101161	480.000	110.000	264.000	4.185	0.0	0.0	0.0	1.250	1.250	474.250
101171	500.000	100.000	270.000	4.275	0.0	0.0	0.0	1.250	1.250	494.250
101181	460.000	80.000	258.000	4.455	0.0	0.0	0.0	1.250	1.250	454.250
101191	560.000	80.000	288.000	4.232	2270.600	12319.992	0.184	1.250	1.250	554.250
101201	590.000	80.000	297.000	4.455	0.0	0.0	0.0	1.250	3.333	584.250
101211	550.000	80.000	285.000	2.896	3123.305	1728.570	1.807	1.250	1.250	544.250
101221	500.000	90.000	270.000	3.928	3123.305	5499.996	0.568	1.250	1.250	494.250
101231	530.000	90.000	279.000	4.147	1989.156	11659.992	0.171	1.250	3.333	524.250
101241	620.000	90.000	306.000	2.401	2397.015	1515.555	1.582	1.250	3.333	614.250
101251	540.000	90.000	282.000	4.365	0.0	0.0	0.0	1.250	3.333	534.250
101261	640.000	90.000	312.000	4.365	0.0	0.0	0.0	1.250	8.000	634.250
101271	660.000	90.000	318.000	4.365	0.0	0.0	0.0	1.250	8.000	654.250
101281	540.000	90.000	282.000	4.365	0.0	0.0	0.0	1.250	8.000	534.250
101291	570.000	60.000	291.000	4.635	0.0	0.0	0.0	1.250	8.000	564.250
101301	570.000	80.000	291.000	4.455	0.0	0.0	0.0	1.250	8.000	564.250
101311	630.000	90.000	309.000	3.928	4296.234	6929.996	0.620	3.333	8.000	624.250
101321	430.000	90.000	249.000	4.365	0.0	0.0	0.0	1.250	8.000	424.250
101331	580.000	80.000	294.000	1.782	2937.232	1063.333	2.762	3.333	8.000	574.250
101341	640.000	90.000	312.000	3.055	3297.195	2346.666	1.405	3.333	8.000	634.250
101351	600.000	90.000	300.000	4.365	0.0	0.0	0.0	3.333	8.000	594.250
101361	620.000	70.000	306.000	0.539	3835.054	852.500	4.499	3.333	8.000	614.250
101371	680.000	90.000	324.000	2.837	0.0	2137.142	0.0	3.333	8.000	674.250
101381	400.000	90.000	240.000	3.274	2736.167	1759.999	1.555	1.250	8.000	394.250
101391	650.000	90.000	315.000	1.746	2937.232	1191.666	2.465	3.333	8.000	644.250
101401	600.000	30.000	300.000	1.471	2397.015	942.857	2.542	3.333	8.000	594.250
101411	490.000	80.000	267.000	2.227	2937.232	1077.999	2.725	3.333	8.000	484.250
101421	500.000	90.000	270.000	1.964	3123.305	999.999	3.123	3.333	8.000	494.250
101431	520.000	100.000	276.000	1.496	3123.305	879.999	3.549	3.333	8.000	514.250
101441	560.000	100.000	288.000	3.847	2628.813	6159.996	0.427	3.333	8.000	554.250
101451	630.000	90.000	309.000	1.964	3460.931	1259.999	2.747	3.333	8.000	624.250
101461	650.000	90.000	315.000	2.182	2270.600	1429.999	1.588	3.333	8.000	644.250
101471	470.000	90.000	261.000	2.837	2937.232	1477.142	1.988	1.250	8.000	464.250
101481	540.000	90.000	282.000	0.655	2937.232	698.823	4.203	3.333	8.000	534.250
101491	480.000	80.000	264.000	0.331	2397.015	621.176	3.859	3.333	8.000	474.250
101501	660.000	120.000	318.000	3.481	1305.017	4839.996	0.270	3.333	8.000	654.250

HRB-SINGER, INC

101011	22.000	89.250	0.364
101021	26.000	87.450	0.117
101031	22.000	86.250	0.743
101041	17.000	88.500	0.455
101051	15.000	93.450	0.380
101061	19.000	112.500	0.455
101071	20.000	93.000	0.520
101081	21.000	99.000	0.743
101091	28.000	102.000	0.728
101101	17.000	108.000	0.706
101111	24.000	111.000	0.759
101121	23.000	115.500	0.759
101131	18.000	118.500	0.743
101141	26.000	120.000	0.743
101151	15.000	118.500	0.759
101161	17.000	132.000	0.728
101171	28.000	135.000	0.743
101181	25.000	129.000	0.775
101191	26.000	144.000	0.736
101201	26.000	148.500	0.775
101211	19.000	142.500	0.504
101221	19.000	135.000	0.683
101231	21.000	139.500	0.721
101241	24.000	153.000	0.418
101251	26.000	141.000	0.759
101261	27.000	156.000	0.759
101271	27.000	159.000	0.759
101281	30.000	141.000	0.759
101291	36.000	145.500	0.806
101301	29.000	145.500	0.775
101311	27.000	154.500	0.683
101321	26.000	124.500	0.759
101331	25.000	147.000	0.310
101341	0.0	156.000	0.531
101351	27.000	150.000	0.759
101361	28.000	153.000	0.094
101371	29.000	162.000	0.493
101381	26.000	120.000	0.569
101391	33.000	157.500	0.304
101401	28.000	150.000	0.256
101411	26.000	133.500	0.387
101421	33.000	135.000	0.342
101431	32.000	138.000	0.260
101441	32.000	144.000	0.669
101451	33.000	154.500	0.342
101461	34.000	157.500	0.380
101471	32.000	130.500	0.493
101481	32.000	141.000	0.114
101491	33.000	132.000	0.058
101501	35.000	159.000	0.605

HRB-SINGER, INC.

APPENDIX D-2

DATA LISTING

OM(1) FORTY-SEVEN SAMPLE BLOCKS PREVIOUSLY OVERMINED

(TOTAL n = 50)

202011	174000.000	81200.000	92800.000	2080.000	0.0	1.000	82.500	13.000	344.000	1670.000
202021	174000.000	74000.000	100000.000	2200.000	0.0	1.000	82.500	13.000	344.000	1663.000
202031	174000.000	111200.000	62800.000	2200.000	0.0	1.000	82.500	13.000	344.000	1655.000
202041	174000.000	170000.000	4000.000	2160.000	0.0	1.000	82.500	13.000	344.000	1635.000
202051	174000.000	174000.000	0.0	2280.000	0.0	1.000	82.500	13.000	344.000	1620.000
202061	174000.000	174000.000	0.0	2440.000	0.0	1.000	82.500	13.000	344.000	1610.000
202071	174000.000	18400.000	155600.000	2040.000	0.0	1.000	82.500	13.000	344.000	1663.000
202081	174000.000	174000.000	0.0	2280.000	0.0	1.000	82.500	13.000	344.000	1634.000
202091	174000.000	174000.000	0.0	2600.000	0.0	1.000	82.500	13.000	344.000	1620.000
202101	174000.000	174000.000	0.0	2520.000	0.0	1.000	82.500	13.000	344.000	1620.000
202111	174000.000	174000.000	0.0	2400.000	0.0	1.000	82.500	13.000	344.000	1600.000
202121	174000.000	60800.000	113200.000	2160.000	0.0	1.000	82.500	13.000	344.000	1665.000
202131	174000.000	8800.000	165200.000	2040.000	0.0	1.000	82.500	13.000	344.000	1660.000
202141	174000.000	161200.000	12800.000	2560.000	0.0	1.000	82.500	13.000	344.000	1625.000
202151	174000.000	174000.000	0.0	2640.000	0.0	1.000	82.500	13.000	344.000	1619.000
202161	174000.000	174000.000	0.0	2640.000	0.0	1.000	82.500	13.000	344.000	1614.000
202171	174000.000	174000.000	0.0	2560.000	0.0	1.000	82.500	13.000	344.000	1610.000
202181	174000.000	174000.000	0.0	2400.000	0.0	1.000	82.500	13.000	344.000	1600.000
202191	174000.000	174000.000	0.0	2360.000	0.0	1.000	82.500	13.000	344.000	1590.000
202201	174000.000	141200.000	32800.000	2440.000	0.0	1.000	82.500	13.000	344.000	1575.000
202211	174000.000	70400.000	103600.000	2120.000	0.0	1.000	82.500	13.000	344.000	1664.000
202221	174000.000	67200.000	106800.000	2480.000	0.0	1.000	82.500	13.000	344.000	1626.000
202231	174000.000	79200.000	94800.000	2560.000	0.0	1.000	82.500	13.000	344.000	1620.000
202241	174000.000	99600.000	74400.000	2600.000	0.0	1.000	82.500	13.000	344.000	1612.000
202251	174000.000	106400.000	67600.000	2600.000	0.0	1.000	82.500	13.000	344.000	1607.000
202261	174000.000	116800.000	57200.000	2400.000	0.0	1.000	82.500	13.000	344.000	1595.000
202271	174000.000	42000.000	132000.000	2200.000	0.0	1.000	82.500	13.000	344.000	1645.000
202281	174000.000	58000.000	116000.000	2320.000	0.0	1.000	82.500	13.000	344.000	1634.000
202291	174000.000	63200.000	110800.000	2480.000	0.0	1.000	82.500	13.000	344.000	1605.000
202301	174000.000	69200.000	104800.000	2200.000	0.0	1.000	82.500	13.000	344.000	1570.000
202311	174000.000	70400.000	103600.000	2360.000	0.0	1.000	82.500	13.000	344.000	1590.000
202321	174000.000	82800.000	91200.000	2280.000	0.0	1.000	82.500	13.000	344.000	1570.000
202331	174000.000	57600.000	116400.000	2760.000	0.0	1.000	82.500	13.000	344.000	1535.000
202341	174000.000	61600.000	112400.000	2600.000	0.0	1.000	82.500	13.000	344.000	1550.000
202351	174000.000	68400.000	105600.000	2760.000	0.0	1.000	82.500	13.000	344.000	1520.000
202361	174000.000	7600.000	166400.000	2720.000	0.0	1.000	82.500	13.000	344.000	1515.000
202371	174000.000	75600.000	98400.000	2680.000	0.0	1.000	82.500	13.000	344.000	1510.000
202381	174000.000	91200.000	82800.000	2760.000	0.0	1.000	82.500	13.000	344.000	1515.000
202391	174000.000	51200.000	122800.000	2680.000	0.0	1.000	82.500	13.000	344.000	1520.000
202401	174000.000	164000.000	10000.000	2400.000	0.0	1.000	82.500	13.000	344.000	1770.000
202411	174000.000	0.0	174000.000	2480.000	0.0	1.000	82.500	13.000	344.000	1795.000
202421	174000.000	144400.000	29600.000	2480.000	0.0	1.000	82.500	13.000	344.000	1820.000
202431	174000.000	174000.000	0.0	2760.000	0.0	0.0	82.500	0.0	344.000	1770.000
202441	174000.000	174000.000	0.0	2760.000	0.0	1.000	82.500	13.000	344.000	1790.000
202451	174000.000	39200.000	134800.000	2520.000	0.0	1.000	82.500	13.000	344.000	1795.000
202461	174000.000	174000.000	0.0	2480.000	0.0	1.000	82.500	13.000	344.000	1795.000
202471	174000.000	174000.000	0.0	2480.000	0.0	1.000	82.500	13.000	344.000	1810.000
202481	174000.000	174000.000	0.0	2560.000	0.0	1.000	82.500	13.000	344.000	1720.000
202491	174000.000	51200.000	122800.000	2680.000	0.0	1.000	82.500	13.000	344.000	1770.000
202501	174000.000	174000.000	0.0	2720.000	0.0	1.000	82.500	13.000	344.000	1770.000

202011	7.330	2.000	7.000	72.250	47.000	6000.000	1500.000	16000.000	50.000	25.000
202021	7.330	2.000	7.000	72.250	40.000	6000.000	1500.000	16000.000	50.000	25.000
202031	7.920	2.000	7.000	72.250	64.000	6000.000	1500.000	16000.000	50.000	25.000
202041	7.330	2.000	8.000	74.250	98.000	6000.000	1500.000	16000.000	37.000	588.000
202051	6.420	4.000	8.000	71.000	100.000	6000.000	1500.000	16000.000	0.0	588.000
202061	6.080	4.000	8.000	71.000	100.000	6000.000	1500.000	16000.000	0.0	588.000
202071	7.330	2.000	7.000	72.250	11.000	6000.000	1500.000	16000.000	50.000	25.000
202081	6.250	2.000	8.000	74.000	100.000	6000.000	1500.000	16000.000	0.0	588.000
202091	5.590	2.000	8.000	73.660	100.000	6000.000	1500.000	16000.000	0.0	588.000
202101	5.580	3.000	8.000	73.580	100.000	6000.000	1500.000	16000.000	0.0	588.000
202111	6.080	4.000	8.000	70.750	100.000	6000.000	1500.000	16000.000	0.0	588.000
202121	6.330	2.000	8.000	67.750	35.000	6000.000	1500.000	16000.000	50.000	25.000
202131	6.000	3.000	8.000	67.750	5.000	6000.000	1500.000	16000.000	50.000	13.000
202141	6.000	3.000	8.000	71.580	93.000	6000.000	1500.000	16000.000	0.0	588.000
202151	5.830	2.000	8.000	71.580	100.000	6000.000	1500.000	16000.000	0.0	588.000
202161	6.000	3.000	8.000	71.750	100.000	6000.000	1500.000	16000.000	0.0	588.000
202171	6.250	4.000	8.000	72.250	100.000	6000.000	1500.000	16000.000	0.0	588.000
202181	5.420	4.000	8.000	72.250	100.000	6000.000	1500.000	16000.000	0.0	588.000
202191	5.500	3.000	8.000	70.500	100.000	6000.000	1500.000	16000.000	0.0	588.000
202201	6.250	4.000	8.000	70.250	81.000	6000.000	1500.000	16000.000	0.0	588.000
202211	6.250	3.000	7.000	71.080	40.000	6000.000	1500.000	16000.000	63.000	25.000
202221	6.330	2.000	8.000	71.080	39.000	6000.000	1500.000	16000.000	63.000	25.000
202231	6.000	3.000	8.000	68.250	46.000	6000.000	1500.000	16000.000	63.000	25.000
202241	6.330	4.000	8.000	68.250	57.000	6000.000	1500.000	16000.000	63.000	237.000
202251	6.000	4.000	8.000	68.250	61.000	6000.000	1500.000	16000.000	63.000	250.000
202261	6.330	4.000	8.000	71.750	67.000	6000.000	1500.000	16000.000	63.000	263.000
202271	6.420	3.000	8.000	68.080	24.000	6000.000	1500.000	16000.000	50.000	25.000
202281	6.670	3.000	8.000	67.160	33.000	6000.000	1500.000	16000.000	63.000	25.000
202291	6.080	3.000	8.000	68.250	36.000	6000.000	1500.000	16000.000	63.000	25.000
202301	6.250	3.000	8.000	68.500	40.000	6000.000	1500.000	16000.000	63.000	25.000
202311	6.330	3.000	8.000	68.250	40.000	6000.000	1500.000	16000.000	63.000	25.000
202321	6.580	3.000	8.000	68.500	47.000	6000.000	1500.000	16000.000	63.000	25.000
202331	5.420	3.000	7.000	76.000	33.000	6000.000	1500.000	16000.000	63.000	25.000
202341	7.750	4.000	7.000	69.750	35.000	6000.000	1500.000	16000.000	50.000	25.000
202351	7.000	3.000	7.000	68.250	39.000	6000.000	1500.000	16000.000	63.000	25.000
202361	5.500	3.000	7.000	70.000	4.000	6000.000	1500.000	16000.000	50.000	25.000
202371	4.920	3.000	7.000	70.750	43.000	6000.000	1500.000	16000.000	63.000	25.000
202381	5.170	3.000	8.000	70.330	52.000	6000.000	1500.000	16000.000	50.000	25.000
202391	5.250	3.000	8.000	72.750	29.000	6000.000	1500.000	16000.000	50.000	25.000
202401	5.250	4.000	7.000	66.250	94.000	6000.000	1500.000	16000.000	0.0	588.000
202411	4.920	3.000	7.000	0.0	0.0	6000.000	1500.000	16000.000	0.0	0.0
202421	5.170	3.000	7.000	60.420	93.000	6000.000	1500.000	16000.000	0.0	588.000
202431	5.170	4.000	7.000	66.000	100.000	6000.000	1500.000	16000.000	0.0	588.000
202441	6.170	4.000	7.000	65.830	100.000	6000.000	1500.000	16000.000	0.0	588.000
202451	4.580	4.000	7.000	64.000	23.000	6000.000	1500.000	16000.000	37.000	425.000
202461	5.420	3.000	7.000	64.000	100.000	6000.000	1500.000	16000.000	0.0	588.000
202471	5.670	3.000	7.000	64.000	100.000	6000.000	1500.000	16000.000	0.0	588.000
202481	5.250	3.000	7.000	67.250	100.000	6000.000	1500.000	16000.000	0.0	588.000
202491	4.250	4.000	7.000	64.250	29.000	6000.000	1500.000	16000.000	63.000	25.000
202501	5.420	3.000	7.000	64.250	100.000	6000.000	1500.000	16000.000	0.0	588.000

HRB-SINGER, INC

202011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202031	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202041	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202051	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202061	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202071	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202081	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202091	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202121	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202131	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202141	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202151	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202161	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202171	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202181	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202191	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202201	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202211	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202221	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202231	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202241	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202251	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202261	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202271	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202281	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202291	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202301	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202311	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202321	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202331	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202341	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202351	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202361	1.000	4.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202371	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202381	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202391	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202401	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202411	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202421	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202431	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
202441	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202451	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202461	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202471	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202481	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202491	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000
202501	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	14.000

202011	341.000	1777.000	4.750	2.000	7.000	51.500	80.000	6000.000	1500.000	16000.000
202021	341.000	1764.000	4.670	2.000	7.000	51025.000	78.000	6000.000	1500.000	16000.000
202031	341.000	1753.000	4.750	2.000	7.000	52.330	83.000	6000.000	1500.000	16000.000
202041	341.000	1738.000	4.420	2.000	8.000	53.500	94.000	6000.000	1500.000	16000.000
202051	341.000	1718.000	4.420	2.000	8.000	66.500	48.000	6000.000	1500.000	16000.000
202061	341.000	1710.000	4.500	3.000	8.000	67.250	49.000	6000.000	1500.000	16000.000
202071	341.000	1764.000	4.330	2.000	7.000	0.0	0.0	6000.000	1500.000	16000.000
202081	341.000	1739.000	4.330	2.000	8.000	54.250	84.000	6000.000	1500.000	16000.000
202091	341.000	1727.000	4.250	2.000	8.000	65.250	42.000	6000.000	1500.000	16000.000
202101	341.000	1720.000	4.170	2.000	8.000	66.500	29.000	6000.000	1500.000	16000.000
202111	341.000	1705.000	4.170	3.000	8.000	66.500	50.000	6000.000	1500.000	16000.000
202121	341.000	1778.000	4.330	2.000	8.000	67.250	57.000	6000.000	1500.000	16000.000
202131	341.000	1764.000	4.330	2.000	7.000	67.250	0.0	6000.000	1500.000	16000.000
202141	341.000	1731.000	4.250	2.000	8.000	54.160	33.000	6000.000	1500.000	16000.000
202151	341.000	1730.000	4.000	2.000	8.000	65.250	36.000	6000.000	1500.000	16000.000
202161	341.000	1721.000	3.830	2.000	8.000	65.250	38.000	6000.000	1500.000	16000.000
202171	341.000	1713.000	4.000	2.000	8.000	47.830	26.000	6000.000	1500.000	16000.000
202181	341.000	1700.000	3.670	3.000	8.000	66.500	42.000	6000.000	1500.000	16000.000
202191	341.000	1705.000	3.830	3.000	8.000	66.500	41.000	6000.000	1500.000	16000.000
202201	341.000	1685.000	3.920	3.000	8.000	66.750	20.000	6000.000	1500.000	16000.000
202211	341.000	1778.000	3.580	2.000	7.000	67.250	36.000	6000.000	1500.000	16000.000
202221	341.000	1740.000	3.580	3.000	8.000	67.250	27.000	6000.000	1500.000	16000.000
202231	341.000	1735.000	3.420	3.000	8.000	67.250	24.000	6000.000	1500.000	16000.000
202241	341.000	1729.000	3.580	2.000	8.000	67.250	15.000	6000.000	1500.000	16000.000
202251	341.000	1724.000	2.500	2.000	8.000	46.000	1.000	6000.000	1500.000	16000.000
202261	341.000	1713.000	3.420	2.000	8.000	47.830	60.000	6000.000	1500.000	16000.000
202271	341.000	1764.000	3.170	3.000	8.000	50.500	9.000	6000.000	1500.000	16000.000
202281	341.000	1754.000	3.670	3.000	8.000	50.500	65.000	6000.000	1500.000	16000.000
202291	341.000	1730.000	3.670	2.000	8.000	49.750	99.000	6000.000	1500.000	16000.000
202301	341.000	1693.000	3.580	3.000	8.000	51.000	100.000	6000.000	1500.000	16000.000
202311	341.000	1704.000	3.580	3.000	8.000	51.750	100.000	6000.000	1500.000	16000.000
202321	341.000	1692.000	3.670	3.000	8.000	51.000	100.000	6000.000	1500.000	16000.000
202331	341.000	1651.000	4.090	2.000	7.000	62.750	100.000	6000.000	1500.000	16000.000
202341	341.000	1659.000	4.330	3.000	7.000	50.750	65.000	6000.000	1500.000	16000.000
202351	341.000	1642.000	4.250	2.000	7.000	62.500	100.000	6000.000	1500.000	16000.000
202361	341.000	1639.000	4.000	3.000	7.000	62.500	42.000	6000.000	1500.000	16000.000
202371	341.000	1633.000	4.000	3.000	7.000	65.000	100.000	6000.000	1500.000	16000.000
202381	341.000	1639.000	4.080	1.000	7.000	53.000	85.000	6000.000	1500.000	16000.000
202391	341.000	1640.000	3.830	1.000	8.000	53.000	57.000	6000.000	1500.000	16000.000
202401	341.000	1910.000	0.0	3.000	7.000	0.0	0.0	6000.000	1500.000	16000.000
202411	341.000	1925.000	4.170	3.000	7.000	52.330	43.000	6000.000	1500.000	16000.000
202421	341.000	1935.000	4.500	3.000	7.000	63.580	38.000	6000.000	1500.000	16000.000
202431	341.000	1880.000	4.580	3.000	7.000	53.330	18.000	6000.000	1500.000	16000.000
202441	341.000	1890.000	4.420	3.000	7.000	51.250	22.000	6000.000	1500.000	16000.000
202451	341.000	1900.000	4.500	3.000	7.000	63.250	42.000	6000.000	1500.000	16000.000
202461	341.000	1910.000	4.580	3.000	7.000	63.250	27.000	6000.000	1500.000	16000.000
202471	341.000	1915.000	4.580	3.000	7.000	63.250	28.000	6000.000	1500.000	16000.000
202481	341.000	1850.000	4.330	3.000	7.000	53.250	100.000	6000.000	1500.000	16000.000
202491	341.000	1880.000	4.750	3.000	7.000	52.750	75.000	6000.000	1500.000	16000.000
202501	341.000	1870.000	4.580	3.000	7.000	63.580	100.000	6000.000	1500.000	16000.000

HRB-SINGER, INC

202011	0.0	588.000	4.000	52611.031	24551.828	28059.203	53.333	6137.957	7014.801	410.000
202021	0.0	588.000	4.000	52611.031	22374.813	30236.219	57.471	5593.703	7559.055	537.000
202031	0.0	588.000	4.000	56845.750	36329.031	20516.719	36.092	9082.258	5129.180	545.000
202041	0.0	588.000	4.000	52611.031	51401.574	1209.457	2.299	12850.391	302.364	525.000
202051	75.000	25.000	4.000	46079.504	46079.504	0.0	0.0	11519.875	0.0	660.000
202061	50.000	25.000	4.000	43639.148	43639.148	0.0	0.0	10909.785	0.0	830.000
202071	0.0	0.0	4.000	52611.031	5563.465	47047.566	89.425	1390.866	11761.891	377.000
202081	50.000	550.000	4.000	44859.367	44859.367	0.0	0.0	11214.840	0.0	646.000
202091	60.000	25.000	4.000	40050.438	40050.438	0.0	0.0	10012.609	0.0	980.000
202101	63.000	25.000	4.000	40050.438	40050.438	0.0	0.0	10012.609	0.0	900.000
202111	50.000	25.000	4.000	43639.148	43639.149	0.0	0.0	10909.785	0.0	800.000
202121	63.000	30.000	4.000	45433.527	15875.629	29557.898	65.057	3968.907	7389.473	495.000
202131	0.0	0.0	4.000	43065.000	2178.001	40887.000	94.943	544.500	10221.750	380.000
202141	63.000	25.000	4.000	43065.000	39897.000	3168.000	7.356	9974.250	792.000	935.000
202151	63.000	25.000	4.000	41844.813	41844.813	0.0	0.0	10461.203	0.0	1021.000
202161	63.000	25.000	4.000	43065.000	43065.000	0.0	0.0	10766.250	0.0	1026.000
202171	63.000	25.000	4.000	44859.367	44859.367	0.0	0.0	11214.840	0.0	950.000
202181	63.000	25.000	4.000	38902.039	38902.039	0.0	0.0	9725.508	0.0	800.000
202191	50.000	25.000	4.000	39476.246	39476.246	0.0	0.0	9869.059	0.0	770.000
202201	50.000	25.000	4.000	44859.367	36403.117	8456.250	18.851	9100.777	2114.063	865.000
202211	63.000	25.000	4.000	44859.367	18150.000	26709.367	59.540	4537.500	6677.340	456.000
202221	63.000	25.000	4.000	45433.527	17546.750	27886.777	61.379	4386.688	6971.691	854.000
202231	63.000	25.000	4.000	43065.000	19602.000	23463.000	54.483	4900.500	5865.750	940.000
202241	50.000	25.000	4.000	45433.527	26006.797	19426.730	42.759	6501.699	4856.680	988.000
202251	0.0	13.000	4.000	43065.000	26334.000	16731.000	38.851	6583.500	4182.750	993.000
202261	50.000	500.000	4.000	45433.527	30497.934	14935.594	32.874	7624.480	3733.898	805.000
202271	0.0	200.000	4.000	46079.504	11122.637	34956.867	75.862	2780.659	8739.215	555.000
202281	0.0	513.000	4.000	47873.879	15957.965	31915.914	66.667	3989.491	7978.977	696.000
202291	0.0	588.000	4.000	43639.148	15850.551	27788.598	63.678	3962.638	6947.148	875.000
202301	0.0	588.000	4.000	44859.367	17840.621	27018.746	60.230	4460.152	6754.684	630.000
202311	0.0	588.000	4.000	45433.527	18382.309	27051.219	59.540	4595.574	6762.805	770.000
202321	0.0	588.000	4.000	47227.902	22473.980	24753.922	52.414	5618.492	6188.480	710.000
202331	0.0	588.000	4.000	38902.039	12877.910	26024.129	66.897	3219.478	6506.031	1225.000
202341	50.000	300.000	4.000	55625.621	19692.742	35932.879	64.598	4923.184	8983.219	1050.000
202351	0.0	588.000	4.000	50242.492	19750.492	30492.000	60.690	4937.621	7623.000	1240.000
202361	63.000	425.000	4.000	39476.246	1724.250	37751.996	95.632	431.063	9437.996	1205.000
202371	0.0	588.000	4.000	35313.285	15343.008	19970.277	56.552	3835.752	4992.566	1170.000
202381	63.000	537.000	4.000	37107.660	19449.527	17659.133	47.586	4862.379	4414.531	1245.000
202391	63.000	450.000	4.000	37681.871	11088.000	26593.871	70.575	2772.000	6648.465	1160.000
202401	0.0	0.0	4.000	37681.871	35516.246	2165.625	5.747	8879.059	541.406	630.000
202411	37.000	25.000	4.000	35313.285	0.0	35313.285	100.000	0.0	8828.320	685.000
202421	63.000	25.000	4.000	37107.660	30795.094	6312.566	17.011	7699.773	1578.142	660.000
202431	75.000	25.000	4.000	37107.660	37107.660	0.0	0.0	9276.914	0.0	990.000
202441	75.000	25.000	4.000	44285.125	44285.125	0.0	0.0	11071.281	0.0	980.000
202451	75.000	25.000	4.000	32872.941	7405.855	25467.086	77.471	1851.464	6366.770	725.000
202461	63.000	200.000	4.000	38902.039	38902.039	0.0	0.0	9725.508	0.0	685.000
202471	0.0	237.000	4.000	40696.414	40696.414	0.0	0.0	10174.102	0.0	670.000
202481	0.0	588.000	4.000	37681.871	37681.871	0.0	0.0	9420.465	0.0	840.000
202491	63.000	563.000	4.000	30504.367	8976.000	21528.367	70.575	2244.000	5382.090	910.000
202501	0.0	588.000	4.000	38902.039	38902.039	0.0	0.0	9725.508	0.0	950.000

HRB-SINGER, INC.

202011	303.000	107.000	210.900	2.650	0.0	1666.500	0.0	4.000	4.000	298.250
202021	436.000	101.000	250.800	2.569	0.0	2179.999	0.0	4.000	4.000	431.330
202031	447.000	98.000	254.100	2.816	0.0	2892.352	0.0	4.000	4.000	442.250
202041	422.000	103.000	246.600	2.868	0.0	7736.660	0.0	4.000	4.000	417.580
202051	562.000	99.000	288.600	0.214	3606.809	1188.845	3.034	4.000	4.000	557.580
202061	730.000	100.000	339.000	0.213	2957.875	1574.509	1.879	4.000	4.000	725.500
202071	276.000	101.000	202.800	0.0	0.0	303.600	0.0	4.000	4.000	271.670
202081	542.000	104.000	282.600	2.487	3034.015	3726.247	0.814	4.000	4.000	537.670
202091	873.000	107.000	381.900	0.142	3340.310	1655.689	2.017	4.000	4.000	868.750
202101	800.000	100.000	360.000	0.114	3459.241	1239.436	2.791	4.000	4.000	795.830
202111	695.000	105.000	328.500	0.173	3110.357	1528.999	2.034	4.000	4.000	690.830
202121	382.000	113.000	234.600	0.259	3374.336	977.209	3.453	4.000	4.000	377.670
202131	272.000	108.000	201.600	0.0	0.0	299.200	0.0	4.000	4.000	267.670
202141	829.000	106.000	368.700	0.114	3416.126	1361.044	2.510	4.000	4.000	824.750
202151	910.000	111.000	393.000	0.101	3555.583	1564.062	2.273	4.000	4.000	906.000
202161	919.000	107.000	395.700	0.111	3658.976	1630.483	2.244	4.000	4.000	915.170
202171	847.000	103.000	374.100	0.090	3555.583	1259.053	2.824	4.000	4.000	843.000
202181	700.000	100.000	330.000	0.139	3763.492	1327.585	2.835	4.000	4.000	696.330
202191	655.000	115.000	316.500	0.098	3289.949	1221.186	2.694	4.000	4.000	651.170
202201	755.000	110.000	346.500	0.056	3239.897	1038.125	3.121	4.000	4.000	751.080
202211	342.000	114.000	222.600	0.080	3825.673	587.812	6.508	4.000	4.000	338.420
202221	740.000	114.000	342.000	0.060	3825.673	1115.068	3.431	4.000	4.000	736.420
202231	825.000	115.000	367.500	0.049	3942.878	1194.078	3.302	4.000	4.000	821.580
202241	871.000	117.000	391.300	0.031	3439.833	1127.176	3.052	4.000	4.000	867.420
202251	876.000	117.000	382.800	0.000	0.0	973.333	0.0	4.000	4.000	873.500
202261	687.000	118.000	326.100	1.210	3545.216	1889.249	1.877	4.000	4.000	683.580
202271	436.000	119.000	250.800	0.160	0.0	527.032	0.0	4.000	4.000	432.830
202281	566.000	120.000	289.800	1.445	0.0	1778.856	0.0	4.000	4.000	562.330
202291	750.000	125.000	345.000	2.156	0.0	82499.938	0.0	4.000	4.000	746.330
202301	507.000	123.000	272.100	2.115	0.0	0.0	0.0	4.000	4.000	503.420
202311	656.000	114.000	316.800	2.196	0.0	0.0	0.0	4.000	4.000	652.420
202321	588.000	122.000	296.400	2.205	0.0	0.0	0.0	4.000	4.000	584.330
202331	1109.000	116.000	452.700	2.628	0.0	0.0	0.0	4.000	4.000	1104.920
202341	941.000	109.000	402.300	1.895	3034.015	2957.427	1.026	4.000	4.000	936.670
202351	1118.000	122.000	455.400	2.727	0.0	0.0	0.0	4.000	4.000	1113.750
202361	1082.000	123.000	444.600	1.047	3555.583	2052.068	1.733	4.000	4.000	1078.000
202371	1047.000	123.000	434.100	2.493	0.0	0.0	0.0	4.000	4.000	1043.000
202381	1121.000	124.000	456.300	2.173	3509.416	8220.664	0.427	4.000	4.000	1116.920
202391	1040.000	120.000	432.000	1.349	3658.976	2660.464	1.375	4.000	4.000	1036.170
202401	490.000	140.000	267.000	0.0	0.0	539.000	0.0	4.000	4.000	490.000
202411	555.000	130.000	286.500	0.080	2708.052	1071.052	2.528	4.000	4.000	550.830
202421	545.000	115.000	283.500	0.113	3289.655	966.935	3.402	4.000	4.000	540.500
202431	880.000	110.000	384.000	0.062	3523.146	1180.487	2.984	4.000	4.000	875.420
202441	870.000	110.000	381.000	0.073	3606.809	1226.922	2.940	4.000	4.000	865.580
202451	620.000	105.000	306.000	0.161	3564.361	1175.861	3.031	4.000	4.000	615.500
202461	570.000	115.000	291.000	0.833	3251.616	858.904	3.786	4.000	4.000	565.420
202471	565.000	105.000	289.500	0.890	0.0	863.194	0.0	4.000	4.000	560.420
202481	710.000	130.000	333.000	2.727	0.0	0.0	0.0	4.000	4.000	705.670
202491	800.000	110.000	360.000	2.464	3174.336	3519.999	0.902	4.000	4.000	795.250
202501	850.000	100.000	375.000	3.222	0.0	0.0	0.0	4.000	4.000	845.420

HRB-SINGER, INC.

202011	20.750	105.450	0.558
202021	0.0	125.400	0.550
202031	19.920	127.050	0.593
202041	20.750	123.300	0.649
202051	4.500	144.300	0.048
202061	3.750	169.500	0.047
202071	72.250	101.400	0.0
202081	19.750	141.300	0.574
202091	8.410	190.950	0.033
202101	7.080	180.000	0.027
202111	4.250	164.250	0.041
202121	0.590	117.300	0.060
202131	0.500	100.800	0.0
202141	17.420	184.350	0.027
202151	6.330	196.500	0.025
202161	6.500	197.850	0.029
202171	24.420	187.050	0.022
202181	5.750	165.000	0.038
202191	4.000	159.250	0.026
202201	3.500	173.250	0.014
202211	3.830	111.300	0.022
202221	3.830	171.000	0.017
202231	1.000	183.750	0.014
202241	1.000	190.650	0.009
202251	22.250	191.400	0.000
202261	23.920	163.050	0.354
202271	17.580	125.400	0.051
202281	16.660	144.900	0.394
202291	18.500	172.500	0.588
202301	17.500	136.050	0.591
202311	16.500	159.400	0.613
202321	17.500	148.200	0.601
202331	13.250	226.350	0.644
202341	19.000	201.150	0.438
202351	5.750	227.700	0.642
202361	7.500	222.300	0.262
202371	5.750	217.050	0.623
202381	17.330	228.150	0.532
202391	19.750	216.000	0.352
202401	66.250	133.500	0.0
202411	0.0	143.250	0.019
202421	0.0	141.750	0.025
202431	12.670	192.000	0.014
202441	14.580	190.500	0.016
202451	0.750	153.000	0.036
202461	0.750	145.500	0.182
202471	0.750	144.750	0.194
202481	14.000	166.500	0.630
202491	11.500	189.000	0.519
202501	0.670	187.500	0.703

HRB-SINGER. INC.

APPENDIX D-3

DATA LISTING

OM-2 THIRTY-TWO SAMPLE BLOCKS PREVIOUSLY OVERMINED

103011	173000.000	126300.000	46700.000	1790.000	0.0	2.000	82.500	3.000	84.000	1363.000
103021	173000.000	173000.000	0.0	1790.000	0.0	2.000	82.500	3.000	84.000	1350.000
103031	173000.000	144100.000	28900.000	1800.000	0.0	2.000	82.500	3.000	84.000	1359.000
103041	173000.000	111800.000	61200.000	1910.000	0.0	2.000	82.500	3.000	84.000	1302.000
103051	173000.000	32400.000	140600.000	1890.000	0.0	2.000	82.500	3.000	84.000	1294.000
103061	173000.000	81800.000	91200.000	1940.000	0.0	2.000	82.500	3.000	84.000	1311.000
103071	173000.000	77000.000	96000.000	1940.000	0.0	2.000	82.500	3.000	84.000	1293.000
103081	173000.000	89300.000	83700.000	1930.000	0.0	2.000	82.500	3.000	84.000	1285.000
103091	173000.000	67200.000	105800.000	1870.000	0.0	2.000	82.500	3.000	84.000	1285.000
103101	173000.000	80700.000	92300.000	1940.000	0.0	2.000	82.500	3.000	84.000	1298.000
103111	173000.000	123400.000	49600.000	1950.000	0.0	2.000	82.500	3.000	84.000	1319.000
103121	173000.000	142900.000	30100.000	1950.000	0.0	2.000	82.500	3.000	84.000	1315.000
103131	173000.000	99800.000	73200.000	1880.000	0.0	2.000	82.500	3.000	84.000	1305.000
103141	173000.000	145600.000	27400.000	1940.000	0.0	2.000	82.500	3.000	84.000	1320.000
103151	173000.000	110000.000	63000.000	1830.000	0.0	2.000	82.500	3.000	84.000	1315.000
103161	173000.000	124300.000	48700.000	1870.000	0.0	2.000	82.500	3.000	84.000	1330.000
103171	173000.000	153100.000	19900.000	1830.000	0.0	2.000	82.500	3.000	84.000	1330.000
103181	173000.000	151600.000	21400.000	1870.000	0.0	2.000	82.500	3.000	84.000	1390.000
103191	173000.000	140200.000	32800.000	1870.000	0.0	2.000	82.500	3.000	84.000	1380.000
103201	173000.000	104100.000	68900.000	1830.000	0.0	2.000	82.500	3.000	84.000	1371.000
103211	173000.000	121800.000	51200.000	1860.000	0.0	2.000	82.500	3.000	84.000	1390.000
103221	173000.000	170200.000	2800.000	1870.000	0.0	2.000	82.500	3.000	84.000	1376.000
103231	173000.000	139700.000	33300.000	1840.000	0.0	2.000	82.500	3.000	84.000	1370.000
103241	173000.000	89100.000	83900.000	1850.000	0.0	2.000	82.500	3.000	84.000	1350.000
103251	173000.000	77200.000	95800.000	1860.000	0.0	2.000	82.500	3.000	84.000	1381.000
103261	173000.000	76300.000	96700.000	1860.000	0.0	2.000	82.500	3.000	84.000	1372.000
103271	173000.000	83700.000	89300.000	1820.000	0.0	2.000	82.500	3.000	84.000	1355.000
103281	173000.000	91500.000	81500.000	1880.000	0.0	2.000	82.500	3.000	84.000	1351.000
103291	173000.000	86900.000	86100.000	1860.000	0.0	2.000	82.500	3.000	84.000	1380.000
103301	173000.000	88100.000	84900.000	1870.000	0.0	2.000	82.500	3.000	84.000	1373.000
103311	173000.000	152400.000	20600.000	1880.000	0.0	2.000	82.500	3.000	84.000	1352.000
103321	173000.000	91100.000	81900.000	1870.000	0.0	2.000	82.500	3.000	84.000	1398.000

103011	4.000	0.0	0.0	67.830	73.000	6000.000	1500.000	7000.000	43.000	550.000
103021	4.000	0.0	0.0	67.000	100.000	6000.000	1500.000	7000.000	0.0	598.000
103031	4.000	0.0	0.0	69.750	93.000	6000.000	1500.000	7000.000	25.000	443.000
103041	4.330	0.0	0.0	75.500	65.000	8000.000	1500.000	6000.000	43.000	437.000
103051	4.250	0.0	0.0	74.580	17.000	8000.000	1500.000	6000.000	50.000	251.000
103061	4.080	0.0	0.0	72.830	47.000	8000.000	1500.000	6000.000	69.000	229.000
103071	4.040	0.0	0.0	73.250	45.000	8000.000	1500.000	6000.000	43.000	25.000
103081	4.170	0.0	0.0	74.500	52.000	8000.000	1500.000	6000.000	50.000	25.000
103091	4.000	0.0	0.0	75.160	39.000	8000.000	1500.000	6000.000	50.000	25.000
103101	4.080	0.0	0.0	72.750	47.000	8000.000	1500.000	6000.000	56.000	25.000
103111	3.920	0.0	0.0	73.500	72.000	8000.000	1500.000	6000.000	50.000	400.000
103121	4.250	0.0	0.0	73.930	83.000	8000.000	1500.000	6000.000	50.000	531.000
103131	4.090	0.0	0.0	75.330	58.000	8000.000	1500.000	6000.000	50.000	397.000
103141	3.830	0.0	0.0	73.670	84.000	8000.000	1500.000	6000.000	13.000	550.000
103151	4.250	0.0	0.0	75.660	64.000	8000.000	1500.000	6000.000	50.000	456.000
103161	4.170	0.0	0.0	73.830	72.000	8000.000	1500.000	6000.000	43.000	425.000
103171	4.170	0.0	0.0	75.330	88.000	8000.000	1500.000	6000.000	63.000	556.000
103181	3.920	0.0	0.0	72.500	88.000	6000.000	1500.000	7000.000	25.000	450.000
103191	4.000	0.0	0.0	72.830	81.000	6000.000	1500.000	7000.000	19.000	469.000
103201	3.830	0.0	0.0	72.330	60.000	6000.000	1500.000	7000.000	63.000	293.000
103211	4.000	0.0	0.0	70.500	71.000	6000.000	1500.000	7000.000	50.000	456.000
103221	3.920	0.0	0.0	71.580	98.000	6000.000	1500.000	7000.000	50.000	588.000
103231	3.830	0.0	0.0	72.330	81.000	6000.000	1500.000	7000.000	63.000	456.000
103241	4.000	0.0	0.0	72.920	52.000	6000.000	1500.000	7000.000	56.000	19.000
103251	4.000	0.0	0.0	71.750	45.000	6000.000	1500.000	7000.000	56.000	19.000
103261	4.000	0.0	0.0	71.830	44.000	6000.000	1500.000	7000.000	43.000	19.000
103271	4.500	0.0	0.0	69.330	48.000	6000.000	1500.000	7000.000	50.000	25.000
103281	4.000	0.0	0.0	70.830	53.000	6000.000	1500.000	7000.000	43.000	19.000
103291	3.600	0.0	0.0	72.580	50.000	6000.000	1500.000	7000.000	50.000	25.000
103301	4.160	0.0	0.0	72.000	51.000	6000.000	1500.000	7000.000	50.000	19.000
103311	3.830	0.0	0.0	70.920	88.000	6000.000	1500.000	7000.000	43.000	531.000
103321	3.750	0.0	0.0	72.580	53.000	6000.000	1500.000	7000.000	56.000	19.000

HRB-SINGER, INC

103011	0.0	0.0	0.0	0.0	1.000	1.000	0.0	0.0	1.000	6.000
103021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103031	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103041	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103051	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103061	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103071	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103081	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103091	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103101	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103121	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103131	1.000	2.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103141	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103151	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103161	1.000	1.000	0.0	0.0	1.000	1.000	0.0	0.0	1.000	6.000
103171	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103181	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103191	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103201	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103211	1.000	3.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103221	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103231	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103241	1.000	2.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103251	1.000	2.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103261	1.000	2.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103271	1.000	2.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103281	1.000	2.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103291	1.000	2.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103301	1.000	2.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103311	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000
103321	1.000	1.000	0.0	0.0	0.0	0.0	0.0	0.0	1.000	6.000

HRB-SINGER, INC.

103011	74.000	1500.000	4.000	0.0	0.0	57.750	83.000	8000.000	1500.000	7000.000
103021	74.000	1497.000	4.000	0.0	0.0	57.670	43.000	8000.000	1500.000	7000.000
103031	74.000	1492.000	4.900	0.0	0.0	57.750	60.000	8000.000	1500.000	7000.000
103041	74.000	1454.000	4.900	0.0	0.0	41.830	54.000	6000.000	1500.000	6000.000
103051	74.000	1443.000	4.900	0.0	0.0	35.330	38.000	6000.000	1500.000	6000.000
103061	74.000	1460.000	4.000	0.0	0.0	46.160	66.000	6000.000	1500.000	6000.000
103071	74.000	1452.000	4.100	0.0	0.0	45.420	77.000	6000.000	1500.000	6000.000
103081	74.000	1443.000	4.250	0.0	0.0	40.830	20.000	6000.000	1500.000	6000.000
103091	74.000	1441.000	4.000	0.0	0.0	43.420	70.000	6000.000	1500.000	6000.000
103101	74.000	1452.000	3.750	0.0	0.0	47.330	50.000	6000.000	1500.000	6000.000
103111	74.000	1469.000	3.700	0.0	0.0	44.920	27.000	6000.000	1500.000	6000.000
103121	74.000	1463.000	4.100	0.0	0.0	51.500	33.000	6000.000	1500.000	6000.000
103131	74.000	1457.000	3.750	0.0	0.0	46.250	65.000	6000.000	1500.000	6000.000
103141	74.000	1476.000	4.100	0.0	0.0	45.580	13.000	6000.000	1500.000	6000.000
103151	74.000	1465.000	4.200	0.0	0.0	46.750	22.000	6000.000	1500.000	6000.000
103161	74.000	1480.000	3.900	0.0	0.0	45.000	24.000	6000.000	1500.000	6000.000
103171	74.000	1473.000	4.170	0.0	0.0	48.420	55.000	6000.000	1500.000	6000.000
103181	74.000	1539.000	3.250	0.0	0.0	46.830	37.000	8000.000	1500.000	7000.000
103191	74.000	1529.000	3.800	0.0	0.0	46.420	46.000	8000.000	1500.000	7000.000
103201	74.000	1517.000	3.800	0.0	0.0	48.080	87.000	8000.000	1500.000	7000.000
103211	74.000	1541.000	4.300	0.0	0.0	46.250	30.000	8000.000	1500.000	7000.000
103221	74.000	1534.000	4.000	0.0	0.0	46.160	97.000	8000.000	1500.000	7000.000
103231	74.000	1523.000	4.000	0.0	0.0	48.500	48.000	8000.000	1500.000	7000.000
103241	74.000	1506.000	4.100	0.0	0.0	42.160	34.000	8000.000	1500.000	7000.000
103251	74.000	1533.000	4.170	0.0	0.0	47.500	92.000	8000.000	1500.000	7000.000
103261	74.000	1531.000	3.900	0.0	0.0	49.250	87.000	8000.000	1500.000	7000.000
103271	74.000	1511.000	3.900	0.0	0.0	45.750	24.000	8000.000	1500.000	7000.000
103281	74.000	1503.000	3.900	0.0	0.0	48.250	20.000	8000.000	1500.000	7000.000
103291	74.000	1537.000	3.600	0.0	0.0	49.250	76.000	8000.000	1500.000	7000.000
103301	74.000	1523.000	3.900	0.0	0.0	49.250	40.000	8000.000	1500.000	7000.000
103311	74.000	1500.000	4.000	0.0	0.0	48.580	14.000	8000.000	1500.000	7000.000
103321	74.000	1539.000	4.100	0.0	0.0	48.250	19.000	8000.000	1500.000	7000.000

HRB-SINGER, INC

103011	25.000	531.000	3.970	28545.000	20839.492	7705.508	26.994	5249.242	1940.934	427.000
103021	43.000	250.000	3.970	28545.000	28545.000	0.0	0.0	7190.176	0.0	440.000
103031	43.000	293.000	3.970	28545.000	23776.492	4768.508	16.705	5989.039	1201.135	441.000
103041	0.0	556.000	3.970	30899.949	19968.871	10931.078	35.376	5029.941	2753.421	608.000
103051	50.000	325.000	3.970	30329.055	5680.125	24648.930	81.272	1430.762	6208.797	606.000
103061	43.000	537.000	3.970	29115.895	13766.914	15348.961	52.717	3467.742	3866.238	629.000
103071	43.000	500.000	3.970	29115.895	12959.094	16156.801	55.491	3264.256	4069.724	647.000
103081	50.000	19.000	3.970	29758.148	15360.703	14397.445	48.382	3869.195	3626.561	645.000
103091	25.000	425.000	3.970	28545.000	11048.000	17457.000	61.156	2792.948	4397.227	595.000
103101	50.000	207.000	3.970	29115.895	13581.797	15534.098	53.353	3421.108	3912.872	642.000
103111	43.000	19.000	3.970	27974.086	19953.766	8020.320	28.671	5026.137	2020.232	631.000
103121	56.000	231.000	3.970	30329.055	25052.149	5276.906	17.399	6310.363	1329.196	635.000
103131	37.000	287.000	3.970	29115.895	16796.336	12319.559	42.312	4230.813	3103.164	575.000
103141	50.000	19.000	3.970	27331.828	23002.973	4328.855	15.838	5794.199	1090.392	620.000
103151	43.000	187.000	3.970	30329.055	19284.367	11044.688	36.416	4857.523	2782.038	515.000
103161	50.000	19.000	3.970	29758.148	21381.141	8377.008	28.150	5385.676	2110.078	540.000
103171	31.000	463.000	3.970	29758.148	26335.102	3423.047	11.503	6633.527	862.229	500.000
103181	43.000	225.000	3.970	27974.086	24513.711	3460.375	12.370	6174.738	871.631	480.000
103191	43.000	113.000	3.970	28545.000	23133.000	5412.000	18.960	5826.953	1363.224	430.000
103201	43.000	475.000	3.970	27331.828	16446.492	10885.336	39.827	4142.691	2741.899	459.000
103211	43.000	343.000	3.970	28545.000	20097.000	8448.000	29.595	5062.215	2127.960	470.000
103221	37.000	589.000	3.970	27974.086	27521.324	452.762	1.619	6932.324	114.046	494.000
103231	43.000	143.000	3.970	27331.828	22070.849	5260.980	19.249	5559.406	1325.184	470.000
103241	50.000	363.000	3.970	28545.000	14701.492	13843.508	48.497	3703.147	3487.030	500.000
103251	25.000	363.000	3.970	28545.000	12738.000	15807.000	55.376	3208.565	3981.613	479.000
103261	37.000	588.000	3.970	28545.000	12589.492	15955.508	55.896	3171.157	4019.020	498.000
103271	50.000	19.000	3.970	32113.117	15536.805	16576.313	51.618	3913.553	4175.391	465.000
103281	43.000	25.000	3.970	28545.000	15097.492	13447.508	47.110	3802.895	3387.282	529.000
103291	25.000	375.000	3.970	25690.484	12904.637	12785.848	49.769	3250.539	3220.617	480.000
103301	43.000	93.000	3.970	29686.789	15117.949	14568.840	49.075	3808.048	3669.733	497.000
103311	50.000	19.000	3.970	27331.828	24077.245	3254.543	11.508	6064.805	819.784	528.000
103321	50.000	25.000	3.970	26760.934	14092.023	12668.910	47.341	3549.629	3191.162	482.000

HRB-SINGER, INC.

103011	290.000	137.000	207.000	1.965	2324.162	1876.469	1.239	4.000	5.333	286.000
103021	293.000	147.000	207.200	0.979	2982.698	565.438	5.275	4.000	5.333	289.000
103031	301.000	149.000	210.300	1.404	2982.698	827.749	3.603	4.000	5.333	297.000
103041	456.000	152.000	256.800	1.205	0.0	1090.434	0.0	5.333	4.000	452.000
103051	450.000	155.000	255.000	0.834	3196.982	798.386	4.004	5.333	4.000	446.000
103061	480.000	149.000	264.000	1.491	2982.698	1552.940	1.921	5.333	4.000	476.000
103071	489.000	153.000	266.400	1.739	2934.484	2333.912	1.257	5.333	4.000	483.900
103081	487.000	159.000	266.100	0.006	3071.590	669.625	4.587	5.333	4.000	482.750
103091	429.000	155.000	248.700	1.537	2324.162	1572.999	1.478	5.333	4.000	425.000
103101	488.000	154.000	266.400	0.995	3336.103	1073.599	3.107	5.333	4.000	484.250
103111	481.000	150.000	264.300	0.009	3140.190	724.794	4.333	5.333	4.000	477.300
103121	487.000	148.000	266.100	0.778	3313.619	799.552	4.144	5.333	4.000	482.900
103131	423.000	152.000	246.900	1.305	2904.599	1329.427	2.185	5.333	4.000	419.250
103141	464.000	156.000	259.200	0.004	3145.303	586.666	5.361	5.333	4.000	459.900
103151	365.000	150.000	229.500	0.535	2888.182	514.743	5.611	5.333	4.000	360.800
103161	390.000	150.000	237.000	0.009	3250.853	564.473	5.759	5.333	4.000	386.100
103171	357.000	143.000	227.100	1.356	2496.379	872.666	2.861	5.333	4.000	352.830
103181	331.000	149.000	219.300	0.586	3420.788	577.936	5.919	4.000	5.333	327.750
103191	341.000	149.000	222.300	0.762	3085.405	694.629	4.442	4.000	5.333	337.200
103201	313.000	146.000	213.900	1.832	3085.405	2640.461	1.165	4.000	5.333	309.200
103211	319.000	151.000	215.700	0.753	2843.676	501.285	5.673	4.000	5.333	314.700
103221	336.000	158.000	220.800	2.113	2783.472	12319.988	0.226	4.000	5.333	332.000
103231	317.000	153.000	215.100	0.973	2982.698	670.576	4.448	4.000	5.333	313.000
103241	344.000	156.000	223.200	0.777	3145.303	573.333	5.486	4.000	5.333	339.900
103251	327.000	152.000	218.100	1.956	2261.187	1998.332	1.132	4.000	5.333	322.830
103261	329.000	159.000	218.700	1.809	2830.376	2783.845	1.017	4.000	5.333	325.100
103271	309.000	156.000	212.700	0.007	3250.853	447.238	7.269	4.000	5.333	305.100
103281	377.000	152.000	233.100	0.020	3032.959	518.375	5.851	4.000	5.333	373.100
103291	323.000	157.000	217.900	1.389	2491.532	1480.416	1.683	4.000	5.333	319.400
103301	347.000	150.000	224.100	0.565	3032.959	636.166	4.768	4.000	5.333	343.100
103311	380.000	148.000	234.000	0.006	3196.982	486.046	6.578	4.000	5.333	376.000
103321	331.000	151.000	219.300	0.021	3145.303	449.506	6.997	4.000	5.333	326.900

HRB-SINGER, INC.

103011	10.080	193.500	0.491
103021	9.330	103.950	0.245
103031	12.000	105.150	0.351
103041	33.670	128.400	0.301
103051	39.250	127.500	0.209
103061	26.670	132.000	0.373
103071	27.830	133.290	0.424
103081	33.670	133.050	0.001
103091	31.740	124.359	0.384
103101	25.420	133.200	0.265
103111	23.690	132.150	0.002
103121	22.430	133.050	0.190
103131	29.040	123.450	0.348
103141	28.090	129.600	0.001
103151	28.910	114.750	0.127
103161	28.830	118.500	0.002
103171	26.910	113.550	0.325
103181	25.670	109.650	0.180
103191	26.410	111.150	0.201
103201	24.250	106.950	0.482
103211	24.250	107.850	0.175
103221	25.420	110.400	0.528
103231	23.830	107.550	0.243
103241	30.760	111.600	0.190
103251	24.250	109.050	0.469
103261	22.580	109.350	0.464
103271	23.580	106.350	0.002
103281	22.580	116.550	0.005
103291	23.330	108.450	0.386
103301	22.750	112.050	0.145
103311	22.340	117.000	0.001
103321	24.330	109.650	0.005

HRB-SINGER, INC.

APPENDIX D-4

DATA LISTING

OM(2) TWENTY-FOUR SAMPLE BLOCKS NOT PREVIOUSLY OVERMINED

103013	173000.000	152600.000	20400.000	1880.000	0.0	2.000	82.500	3.000	84.000	1401.000
103023	173000.000	133800.000	39200.000	1850.000	0.0	2.000	82.500	3.000	84.000	1400.000
103033	173000.000	126100.000	46900.000	1810.000	0.0	2.000	82.500	3.000	84.000	1399.000
103043	173000.000	107300.000	65700.000	1790.000	0.0	2.000	82.500	3.000	84.000	1395.000
103053	173000.000	83300.000	89700.000	1850.000	0.0	2.000	82.500	3.000	84.000	1392.000
103063	173000.000	123200.000	49800.000	1860.000	0.0	2.000	82.500	3.000	84.000	1380.000
103073	173000.000	161900.000	11100.000	1840.000	0.0	2.000	82.500	3.000	84.000	1362.000
103083	173000.000	173000.000	0.0	1800.000	0.0	2.000	82.500	3.000	84.000	1364.000
103093	173000.000	121200.000	51800.000	1780.000	0.0	2.000	82.500	3.000	84.000	1363.000
103103	173000.000	58600.000	114400.000	1860.000	0.0	2.000	82.500	3.000	84.000	1397.000
103113	173000.000	125100.000	47900.000	1850.000	0.0	2.000	82.500	3.000	84.000	1394.000
103123	173000.000	157100.000	15900.000	1720.000	0.0	2.000	82.500	3.000	84.000	1391.000
103133	173000.000	82400.000	90600.000	1800.000	0.0	2.000	82.500	3.000	84.000	1388.000
103143	173000.000	116300.000	56700.000	1790.000	0.0	2.000	82.500	3.000	84.000	1369.000
103153	173000.000	173000.000	0.0	1800.000	0.0	2.000	82.500	3.000	84.000	1363.000
103163	173000.000	163000.000	10000.000	1790.000	0.0	2.000	82.500	3.000	84.000	1360.000
103173	173000.000	173000.000	0.0	1800.000	0.0	2.000	82.500	3.000	84.000	1360.000
103183	173000.000	169400.000	4600.000	1740.000	0.0	2.000	82.500	3.000	84.000	1365.000
103193	173000.000	166000.000	7000.000	1810.000	0.0	2.000	82.500	3.000	84.000	1354.000
103203	173000.000	81900.000	91100.000	1800.000	0.0	2.000	82.500	3.000	84.000	1369.000
103213	173000.000	162000.000	11000.000	1830.000	0.0	2.000	82.500	3.000	84.000	1375.000
103223	173000.000	165200.000	7800.000	1820.000	0.0	2.000	82.500	3.000	84.000	1370.000
103233	173000.000	110200.000	62800.000	1870.000	0.0	2.000	82.500	3.000	84.000	1355.000
103243	173000.000	145000.000	28000.000	1920.000	0.0	2.000	82.500	3.000	84.000	1378.000

HRB-SINGER, INC.

103013	3.830	0.0	0.0	69.920	98.000	6000.000	1500.000	7000.000	43.000	563.000
103023	3.750	0.0	0.0	69.330	77.000	6000.000	1500.000	7000.000	43.000	487.000
103033	3.580	0.0	0.0	69.250	73.000	6000.000	1500.000	7000.000	41.000	513.000
103043	3.830	0.0	0.0	69.250	62.000	6000.000	1500.000	7000.000	43.000	450.000
103053	3.920	0.0	0.0	69.420	48.000	6000.000	1500.000	7000.000	56.000	113.000
103063	3.920	0.0	0.0	69.420	71.000	6000.000	1500.000	7000.000	50.000	350.000
103073	3.830	0.0	0.0	69.250	94.000	6000.000	1500.000	7000.000	37.000	588.000
103083	3.670	0.0	0.0	69.160	100.000	6000.000	1500.000	7000.000	0.0	588.000
103093	3.920	0.0	0.0	68.500	70.000	6000.000	1500.000	7000.000	75.000	437.000
103103	3.830	0.0	0.0	71.000	34.000	6000.000	1500.000	7000.000	37.000	19.000
103113	3.920	0.0	0.0	70.750	73.000	6000.000	1500.000	7000.000	56.000	463.000
103123	3.920	0.0	0.0	70.500	91.000	6000.000	1500.000	7000.000	50.000	550.000
103133	3.920	0.0	0.0	70.250	48.000	6000.000	1500.000	7000.000	50.000	19.000
103143	3.830	0.0	0.0	68.670	68.000	6000.000	1500.000	7000.000	50.000	431.000
103153	3.920	0.0	0.0	68.750	100.000	6000.000	1500.000	7000.000	0.0	588.000
103163	3.830	0.0	0.0	69.000	94.000	6000.000	1500.000	7000.000	0.0	588.000
103173	4.000	0.0	0.0	67.160	100.000	6000.000	1500.000	7000.000	0.0	598.000
103183	4.080	0.0	0.0	67.330	98.000	6000.000	1500.000	7000.000	0.0	588.000
103193	4.000	0.0	0.0	67.000	96.000	6000.000	1500.000	7000.000	0.0	598.000
103203	3.750	0.0	0.0	72.420	48.000	6000.000	1500.000	7000.000	63.000	19.000
103213	3.750	0.0	0.0	72.420	94.000	6000.000	1500.000	7000.000	43.000	588.000
103223	3.920	0.0	0.0	70.000	96.000	6000.000	1500.000	7000.000	37.000	588.000
103233	4.000	0.0	0.0	68.420	64.000	6000.000	1500.000	7000.000	43.000	456.000
103243	4.000	0.0	0.0	73.830	84.000	6000.000	1500.000	7000.000	25.000	463.000

103013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103033	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103043	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103053	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103063	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103073	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103083	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103093	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103103	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103113	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103153	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103163	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103173	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103183	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103193	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103203	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103213	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103223	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103233	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0
103243	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.000	0.0

103013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103033	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103043	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103053	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103063	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103073	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103083	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103093	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103103	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103113	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103153	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103163	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103173	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103183	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103193	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103203	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103213	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103223	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103233	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103243	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

103013	0.0	0.0	3.970	27331.828	24108.887	3222.941	11.792	6072.766	811.824	479.000
103023	0.0	0.0	3.970	26760.934	20697.184	6063.750	22.659	5213.395	1527.393	450.000
103033	0.0	0.0	3.970	25547.766	18621.805	6925.961	27.110	4690.629	1744.575	411.000
103043	0.0	0.0	3.970	27331.828	16952.055	10379.773	37.977	4270.039	2614.553	395.000
103053	0.0	0.0	3.970	27974.086	13469.598	14504.488	51.850	3392.846	3653.524	458.000
103063	0.0	0.0	3.970	27974.086	19921.430	8052.656	28.786	5017.992	2028.377	480.000
103073	0.0	0.0	3.970	27331.828	25578.168	1753.660	6.416	6442.863	441.728	478.000
103083	0.0	0.0	3.970	26190.023	26190.023	0.0	0.0	6596.980	0.0	436.000
103093	0.0	0.0	3.970	27974.086	19598.031	8376.055	29.942	4936.531	2109.838	417.000
103103	0.0	0.0	3.970	27331.828	9258.063	18073.766	66.127	2332.006	4552.586	463.000
103113	0.0	0.0	3.970	27974.086	20228.660	7745.426	27.688	5095.379	1950.989	456.000
103123	0.0	0.0	3.970	27974.086	25403.055	2571.031	9.191	6398.754	647.615	329.000
103133	0.0	0.0	3.970	27974.086	13324.070	14650.016	52.370	3356.189	3690.181	412.000
103143	0.0	0.0	3.970	27331.828	18373.934	8957.895	32.775	4628.195	2256.397	421.000
103153	0.0	0.0	3.970	27974.086	27974.086	0.0	0.0	7046.367	0.0	437.000
103163	0.0	0.0	3.970	27331.828	25751.949	1579.879	5.780	6486.637	397.954	430.000
103173	0.0	0.0	3.970	29115.895	29115.895	0.0	0.0	7333.977	0.0	440.000
103183	0.0	0.0	3.970	29115.895	28341.711	774.184	2.659	7138.969	195.008	375.000
103193	0.0	0.0	3.970	29115.895	27937.789	1178.105	4.046	7037.227	296.752	456.000
103203	0.0	0.0	3.970	26760.934	12668.902	14092.031	52.659	3191.160	3549.631	431.000
103213	0.0	0.0	3.970	26760.934	25059.367	1701.566	6.358	6312.184	428.606	455.000
103223	0.0	0.0	3.970	27974.086	26712.828	1261.258	4.509	6728.672	317.697	450.000
103233	0.0	0.0	3.970	28545.000	18183.000	10362.000	36.301	4580.098	2610.076	515.000
103243	0.0	0.0	3.970	28545.000	23925.000	4620.000	16.185	6026.449	1163.728	542.000

HRB-SINGER, INC.

103013	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103023	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103033	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103043	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103053	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103063	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103073	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103083	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103093	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103103	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103113	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103143	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103153	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103163	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103173	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103183	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103193	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103203	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103213	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103223	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103233	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0
103243	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.000	0.0	0.0

103013	0.0	0.0	0.0
103023	0.0	0.0	0.0
103033	0.0	0.0	0.0
103043	0.0	0.0	0.0
103053	0.0	0.0	0.0
103063	0.0	0.0	0.0
103073	0.0	0.0	0.0
103083	0.0	0.0	0.0
103093	0.0	0.0	0.0
103103	0.0	0.0	0.0
103113	0.0	0.0	0.0
103123	0.0	0.0	0.0
103133	0.0	0.0	0.0
103143	0.0	0.0	0.0
103153	0.0	0.0	0.0
103163	0.0	0.0	0.0
103173	0.0	0.0	0.0
103183	0.0	0.0	0.0
103193	0.0	0.0	0.0
103203	0.0	0.0	0.0
103213	0.0	0.0	0.0
103223	0.0	0.0	0.0
103233	0.0	0.0	0.0
103243	0.0	0.0	0.0

APPENDIX E-1

PRINCIPAL COMPONENTS ANALYSIS -- UM(1) n = 31

24 VARIABLES, 9 FACTORS

NOTE: For an interpretation of the following pages see pages 152, 161, 163, Table VIII-1 and Section VIII C4b1.

SYMMETRIC CORRELATION MATRIX

NUMBER CASES 31 PROBLEM NAME UM(1)-2431

X		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15																
19	2	-0.051														
20	3	0.734	-0.205													
25	4	-0.419	-0.253	-0.266												
31	5	0.501	0.294	0.353	-0.498											
41	6	-0.098	0.056	-0.118	0.244	-0.191										
42	7	0.471	0.317	0.328	-0.285	0.836	-0.046									
47	8	-1.000	0.050	-0.732	0.420	-0.500	0.097	-0.467								
48	9	0.965	-0.073	0.766	-0.402	0.475	-0.056	0.506	-0.963							
49	10	-0.358	-0.090	-0.188	0.135	-0.198	0.045	-0.167	0.358	-0.272						
50	11	-0.170	-0.194	0.142	0.627	-0.054	0.245	0.159	0.177	-0.127	0.070					
51	12	-0.154	-0.189	0.151	0.630	-0.026	0.224	0.202	0.161	-0.110	0.064	0.996				
52	13	0.221	0.120	0.054	-0.183	0.312	-0.300	0.390	-0.230	0.218	-0.071	-0.377	-0.294			
53	14	-0.154	-0.189	0.151	0.630	-0.026	0.224	0.202	0.161	-0.110	0.052	0.996	1.000	-0.293		
54	15	0.509	0.298	0.349	-0.453	0.979	-0.146	0.879	-0.505	0.508	-0.189	0.026	0.049	0.234	0.049	
55	16	-0.090	-0.033	-0.166	0.273	-0.423	-0.032	-0.286	0.082	-0.118	0.042	-0.013	-0.009	0.047	-0.009	-0.418
56	17	0.043	0.045	-0.031	0.223	-0.143	-0.142	-0.034	-0.049	0.003	-0.013	0.106	0.119	0.101	0.119	-0.137
57	18	-0.357	-0.133	-0.404	0.064	-0.767	0.109	-0.787	0.349	-0.354	0.165	-0.513	-0.530	-0.001	-0.529	-0.819
58	19	-0.419	-0.253	-0.266	1.000	-0.498	0.244	-0.285	0.420	-0.401	0.139	0.627	0.630	-0.183	0.630	-0.453
59	20	-0.358	-0.254	-0.199	0.760	-0.245	0.309	-0.042	0.365	-0.320	0.103	0.664	0.665	-0.215	0.665	-0.192
60	21	-0.154	-0.189	0.151	0.630	-0.026	0.224	0.202	0.161	-0.110	0.064	0.996	1.000	-0.294	1.000	0.049
61	22	-0.380	-0.079	-0.245	0.399	-0.266	-0.057	-0.180	0.383	-0.407	0.052	0.326	0.336	-0.013	0.336	-0.268
62	23	-0.151	-0.189	0.152	0.627	-0.022	0.226	0.206	0.158	-0.107	0.053	0.996	1.000	-0.294	1.000	0.053
63	24	0.509	0.298	0.349	-0.453	0.979	-0.146	0.879	-0.505	0.508	-0.198	0.026	0.049	0.234	0.049	1.000

	16	17	18	19	20	21	22	23
17	0.940							
18	0.354	0.049						
19	0.273	0.223	0.064					
20	-0.185	-0.198	-0.192	0.760				
21	-0.009	0.119	-0.530	0.630	0.665			
22	-0.078	-0.089	0.002	0.399	0.514	0.336		
23	-0.013	0.115	-0.533	0.627	0.665	1.000	0.336	
24	-0.418	-0.138	-0.819	-0.453	-0.192	0.049	-0.268	0.053

HRB-SINGER, INC.

MEANS BFR-2431

VARIABLES										
1 TO 10	52.258	50.323	2.356	0.489	60.968	1.760	2.466	48.097	3.669	1.571
11 TO 20	397.129	485.839	88.710	265.774	2.595	3.096	2.879	2.335	2.256	5.521
21 TO 24	479.839	25.355	133.032	0.451						

STANDARD DEVIATIONS

VARIABLES										
1 TO 10	22.201	15.541	0.611	0.503	25.639	0.205	0.435	22.282	0.207	0.001
11 TO 20	157.253	152.363	14.547	45.666	1.197	1.283	1.292	1.802	1.057	3.208
21 TO 24	152.363	7.838	22.962	0.208						

STATISTICS COMPLETED FOR BFR-2431

HRB-SINGER, INC

THE ORIGINAL MATRIX OF FACTOR LOADINGS

X		F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
15	1	-0.67372	-0.42372	0.50743	0.21199	-0.04825	-0.13424	-0.03489	-0.07240	-0.13944	0.0
19	2	-0.27075	-0.00059	-0.39114	-0.48140	0.34424	-0.31001	0.13189	-0.41848	-0.17759	0.0
20	3	-0.37841	-0.51879	0.48368	0.35145	-0.06328	0.19131	0.03229	-0.20996	0.08438	0.0
25	4	0.86914	-0.10705	0.16656	-0.07096	-0.13935	-0.23870	-0.16004	0.15084	-0.20022	0.0
37	5	-0.64153	-0.63371	-0.29923	-0.19247	-0.02143	0.02805	-0.03549	0.12026	-0.02649	0.0
41	6	0.29298	-0.06306	-0.02533	0.26743	0.62261	-0.48692	-0.30465	-0.10261	0.18345	0.0
42	7	-0.44358	-0.74827	-0.19071	-0.28145	-0.02777	-0.13199	-0.17740	-0.01596	0.08221	0.0
47	8	0.67664	0.41569	-0.51182	-0.20610	0.04953	0.13798	0.03943	0.07254	0.13471	0.0
48	9	-0.64336	-0.45105	0.49419	0.24773	-0.02027	-0.09493	-0.13163	-0.09624	-0.09717	0.0
49	10	0.25902	0.17390	-0.17869	-0.04576	0.08902	0.56125	-0.67546	-0.23880	-0.17477	0.0
50	11	0.70343	-0.68265	0.06749	0.00962	0.09725	0.10226	0.07056	-0.04474	0.06214	0.0
51	12	0.68785	-0.70301	0.07001	-0.02471	0.04374	0.08021	0.03762	-0.05300	0.09760	0.0
52	13	-0.39919	0.01661	0.00266	-0.36314	-0.59227	-0.25835	-0.37824	-0.07629	0.34570	0.0
53	14	0.68758	-0.70312	0.07099	-0.02441	0.04264	0.07366	0.04641	-0.04829	0.10258	0.0
54	15	-0.59652	-0.69792	-0.28710	-0.18472	0.03813	0.02136	-0.03853	0.12109	-0.07496	0.0
55	16	0.22584	0.31894	0.65962	-0.60983	0.11751	0.00931	0.00050	0.00192	0.00194	0.0
56	17	0.13317	0.04738	0.62914	-0.73617	0.08270	0.06980	0.04750	0.01010	-0.03974	0.0
57	18	0.14629	0.92218	0.18337	0.14200	0.01164	-0.10169	-0.09559	-0.06753	0.09556	0.0
58	19	0.86925	-0.10697	0.16632	-0.07106	-0.13905	-0.23666	-0.16301	0.14927	-0.20171	0.0
59	20	0.74876	-0.32708	-0.18718	0.20607	-0.19439	-0.25750	-0.14698	0.10077	-0.16419	0.0
60	21	0.68787	-0.70300	0.06997	-0.02473	0.04378	0.08054	0.03716	-0.05323	0.09736	0.0
61	22	0.52415	-0.02404	-0.24631	0.01477	-0.51931	-0.10404	0.22604	-0.44071	-0.10626	0.0
62	23	0.68496	-0.70631	0.06861	-0.02211	0.04365	0.07379	0.04409	-0.04965	0.10019	0.0
63	24	-0.59657	-0.69845	-0.28655	-0.18420	0.03749	0.01639	-0.03112	0.12441	-0.07107	0.0
SUM SQ.		7.99419	6.32836	2.51337	1.88301	1.26216	1.05621	0.91400	0.62372	0.46069	0.0
VAREXP		33.30913	26.36815	10.47239	7.84586	5.25900	4.40087	3.80831	2.59882	1.91953	0.0
CUMPER		33.30913	59.67728	70.14966	77.99551	83.25452	87.65538	91.46368	94.06250	95.98203	95.98203

HRB-SINGER, INC.

THE ROTATED MATRIX OF FACTOR LOADINGS

	F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
1	-0.15736	-0.30383	0.91823	-0.04265	0.00899	-0.02633	0.13580			
2	-0.22604	-0.37615	-0.20216	-0.13365	0.19305	0.04113	0.04554			
3	0.20159	-0.12328	0.83499	0.07607	-0.09534	0.00192	-0.00377			
4	0.59884	0.32786	-0.23458	-0.17048	0.06757	-0.03120	-0.01981			
5	-0.06548	-0.92481	0.22523	0.12749	-0.07504	-0.08324	0.04847			
6	0.21450	0.15462	-0.01572	0.12883	0.90047	0.07719	-0.00270			
7	0.16693	-0.85623	0.25357	0.02295	0.08323	-0.28134	0.02140			
8	0.16434	0.30034	-0.91714	0.04979	-0.01214	0.03420	-0.13585			
9	-0.11290	-0.30088	0.92263	-0.01041	0.06651	-0.05260	0.04350			
10	0.04419	0.10857	-0.20884	0.00632	0.00759	0.00727	-0.96912			
11	0.98287	-0.05355	-0.03333	-0.01853	0.04537	0.13453	-0.02242			
12	0.98839	-0.07710	-0.02625	-0.02913	0.03681	0.05237	-0.02121			
13	-0.27297	-0.22908	0.08653	-0.10473	-0.10537	-0.90536	0.00666			
14	0.98868	-0.07649	-0.02755	-0.02913	0.03728	0.05160	-0.00843			
15	0.00056	-0.94719	0.24336	0.11718	-0.03898	-0.01928	0.03552			
16	-0.00458	0.32749	-0.03302	-0.92797	0.00429	-0.05012	-0.00234			
17	0.11197	0.05492	0.03867	-0.97019	-0.10156	-0.04906	0.01159			
18	-0.49476	0.79155	-0.21346	-0.09543	0.14520	-0.07630	-0.05826			
19	0.59875	0.32775	-0.23412	-0.17050	0.06751	-0.03112	-0.02397			
20	0.64652	0.12082	-0.21301	0.29947	0.07467	-0.03946	-0.00612			
21	0.98837	-0.07712	-0.02618	-0.02913	0.03679	0.05239	-0.02186			
22	0.40593	0.32329	-0.22564	0.27719	-0.41846	-0.23810	0.04429			
23	0.98843	-0.08001	-0.02506	-0.02564	0.03835	0.05263	-0.01099			
24	0.00122	-0.94682	0.24247	0.11755	-0.03872	-0.01949	0.04568			
SUM SQ.	6.74236	4.99780	3.81612	2.13969	1.11744	1.01880	0.99440			
VAREXP	28.09317	20.82417	15.90050	8.91536	4.65601	4.24498	4.14334			
CUMPER	28.09317	48.91734	64.81784	73.73318	78.38919	82.63417	86.77751			

HRB-SINGER, INC

APPENDIX E-2

PRINCIPAL COMPONENTS ANALYSIS -- UM(1) n = 50

21 VARIABLES, 9 FACTORS

NOTE: For an interpretation of the following pages see pages 152, 161, Table VIII-1, and Section VIII C4b1.

SYMMETRIC CORRELATION MATRIX

NUMBER CASES 50 PROBLEM NAME, UM(1)-5021

X		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15																
19	2	-0.334														
20	3	0.730	-0.212													
24	4	-0.392	-0.082	-0.330												
37	5	0.331	0.004	0.281	-0.561											
41	6	-0.091	0.189	-0.130	0.347	-0.672										
42	7	0.240	0.104	0.146	-0.271	0.590	-0.314									
47	8	-0.997	0.330	-0.720	0.397	-0.326	0.071	-0.230								
48	9	0.735	-0.195	0.687	-0.178	0.186	-0.111	0.250	-0.700							
49	10	-0.285	0.351	-0.131	0.111	-0.136	0.188	-0.056	0.288	-0.184						
50	11	-0.137	-0.043	0.079	0.513	-0.116	0.091	0.003	0.150	0.043	0.102					
51	12	-0.139	-0.031	0.077	0.517	-0.095	0.080	0.035	0.153	0.045	0.106	0.997				
52	13	0.026	0.145	-0.049	-0.157	0.279	-0.148	0.354	-0.028	0.009	0.001	-0.427	-0.351			
53	14	-0.140	-0.031	0.077	0.517	-0.095	0.081	0.036	0.153	0.045	0.106	0.997	1.000	-0.351		
54	15	0.349	0.001	0.291	-0.533	0.987	-0.656	0.640	-0.342	0.220	-0.135	-0.051	-0.034	0.207	-0.034	
58	16	-0.361	-0.046	-0.276	0.957	-0.607	0.405	-0.290	0.368	-0.138	0.107	0.544	0.546	-0.191	0.546	-0.575
59	17	-0.322	0.031	-0.202	0.653	-0.361	0.308	-0.144	0.330	-0.100	0.160	0.701	0.696	-0.322	0.697	-0.314
60	18	-0.139	-0.031	0.077	0.517	-0.095	0.080	0.036	0.153	0.045	0.106	0.997	1.000	-0.351	1.000	-0.034
61	19	-0.359	0.023	-0.268	0.371	-0.216	0.030	-0.132	0.360	-0.252	0.054	0.393	0.395	-0.139	0.395	-0.207
62	20	-0.134	-0.034	0.079	0.515	-0.093	0.081	0.035	0.147	0.048	0.103	0.997	1.000	-0.353	1.000	-0.032
63	21	0.349	0.001	0.291	-0.533	0.987	-0.656	0.639	-0.342	0.220	-0.135	-0.051	-0.034	0.207	-0.034	1.000

	16	17	18	19	20
17	0.708				
18	0.546	0.696			
19	0.371	0.552	0.395		
20	0.544	0.696	1.000	0.394	
21	-0.575	-0.314	-0.034	-0.206	-0.031

HRB-SINGER, INC.

MEANS UM(1)-5021

VARIABLES										
1 TO 10	53.860	47.441	2.412	0.366	75.100	0.446	1.567	46.881	3.691	1.530
11 TO 20	388.520	478.520	90.000	263.580	3.230	1.957	4.791	472.520	25.280	131.920
21 TO 21	0.562									

STANDARD DEVIATIONS

VARIABLES										
1 TO 10	24.296	19.940	0.588	0.480	27.544	1.704	0.008	24.372	0.261	0.221
11 TO 20	153.248	148.029	13.401	44.362	1.263	0.995	3.287	148.029	6.580	22.282
21 TO 21	0.220									

STATISTICS COMPLETED FOR UM(1)-5021

HRB-SINGER, INC

THE ORIGINAL MATRIX OF FACTOR LOADINGS

	X	F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
15	1	-0.50649	-0.50321	-0.63591	0.07596	-0.06971	0.08917	0.01499	-0.12130	0.04873	0.0
19	2	0.04732	0.19642	0.42943	0.68661	0.07541	0.22115	-0.31677	0.19446	-0.27757	0.0
20	3	-0.30963	-0.57152	-0.54037	0.18916	0.10725	0.07121	0.14224	0.24978	0.00228	0.0
24	4	0.81205	0.12883	-0.09436	-0.10453	-0.38905	-0.18404	0.10083	-0.07876	-0.19945	0.0
37	5	-0.59722	-0.61568	0.45468	-0.05488	0.00188	-0.02656	0.02632	-0.05178	-0.02299	0.0
41	6	0.41039	0.41172	-0.41993	0.43144	-0.05183	0.05803	-0.30352	-0.24645	0.26622	0.0
42	7	-0.33738	-0.50934	0.35063	0.21462	-0.42158	0.01071	-0.16424	-0.27369	0.03408	0.0
47	8	0.51116	0.48426	0.63421	-0.07455	0.06228	-0.09181	0.00128	0.13423	-0.07871	0.0
48	9	-0.26958	-0.51783	-0.57941	0.18507	-0.18171	0.10075	0.09227	0.09833	-0.33008	0.0
49	10	0.22314	0.15892	0.24479	0.64942	0.20676	-0.09967	0.59307	-0.18281	0.04871	0.0
50	11	0.79608	-0.58361	0.02530	0.02672	0.10361	-0.05265	-0.04922	0.05118	0.05932	0.0
51	12	0.78776	-0.59367	0.05067	0.04459	0.04325	-0.05309	-0.03870	0.08152	0.08652	0.0
52	13	-0.40159	0.11678	0.26960	0.18604	-0.70486	0.01571	0.13659	0.31844	0.27634	0.0
53	14	0.78785	-0.59357	0.05081	0.04473	0.04275	-0.05302	-0.03868	0.08135	0.08642	0.0
54	15	-0.55551	-0.67106	0.43934	-0.04079	0.01243	-0.03087	-0.00702	-0.11628	-0.05449	0.0
58	16	0.84158	0.11632	-0.15647	-0.04948	-0.36379	-0.13654	0.05793	-0.06027	-0.20594	0.0
59	17	0.83097	-0.15716	0.02223	0.00748	-0.10641	0.20441	0.02013	-0.21953	-0.12295	0.0
60	18	0.78775	-0.59370	0.05073	0.04464	0.04311	-0.05309	-0.03879	0.08134	0.08659	0.0
61	19	0.54764	-0.01049	0.23122	-0.25727	-0.05460	0.71471	0.19246	-0.02829	0.06343	0.0
62	20	0.78594	-0.59651	0.04751	0.04299	0.04407	-0.05142	-0.04024	0.07851	0.08771	0.0
63	21	-0.55530	-0.67123	0.43910	-0.04089	0.01301	-0.03065	-0.00681	-0.11544	-0.05446	0.0
	SUM SQ.	7.62634	4.67745	2.74115	1.33586	1.09550	0.71577	0.67910	0.53009	0.48680	0.0
	VAREXP	36.31590	22.27357	13.05308	6.36125	5.21667	3.40844	3.23381	2.52425	2.31808	0.0
	CUMPER	36.31590	58.58948	71.64255	78.00380	83.22046	86.62889	89.86270	92.38695	94.70502	94.70502

HRB-SINGER, INC.

THE ROTATED MATRIX OF FACTOR LOADINGS

	F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
1	-0.12208	-0.19564	-0.89560	-0.19626	0.02425	-0.08184	-0.10031			
2	-0.02493	-0.02710	0.21821	0.93612	-0.06518	-0.00707	0.16941			
3	0.12667	-0.09502	-0.84851	-0.02726	-0.01960	-0.09918	0.02595			
4	0.46399	0.43220	0.23611	-0.11341	-0.06492	0.05566	0.01490			
5	-0.05947	-0.93376	-0.13682	-0.01135	-0.07654	-0.05623	-0.02402			
6	0.08114	0.67912	-0.01180	0.17535	0.01866	-0.05835	0.09332			
7	0.04789	-0.74323	-0.14507	0.13204	-0.29665	-0.03697	-0.02679			
8	0.13383	0.18690	0.07948	0.20396	-0.02417	0.08247	0.10508			
9	0.03379	-0.11131	-0.89714	0.08130	-0.01109	-0.04919	-0.06156			
10	0.08013	0.07826	0.15429	0.16475	-0.01260	-0.00556	0.96551			
11	0.98417	0.02433	0.00312	-0.00871	0.13309	0.06939	0.02142			
12	0.99144	0.00768	0.00542	-0.00321	0.05467	0.07106	0.02385			
13	-0.30295	-0.19166	0.02395	0.06415	-0.91744	-0.00864	0.01846			
14	0.99139	0.00763	0.00551	-0.00311	0.05437	0.07118	0.02391			
15	-0.00514	-0.95712	-0.16019	-0.00067	-0.01661	-0.06032	-0.02699			
16	0.49555	0.48479	0.17729	-0.05281	-0.04245	0.06909	0.00337			
17	0.63911	0.21013	0.14122	0.05264	0.16040	0.37362	0.07287			
18	0.99144	0.00758	0.00546	-0.00323	0.05461	0.07106	0.02384			
19	0.32661	0.11487	0.24275	-0.01105	-0.00043	0.88959	-0.01612			
20	0.99129	0.00629	0.00181	-0.00547	0.05701	0.07211	0.02183			
21	-0.00477	-0.95675	-0.16043	-0.00058	-0.01651	-0.06018	-0.02703			
SUM SQ.	6.03748	4.33514	3.42988	1.06204	1.00418	1.00512	1.00671			
VAREXP	28.74991	20.64352	16.33272	5.05733	4.78181	4.78628	4.79388			
CUMPER	28.74991	49.39343	65.72615	70.78348	75.56528	80.35155	85.14542			

HRB-SINGER, INC

APPENDIX E-3

PRINCIPAL COMPONENTS ANALYSIS -- OM(1) n = 29

19 VARIABLES, 6 FACTORS

NOTE: For an interpretation of the following pages see pages 152, 161, Table VIII-1, and Section VIII C4b2.

SYMMETRIC CORRELATION MATRIX

NUMBER CASES 29 PROBLEM NAME OM(1)-2919

X 15		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	2	-0.924														
26	3	0.814	-0.796													
37	4	-0.259	0.283	-0.344												
41	5	-0.062	-0.039	-0.039	-0.252											
42	6	-0.434	0.447	-0.434	0.716	-0.224										
47	7	-1.000	0.924	-0.813	0.259	0.062	0.434									
48	8	0.905	-0.732	0.680	-0.210	-0.170	-0.449	-0.905								
44	9	-0.887	0.864	-0.698	0.175	-0.075	0.344	0.887	-0.697							
50	10	-0.145	0.126	-0.175	0.008	0.025	0.303	0.145	-0.245	0.080						
51	11	-0.126	0.105	-0.157	0.005	0.028	0.289	0.126	-0.228	0.058	0.999					
52	12	-0.574	0.612	-0.536	0.084	-0.098	0.466	0.574	-0.529	0.615	0.323	0.290				
53	13	-0.125	0.104	-0.157	0.005	0.028	0.289	0.125	-0.229	0.058	0.999	1.000	0.291			
55	14	-0.225	0.293	-0.189	-0.399	0.572	-0.253	0.225	-0.197	0.192	0.116	0.110	0.226	0.110		
56	15	-0.205	0.237	-0.294	0.791	7 0.203	0.746	0.205	-0.215	0.132	0.576	0.574	0.213	0.574	-0.288	
57	16	0.035	-0.026	0.058	-0.653	0.284	-0.618	-0.035	0.112	0.039	-0.608	-0.613	-0.038	-0.613	0.453	-0.900
60	17	-0.126	0.106	-0.157	0.005	0.028	0.289	0.126	-0.228	0.058	0.999	1.000	0.291	1.000	0.110	0.574
61	18	0.047	0.023	-0.037	0.409	-0.081	0.541	-0.047	0.078	0.010	0.394	0.396	0.067	0.395	-0.095	0.576
62	19	-0.123	0.103	-0.155	0.002	0.029	0.287	0.123	-0.226	0.055	0.999	1.000	0.290	1.000	0.110	0.972

	16	17	18
17	-0.613		
18	-0.531	0.396	
19	-0.611	1.000	0.393

HRB-SINGER, INC.

MEANS OM(1)-2919

VARIABLES										
1 TO 10	72.862	0.719	1.557	42.345	60.966	1.738	27.143	3.809	1.894	873.483
11 TO 19	763.207	110.276	349.103	3.537	3.181	2.561	759.172	8.967	174.483	

STANDARD DEVIATIONS

VARIABLES										
1 TO 10	31.902	0.872	0.018	18.636	8.056	0.561	31.898	0.319	1.874	190.696
11 TO 19	188.581	6.897	56.454	0.032	0.227	1.164	188.586	7.403	28.337	

STATISTICS COMPLETED FOR OM(1)-2919

HRB-SINGER, INC

THE ORIGINAL MATRIX OF FACTOR LOADINGS

X		F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
15	1	-0.65775	-0.72675	-0.04273	-0.01772	-0.13148	-0.08779	0.0	0.0	0.0	0.0
19	2	0.63561	0.69883	0.00199	0.02588	-0.08236	0.15098	0.0	0.0	0.0	0.0
20	3	-0.62863	-0.58654	0.02194	0.05388	-0.04360	-0.07309	0.0	0.0	0.0	0.0
37	4	0.41600	0.04006	-0.81280	-0.28164	0.10539	-0.04253	0.0	0.0	0.0	0.0
41	5	-0.05901	0.10207	0.54330	-0.74193	0.21080	-0.17702	0.0	0.0	0.0	0.0
42	6	0.69077	0.05418	-0.55301	-0.15125	-0.17340	-0.24782	0.0	0.0	0.0	0.0
47	7	0.65765	0.72657	0.04266	0.01788	0.13159	0.08752	0.0	0.0	0.0	0.0
48	8	-0.65946	-0.57513	-0.11232	0.03031	-0.29170	0.13281	0.0	0.0	0.0	0.0
49	9	0.55988	0.70548	0.02092	0.15582	-0.11546	0.20199	0.0	0.0	0.0	0.0
50	10	0.77499	-0.52706	0.33624	0.08504	0.02148	0.00564	0.0	0.0	0.0	0.0
51	11	0.76171	-0.54648	0.33529	0.07715	0.03775	0.02229	0.0	0.0	0.0	0.0
52	12	0.60158	0.36917	0.12912	0.24053	-0.43804	-0.45337	0.0	0.0	0.0	0.0
53	13	0.76140	-0.54651	0.33587	0.07767	0.03809	0.02142	0.0	0.0	0.0	0.0
55	14	0.07479	0.27168	0.72724	-0.40718	-0.26820	0.03937	0.0	0.0	0.0	0.0
56	15	0.73923	-0.34281	-0.48780	-0.17874	0.06729	-0.03877	0.0	0.0	0.0	0.0
57	16	-0.63037	0.53290	0.47066	0.02814	-0.20185	-0.00064	0.0	0.0	0.0	0.0
60	17	0.76187	-0.54618	0.33538	0.07738	0.03707	0.02317	0.0	0.0	0.0	0.0
61	18	0.42917	-0.39869	-0.31627	-0.37789	-0.49435	0.28700	0.0	0.0	0.0	0.0
62	19	0.75943	-0.54789	0.33776	0.07858	0.03778	0.02012	0.0	0.0	0.0	0.0
	SUM SQ.	7.47959	4.97605	2.94872	1.11264	0.78692	0.48940	0.0	0.0	0.0	0.0
	VAREXP	39.36627	26.18971	15.51956	5.85598	4.14168	2.57577	0.0	0.0	0.0	0.0
	CUMPER	39.36627	65.55598	81.07553	86.93150	91.07318	93.64894	93.64894	93.64894	93.64894	93.64894

HRB-SINGER, INC.

THE ROTATED MATRIX OF FACTOR LOADINGS

	F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
1	-0.05275	-0.98311	0.09154	0.05941	-0.06750	0.04657	0.0			
2	0.02317	0.94068	-0.06885	0.00647	-0.13039	-0.12416	0.0			
3	-0.07070	-0.83915	0.17050	0.07168	0.03020	0.07442	0.0			
4	-0.10512	0.21437	-0.91893	0.11192	-0.09872	0.06184	0.0			
5	0.02286	0.00981	0.12375	-0.94992	0.08983	0.09464	0.0			
6	0.16368	0.34861	-0.77567	0.08496	-0.15569	-0.34471	0.0			
7	0.05278	0.98288	-0.09161	-0.05930	0.06777	-0.04669	0.0			
8	-0.16848	-0.83904	0.15630	0.18768	-0.28630	0.08908	0.0			
9	-0.00608	0.91731	0.04040	0.12207	-0.13274	-0.11982	0.0			
10	0.98583	0.08468	-0.10190	-0.02648	-0.05659	-0.07649	0.0			
11	0.98898	0.06590	-0.10249	-0.02875	-0.05670	-0.04836	0.0			
12	0.21913	0.53970	-0.01572	0.05293	-0.01464	-0.79214	0.0			
13	0.98899	0.06562	-0.10199	-0.02882	-0.05573	-0.04887	0.0			
14	0.10498	0.25372	0.49001	-0.66276	-0.26441	-0.15129	0.0			
15	0.48273	0.13560	-0.81309	0.09403	-0.13612	-0.00184	0.0			
16	-0.56313	0.04549	0.74789	-0.22529	0.01553	-0.12198	0.0			
17	0.98887	0.06637	-0.10205	-0.02834	-0.05761	-0.04824	0.0			
18	0.31215	-0.07972	-0.47838	-0.01197	-0.76102	-0.02807	0.0			
19	0.98929	0.06327	-0.09990	-0.02908	-0.05472	-0.04983	0.0			
SUM SQ.	5.66902	5.64132	3.27940	1.49023	0.85258	0.86063	0.0			
VAREXP	29.83694	29.69115	17.25998	7.84334	4.48726	4.52961	0.0			
CUMPER	29.83694	59.52809	76.78807	84.63141	89.11867	93.64827	93.64827			

HRB-SINGER, INC

APPENDIX E-4

PRINCIPAL COMPONENTS ANALYSIS -- OM(1) n = 47

16 VARIABLES, 6 FACTORS

NOTE: For an interpretation of the following pages see pages 152, 161, Table VIII-1, and Section VIII C4b2.

SYMMETRIC CORRELATION MATRIX

NUMBER CASES 47 PROBLEM NAME OM(1)-4716

X 15		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19	2	-0.890														
20	3	0.897	-0.872													
37	4	-0.166	0.310	-0.343												
41	5	0.306	-0.416	0.411	-0.508											
42	6	-0.251	0.392	-0.392	0.816	-0.505										
47	7	-1.000	0.889	-0.896	0.164	-0.303	0.249									
48	8	0.880	-0.645	0.694	0.015	0.162	-0.063	-0.882								
49	9	-0.891	0.907	-0.820	0.210	-0.333	0.291	0.891	-0.656							
50	10	0.024	-0.050	0.048	0.066	0.243	0.107	-0.021	-0.037	-0.065						
51	11	0.042	-0.067	0.065	0.058	0.254	0.096	-0.039	-0.023	-0.083	0.999					
52	12	-0.471	0.462	-0.452	0.228	-0.227	0.343	0.473	-0.400	0.458	0.321	0.287				
53	13	0.042	-0.068	0.066	0.057	0.254	0.095	-0.039	-0.023	-0.083	0.999	1.000	0.287			
60	14	0.041	-0.066	0.065	0.058	0.254	0.095	-0.038	-0.023	-0.082	0.999	1.000	0.288	1.000		
61	15	-0.105	0.284	-0.210	0.348	-0.312	0.500	0.102	0.089	0.243	-0.003	-0.008	0.138	-0.010	-0.008	
62	16	0.044	-0.069	0.067	0.057	0.254	0.094	-0.041	-0.021	-0.086	0.999	1.000	0.288	1.000	1.000	-0.011

HRB-SINGER, INC.

MEANS OM(1)-4716

VARIABLES										
1 TO 10	65.170	1.002	2.095	54.575	1.099	2.019	34.748	3.768	2.362	830.681
11 TO 16	718.957	111.723	335.808	714.894	10.843	167.819				

STANDARD DEVIATIONS

VARIABLES										
1 TO 10	31.938	0.874	0.680	31.222	0.876	0.722	31.874	0.315	1.816	227.212
11 TO 16	224.701	8.261	67.317	224.797	7.784	33.765				

STATISTICS COMPLETED FOR OM(1)-4716

HRB-SINGER, INC

THE ORIGINAL MATRIX OF FACTOR LOADINGS

X		F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
15	1	-0.94352	-0.09856	-0.28786	-0.00897	-0.07795	0.00484	0.0	0.0	0.0	0.0
19	2	0.93540	0.07020	0.03974	0.11970	0.05727	0.00189	0.0	0.0	0.0	0.0
20	3	-0.92745	-0.07247	-0.05739	0.00653	-0.10903	0.02435	0.0	0.0	0.0	0.0
37	4	0.38278	0.12914	-0.77233	-0.29360	0.21479	-0.21079	0.0	0.0	0.0	0.0
41	5	-0.51787	0.19539	0.52278	0.26452	0.09771	-0.58294	0.0	0.0	0.0	0.0
42	6	0.46636	0.18576	-0.76747	-0.10462	0.07703	-0.21163	0.0	0.0	0.0	0.0
47	7	0.94254	0.10152	0.29121	0.00741	0.07554	-0.00593	0.0	0.0	0.0	0.0
48	8	-0.75445	-0.13673	-0.47271	0.11932	-0.06392	-0.04759	0.0	0.0	0.0	0.0
49	9	0.90711	0.05085	0.14468	0.16790	0.01322	-0.02651	0.0	0.0	0.0	0.0
50	10	-0.13195	0.98995	0.00696	0.00448	0.02007	0.04416	0.0	0.0	0.0	0.0
51	11	-0.15282	0.98570	0.00867	0.01015	0.04611	0.05071	0.0	0.0	0.0	0.0
52	12	0.52774	0.41678	-0.04455	-0.15331	-0.70222	-0.16512	0.0	0.0	0.0	0.0
53	13	-0.15371	0.98554	0.00969	0.00980	0.04599	0.05092	0.0	0.0	0.0	0.0
60	14	-0.15250	0.98576	0.00927	0.01097	0.04503	0.05111	0.0	0.0	0.0	0.0
61	15	0.28261	0.03591	-0.60137	0.71431	-0.09267	0.07356	0.0	0.0	0.0	0.0
62	16	-0.15498	0.98548	0.00947	0.00731	0.04377	0.05063	0.0	0.0	0.0	0.0
SUM SQ.		6.00801	5.18162	2.23975	0.75819	0.60311	0.47763	0.0	0.0	0.0	0.0
VAREXP		37.55008	32.38513	13.99841	4.73868	3.76944	2.98519	0.0	0.0	0.0	0.0
CUMPER		37.55008	69.93521	83.93362	88.67230	92.44174	95.42693	95.42693	95.42693	95.42693	95.42693

HRB-SINGER, INC.

APPENDIX E-5

PRINCIPAL COMPONENTS ANALYSIS -- OM(2) n = 32

22 VARIABLES, 9 FACTORS

NOTE: For an interpretation of the following pages see pages 152, 161, Table VIII-1 and Section VIII C4b2.

SYMMETRIC CORRELATION MATRIX

NUMBER CASES 32 PROBLEM NAME OM(2)-3222

X		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15																
19	2	-0.475														
20	3	0.726	-0.296													
25	4	0.112	-0.049	0.215												
37	5	-0.123	0.205	-0.067	0.057											
41	6	0.050	-0.062	-0.019	-0.079	-0.547										
42	7	-0.093	0.170	0.094	-0.093	0.788	-0.507									
47	8	-1.000	0.477	-0.725	-0.113	0.121	-0.049	0.092								
48	9	0.963	-0.402	0.644	0.146	-0.142	0.010	-0.130	-0.962							
49	10	-0.339	0.561	-0.175	0.046	0.036	-0.035	-0.065	0.340	-0.267						
50	11	-0.316	0.163	-0.079	-0.176	-0.205	0.128	-0.159	0.317	-0.294	0.235					
51	12	-0.289	0.157	-0.040	-0.151	-0.210	0.125	-0.156	0.290	-0.265	0.230	0.998				
52	13	-0.480	0.134	-0.542	-0.393	-0.012	0.089	-0.096	0.480	-0.492	0.151	0.410	0.346			
53	14	-0.290	0.159	-0.039	-0.151	-0.209	0.121	-0.154	0.292	-0.267	0.230	0.998	1.000	0.348		
55	15	0.049	-0.062	-0.056	-0.036	-0.342	0.921	-0.397	-0.048	-0.010	-0.034	-0.029	-0.033	0.037	-0.036	
56	16	-0.071	0.235	-0.033	0.026	0.897	-0.408	0.618	0.069	-0.104	0.130	0.010	-0.004	0.184	-0.002	-0.265
57	17	0.181	-0.245	0.017	-0.029	-0.901	0.684	-0.735	-0.179	0.181	-0.132	-0.135	-0.134	-0.062	-0.136	0.574
58	18	-0.210	0.168	0.151	0.033	-0.156	-0.005	-0.035	0.210	-0.177	0.159	0.849	0.861	0.167	0.863	-0.128
59	19	0.210	-0.168	-0.151	-0.033	0.156	0.005	0.035	-0.210	0.176	-0.159	-0.849	-0.860	-0.168	-0.862	0.128
60	20	-0.288	0.156	-0.040	-0.151	-0.210	0.125	-0.156	0.289	-0.265	0.231	0.998	1.000	0.346	1.000	-0.032
61	21	-0.476	0.378	-0.151	-0.246	-0.201	-0.006	-0.090	0.477	-0.483	0.470	0.627	0.600	0.600	0.602	-0.123
62	22	-0.285	0.157	-0.033	-0.140	-0.225	0.136	-0.164	0.287	-0.265	0.231	0.996	1.000	0.337	0.999	-0.023

	16	17	18	19	20	21
17	-0.869					
18	-0.024	-0.170				
19	0.024	0.170	-1.000			
20	-0.004	-0.133	0.860	-0.860		
21	-0.026	-0.045	0.591	-0.591	0.600	
22	-0.019	-0.119	0.863	-0.863	1.000	0.602

HRB-SINGER, INC.

MEANS OM(2)-3222

VARIABLES										
1 TO 10	64.188	45.782	2.153	0.072	48.156	40.844	2.201	35.875	3.644	1.521
11 TO 20	531.156	379.781	151.375	233.906	2870.719	2.981	3.731	4.582	4.748	375.813
21 TO 22	25.276	117.000								

STANDARD DEVIATIONS

VARIABLES										
1 TO 10	19.420	14.881	0.649	0.243	24.689	11.155	0.559	19.396	0.147	0.276
11 TO 20	71.014	69.027	5.253	20.651	602.719	0.313	2.116	0.670	0.670	69.004
21 TO 22	6.200	10.308								

STATISTICS COMPLETED FOR OM(2)-3222

HRB-SINGER, INC

THE ORIGINAL MATRIX OF FACTOR LOADINGS

X		F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
15	1	-0.55751	0.45419	-0.62275	0.09358	-0.10623	0.23667	0.08780	0.01104	0.06398	0.0
19	2	0.34572	-0.40643	0.25635	-0.46656	-0.28502	0.29454	-0.24226	0.15788	0.40914	0.0
20	3	-0.24457	0.33810	-0.73342	-0.16156	-0.10821	0.11550	-0.22113	-0.30722	-0.14004	0.0
25	4	-0.18718	0.02846	-0.20360	-0.64971	-0.06046	-0.51205	0.40659	-0.20369	0.08179	0.0
37	5	-0.14667	-0.87577	-0.27923	0.12284	-0.29449	-0.10528	0.04176	0.00104	-0.02116	0.0
41	6	0.07057	0.68084	0.41133	0.11099	-0.55122	-0.09568	-0.07994	-0.07076	-0.00164	0.0
42	7	-0.09974	-0.74584	-0.33286	0.14678	-0.12246	-0.06467	-0.39823	-0.13296	-0.08069	0.0
47	8	0.55863	-0.45235	0.62304	-0.09467	0.10662	-0.23494	-0.08923	-0.01063	-0.06384	0.0
48	9	-0.52707	0.44430	-0.61136	0.00731	-0.06136	0.25375	0.12766	0.12454	0.13036	0.0
49	10	0.36723	-0.20750	0.19655	-0.57220	-0.23310	0.48111	0.17019	0.09010	-0.33342	0.0
50	11	0.94895	0.16803	-0.19585	0.10630	-0.04182	-0.02243	0.06221	0.09850	-0.02439	0.0
51	12	0.93758	0.18602	-0.23271	0.07399	-0.04567	-0.04254	0.03682	0.12273	-0.03653	0.0
52	13	0.50836	-0.17279	0.41057	0.46493	0.03507	0.25505	0.35687	-0.28018	0.14987	0.0
53	14	0.93877	0.18319	-0.23355	0.07371	-0.04320	-0.04169	0.03606	0.11894	-0.03328	0.0
55	15	-0.06443	0.53481	0.43349	0.11717	-0.66678	-0.15261	-0.06021	-0.09025	-0.04145	0.0
56	16	0.03230	-0.75808	-0.32334	0.18463	-0.42995	0.03761	0.24749	-0.05065	0.04173	0.0
57	17	-0.17272	0.84325	0.46062	-0.07525	0.11561	0.04755	-0.07518	-0.05483	0.03278	0.0
58	18	0.84024	0.15150	-0.38587	-0.12051	0.03512	-0.12487	-0.11910	-0.13683	0.10484	0.0
59	19	-0.84020	-0.15151	0.38592	0.12037	-0.03507	0.12495	0.11909	0.13671	-0.10519	0.0
60	20	0.93744	0.18646	-0.23284	0.07417	-0.04573	-0.04216	0.03678	0.12239	-0.03731	0.0
61	21	0.76753	-0.04684	0.15044	-0.08786	0.13334	0.38737	-0.02097	-0.41192	-0.00282	0.0
62	22	0.93657	0.19973	-0.22973	0.06098	-0.04654	-0.04738	0.03146	0.11589	-0.03649	0.0
	SUM SQ.	7.99767	4.53926	3.43912	1.39783	1.25716	1.07512	0.73612	0.57398	0.39181	0.0
	VAREXP	36.35303	20.63297	15.63235	6.35375	5.71437	4.88690	3.34598	2.60901	1.78096	0.0
	CUMPER	36.35303	56.98599	72.61833	78.97208	84.68645	89.57335	92.91933	95.52832	97.30928	97.30928

HRB-SINGER, INC.

THE ROTATED MATRIX OF FACTOR LOADINGS

	F 1	F 2	F 3	F 4	F 5	F 6	F 7	F 8	F 9	F 10
1	-0.17986	0.05896	-0.96294	-0.00884	-0.03178	-0.10200	-0.07069			
2	0.10351	-0.17454	0.32822	0.02442	0.00091	0.31342	-0.00854			
3	0.09245	-0.03767	-0.76811	-0.12317	0.00475	0.01184	-0.24276			
4	-0.07271	-0.01063	-0.08130	-0.96910	0.03108	0.03872	-0.15759			
5	-0.18771	-0.95101	0.09797	-0.04149	0.16213	-0.00422	-0.03949			
6	0.08546	0.39218	-0.01822	0.04421	-0.89968	-0.01671	0.03179			
7	-0.11670	-0.78645	0.00864	0.18185	0.22203	-0.12714	-0.20882			
8	0.18095	-0.05679	0.96241	0.00997	0.03172	0.10305	0.07023			
9	-0.15666	0.10382	-0.94670	-0.04225	0.04148	-0.06876	-0.09753			
10	0.15095	-0.03763	0.19599	-0.05000	0.01713	0.92623	0.03998			
11	0.97009	0.02040	0.13498	0.09814	-0.03344	0.07764	0.12357			
12	0.98064	0.02493	0.10873	0.07313	-0.02960	0.07885	0.06384			
13	0.22828	-0.05157	0.39653	0.23077	-0.06320	0.01334	0.83064			
14	0.98093	0.02376	0.10960	0.07238	-0.02630	0.07697	0.06685			
15	-0.06586	0.22440	0.01257	-0.00065	-0.95794	-0.00418	0.00185			
16	0.00193	-0.94503	-0.02055	-0.05843	0.04860	0.09227	0.20627			
17	-0.16112	0.89360	-0.08161	0.03007	-0.38282	-0.05241	0.01972			
18	0.92244	0.01303	0.02890	-0.12872	0.08300	-0.05137	0.00787			
19	-0.92245	-0.01298	-0.02882	0.12871	-0.08297	0.05165	-0.00792			
20	0.98050	0.02513	0.10835	0.07345	-0.02982	0.07928	0.06388			
21	0.53556	0.12732	0.30202	0.12663	0.11949	0.31868	0.49165			
22	0.98108	0.03843	0.10737	0.06339	-0.03658	0.07994	0.05766			
SUM SQ.	7.05320	3.49249	3.83293	1.13064	1.99356	1.14914	1.15701			
VAREXP	32.05998	15.87496	17.42239	5.13929	9.06161	5.22337	5.25911			
CUMPER	32.05998	47.93494	65.35733	70.49661	79.55821	84.78157	90.04068			

HRB-SINGER, INC

APPENDIX F-1

MULTIPLE REGRESSION ANALYSIS -- UM(1) n = 30, n = 49, and n = 31

NOTE: For an interpretation of the following pages see pages 152, 167, Table VIII-1, and Section VIII C5a.

MULTIPLE REGRESSION.....UM(1)-30-24

SELECTION..... 1

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
37	2	60.66666	26.02165	0.49904	0.27186	0.16028	1.69613
52	3	89.66666	14.79359	0.22033	0.25620	0.28467	0.90001
60	4	474.69995	152.21152	-0.17121	0.03076	0.03500	0.87872
61	5	1.40849	0.10472	-0.45274	-105.55061	50.60803	-2.08565
	DEPENDENT						
15	1	51.96666	22.51968				

INTERCEPT 146.82469

MULTIPLE CORRELATION 0.61693

STD. ERROR OF ESTIMATE 19.09062

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5595.65234	1398.91309	3.83840
DEVIATION FROM REGRESSION	25	9111.31250	364.45239	
TOTAL	29	14706.96484		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-30-24

SELECTION...., 1

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	52.65845	7.34155
2	25.00000	40.76836	-15.76836
3	46.00000	61.92079	-15.92079
4	59.00000	66.02251	-7.02251
5	60.00000	61.77547	-1.77547
6	95.00000	60.73559	34.26442
7	92.00000	77.99617	14.00383
8	41.00000	60.83237	-19.83237
9	50.00000	66.72404	-16.72404
10	80.00000	74.54466	5.45534
11	93.00000	72.28795	20.71205
12	52.00000	58.05988	-6.05988
13	77.00000	57.43285	19.56715
14	86.00000	62.39378	23.60622
15	41.00000	60.75531	-19.75531
16	51.00000	48.28976	2.71024
17	43.00000	36.34889	6.65111
18	33.00000	53.03619	-20.03619
19	22.00000	40.23318	-18.23318
20	23.00000	28.20419	-5.20419
21	35.00000	46.44585	-11.44585
22	40.00000	36.97899	3.02101
23	23.00000	38.91530	-15.91530
24	21.00000	55.09769	-34.09769
25	36.00000	40.97734	-4.97734
26	68.00000	41.57954	26.42046
27	74.00000	42.97113	31.02887
28	32.00000	31.53125	0.46875
29	49.00000	25.64612	23.35388
30	52.00000	57.82159	-5.82159

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-49

SELECTION..... 1

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEFF.	COMPUTED T VALUE
37	2	75.29407	27.81934	0.33231	0.22665	0.12441	1.82188
52	3	90.00000	13.54006	0.02572	-0.15837	0.26414	-0.59956
60	4	469.22437	147.69972	-0.14792	0.01581	0.02855	0.55354
61	5	1.40110	0.09929	-0.42255	-105.85835	41.29791	-2.56328
	DEPENDENT						
15	1	53.71428	24.52550				

INTERCEPT 191.82335

MULTIPLE CORRELATION 0.50019

STD. ERROR OF ESTIMATE 22.19134

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	7223.46484	1805.86621	3.67037
DEVIATION FROM REGRESSION	44	21648.53516	492.01196	
TOTAL	48	29872.00000		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-49,

SELECTION..... 1

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	46.55531	13.44469
2	25.00000	39.19418	-14.19418
3	40.00000	50.15541	-10.15541
4	46.00000	63.76619	-17.76619
5	59.00000	67.84349	-8.84349
6	60.00000	61.21396	-1.21396
7	95.00000	57.51317	37.48683
8	40.00000	62.72192	-22.72192
9	30.00000	48.22211	-18.22211
10	92.00000	72.17009	19.82991
11	91.00000	59.43028	31.56972
12	100.00000	61.80988	38.19012
13	86.00000	71.76332	14.23668
14	33.00000	55.08986	-22.08986
15	99.00000	81.81563	17.18437
16	59.00000	74.24863	-15.24863
17	21.00000	53.28299	-32.28299
18	41.00000	61.00513	-20.00513
19	41.00000	59.65283	-18.65283
20	99.00000	61.26025	37.73975
21	50.00000	67.09203	-17.09203
22	80.00000	70.38435	9.61565
23	93.00000	67.43987	25.56013
24	52.00000	53.65659	-1.65659
25	72.00000	58.88631	13.11369
26	24.00000	58.66737	-34.66737
27	41.00000	58.98347	-17.98347
28	55.00000	52.32315	2.67685
29	74.00000	49.18544	24.81456
30	77.00000	55.86301	21.13699
31	86.00000	56.24280	29.75720
32	41.00000	57.14767	-16.14767
33	51.00000	49.30272	1.69728
34	24.00000	58.03514	-34.03514
35	43.00000	41.79852	1.20148
36	44.00000	48.08516	-4.08516
37	33.00000	51.00722	-18.00722
38	22.00000	36.01666	-14.01666
39	23.00000	50.08354	-27.08354
40	35.00000	48.34711	-13.34711
41	40.00000	34.77905	5.22095
42	23.00000	32.72702	-9.72702
43	21.00000	45.82509	-24.82509
44	36.00000	36.83380	-0.83380
45	69.00000	36.90697	31.09303
46	74.00000	40.31993	33.68007
47	32.00000	30.09375	1.90625
48	49.00000	29.24707	19.75293
49	53.00000	39.97658	13.02342

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION..... 8

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
52	13	88.70967	14.54689	0.22091	0.24356	0.24729	0.98489
55	16	3.09593	1.28344	-0.08991	1.62477	3.12651	0.51967
57	18	2.33515	1.80213	-0.35746	-4.57754	2.08310	-2.19747
58	19	2.25644	1.05664	-0.41932	-6.10666	3.93923	-1.55021
61	22	25.35483	7.83815	-0.38021	-0.71948	0.50140	-1.43493
	DEPENDENT						
15	1	52.25906	22.20050				

INTERCEPT 68,33292

MULTIPLE CORRELATION 0.61489

STD. ERROR OF ESTIMATE 19.17857

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	5	5590.42188	1118.08423	3.03977
DEVIATION FROM REGRESSION	25	9195.45703	367.81812	
TOTAL	30	14785.87891		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-31

SELECTION..... 8

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	50.36371	9.63629
2	25.00000	41.85762	-16.85762
3	46.00000	53.85062	-7.85062
4	59.00000	54.93503	4.06497
5	60.00000	63.04320	-3.04320
6	95.00000	63.25549	31.74451
7	92.00000	76.81201	15.18799
8	41.00000	66.10645	-25.10645
9	50.00000	63.90723	-13.90723
10	80.00000	72.01894	7.98106
11	93.00000	72.09254	20.90746
12	52.00000	63.61130	-11.61130
13	77.00000	56.51300	20.48700
14	86.00000	53.55663	32.44337
15	41.00000	61.10699	-20.10699
16	51.00000	42.49602	8.50398
17	61.00000	71.33788	-10.33788
18	43.00000	30.12555	12.87445
19	33.00000	62.40237	-29.40237
20	22.00000	40.54901	-18.54901
21	23.00000	29.02380	-6.02380
22	35.00000	41.95963	-6.95963
23	40.00000	37.57170	2.42830
24	23.00000	38.75841	-15.75841
25	21.00000	52.91847	-31.91847
26	36.00000	39.33687	-3.33687
27	68.00000	43.63002	24.36998
28	74.00000	56.12177	17.87823
29	32.00000	33.30357	-1.30357
30	49.00000	31.56190	17.43810
31	52.00000	55.86963	-3.86963

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MULTIPLE REGRESSION.....JUN(1)-31

SELECTION..... 2

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
52	13	88.70967	14.54689	0.22091	0.25936	0.24195	1.07197
57	18	2.33515	1.80213	-0.35746	-4.19370	1.92022	-2.18397
58	19	2.25644	1.05664	-0.41932	-5.39471	3.64112	-1.48161
61	22	25.35483	7.83815	-0.38021	-0.77829	0.48156	-1.61620
	DEPENDENT						
15	1	52.25406	22.20050				

INTERCEPT 70.94952

MULTIPLE CORRELATION 0.60940

STD. ERROR OF ESTIMATE 18.90744

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5491.08984	1372.77246	3.84001
DEVIATION FROM REGRESSION	26	9294.78906	357.49170	
TOTAL	30	14785.87891		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UH(1)-31

SELECTION..... 9

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	51.03828	8.96172
2	25.00000	42.43785	-17.43785
3	46.00000	54.10397	-8.10397
4	59.00000	55.36699	3.63301
5	60.00000	62.31970	-2.31870
6	95.00000	62.79204	32.20796
7	92.00000	75.56923	16.43077
8	41.00000	63.96449	-22.96449
9	50.00000	62.57680	-12.57680
10	80.00000	70.37061	9.62939
11	93.00000	70.49152	22.50848
12	52.00000	62.24352	-10.24352
13	77.00000	62.34254	14.65746
14	86.00000	52.71362	33.28638
15	41.00000	67.27103	-26.27103
16	51.00000	42.70209	8.29791
17	61.00000	72.74939	-11.74939
18	43.00000	30.47655	12.52345
19	33.00000	60.81273	-27.81273
20	22.00000	40.32744	-18.32744
21	23.00000	28.32176	-5.32176
22	35.00000	42.09152	-7.09152
23	40.00000	37.55959	2.44041
24	23.00000	39.12822	-16.12822
25	21.00000	52.21257	-31.21257
26	36.00000	39.11127	-3.11127
27	68.00000	43.19768	24.80232
28	74.00000	54.29774	19.70226
29	32.00000	33.80872	-1.80872
30	49.00000	31.86266	17.13734
31	52.00000	55.73590	-3.73590

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....11

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEFF.	COMPUTED T VALUE
37	5	69.96773	25.63910	0.50142	0.39089	0.18481	2.11511
51	12	485.83862	152.36195	-0.15399	-0.00642	0.02740	-0.23415
55	16	3.09593	1.28344	-0.08991	1.36730	3.32776	0.41089
52	13	88.70967	14.54689	0.22091	0.09207	0.29201	0.31530
61	22	25.35483	7.83815	-0.38021	-0.67479	0.54365	-1.24123
	DEPENDENT						
15	1	52.25806	22.20050				

INTERCEPT 36.25223

MULTIPLE CORRELATION 0.57440

STD. ERROR OF ESTIMATE 19.90723

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	5	4878.42188	975.68433	2.46200
DEVIATION FROM REGRESSION	25	9907.45703	396.29810	
TOTAL	30	14785.87891		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UH(1)-31

SELECTION.....11

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	54.47792	5.52208
2	25.00000	48.95193	-23.95193
3	46.00000	59.95142	-13.95142
4	59.00000	57.15172	1.84828
5	60.00000	57.54665	2.45335
6	95.00000	62.50259	32.49741
7	92.00000	73.65756	18.34244
8	41.00000	64.20332	-23.20332
9	50.00000	57.45448	-7.45448
10	80.00000	68.46811	11.53189
11	93.00000	68.61247	24.38753
12	52.00000	50.48607	1.51393
13	77.00000	57.15756	19.84244
14	86.00000	62.42447	23.57553
15	41.00000	61.00079	-20.00079
16	51.00000	43.40424	7.59576
17	61.00000	74.62904	-13.62904
18	43.00000	32.54344	10.45656
19	33.00000	58.44356	-25.44356
20	22.00000	38.47754	-16.47754
21	23.00000	32.61890	-9.61890
22	35.00000	47.21570	-12.21570
23	40.00000	41.43121	-1.43121
24	23.00000	38.98953	-15.98953
25	21.00000	60.12907	-39.12907
26	36.00000	40.65736	-4.65736
27	68.00000	41.55847	26.44153
28	74.00000	50.07925	23.92075
29	32.00000	30.08591	1.91409
30	49.00000	28.75504	20.24496
31	52.00000	56.93445	-4.93445

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....13

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
51	12	485.83862	152.36195	-0.15399	-0.00924	0.02672	-0.34578
52	13	89.70967	14.54689	0.22091	0.15235	0.26834	0.56776
54	15	2.59480	1.19654	0.50872	7.84719	3.26062	2.40666
61	22	25.35483	7.83815	-0.38021	-0.69175	0.51181	-1.35157
	DEPENDENT						
15	1	52.25806	22.20050				

INTERCEPT 40.40875

MULTIPLE CORRELATION 0.58295

STD. ERROR OF ESTIMATE 19.37598

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5024.72266	1256.18066	3.34599
DEVIATION FROM REGRESSION	26	9761.15625	375.42896	
TOTAL	30	14785.87891		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....13

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	56.56352	3.43648
2	25.00000	41.23308	-16.23308
3	46.00000	61.15697	-15.15697
4	59.00000	58.80638	0.19362
5	60.00000	58.29538	1.70462
6	95.00000	63.25507	31.74493
7	92.00000	72.79517	19.20483
8	41.00000	62.64719	-21.64719
9	50.00000	57.09795	-7.09795
10	80.00000	67.18164	12.81836
11	93.00000	67.23952	25.76048
12	52.00000	50.63165	1.36835
13	77.00000	62.22948	14.77052
14	86.00000	60.44670	25.55330
15	41.00000	66.41530	-25.41530
16	51.00000	43.92854	7.07146
17	61.00000	74.25618	-13.25618
18	43.00000	30.20622	12.79378
19	33.00000	58.13115	-25.13115
20	22.00000	38.90888	-16.90888
21	23.00000	31.61061	-8.61061
22	35.00000	47.56023	-12.56023
23	40.00000	42.08528	-2.08528
24	23.00000	40.44327	-17.44327
25	21.00000	58.52249	-37.52249
26	36.00000	40.88432	-4.88432
27	68.00000	41.71851	26.28149
28	74.00000	49.90477	24.09523
29	32.00000	32.13554	-0.13554
30	49.00000	27.93208	21.06792
31	52.00000	55.69835	-3.69835

HRB-SINGER, INC

MULTIPLE REGRESSION.....UN(1)-31

SELECTION.....14

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
52	11	88.70967	14.54689	0.22091	0.16338	0.24968	0.65434
54	15	2.59480	1.19654	0.50872	6.60692	3.35839	1.96729
58	19	2.25644	1.05664	-0.41932	-3.13455	3.95471	-0.79261
61	22	25.35483	7.83815	-0.38021	-0.63384	0.49217	-1.28785
	DEPENDENT						
15	1	52.25806	22.20050				

INTERCEPT 43.76498

MULTIPLE CORRELATION 0.59367

STD. ERROR OF ESTIMATE 19.19002

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5211.18750	1302.79688	3.53773
DEVIATION FROM REGRESSION	26	9574.69141	368.25732	
TOTAL	30	14785.87891		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....14

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	57.69565	2.30435
2	25.00000	44.13811	-19.13811
3	46.00000	61.07910	-15.07910
4	59.00000	59.45955	-0.45955
5	60.00000	59.81143	0.18857
6	95.00000	63.27577	31.72423
7	92.00000	72.24007	19.75993
8	41.00000	64.39778	-23.39778
9	50.00000	60.00778	-10.00778
10	80.00000	68.45988	11.54012
11	93.00000	68.63913	24.36087
12	52.00000	55.20193	-3.20193
13	77.00000	63.96962	13.03038
14	86.00000	56.86934	29.13066
15	41.00000	66.91028	-25.91028
16	51.00000	42.32478	8.67522
17	61.00000	70.11656	-9.11656
18	43.00000	30.57710	12.42290
19	33.00000	59.70212	-26.70212
20	22.00000	38.65004	-16.65004
21	23.00000	30.19963	-7.19963
22	35.00000	44.63103	-9.63103
23	40.00000	40.09035	-0.09035
24	23.00000	39.26593	-16.26593
25	21.00000	54.79890	-33.79890
26	36.00000	40.09035	-4.09035
27	68.00000	40.89682	27.10318
28	74.00000	53.01189	20.98811
29	32.00000	32.07573	-0.07573
30	49.00000	27.66748	21.33252
31	52.00000	53.74672	-1.74672

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....16

	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEFF.	COMPUTED T VALUE
X							
51	12	485.83862	152.36195	-0.15399	-0.00926	0.02672	-0.34650
52	13	88.70967	14.54689	0.22091	0.15241	0.26831	0.56805
61	22	25.35483	7.83815	-0.38021	-0.69193	0.51175	-1.35208
63	24	0.45129	0.20794	0.50868	45.16109	18.75981	2.40733
	DEPENDENT						
15	1	52.25806	22.20050				

INTERCEPT 40.39801

MULTIPLE CORRELATION 0.58301

STD. ERROR OF ESTIMATE 19.37500

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5025.71484	1256.42871	3.34699
DEVIATION FROM REGRESSION	26	9760.16406	375.39087	
TOTAL	30	14785.87891		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....16

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	56.57449	3.42551
2	25.00000	41.23900	-16.23900
3	46.00000	61.14182	-15.14182
4	59.00000	58.83311	0.16689
5	60.00000	58.27679	1.72321
6	95.00000	63.24791	31.75209
7	92.00000	72.79793	19.20207
8	41.00000	62.65546	-21.65546
9	50.00000	57.11412	-7.11412
10	80.00000	67.18495	12.81505
11	93.00000	67.23949	25.76051
12	52.00000	50.64677	1.35323
13	77.00000	62.24838	14.75162
14	86.00000	60.44612	25.55388
15	41.00000	66.42174	-25.42174
16	51.00000	43.92360	7.07640
17	61.00000	74.24683	-13.24683
18	43.00000	30.19862	12.80138
19	33.00000	58.11885	-25.11885
20	22.00000	38.99335	-16.99335
21	23.00000	31.60336	-8.60336
22	35.00000	47.54224	-12.54224
23	40.00000	42.09807	-2.09807
24	23.00000	40.42575	-17.42575
25	21.00000	58.52635	-37.52635
26	36.00000	40.89462	-4.89462
27	68.00000	41.73367	26.26633
28	74.00000	49.88702	24.11298
29	32.00000	32.12299	-0.12299
30	49.00000	27.93333	21.06667
31	52.00000	55.68282	-3.68282

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....17

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
52	13	88.70967	14.54689	0.22091	0.16351	0.24966	0.65490
58	19	2.25644	1.05664	-0.41932	-3.13306	3.95476	-0.79223
61	22	25.35483	7.83815	-0.38021	-0.63418	0.49213	-1.28865
63	24	0.45129	0.20794	0.50868	38.02161	19.32242	1.96774
	DEPENDENT						
15	1	52.25806	22.20050				

INTERCEPT 43.74388

MULTIPLE CORRELATION 0.59370

STD. ERROR OF ESTIMATE 19.18944

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5211.76172	1302.94043	3.53834
DEVIATION FROM REGRESSION	26	9574.11719	368.23511	
TOTAL	30	14785.87891		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UN(1)-31

SELECTION.....17

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	57.70103	2.29897
2	25.00000	44.13794	-19.13794
3	46.00000	61.06178	-15.06178
4	59.00000	59.47852	-0.47852
5	60.00000	59.79343	0.20657
6	95.00000	63.26570	31.73430
7	92.00000	72.24026	19.75974
8	41.00000	64.40321	-23.40321
9	50.00000	60.02145	-10.02145
10	80.00000	68.46236	11.53764
11	93.00000	68.63882	24.36118
12	52.00000	55.21573	-3.21573
13	77.00000	63.98352	13.01648
14	86.00000	56.87216	29.12784
15	41.00000	66.91275	-25.91275
16	51.00000	42.32339	8.67661
17	61.00000	70.11824	-9.11824
18	43.00000	30.57315	12.42685
19	33.00000	59.68864	-26.68864
20	22.00000	38.65691	-16.65691
21	23.00000	30.19243	-7.19243
22	35.00000	44.61691	-9.61691
23	40.00000	40.10172	-0.10172
24	23.00000	39.25317	-16.25317
25	21.00000	54.80402	-33.80402
26	36.00000	40.10172	-4.10172
27	68.00000	40.91235	27.08765
28	74.00000	52.99393	21.00607
29	32.00000	32.06697	-0.06697
30	49.00000	27.66855	21.33145
31	52.00000	53.73820	-1.73820

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....19

	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
X							
51	12	485.83862	152.36195	-0.15399	-0.04271	0.03155	-1.35343
52	13	88.70967	14.54689	0.22091	0.19953	0.25734	0.77534
57	18	2.33515	1.80213	-0.35746	-6.30792	2.39155	-2.63759
61	22	25.35483	7.83815	-0.38021	-0.79049	0.48805	-1.61969
	DEPENDENT						
15	1	52.25806	22.20050				

INTERCEPT 90.07922

MULTIPLE CORRELATION 0.60263

STD. ERROR OF ESTIMATE 19.03047

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5369.73438	1342.43359	3.70675
DEVIATION FROM REGRESSION	26	9416.14453	362.15918	
TOTAL	30	14785.87891		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UN(1)-31

SELECTION.....19

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	60.00000	49.34422	10.65578
2	25.00000	40.34700	-15.34700
3	46.00000	56.07988	-10.07988
4	59.00000	55.80998	3.19002
5	60.00000	62.36331	-2.36331
6	95.00000	67.10138	27.89862
7	92.00000	80.90891	11.09109
8	41.00000	60.43761	-19.43761
9	50.00000	56.11618	-6.11618
10	80.00000	68.06856	11.93144
11	93.00000	67.72957	25.27043
12	52.00000	52.62039	-0.62039
13	77.00000	58.71143	18.28857
14	86.00000	55.87744	30.12256
15	41.00000	69.05705	-28.05705
16	51.00000	44.09956	6.90044
17	61.00000	74.18178	-13.18178
18	43.00000	27.04881	15.95119
19	33.00000	60.62405	-27.62405
20	22.00000	38.67384	-16.67384
21	23.00000	32.28542	-9.28542
22	35.00000	47.40497	-12.40497
23	40.00000	40.91656	-0.91656
24	23.00000	40.13579	-17.13579
25	21.00000	58.10820	-37.10820
26	36.00000	37.69868	-1.69868
27	68.00000	43.37123	24.62877
28	74.00000	50.11618	23.88382
29	32.00000	33.18625	-1.18625
30	49.00000	35.10759	13.89241
31	52.00000	56.46591	-4.46591

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....27

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
52	13	89.70967	14.54689	-0.22996	-0.25804	0.24824	-1.03948
56	16	3.09593	1.28344	0.08177	-1.71513	3.13845	-0.54649
57	18	2.33515	1.80213	0.34859	4.50624	2.09106	2.15501
58	19	2.25644	1.05664	0.41978	6.11924	3.95428	1.54750
61	22	25.35483	7.83815	0.38323	0.72985	0.50332	1.45008
	DEPENDENT						
47	8	48.09677	22.28203				

INTERCEPT 33.46136

MULTIPLE CORRELATION 0.61474

STD. ERROR OF ESTIMATE 19.25182

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	5	5628.84375	1125.76855	3.03742
DEVIATION FROM REGRESSION	25	9265.82422	370.63281	
TOTAL	30	14894.66797		

MULTIPLE REGRESSION..... UM(1)-31

SELECTION.....27

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	40.00000	49.35638	-9.35638
2	74.00000	58.00151	15.99849
3	54.00000	46.18140	7.81860
4	41.00000	45.07315	-4.07315
5	40.00000	37.17758	2.82242
6	5.00000	36.81021	-31.81021
7	8.00000	23.40012	-15.40012
8	60.00000	34.49869	25.50131
9	50.00000	36.49648	13.50352
10	20.00000	28.32837	-8.32837
11	8.00000	28.32175	-20.32175
12	49.00000	36.72618	12.27382
13	24.00000	44.59218	-20.59218
14	14.00000	46.88382	-32.88382
15	60.00000	39.82224	20.17776
16	50.00000	57.93083	-7.93083
17	39.00000	28.74539	10.25461
18	57.00000	70.34268	-13.34268
19	68.00000	37.95293	30.04707
20	78.00000	59.83742	18.16258
21	78.00000	72.18184	5.81816
22	66.00000	58.48045	7.51955
23	60.00000	62.76523	-2.76523
24	78.00000	61.39267	16.60733
25	79.00000	47.46184	31.53816
26	64.00000	61.02246	2.97754
27	32.00000	56.83893	-24.83893
28	26.00000	44.26163	-18.26163
29	69.00000	66.94841	2.05159
30	52.00000	68.87747	-16.87747
31	48.00000	44.29103	3.70897

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....28

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEFF.	COMPUTED T VALUE
52	13	88.70967	14.54689	-0.22996	-0.27472	0.24301	-1.13050
57	18	2.33515	1.80213	0.34859	4.10105	1.92864	2.12639
58	19	2.25644	1.05664	0.41978	5.36769	3.65709	1.46775
61	22	25.35483	7.83815	0.38323	0.79194	0.48367	1.63735
	DEPENDENT						
47	8	48.09677	22.28203				

INTERCEPT 30.69922

MULTIPLE CORRELATION 0.60867

STD. ERROR OF ESTIMATE 18.99039

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5518.15625	1379.53906	3.82530
DEVIATION FROM REGRESSION	26	9376.51172	360.63501	
TOTAL	30	14894.66797		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....28

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	40.00000	48.64435	-8.64435
2	74.00000	57.38904	16.61096
3	54.00000	45.91399	8.08601
4	41.00000	44.61716	-3.61716
5	40.00000	37.94240	2.05760
6	5.00000	37.29945	-32.29945
7	8.00000	24.71202	-16.71202
8	60.00000	36.75977	23.24023
9	50.00000	37.90089	12.09911
10	20.00000	30.06839	-10.06839
11	8.00000	30.01184	-22.01184
12	49.00000	38.17015	10.82985
13	24.00000	38.43840	-14.43840
14	14.00000	47.77376	-33.77376
15	60.00000	33.31537	26.68463
16	50.00000	57.71332	-7.71332
17	39.00000	27.25537	11.74463
18	57.00000	69.97220	-12.97220
19	68.00000	39.63100	28.36900
20	78.00000	60.07132	17.92868
21	78.00000	72.92297	5.07703
22	66.00000	58.34123	7.65877
23	60.00000	62.77803	-2.77803
24	78.00000	61.00232	16.99768
25	79.00000	48.20703	30.79297
26	64.00000	61.26064	2.73936
27	32.00000	57.29535	-25.29535
28	26.00000	46.18710	-20.18710
29	69.00000	66.41524	2.58476
30	52.00000	68.56001	-16.56001
31	48.00000	44.43227	3.56773

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....30

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEFF.	COMPUTED T VALUE
37	5	60.96773	25.63910	-0.50020	-0.39152	0.18500	-2.11638
51	12	485.83862	152.36195	0.16122	0.00711	0.02743	0.25920
55	16	3.09593	1.28344	0.08177	-1.49855	3.33119	-0.44985
52	13	88.70967	14.54689	-0.22996	-0.10410	0.29231	-0.35611
61	22	25.35483	7.83815	0.38323	0.68027	0.54421	1.25002
	DEPENDENT						
47	8	48.09677	22.28203				

INTERCEPT 65.13867

MULTIPLE CORRELATION 0.57746

STD. ERROR OF ESTIMATE 19.92775

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	5	4966.76953	993.35376	2.50142
DEVIATION FROM REGRESSION	25	9927.89844	397.11572	
TOTAL	30	14894.66797		

MULTIPLE REGRESSION.....UH(1)-31

SELECTION.....30

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	40.00000	45.36768	-5.36768
2	74.00000	51.03351	22.96649
3	54.00000	40.09747	13.90253
4	41.00000	42.91824	-1.91824
5	40.00000	42.62694	-2.62694
6	5.00000	37.46283	-32.46283
7	8.00000	26.34485	-18.34485
8	60.00000	36.25536	23.74464
9	50.00000	42.95975	7.04025
10	20.00000	31.77527	-11.77527
11	8.00000	31.68520	-23.68520
12	49.00000	49.90533	-0.90533
13	24.00000	43.98479	-19.98479
14	14.00000	37.93481	-23.93481
15	60.00000	39.90776	20.09224
16	50.00000	57.08315	-7.08315
17	39.00000	25.60059	13.39941
18	57.00000	68.10588	-11.10588
19	69.00000	41.78603	26.21397
20	78.00000	61.98198	16.01802
21	78.00000	68.51801	9.48199
22	66.00000	53.20839	12.79161
23	60.00000	58.91757	1.08243
24	78.00000	61.25374	16.74626
25	79.00000	40.11676	38.88324
26	64.00000	59.77580	4.22420
27	32.00000	58.91489	-26.91489
28	26.00000	50.23404	-24.23404
29	69.00000	70.30777	-1.30777
30	52.00000	71.73433	-19.73433
31	48.00000	43.19975	4.80025

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....32

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
51	12	485.83862	152.36195	0.16122	0.00966	0.02679	0.36058
52	13	88.70967	14.54689	-0.22996	-0.16804	0.26911	-0.62445
54	15	2.59480	1.19654	-0.50483	-7.74339	3.26998	-2.36802
61	22	25.35483	7.83815	0.38323	0.70538	0.51328	1.37425
	DEPENDENT						
47	8	44.09677	22.28203				

INTERCEPT 60.51794

MULTIPLE CORRELATION 0.58385

STD. ERROR OF ESTIMATE 19.43159

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5077.39063	1269.34766	3.36173
DEVIATION FROM REGRESSION	26	9817.27734	377.58740	
TOTAL	30	14894.66797		

H R B - S I N G E R . I N C .

MULTIPLE REGRESSION.....UH(1)-31

SELECTION.....32

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	40.00000	43.23624	-3.23624
2	74.00000	58.62560	15.37440
3	54.00000	38.94110	15.05890
4	41.00000	41.23302	-0.23302
5	40.00000	41.89760	-1.89760
6	5.00000	36.77837	-31.77837
7	8.00000	27.35063	-19.35063
8	60.00000	38.05443	21.94557
9	50.00000	43.36531	6.63469
10	20.00000	33.21065	-13.21065
11	8.00000	33.21545	-25.21545
12	49.00000	49.72102	-0.72102
13	24.00000	38.54039	-14.54039
14	14.00000	40.10963	-26.10963
15	60.00000	34.08820	25.91180
16	50.00000	56.51357	-6.51357
17	39.00000	25.80481	13.19519
18	57.00000	70.32161	-13.32161
19	68.00000	42.24640	25.75360
20	78.00000	61.43120	16.56880
21	78.00000	69.63329	8.36671
22	66.00000	52.90366	13.09634
23	60.00000	58.29399	1.70601
24	78.00000	59.72531	18.27469
25	79.00000	41.90706	37.09294
26	64.00000	59.54993	4.45007
27	32.00000	58.76045	-26.76045
28	26.00000	50.53882	-24.53882
29	69.00000	68.11115	0.88885
30	52.00000	72.42618	-20.42618
31	48.00000	44.46249	3.53751

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....33

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
52	13	89.70967	14.54689	-0.22996	-0.18051	0.25045	-0.72075
54	15	2.59480	1.19654	-0.50483	-6.48680	3.36865	-1.92564
58	19	2.25644	1.05664	0.41978	3.14645	3.96679	0.79320
61	22	25.35483	7.83815	0.38323	0.65022	0.49367	1.31711
	DEPENDENT						
47	8	48.09677	22.28203				

INTERCEPT 57.35579

MULTIPLE CORRELATION 0.59434

STD. ERROR OF ESTIMATE 19.24863

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5261.40625	1315.35156	3.55011
DEVIATION FROM REGRESSION	26	9633.26172	370.51001	
TOTAL	30	14894.66797		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....33

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	40.00000	42.16711	-2.16711
2	74.00000	55.79083	18.20917
3	54.00000	39.10770	14.89230
4	41.00000	40.64198	0.35802
5	40.00000	40.40813	-0.40813
6	5.00000	36.83366	-31.83366
7	8.00000	27.94862	-19.94862
8	60.00000	36.30153	23.69847
9	50.00000	40.41637	9.58363
10	20.00000	31.91690	-11.91690
11	8.00000	31.79674	-23.79674
12	49.00000	45.07332	3.92668
13	24.00000	36.80562	-12.80562
14	14.00000	43.66324	-29.66324
15	60.00000	33.63370	26.36630
16	50.00000	58.08856	-8.08856
17	39.00000	29.81972	9.18028
18	57.00000	69.90739	-12.90739
19	68.00000	40.71080	27.28920
20	78.00000	61.71873	16.28127
21	78.00000	71.08212	6.91788
22	66.00000	55.85216	10.14784
23	60.00000	60.30461	-0.30461
24	78.00000	60.88512	17.11488
25	79.00000	45.63466	33.36534
26	64.00000	60.30461	3.69539
27	32.00000	59.54071	-27.54071
28	26.00000	47.44682	-21.44682
29	69.00000	68.14561	0.85439
30	52.00000	72.70264	-20.70264
31	48.00000	46.34926	1.65074

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....35

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COFF.	COMPUTED T VALUE
51	12	485.83862	152.36195	0.16122	0.00968	0.02679	0.36129
52	13	89.70967	14.54689	-0.22996	-0.16810	0.26908	-0.62474
41	22	25.35483	7.83815	0.38323	0.70555	0.51322	1.37476
63	24	0.45129	0.20794	-0.50479	-44.56453	18.81361	-2.36874
	DEPENDENT						
47	8	48.09677	22.28203				

INTERCEPT 60.52864

MULTIPLE CORRELATION 0.58391

STD. ERROR OF ESTIMATE 19.43057

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5078.43359	1269.60840	3.36278
DEVIATION FROM REGRESSION	26	9816.23438	377.54736	
TOTAL	30	14894.66797		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....35

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	40.00000	43.22549	-3.22549
2	74.00000	58.61998	15.38002
3	54.00000	38.95602	15.04398
4	41.00000	41.20673	-0.20673
5	40.00000	41.91594	-1.91594
6	5.00000	36.78535	-31.78535
7	8.00000	27.34772	-19.34772
8	60.00000	38.04601	21.95399
9	50.00000	43.34935	6.65065
10	20.00000	33.20726	-13.20726
11	8.00000	33.21530	-25.21530
12	49.00000	49.70619	-0.70619
13	24.00000	38.52141	-14.52141
14	14.00000	40.11003	-26.11003
15	60.00000	34.08157	25.91843
16	50.00000	56.51852	-6.51852
17	39.00000	25.81422	13.18578
18	57.00000	70.32933	-13.32933
19	69.00000	42.25842	25.74158
20	78.00000	61.42686	16.57314
21	79.00000	69.64040	8.35960
22	66.00000	52.92142	13.07858
23	60.00000	58.28140	1.71860
24	78.00000	59.74274	18.25726
25	79.00000	41.90306	37.09694
26	64.00000	59.53981	4.46019
27	32.00000	58.74553	-26.74553
28	26.00000	50.55621	-24.55621
29	69.00000	68.12376	0.87624
30	52.00000	72.42516	-20.42516
31	48.00000	44.47777	3.52223

HRB-SINGER, INC

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....36

VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COFF.	COMPUTED T VALUE
X						
52 13	88.70967	14.54689	-0.22996	-0.18063	0.25043	-0.72131
56 19	2.25644	1.05664	0.41978	3.14493	3.96683	0.79281
61 22	25.35483	7.83815	0.39323	0.65055	0.49363	1.31789
64 24	0.45129	0.20794	-0.50479	-37.33112	19.38139	-1.92613
DEPENDENT						
47 8	48.09677	22.28203				

INTERCEPT 57.37695

MULTIPLE CORRELATION 0.59438

STD. ERROR OF ESTIMATE 19.24802

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5262.01953	1315.50488	3.55075
DEVIATION FROM REGRESSION	26	9632.64844	370.48633	
TOTAL	30	14894.66797		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....36

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	40.00000	42.16191	-2.16191
2	74.00000	55.79123	18.20877
3	54.00000	39.12469	14.87531
4	41.00000	40.62341	0.37659
5	40.00000	40.42580	-0.42580
6	5.00000	36.84351	-31.84351
7	8.00000	27.94826	-19.94826
8	60.00000	36.29596	23.70404
9	50.00000	40.40291	9.59709
10	20.00000	31.91431	-11.91431
11	8.00000	31.79684	-23.79684
12	49.00000	45.05980	3.94020
13	24.00000	36.79170	-12.79170
14	14.00000	43.66019	-29.66019
15	60.00000	33.63101	26.36899
16	50.00000	58.08992	-8.08992
17	39.00000	29.81796	9.18204
18	57.00000	69.91144	-12.91144
19	68.00000	40.72392	27.27608
20	78.00000	61.71198	16.28802
21	78.00000	71.08913	6.91087
22	66.00000	55.86597	10.13403
23	60.00000	60.29340	-0.29340
24	78.00000	60.89766	17.10234
25	79.00000	45.62926	33.37074
26	64.00000	60.29340	3.70660
27	32.00000	59.52536	-27.52536
28	26.00000	47.46440	-21.46440
29	69.00000	68.15434	0.84566
30	52.00000	72.70177	-20.70177
31	48.00000	46.35744	1.64256

MULTIPLE REGRESSION.....UM(1)-31

SELECTION.....38

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
51	12	485.83862	152.36195	0.16122	0.04255	0.03169	1.34298
52	13	88.70967	14.54689	-0.22996	-0.21500	0.25841	-0.83201
57	18	2.33515	1.80213	0.34859	6.20740	2.40151	2.58479
61	22	25.35483	7.83815	0.38323	0.80368	0.49008	1.63989
	DEPENDENT						
47	8	40.09677	22.28203				

INTERCEPT 11.62309

MULTIPLE CORRELATION 0.60211

STD. ERROR OF ESTIMATE 19.10977

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	5399.89063	1349.97266	3.69670
DEVIATION FROM REGRESSION	26	9494.77734	365.18359	
TOTAL	30	14894.66797		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....UN(1)-31

SELECTION.....38

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	40.00000	50.32712	-10.32712
2	74.00000	59.46431	14.53569
3	54.00000	43.94028	10.05972
4	41.00000	44.17169	-3.17169
5	40.00000	37.89291	2.10709
6	5.00000	33.00101	-28.00101
7	8.00000	19.38889	-11.38889
8	60.00000	40.26575	19.73425
9	50.00000	44.33252	5.66748
10	20.00000	32.35767	-12.35767
11	8.00000	32.75867	-24.75867
12	49.00000	47.75194	1.24806
13	24.00000	42.04707	-18.04707
14	14.00000	44.62941	-30.62941
15	60.00000	31.52858	28.47142
16	50.00000	56.32823	-6.32823
17	39.00000	25.84836	13.15164
18	57.00000	73.39229	-16.39229
19	68.00000	39.81137	28.18863
20	78.00000	61.72417	16.27583
21	78.00000	68.97478	9.02522
22	66.00000	53.05383	12.94617
23	60.00000	59.43808	0.56192
24	78.00000	60.00462	17.99538
25	79.00000	42.33966	36.66034
26	64.00000	62.67326	1.32674
27	32.00000	57.12741	-25.12741
28	26.00000	50.34344	-24.34344
29	69.00000	67.04053	1.95947
30	52.00000	65.33051	-13.33051
31	48.00000	43.71281	4.28719

APPENDIX F-2

MULTIPLE REGRESSION ANALYSIS -- OM(1) n = 29

NOTE: For an interpretation of the following pages see pages 152, 167, Table VIII-1 and Section VIII C5b.

MULTIPLE REGRESSION.....OH(1)-29

SELECTION..... 3

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
37	4	42.34482	18.63611	-0.25876	-0.60523	0.30693	-1.97190
41	5	60.96552	8.05552	-0.06186	-0.73710	0.63957	-1.15248
50	10	873.48267	190.69749	-0.14495	-0.00797	0.03067	-0.25976
52	12	110.27585	6.89666	-0.57363	-2.60212	0.77196	-3.37080
61	18	8.96723	7.40330	0.04733	1.00620	0.81870	1.22902
	DEPENDENT						
15	1	72.86206	31.90244				

INTERCEPT 428.31567

MULTIPLE CORRELATION 0.66606

STD. ERROR OF ESTIMATE 26.25539

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	5	12642.49219	2528.49829	3.66797
DEVIATION FROM REGRESSION	23	15854.95313	689.34570	
TOTAL	28	28497.44531		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....OM(1)-29

SELECTION..... 3

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	100.00000	88.24312	11.75688
2	100.00000	98.75226	1.24774
3	100.00000	84.72551	15.27449
4	100.00000	80.89671	19.10329
5	100.00000	104.06726	-4.06726
6	100.00000	85.87840	14.12160
7	35.00000	49.89934	-14.89934
8	93.00000	96.15913	-3.15913
9	100.00000	69.48888	30.51112
10	100.00000	78.81789	21.18211
11	100.00000	115.12613	-15.12613
12	100.00000	95.65797	4.34203
13	100.00000	65.29189	34.70811
14	81.00000	89.75217	-8.75217
15	40.00000	63.66844	-23.66844
16	39.00000	65.94432	-26.94432
17	46.00000	61.62558	-15.62558
18	57.00000	71.06796	-14.06796
19	67.00000	65.75046	1.24954
20	35.00000	79.24112	-44.24112
21	4.00000	34.34338	-30.34338
22	52.00000	15.28828	36.71172
23	29.00000	45.75529	-16.75529
24	83.00000	60.89688	22.10312
25	100.00000	80.76614	19.23386
26	100.00000	80.34668	19.65332
27	23.00000	69.36865	-46.36865
28	100.00000	61.58960	38.41040
29	29.00000	54.57303	-25.57303

HRB-SINGER, INC

MULTIPLE REGRESSION.....ON(1)-29

SELECTION..... 4

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
37	4	42.34482	18.63611	-0.25876	-0.67184	0.35502	-1.89237
41	5	60.96552	8.05552	-0.06186	-0.69182	0.64892	-1.06610
52	12	110.27585	6.89666	-0.57363	-2.65386	0.72404	-3.66535
57	16	2.56103	1.16355	0.03517	-2.68972	6.19513	-0.43417
61	18	8.96723	7.40330	0.04733	0.77679	0.79731	0.97427
	DEPENDENT						
15	1	72.86206	31.90244				

INTERCEPT 436.06738

MULTIPLE CORRELATION 0.66824

STD. ERROR OF ESTIMATE 26.18680

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	5	12725.22656	2545.04517	3.71134
DEVIATION FROM REGRESSION	23	15772.21875	685.74854	
TOTAL	28	28497.44531		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....OH(1)-29

SELECTION..... 4

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	100.00000	87.19969	12.80031
2	100.00000	101.02596	-1.02596
3	100.00000	82.20322	17.79678
4	100.00000	83.47701	16.52299
5	100.00000	105.60914	-5.60914
6	100.00000	87.06973	12.93027
7	35.00000	45.40987	-10.40987
8	93.00000	95.78293	-2.78293
9	100.00000	72.52895	27.47105
10	100.00000	82.01341	17.98659
11	100.00000	113.05119	-13.05119
12	100.00000	95.73352	4.26648
13	100.00000	64.60838	35.39162
14	81.00000	90.44133	-9.44133
15	40.00000	51.22089	-11.22089
16	39.00000	65.55183	-26.55183
17	46.00000	63.06476	-17.06476
18	57.00000	73.46985	-16.46985
19	67.00000	61.53415	5.46585
20	35.00000	80.52425	-45.52425
21	4.00000	39.01279	-35.01279
22	52.00000	18.60255	33.39745
23	29.00000	47.35391	-18.35391
24	83.00000	57.64685	25.35315
25	100.00000	81.98915	18.01085
26	100.00000	80.89316	19.10684
27	23.00000	69.74059	-46.74059
28	100.00000	59.53722	40.46278
29	29.00000	56.68201	-27.68201

HRB-SINGER, INC

MULTIPLE REGRESSION..... OH(1)-29

SELECTION..... 8

	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
X							
37	4	42.34482	18.63611	0.25877	0.60521	0.30689	1.97207
41	5	60.96552	8.05552	0.06188	0.73709	0.63949	1.15263
50	10	873.48267	190.69748	0.14496	0.00797	0.03067	0.25991
52	12	110.27585	6.89666	0.57361	2.60166	0.77186	3.37065
61	18	8.96723	7.40330	-0.04734	-1.00620	0.81859	-1.22918
	DEPENDENT						
47	7	27.14272	31.89815				

INTERCEPT -328.26074

MULTIPLE CORRELATION 0.66606

STD. ERROR OF ESTIMATE 26.25185

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	5	12639.10938	2527.82178	3.66798
DEVIATION FROM REGRESSION	23	15850.67578	689.15967	
TOTAL	28	28489.78516		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....OM(1)-29

SELECTION..... 8

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	0.01000	11.76645	-11.75645
2	0.01000	1.25753	-1.24753
3	0.01000	15.28021	-15.27021
4	0.01000	19.10997	-19.09996
5	0.01000	-4.05723	4.06723
6	0.01000	14.12884	-14.11884
7	65.00000	50.10258	14.89742
8	7.00000	3.84830	3.15170
9	0.01000	30.51648	-30.50647
10	0.01000	21.18874	-21.17873
11	0.01000	-15.11700	15.12700
12	0.01000	4.35148	-4.34148
13	0.01000	34.71080	-34.70079
14	19.00000	10.25345	8.74655
15	60.00000	36.33351	23.66649
16	61.00000	34.05885	26.94115
17	54.00000	38.37807	15.62193
18	43.00000	28.93495	14.06505
19	33.00000	34.25015	-1.25015
20	65.00000	20.76434	44.23566
21	96.00000	65.65691	30.34309
22	48.00000	84.71034	-36.71034
23	71.00000	54.24529	16.75471
24	17.00000	39.10478	-22.10478
25	0.01000	19.23969	-19.22968
26	0.01000	19.65904	-19.64903
27	77.00000	30.63806	46.36194
28	0.01000	38.41258	-38.40257
29	71.00000	45.43089	25.56911

HRB-SINGER, INC

MULTIPLE REGRESSION.....OM(1)-29

SELECTION..... 9

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
37	4	42.34482	18.63611	0.25877	0.67177	0.35498	1.89242
41	5	60.96552	8.05552	0.06188	0.69184	0.64884	1.06627
52	12	110.27585	6.89666	0.57361	2.65344	0.72395	3.66523
54	16	2.56103	1.16355	-0.03518	2.68865	6.19432	0.43405
61	18	8.96723	7.40330	-0.04734	-0.77680	0.79720	-0.97441
	DEPENDENT						
47	7	27.14272	31.89815				

INTERCEPT -336.01074

MULTIPLE CORRELATION 0.66823

STD. ERROR OF ESTIMATE 26.18336

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	5	12721.69922	2544.33984	3.71128
DEVIATION FROM REGRESSION	23	15768.08594	685.56885	
TOTAL	28	28489.78516		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....ON(1)-29

SELECTION..... 9

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	0.01000	12.80955	-12.79955
2	0.01000	-1.01679	1.02679
3	0.01000	17.80310	-17.79309
4	0.01000	16.52953	-16.51952
5	0.01000	-5.59826	5.60826
6	0.01000	12.93707	-12.92707
7	65.00000	54.59132	10.40868
8	7.00000	4.22447	2.77553
9	0.01000	27.47636	-27.46635
10	0.01000	17.99338	-17.98337
11	0.01000	-13.04248	13.05248
12	0.01000	4.27534	-4.26534
13	0.01000	35.39404	-35.38403
14	19.00000	9.56432	9.43568
15	60.00000	48.77844	11.22156
16	61.00000	34.45151	26.54849
17	54.00000	36.93849	17.06151
18	43.00000	26.53342	16.46658
19	33.00000	38.46631	-5.46631
20	65.00000	19.48080	45.51920
21	96.00000	60.98746	35.01254
22	48.00000	81.39540	-33.39540
23	71.00000	52.64641	18.35359
24	17.00000	42.35530	-25.35530
25	0.01000	18.01703	-18.00702
26	0.01000	19.11281	-19.10280
27	77.00000	30.26599	46.73401
28	0.01000	40.46552	-40.45551
29	71.00000	43.32207	27.67793

HRB-SINGER, INC

APPENDIX F-3

MULTIPLE REGRESSION ANALYSIS -- OM(2) n = 32

NOTE: For an interpretation of the following pages see pages 152, 167, Table VIII-1, and Section VIII C5b.

MULTIPLE REGRESSION.....OM(2)-32

SELECTION..... 6

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COFF.	COMPUTED T VALUE
37	5	48.15625	24.68915	-0.12319	-0.15815	0.12917	-1.22431
50	11	531.15625	71.01367	-0.31601	-0.01102	0.05603	-0.19673
52	13	151.37500	5.25325	-0.47976	-0.98782	0.74085	-1.33336
61	21	25.27554	6.20014	-0.47599	-1.03537	0.73598	-1.40679
	DEPENDENT						
15	1	64.18750	19.41965				

INTERCEPT 253.35963

MULTIPLE CORRELATION 0.56838

STD. ERROR OF ESTIMATE 17.12057

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	3776.73291	944.18311	3.22121
DEVIATION FROM REGRESSION	27	7914.08594	293.11426	
TOTAL	31	11690.81641		

H R B - S I N G E R . I N C .

MULTIPLE REGRESSION.....OM(2)-32

SELECTION..... 6

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	73.00000	89.75812	-16.75812
2	100.00000	86.83899	13.16101
3	83.00000	88.28979	-5.28979
4	65.00000	53.10751	11.89249
5	19.00000	45.93124	-26.93124
6	47.00000	61.18933	-14.18933
7	45.00000	48.17203	-3.17203
8	52.00000	52.14972	-0.14972
9	39.00000	48.87764	-9.87764
10	47.00000	59.93146	-12.93146
11	72.00000	64.36967	7.63033
12	83.00000	71.71985	11.28015
13	58.00000	56.48399	1.51601
14	84.00000	61.28535	22.71465
15	64.00000	66.09737	-2.09737
16	72.00000	65.58835	6.41165
17	88.00000	70.02934	17.97066
18	88.00000	68.45338	19.54662
19	81.00000	66.15364	14.84636
20	60.00000	65.21115	-5.21115
21	71.00000	69.16521	1.83479
22	98.00000	50.17860	47.82140
23	81.00000	64.77779	16.22221
24	52.00000	56.52255	-4.52255
25	45.00000	59.85449	-14.85449
26	44.00000	53.77887	-9.77887
27	48.00000	65.92381	-17.92381
28	53.00000	70.83762	-17.83762
29	50.00000	56.80579	-6.80579
30	51.00000	69.82701	-18.82701
31	88.00000	75.99728	12.00272
32	53.00000	70.68976	-17.68976

HRB-SINGER, INC

MULTIPLE REGRESSION.....ON(2)-32

SELECTION..... 7

X	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
37	5	48.15625	24.68915	-0.12319	-0.15815	0.12917	-1.22431
51	12	379.78125	69.02605	-0.28860	-0.01102	0.05603	-0.19674
52	13	151.37500	5.25325	-0.47976	-0.99885	0.73910	-1.35143
61	21	25.27554	6.20014	-0.47599	-1.03537	0.73598	-1.40680
	DEPENDENT						
15	1	64.18750	19.41965				

INTERCEPT 253.35985

MULTIPLE CORRELATION 0.56838

STD. ERROR OF ESTIMATE 17.12056

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	3776.73560	944.18384	3.22122
DEVIATION FROM REGRESSION	27	7914.08203	293.11401	
TOTAL	31	11690.81641		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....OM(2)-32

SELECTION..... 7

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	73.00000	89.75813	-16.75813
2	100.00000	86.83900	13.16100
3	83.00000	88.28981	-5.28981
4	65.00000	53.10750	11.89250
5	19.00000	45.93124	-26.93124
6	47.00000	61.18930	-14.18930
7	45.00000	48.17200	-3.17200
8	52.00000	52.14969	-0.14969
9	39.00000	48.87762	-9.87762
10	47.00000	59.93146	-12.93146
11	72.00000	64.36966	7.63034
12	83.00000	71.71983	11.28017
13	58.00000	56.48399	1.51601
14	84.00000	61.28535	22.71465
15	64.00000	66.09737	-2.09737
16	72.00000	65.58835	6.41165
17	88.00000	70.02936	17.97064
18	88.00000	68.45337	19.54663
19	81.00000	66.15364	14.84636
20	60.00000	65.21117	-5.21117
21	71.00000	69.16521	1.83479
22	98.00000	50.17859	47.82141
23	81.00000	64.77777	16.22223
24	52.00000	56.52255	-4.52255
25	45.00000	59.85449	-14.85449
26	44.00000	53.77887	-9.77887
27	48.00000	65.92381	-17.92381
28	53.00000	70.83760	-17.83760
29	50.00000	56.80579	-6.80579
30	51.00000	69.82701	-18.82701
31	88.00000	75.99728	12.00272
32	53.00000	70.68974	-17.68974

HRB-SINGER, INC

MULTIPLE REGRESSION.....OM(2)-321

SELECTION..... 8

	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
X 50	11	531.15625	71.01367	-0.31601	0.00385	0.05681	0.06784
52	13	151.37500	5.25325	-0.47976	-1.09336	0.74173	-1.47406 ✓
57	17	3.73093	2.11643	0.18124	1.39005	1.48550	0.93574 ✓
61	21	25.27554	6.20014	-0.47599	-0.94108	0.73689	-1.27710 ✓
	DEPENDENT						
15	1	64.18750	19.41965				

INTERCEPT 246.24710

MULTIPLE CORRELATION 0.55490

STD. ERROR OF ESTIMATE 17.31091

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	3599.77222	899.94287	3.00313
DEVIATION FROM REGRESSION	27	8091.04688	299.66821	
TOTAL	31	11690.81641		

HRB-SINGER, INC.

MULTIPLE REGRESSION.....OM(2)-32

SELECTION..... 8

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	73.00000	90.34067	-17.34067
2	100.00000	85.77879	14.22121
3	83.00000	88.58820	-5.58820
4	65.00000	50.72820	14.27180
5	19.00000	46.64215	-27.64215
6	47.00000	63.33174	-16.33174
7	45.00000	50.45848	-5.45848
8	52.00000	50.67708	1.32292
9	39.00000	50.12578	-11.12578
10	47.00000	60.74557	-13.74557
11	72.00000	63.79865	8.20135
12	83.00000	71.52428	11.47572
13	58.00000	57.93697	0.06303
14	84.00000	59.08899	24.91101
15	64.00000	64.82027	-0.82027
16	72.00000	65.20041	6.79959
17	88.00000	70.47546	17.52454
18	88.00000	69.25873	18.74127
19	81.00000	66.54361	14.45639
20	60.00000	67.17754	-7.17754
21	71.00000	68.02226	2.97774
22	98.00000	51.79837	46.20163
23	81.00000	64.53499	16.46501
24	52.00000	56.29451	-4.29451
25	45.00000	60.65277	-15.65277
26	44.00000	54.45270	-10.45270
27	48.00000	65.39084	-17.39084
28	53.00000	68.97813	-15.97813
29	50.00000	56.82021	-6.82021
30	51.00000	65.38026	-18.38026
31	88.00000	74.58830	13.41170
32	53.00000	69.84201	-16.84201

HRB-SINGER, INC

MULTIPLE REGRESSION.....OM(2)-32

SELECTION..... 9

	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
X							
51	12	379.78125	69.02605	-0.28860	0.00385	0.05681	0.06784
52	13	151.37500	5.25325	-0.47976	-1.08950	0.74117	-1.46998
57	17	3.73093	2.11643	0.18124	1.39005	1.49550	0.93574
61	21	25.27554	6.20014	-0.47599	-0.94108	0.73688	-1.27710
	DEPENDENT						
15	1	64.18750	19.41965				

INTERCEPT 246.24736

MULTIPLE CORRELATION 0.55490

STD. ERROR OF ESTIMATE 17.31091

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	3599.77441	899.94360	3.00313
DEVIATION FROM REGRESSION	27	8091.04297	299.66821	
TOTAL	31	11690.81641		

HRB-SINGER, INC.

MILTIPLE REGRESSION.....ON(2)-32

SELECTION..... 9

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	73.00000	90.34068	-17.34068
2	100.00000	85.77882	14.22118
3	83.00000	88.58821	-5.58821
4	65.00000	50.72818	14.27182
5	19.00000	46.64214	-27.64214
6	47.00000	63.33171	-16.33171
7	45.00000	50.45845	-5.45845
8	52.00000	50.67706	1.32294
9	39.00000	50.12578	-11.12578
10	47.00000	60.74554	-13.74554
11	72.00000	63.79863	8.20137
12	83.00000	71.52428	11.47572
13	58.00000	57.93695	0.06305
14	84.00000	59.08896	24.91104
15	64.00000	64.82027	-0.82027
16	72.00000	65.20042	6.79958
17	88.00000	70.47548	17.52452
18	88.00000	69.25873	18.74127
19	81.00000	66.54361	14.45639
20	60.00000	67.17755	-7.17755
21	71.00000	68.02229	2.97771
22	98.00000	51.79837	46.20163
23	81.00000	64.53497	16.46503
24	52.00000	56.29451	-4.29451
25	45.00000	60.65279	-15.65279
26	44.00000	54.45270	-10.45270
27	48.00000	65.39084	-17.39084
28	53.00000	68.97813	-15.97813
29	50.00000	56.82021	-6.82021
30	51.00000	69.38028	-18.38028
31	88.00000	74.58830	13.41170
32	53.00000	69.84203	-16.84203

HRB-SINGER, INC.

MULTIPLE REGRESSION.....OM(2)-32

SELECTION.....10

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	73.00000	90.34227	-17.34227
2	100.00000	86.91113	13.08887
3	83.00000	88.69919	-5.69919
4	65.00000	50.50575	14.49425
5	19.00000	46.31464	-27.31464
6	47.00000	63.87595	-16.87595
7	45.00000	51.49662	-6.49662
8	52.00000	51.13361	0.86639
9	39.00000	50.66747	-11.66747
10	47.00000	61.87904	-14.87904
11	72.00000	64.35202	7.64798
12	83.00000	72.70580	10.29420
13	58.00000	58.62015	-0.62015
14	84.00000	60.28706	23.71294
15	64.00000	65.87958	-1.87958
16	72.00000	66.18591	5.81409
17	88.00000	71.10504	16.89496
18	88.00000	68.28635	19.71365
19	81.00000	65.31683	15.68317
20	60.00000	65.86497	-5.86497
21	71.00000	67.40739	3.59261
22	98.00000	51.03307	46.96693
23	81.00000	64.02968	16.97032
24	52.00000	55.07111	-3.07111
25	45.00000	59.71609	-14.71609
26	44.00000	54.22388	-10.22388
27	48.00000	65.39093	-17.39093
28	53.00000	68.44623	-15.44623
29	50.00000	56.42436	-6.42436
30	51.00000	68.71114	-17.71114
31	88.00000	73.84666	14.15334
32	53.00000	69.27669	-16.27669

HRB-SINGER, INC.

MULTIPLE REGRESSION.....OM(2)-32

SELECTION.....10

	VARIABLE NO.	MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEFF.	COMPUTED T VALUE
X							
52	13	151.37500	5.25325	-0.47976	-1.01746	0.77609	-1.31101
57	17	3.73093	2.11643	0.18124	1.47001	1.49959	0.98027
58	18	4.58187	0.67034	-0.20969	1.91164	6.11930	0.31240
61	21	25.27554	6.20014	-0.47599	-1.07287	0.80492	-1.33289
	DEPENDENT						
15	1	64.18750	19.41965				

INTERCEPT 231.07970

MULTIPLE CORRELATION 0.55704

STD. ERROR OF ESTIMATE 17.28119

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	3627.53931	906.88477	3.03672
DEVIATION FROM REGRESSION	27	8063.27734	298.63989	
TOTAL	31	11690.81641		

HRB-SINGER, INC

APPENDIX F-4

MULTIPLE REGRESSION ANALYSIS COMBINED

OM(1) n = 29 AND OM(2) n = 32

NOTE: For an interpretation of the following pages, see pages 152, 167, Table VIII-1, and Section VIII C5b.

MULTIPLE REGRESSION..... OM(1) & OM(2)

SELECTION..... 1

VARIABLE X NO.		MEAN	STANDARD DEVIATION	CORRELATION X VS Y	REGRESSION COEFFICIENT	STD. ERROR OF REG.COEF.	COMPUTED T VALUE
31	2	45.39443	22.03577	-0.19899	-0.28018	0.13652	-2.05222
52	3	131.83606	21.55780	-0.30954	-1.20823	0.26330	-4.58884
60	4	559.06543	237.31883	0.04661	-0.06115	0.01904	-3.21192
61	5	1.08667	0.46706	-0.05362	26.07884	8.92031	2.92353
DEPENDENT							
15	1	68.31146	26.24661				

INTERCEPT 246.10760

MULTIPLE CORRELATION 0.54986

STD. ERROR OF ESTIMATE 22.69206

ANALYSIS OF VARIANCE FOR THE REGRESSION

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F VALUE
ATTRIBUTABLE TO REGRESSION	4	12496.98828	3124.24707	6.06732
DEVIATION FROM REGRESSION	56	28836.09375	514.93018	
TOTAL	60	41333.08203		

MULTIPLE REGRESSION.....OM(1) & OM(2)

SELECTION..... 1

TABLE OF RESIDUALS

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
1	73.00000	66.01773	6.98227
2	100.00000	64.07236	35.92764
3	83.00000	70.14644	12.85356
4	65.00000	59.50702	5.49298
5	19.00000	61.27115	-42.27115
6	47.00000	55.66794	-8.66794
7	45.00000	40.50990	4.49010
8	52.00000	59.88789	-7.88789
9	39.00000	51.19043	-12.19043
10	47.00000	53.07274	-6.07274
11	72.00000	66.10785	5.89215
12	83.00000	63.73805	19.26195
13	58.00000	56.80019	1.19981
14	84.00000	63.63802	20.36198
15	64.00000	74.73300	-10.73300
16	72.00000	72.61771	-0.61771
17	88.00000	73.62556	14.37444
18	88.00000	72.42664	15.57336
19	81.00000	69.66760	11.33240
20	60.00000	62.55238	-2.55238
21	71.00000	72.11444	-1.11444
22	98.00000	44.36682	53.63318
23	81.00000	64.56845	16.43155
24	52.00000	66.10985	-14.10985
25	45.00000	55.84770	-10.84770
26	44.00000	45.05841	-1.05841
27	48.00000	68.05295	-20.05295
28	53.00000	69.35260	-16.35260
29	50.00000	51.28888	-1.28888
30	51.00000	68.07837	-17.07837
31	88.00000	75.55278	12.44722
32	53.00000	74.48865	-21.48865
33	100.00000	97.18362	2.81638
34	100.00000	82.15286	17.84714
35	100.00000	97.81348	2.18652
36	100.00000	76.03903	23.96097
37	100.00000	90.67340	9.32660
38	100.00000	79.38017	20.61983
39	35.00000	62.87564	-27.87564
40	93.00000	90.70055	2.29945
41	100.00000	67.41676	32.58324
42	100.00000	71.45190	28.54810
43	100.00000	99.01932	0.98068
44	100.00000	90.77333	9.22667
45	100.00000	71.58754	28.41246
46	81.00000	75.88448	5.11552
47	40.00000	92.84239	-52.84239

CASE NO.	Y VALUE	Y ESTIMATE	RESIDUAL
48	39.00000	71.02469	-32.02469
49	46.00000	50.27200	-4.27200
50	57.00000	47.62520	9.37480
51	67.00000	80.85854	-13.85854
52	35.00000	72.25188	-37.25188
53	4.00000	42.64922	-38.64922
54	52.00000	36.47391	15.52609
55	29.00000	55.59189	-26.59189
56	83.00000	84.60550	-1.60550
57	100.00000	83.41373	16.58627
58	100.00000	84.43419	15.56581
59	23.00000	66.70117	-43.70117
60	100.00000	61.94035	38.05965
61	29.00000	71.24057	-42.24057