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4967-M
USER'S MANUAL FOR THE COAL LOSS CALCULATION MODEL COMPUTER PROGRAM

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A. INTRODUCTION

The Department of Interior, U.S. Bureau of Mines performs the task of estimating the quantity of coal reserves existing in each state on a county by county basis. As a part of Information Circular 8655, the Bureau of Mines established the criteria for the uniform estimations of coal reserves and listed the most recent estimates of coal reserves by county and by seam. At the same time however, the Bureau recognized that these figures represented the upper bound with regard to the estimated actually usable or obtainable reserves. Recovery of these reserves are subject to the mining methods used and to the resolution of such problems as the use of poor quality coal and competition provided by conflicting land use. These problems, in practice restrict the recovery of the estimated quantities of coal reserves listed in IC 8655. Another impact, the subject of this manual, is the impact resulting from previous mining activities. In particular, many of the reserve seams included in the reserve estimates overlie or underlie mined-out coal beds. Portions of these reserve seams may therefore be unmineable or at best may have a reduced quantity of extractable coal.

In order to improve the accuracy of the coal reserve base estimates, the Bureau of Mines funded an effort[1] to develop a systematic methodology for estimating the coal loss associated with the impact of previous mining activity. The coal loss calculation model (CLCM) described in this manual is a result of that effort and addresses the percentage of coal loss in reserve seams due to previous overmining or undermining.

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 a single adjacent seam. The model does not address combined effects of more than one previously mined seam.

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[1] Contract No. J0357129 performed by HRB-Singer, Inc.

B. UTILITY AND LIMITATIONS OF THE MODEL

The CLCM model addresses the two basic effects of seam interaction, 1) subsidence due to undermining a reserve seam and 2) 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 probable intensity or magnitude of these effects on coal loss. The calculated coal loss is reported as a percentage. Separate percentage values of coal loss are shown for the effects of subsidence and high stress. The higher of the two values is reported as the predicted coal loss percentage in the reserve seam. The predicted coal loss percentages are then averaged to show the average coal loss percentage for the reserve seam.

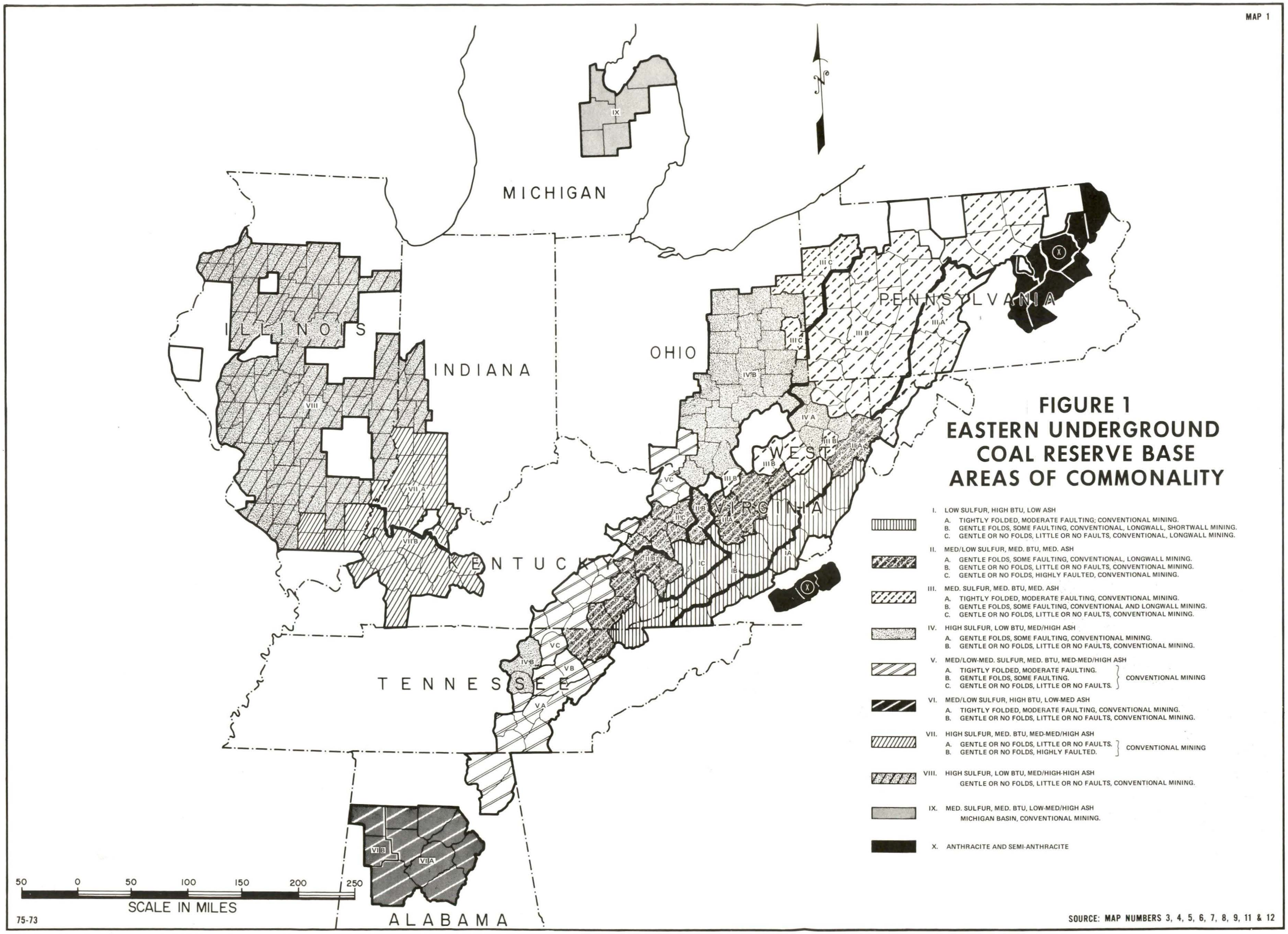
Although the model will function with only one observation, the more data points that can be input into the model for a given area, the more precise will be the coal loss calculation. Fifty data points are judged sufficient to adequately characterize a given mine. The model is specific in the prediction 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 of 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 a mine located in Cambria County, Pennsylvania to calculate the percent 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 <u>assumed</u> 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 previously overmined (seam 071) then the CLCM must be exercised on specific mine data to determine the percent coal loss expected. 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 made:

1. Use only the data from the previously mined seam showing the largest percentage coal loss.
2. Calculate the percentage 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 occurring 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 subregion IIIA (Figure 1) 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 loss percentages 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


MAP 1
FIGURE 1
EASTERN UNDERGROUND
COAL RESERVE BASE
AREAS OF COMMONALITY
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
WEST VIRGINIA
KENTUCKY
TENNESSEE
ALABAMA
IX
VIII
VII A
VII B
IV B
IV A
III C
III B
III A
II C
II B
II A
IC
IB
IA
VC
VB
VA
VI B
VI A
X
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
50 0 50 100 150 200 250
SCALE IN MILES
75-73
SOURCE: MAP NUMBERS 3, 4, 5, 6, 7, 8, 9, 11 & 12

considered are present and that basic input parameters are essentially 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. 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 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 parameters, these should be substituted in the model where applicable. This is particularly true for the input parameters 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.

The model does not address the combined effects of more than one previously mined seam. In this instance and in the absence of research data, it is suggested that the maximum calculated percentage coal loss due to an individual previously mined seam be taken as the best estimate. The results of all previously mined seams should not be added. For example, if three seams have been mined, one above and two below the reserve seam, and coal loss due to each seam was calculated as 11%, 15%, and 5%, then take 15% as the estimated coal loss when mining the reserve seam and not 31% which is the sum of all individually calculated losses.

C. REGIONAL ADJUSTMENTS

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 (Table 1) is offered using calculations made in Area IIIB as a standard of 1.0. Calculations made in one sub-region may be

TABLE 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	[illegible].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		

adjusted to predict percent 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.

D. VARIABLES

This section provides a description of the variables input into the CLCM program. They are listed in the order in which they are read into the program. All twelve variables are required as input in either the under or overmined condition.

1. <u>Strength of the Immediate Roof - Currently Mined Seam (CMS)</u>

This is the unconfined compressive strength of the roof lithology (top) measured in lbs/in^2. In the absence of laboratory test data, the strength is approximated by equating the lithologies shown in Table 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. They should not be used outside this context nor regarded as specific actual values for a given lithology.

TABLE 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	

2. <u>Strength of Floor - CMS</u>

This is the unconfined compressive strength of the floor lithology (bottom) measured in lbs/in^2. Comments made for item 1 are applicable here also.

3. Seam Thickness - Previously Mined Seam (PMS)

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.

4. Percent Extraction - PMS

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

5. Strength of Immediate Roof - PMS

Same as No. 1 above.

6. Strength of Floor - PMS

Same as No. 2 above.

7. Minimum Pillar Width - PMS

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

8. 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 is measured across the cavity at the widest point.

9. 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.

10. Depth of Overburden

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.

11. Time Since Previous Mining

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

12. 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 2. 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

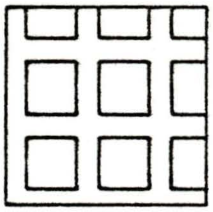
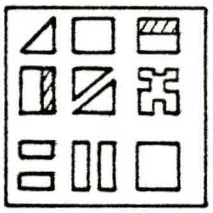
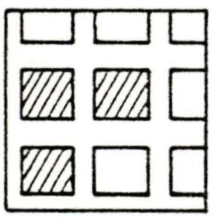
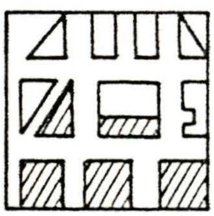
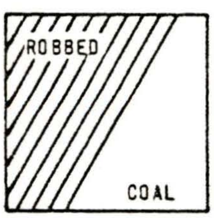
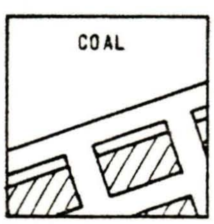
	SPACING	PILLAR GEOMETRY	HIGHSTRESS COAL LOSS (HSTRCL) MULTIPLIER)
	REGULAR	UNIFORM	.6
	REGULAR	NON-UNIFORM RESULT OF CUTTING PILLARS IN RETREAT MINING.	.7
	IRREGULAR	UNIFORM PULLING SOME PILLARS IN RETREAT MINING.	.8
	IRREGULAR	NON-UNIFORM RESULT OF PULLING AND SLABBING PILLARS IN RETREAT MINING.	.9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

FIG. 2 PILLAR SPACING AND GEOMETRY MULTIPLIER

76-65

II. THE MODEL ALGORITHM

The coal loss calculation model is an engineering assessment approach which examines the characteristics of each seam and logically determines, based on empirical data, the probability of subsidence or high stress concentrations actually occurring. If these conditions are met, then a calculation of the probable impact of coal loss due to previous mining is made.

This section describes the flow of the model and the decision conditions in more general terms than the program flow diagram (Appendix C) or the Fortran program listing (Appendix D). (See Section III E 3 or Appendix A for glossary information.)

- 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.

- PART II - Subsidence Effects

STEP 1: Test for Subsidence

Subsidence will occur in the overlying seam if the PMS 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) $+ 60$

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

or

(6) Span/DT $\geq$ 0.25

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

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

- <u>PART III</u> - 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 $\geq$ 120 feet, go to STEP 4, else continue.

(1) If PSUB $\leq$ 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 $\geq$ 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 $\leq$ 60 feet

If DT > 60 feet, go to STEP 4

(1) If CMSRAT $\leq$ 0.625 or $\geq$ 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 $\geq$ 90 feet go to STEP 5, else continue.

(1) If CMSRAT $\leq$ 0.625 or $\geq$ 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 $\geq$ 90 and < 120 feet

If DT $\geq$ 120 feet, go to STEP 6, else continue.

(1) If CMSRAT $\leq$ 0.625 or $\geq$ 2.4, then HSTRES = 15%

or

(2) If CMSRAT > 0.625 and < 2.4 then HSTRES = 10%. If true, go to PART V, else continue.

STEP 6: DT $\geq$ 120 feet

(1) If DT < VERT and (CMSRAT $\leq$ 0.625 or $\geq$ 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 $\neq$ 0 then (PILPAT) (HSTRES) = HSTRES (Adjusted).

STEP 2: PMS DEPTH Shallow Depth Adjustment

If PMS Depth $\leq$ 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 $\geq$ 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 percentage coal loss for N seams above or below a previously mined seam.

III. EXERCISING THE PROGRAM

A. DESCRIPTION

The program, CLCM, was developed on an IBM 360/40 computer utilizing a DØS system. The program is written in Fortran IV computer language.

The CLCM consists of a stand-alone main program containing approximately 300 Fortran statements and comments. It contains a glossary of variable names[1] and user instructions for control card and data input.

B. CAPACITY

The capacity of the program and the format required for data input have been set up as follows:

1. Input Variables -- Twelve (12) input variables are required for running the program for calculating the coal loss for one (1) currently mined or reserve seam. Only five (5) input variables are required for successive seams.

2. Number of Observations -- The maximum number of observations allowed in the program as written is fifty (50). It is believed that 50 observations should be sufficient to represent a given mine. This capacity can be modified, if desired, to include more observations. Program modifications are discussed in Section V.

3. Input Format -- This program allows a variable format to be input by the user with the data cards.

4. Number of Seams -- Only one seam is addressed at a time by the program. Any number of seams may exist in the input data stream. An end of file signifies no more data input and terminates execution.

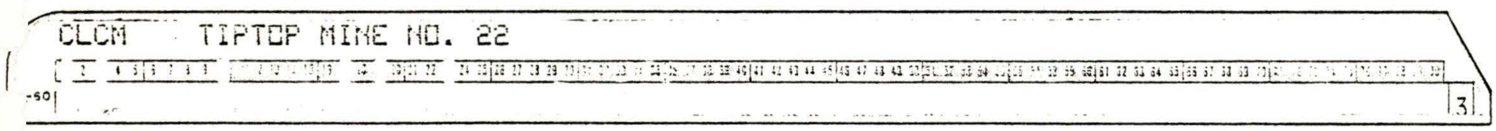
[1] The glossary is included in Appendix B, Glossary of Variables and in Appendix D, The Program Listing.

C. INPUT

1. Title Card

A title card must be included. It is the first card in the data deck setup (Figures 3 and 4).

Col 1-80 Any title desired (Alphanumeric)



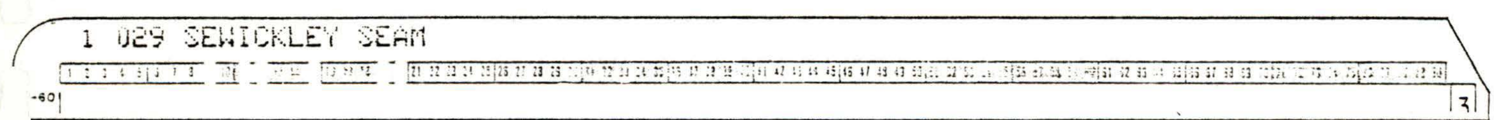
2. Control Card

One control card is required per run regardless of the number of seams included in the data set (Figures 3 and 4).

Col 1-2 Number of data sets (Equals the number of reserve seams)

Col 4-6 USBM Seam Code (Previously mined seam)

Col 8-35 Seam Name (Previously mined seam. Alphanumeric)



3. Parameter Card

One parameter card is required for each reserve seam (Figures 3 and 4).

Col 1-3 USBM Seam Code (Currently mined or reserve seam).

Col 5-30 Seam Name (Currently mined or reserve seam. Alphanumeric).

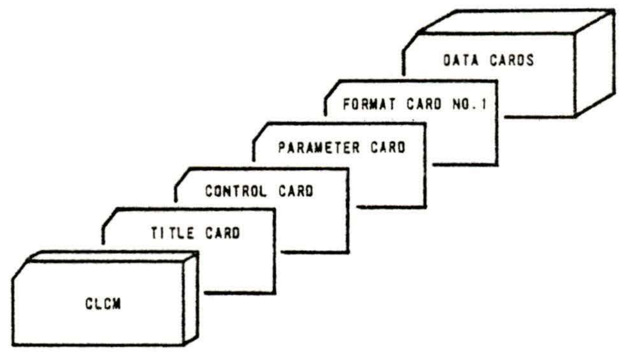


FIG. 3 DECK SET-UP FOR ONE RESERVE SEAM

76-65

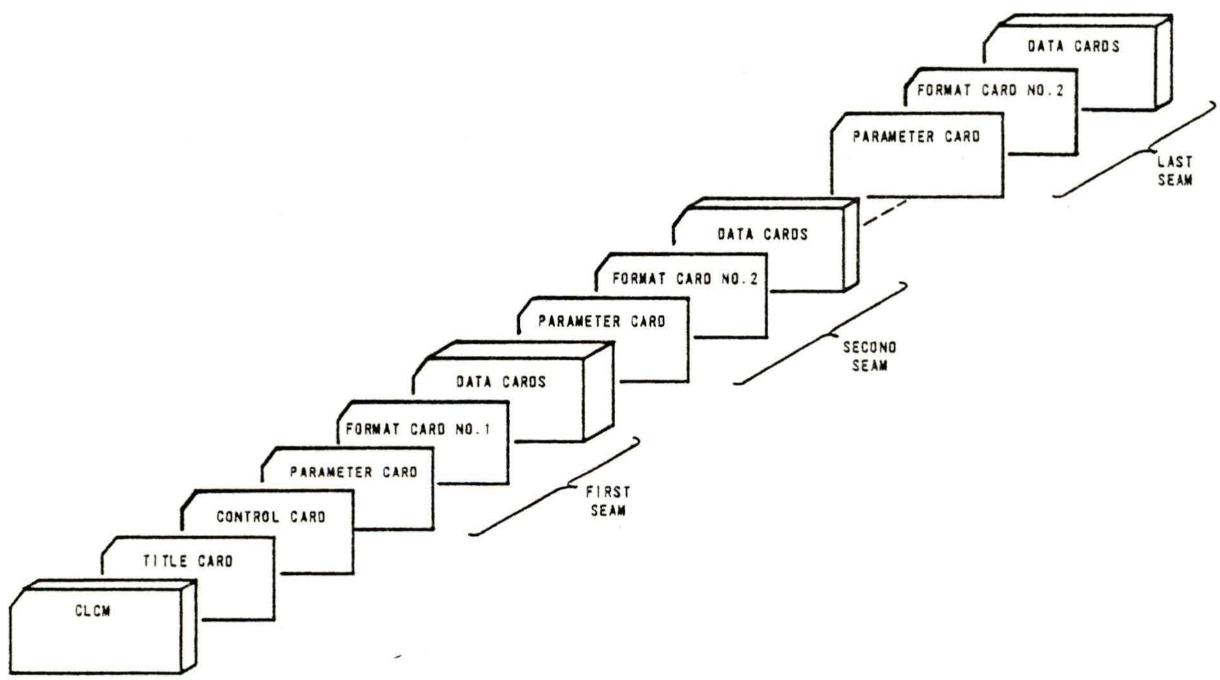


FIG. 4 DECK SET-UP FOR MULTIPLE RESERVE SEAMS

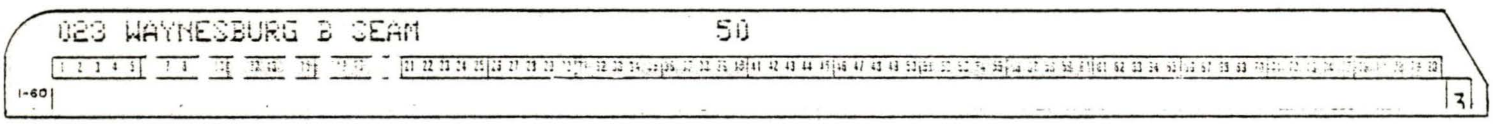
76-65

Col 39-40 Number of sample points (50 Maximum)

Col 46-50 Regional Multiplier (if none, leave blank)

Col 56-60 Lithology Multiplier (if none leave blank)

Col 70 Alignment of Pillars, 1 if aligned; blank if not aligned.



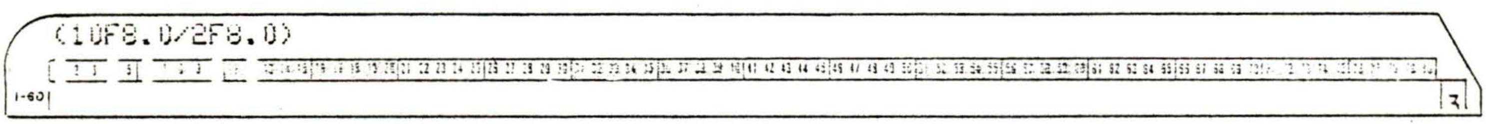
4. <u>Format Cards</u>

The format cards are variable and are controlled by the user.

a. Format Card Number 1. (Figures 3 and 4)

This variable format must be enclosed in parentheses and begun in column 1. Do not include the word "Format". All data are read as real variables.

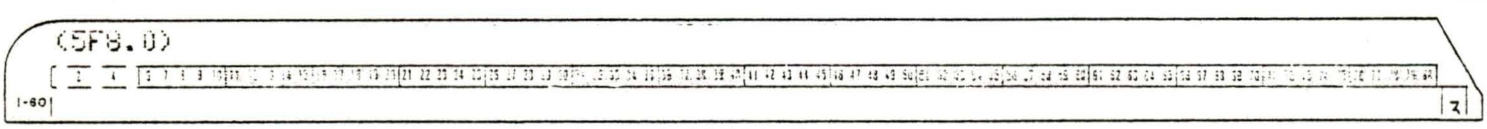
Example: (10F8.0/2F8.0)



b. Format Card Number 2.

This variable format card is only required for successive seams. It must be enclosed in parentheses and begun in column 1. Do not include the word "Format". All data are read as real variables.

Example: (5F8.0)



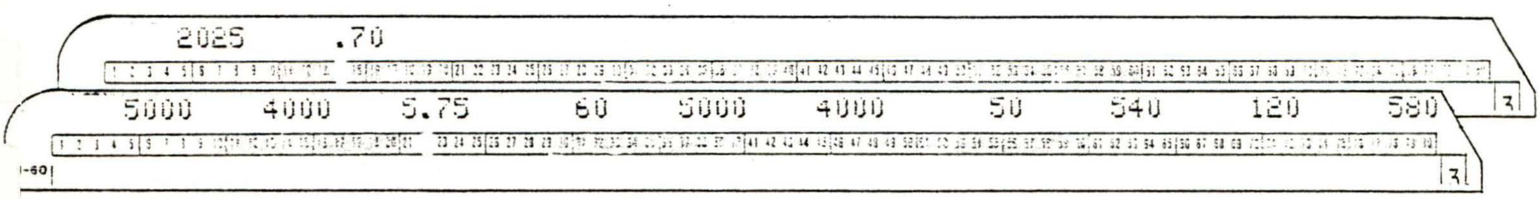
5. <u>Data Cards</u>

a. Initial Data Cards

The data cards include variables from the previously mined seam as well as the initial currently mined or reserve seam.

	Input Variables	Unit	Limits	Example
1.	CMS Roof Strength	lbs. in^2.	--	5000
2.	CMS floor Strength	lbs. in^2.	--	4000
3.	PMS Seam Thickness	ft.	50	5.76
4.	PMS Percent Extraction	Unit	100	60
5.	PMS Roof Strength	lbs. in^2.	--	5000
6.	PMS Floor Strength	lbs. in^2.	--	4000
7.	PMS Pillar Width	ft.	--	50
8.	PMS Span	ft.	--	540
9.	Distance Between Seams	ft.	--	120
10.	PMS Depth Below Surface	ft.	2000	580
11.	Time Elapsed Between Mining	years	--	20.25[1]
12.	Pillar Pattern	Unit	1.0	.70

Card Example:



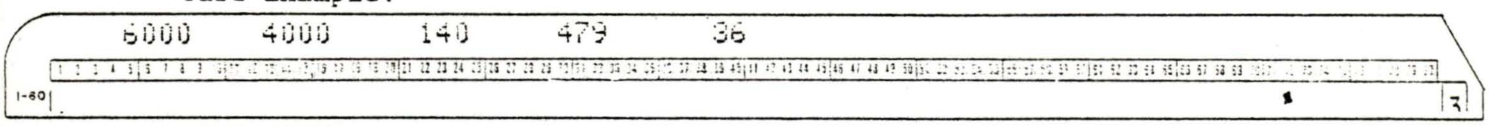
b. Successive Data Cards

These data cards include variables from successive seams only.

[1] If the seam is a reserve seam, include time elapsed from PMS mining to present date.

	Variable	Unit	Limits	Example
1.	CMS Roof Strength	lbs. in^2.	--	6000
2.	CMS Floor Strength	lbs. in^2.	00	4000
3.	Distance Between Seams	ft.	--	140
4.	PMS Depth Below Surface	ft.	2000	580[1]
5.	Time Between Mining	years	--	36[2]

Card Example:



D. DECK SETUP

Figure 3 shows the deck setup required to execute the program for one currently mined or reserve seam. Figure 4 shows the deck setup for multiple reserve seams.

E. OUTPUT

1. Title Page

The title page (Figure 5) lists the information input on the title card and describes the condition of the currently mined or reserve seam, that is, whether it is an overmined or undermined condition. The title page of successive seams does not include the title card information. The title page also contains the seams of immediate concern in their correct geological order. In Figure 5, the 084 seam, the reserve seam, has been previously overmined. It underlies the 074 seam.

[1] This variable can be input for specificity or left blank, in which case the actual values from the initial seam observations will be input. If there is only one observation in this successive seam and the value is left blank, then the average PMS depth value from the initial seam will be input.

[2] If the seam is a reserve seam, include time elapsed from PMS mining to present date.

```
                    CLCM.....VALIDATION RUN

                     OVERMINED CONDITION
                     -------------------

     074  LOWER FREEPORT              PREVIOUSLY MINED SEAM

     084  LOWER KITTANNING         CURRENTLY MINED OR RESERVE SEAM
```

FIG. 5 THE TITLE PAGE

2. Input Data

The second page of output contains a listing and averages of the input data variables (Figure 6). The heading of the data page includes the input variables described in Section I D. The input data are listed to verify the input of the data, to allow the user a visual check of the input data, and to provide a listing of data to be used in checking values included in the output phase of the program.

The input data averages generated by the program are utilized in the execution of successive seams in which only one observation is provided.

3. Calculations

The third page of output (Figure 7) contains the calculations made in the program. The calculations include several critical parameters used as decision bounds within the algorithm. The output items are listed in order with their internal program variable names and units:

OUTPUT VARIABLE	INTERNAL VARIABLE NAME	UNIT
a. PMS Strength/Load Ratio	PILRAT	--
b. PMS Roof/Floor Ratio	PMSRAT	--
c. CMS Roof/Floor Ratio	CMSRAT	--
d. Maximum Vertical Extent of the Pressure Area	VERT	Feet
e. Maximum Horizontal Extent of the Pressure Arch	HORIZ	Feet
f. PMS Width/Depth Ratio	WDRAT	--
g. Percent Subsidence[1]	PSUB	Percent
h. Maximum Subsidence[1]	SUB	Feet
i. Subsidence Coal Loss[1]	SUBCL	Percent
j. High Stress Coal Loss	HSTRES	Percent
k. Predicted Coal Loss	CMSCL	Percent

[1] These variables are computed as zero values when the program is run for the overmined condition. In this geological situation there is no subsidence occurring.

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	6000.00	1500.00	4.00	83.00	8000.00	1500.00	25.00	531.00	137.00	290.00	10.08	1.00
2	6000.00	1500.00	4.00	43.00	8000.00	1500.00	43.00	250.00	147.00	293.00	9.33	1.00
3	6000.00	1500.00	4.00	60.00	8000.00	1500.00	43.00	293.00	140.00	301.00	12.00	1.00
4	8000.00	1500.00	4.00	54.00	6000.00	1500.00	0.0	556.00	152.00	456.00	33.67	1.00
5	8000.00	1500.00	4.00	38.00	6000.00	1500.00	50.00	325.00	156.00	450.00	39.25	1.00
6	8000.00	1500.00	4.00	66.00	6000.00	1500.00	43.00	537.00	149.00	480.00	26.67	1.00
7	8000.00	1500.00	4.10	77.00	6000.00	1500.00	43.00	500.00	159.00	488.00	27.83	1.00
8	8000.00	1500.00	4.25	20.00	6000.00	1500.00	50.00	19.00	158.00	487.00	33.67	0.60
9	8000.00	1500.00	4.00	70.00	6000.00	1500.00	25.00	425.00	156.00	429.00	31.74	0.80
10	8000.00	1500.00	3.75	50.00	6000.00	1500.00	50.00	207.00	154.00	488.00	25.42	0.90
11	8000.00	1500.00	3.70	27.00	6000.00	1500.00	43.00	19.00	150.00	481.00	28.58	0.60
12	8000.00	1500.00	4.10	33.00	6000.00	1500.00	56.00	231.00	148.00	487.00	22.43	0.80
13	8000.00	1500.00	3.75	65.00	6000.00	1500.00	37.00	287.00	152.00	423.00	29.08	1.00
14	8000.00	1500.00	4.10	13.00	6000.00	1500.00	50.00	19.00	156.00	464.00	28.09	0.60
15	8000.00	1500.00	4.20	22.00	6000.00	1500.00	43.00	187.00	150.00	365.00	28.91	1.00
16	8000.00	1500.00	3.90	24.00	6000.00	1500.00	50.00	19.00	150.00	390.00	28.83	0.60
17	8000.00	1500.00	4.17	55.00	6000.00	1500.00	31.00	463.00	143.00	357.00	26.91	1.00
18	6000.00	1500.00	3.25	37.00	8000.00	1500.00	43.00	225.00	149.00	331.00	25.67	0.80
19	6000.00	1500.00	3.80	46.00	8000.00	1500.00	43.00	113.00	149.00	341.00	26.41	0.80
20	6000.00	1500.00	3.80	87.00	8000.00	1500.00	43.00	475.00	146.00	313.00	24.25	1.00
21	6000.00	1500.00	4.30	30.00	8000.00	1500.00	43.00	343.00	151.00	319.00	24.25	1.00
22	6000.00	1500.00	4.00	97.00	8000.00	1500.00	37.00	588.00	158.00	336.00	25.42	0.90
23	6000.00	1500.00	4.00	48.00	8000.00	1500.00	43.00	143.00	153.00	317.00	23.83	1.00
24	6000.00	1500.00	4.10	34.00	8000.00	1500.00	50.00	363.00	156.00	344.00	30.76	1.00
25	6000.00	1500.00	4.17	82.00	8000.00	1500.00	25.00	363.00	152.00	327.00	24.25	1.00
26	6000.00	1500.00	3.90	87.00	8000.00	1500.00	37.00	588.00	159.00	329.00	22.58	1.00
27	6000.00	1500.00	3.90	24.00	8000.00	1500.00	50.00	19.00	156.00	309.00	23.58	0.60
28	6000.00	1500.00	3.90	20.00	8000.00	1500.00	43.00	25.00	152.00	377.00	22.58	0.60
29	6000.00	1500.00	3.60	76.00	8000.00	1500.00	25.00	375.00	157.00	323.00	23.33	1.00
30	6000.00	1500.00	3.90	40.00	8000.00	1500.00	43.00	93.00	150.00	347.00	22.75	1.00
31	6000.00	1500.00	4.00	14.00	8000.00	1500.00	50.00	19.00	148.00	380.00	22.34	0.60
32	6000.00	1500.00	4.10	19.00	8000.00	1500.00	50.00	25.00	151.00	331.00	24.33	0.60
AVERAGE	6875.00	1500.00	3.96	48.16	7125.00	1500.00	42.16	269.53	151.38	379.78	25.28	0.87

FIG. 6 THE INPUT DATA

004 LOWER 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	PREDICTED COAL LOSS
1	1.24	5.33	4.00	207.00	0.0	3.88	0.0	0.0	0.0	0.07	0.07
2	3.28	5.33	4.00	207.90	0.0	1.70	0.0	0.0	0.0	0.07	0.07
3	3.60	5.33	4.00	210.30	0.0	2.09	0.0	0.0	0.0	0.08	0.08
4	0.0	4.00	5.33	256.80	0.0	3.66	0.0	0.0	0.0	0.10	0.10
5	4.00	4.00	5.33	255.00	0.0	2.08	0.0	0.0	0.0	0.10	0.10
6	1.92	4.00	5.33	264.00	0.0	3.60	0.0	0.0	0.0	0.10	0.10
7	1.26	4.00	5.33	266.40	0.0	3.14	0.0	0.0	0.0	0.10	0.10
8	4.59	4.00	5.33	266.10	0.0	0.12	0.0	0.0	0.0	0.06	0.06
9	1.48	4.00	5.33	248.70	0.0	2.72	0.0	0.0	0.0	0.08	0.08
10	3.11	4.00	5.33	266.40	0.0	1.34	0.0	0.0	0.0	0.09	0.09
11	4.33	4.00	5.33	264.30	0.0	0.13	0.0	0.0	0.0	0.06	0.06
12	4.14	4.00	5.33	266.10	0.0	1.56	0.0	0.0	0.0	0.08	0.08
13	2.18	4.00	5.33	246.90	0.0	1.89	0.0	0.0	0.0	0.10	0.10
14	5.36	4.00	5.33	259.20	0.0	0.12	0.0	0.0	0.0	0.06	0.06
15	5.61	4.00	5.33	229.50	0.0	1.25	0.0	0.0	0.0	0.09	0.09
16	5.76	4.00	5.33	217.00	0.0	0.13	0.0	0.0	0.0	0.06	0.06
17	2.86	4.00	5.33	227.10	0.0	3.24	0.0	0.0	0.0	0.09	0.09
18	5.92	5.33	4.00	219.30	0.0	1.51	0.0	0.0	0.0	0.07	0.07
19	4.44	5.33	4.00	222.30	0.0	0.76	0.0	0.0	0.0	0.07	0.07
20	1.16	5.33	4.00	213.90	0.0	3.25	0.0	0.0	0.0	0.08	0.08
21	5.67	5.33	4.00	215.70	0.0	2.27	0.0	0.0	0.0	0.08	0.08
22	0.23	5.33	4.00	220.80	0.0	3.72	0.0	0.0	0.0	0.08	0.08
23	4.45	5.33	4.00	215.10	0.0	0.93	0.0	0.0	0.0	0.08	0.08
24	5.49	5.33	4.00	223.20	0.0	2.33	0.0	0.0	0.0	0.09	0.09
25	1.13	5.33	4.00	218.10	0.0	2.39	0.0	0.0	0.0	0.08	0.08
26	1.02	5.33	4.00	218.70	0.0	3.70	0.0	0.0	0.0	0.08	0.08
27	7.27	5.33	4.00	212.70	0.0	0.12	0.0	0.0	0.0	0.05	0.05
28	5.85	5.33	4.00	233.10	0.0	0.16	0.0	0.0	0.0	0.06	0.06
29	1.68	5.33	4.00	216.90	0.0	2.39	0.0	0.0	0.0	0.08	0.08
30	4.77	5.33	4.00	224.10	0.0	0.62	0.0	0.0	0.0	0.09	0.09
31	6.58	5.33	4.00	234.00	0.0	0.13	0.0	0.0	0.0	0.06	0.06
32	7.00	5.33	4.00	219.30	0.0	0.17	0.0	0.0	0.0	0.05	0.05
AVERAGE	3.85	4.75	4.58	233.93	0.0	1.78	0.0	0.0	0.0	0.08	0.08

FIG. 7 PROGRAM CALCULATIONS

The items are averaged at the bottom of the columns for the convenience of the user. Formulas for these calculations are shown in Appendix A.

Whenever conditions are present which may result in the occurrence of a bump, this condition is noted by the presence of an asterisk by the high stress coal loss and by a message at the bottom of the page (Figure 11).

IV. SAMPLE CASE

The following sample case is an example of the necessary input cards, including control cards and input data, and the actual output calculated from the CLCM program.

Using the instructions in Section IIIC, the user should set up a control card and input data card deck such as shown in Figure 8 using the deck set-up instructions in Figure 4. This sample is set up to calculate coal loss in two reserve seams.

The CLCM will generate the output shown in Figures 9 to 14. Figure 9 is the sample case title page for the first reserve seam. It shows that Seam 084 is the previously mined seam and of course, is the previously mined seam in Figure 12. Figures 9 and 12 also show the reserve seams in question. The seams will always appear in the proper geological order and the title page will state the condition whether overmined or undermined. Figure 10 lists the input data cards for the first situation, an undermined condition; the previously mined seam (084) is below the reserve seam (076). Column items 1 and 2 are the roof strength and floor strength values (see Table 2) for the currently mined or reserve seam. If a reserve seam, these data can be obtained from drill hole logs. Column items 3-12 list input data for the previously mined seam. These items are spelled out in detail in Section III C5. The averages of the data input variables are presented for the convenience of the user as well as to provide an input into successive reserve seam calculations in which there is only one input observation. The second reserve seam of the sample case is an example with one observation. The average values in Figure 10 are the same as the input values of the second reserve seam (Figure 13) with the exception of items 1 and 2 which are peculiar to the second reserve seam.

Figures 11 and 14 show the output for the first and second reserve seams respectively. The output column items are explained in detail in Section E3. The sample case is an undermined case while Figure 7 shows the overmined case output. If the equations listed in Section II, the program flow diagram in

TITLE CARD → CLCM....VALIDATION RUN

CONTROL CARD → 2 084 B LOWER KITTANNING

PARAMETER CARD → 076 C' UPPER KITTANNING 50

FORMAT CARD NO. 1 → (10F8.0/2F8.0)

DATA CARDS (1ST RESERVE SEAM)

```
CLCM....VALIDATION RUN
 2 084 B    LOWER KITTANNING
076 C'  UPPER KITTANNING              50
(10F8.0/2F8.0)
 5000.00 4000.00    5.75   50.00 5000.00 4000.00   50.00  160.00  110.00  195.00
   22.00    0.70
 5000.00 4000.00    5.75   45.00 5000.00 4000.00   45.00   40.00  100.00  183.00
   26.00    0.70
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00  100.00  175.00
   22.00    1.00
 5000.00 4000.00    5.75   60.00 5000.00 4000.00   50.00  160.00   90.00  190.00
   17.00    0.70
 5000.00 4000.00    5.75   50.00 5000.00 4000.00   45.00  200.00   90.00  223.00
   15.00    0.80
 5000.00 4000.00    5.75   60.00 5000.00 4000.00   45.00  140.00   90.00  350.00
   19.00    0.80
 5000.00 4000.00    5.75   70.00 5000.00 4000.00   40.00  360.00  100.00  220.00
   20.00    0.80
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00  100.00  260.00
   21.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00  110.00  280.00
   28.00    1.00
 5000.00 4000.00    5.75   95.00 5000.00 4000.00   40.00  840.00  100.00  320.00
   17.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00   90.00  340.00
   24.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00   90.00  370.00
   23.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00  100.00  390.00
   18.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00  100.00  400.00
   26.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00   90.00  390.00
   15.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00  110.00  480.00
   17.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00  100.00  500.00
   28.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 4000.00     0.0  840.00   80.00  460.00
   25.00    1.00
 5000.00 4000.00    5.75   95.00 5000.00 4000.00   40.00  840.00   80.00  560.00
   26.00    1.00
 5000.00 4000.00    5.75  100.00 5000.00 1500.00     0.0  840.00   80.00  590.00
   26.00    1.00
 5000.00 4000.00    5.75   65.00 5000.00 4000.00   80.00  580.00   80.00  550.00
   19.00    0.80
 5000.00 4000.00    5.75   90.00 5000.00 4000.00   80.00  780.00   90.00  500.00
   19.00    1.00
 5000.00 4000.00    5.75   95.00 5000.00 1500.00   30.00  840.00   90.00  530.00
   21.00    1.00
 5000.00 4000.00    5.75   55.00 5000.00 1500.00   45.00  400.00   90.00  620.00
   24.00    0.90
 5000.00 4000.00    5.75  100.00 5000.00 1500.00     0.0  840.00   90.00  540.00
   26.00    1.00
 5000.00 4000.00    5.75  100.0012000.00 1500.00     0.0  840.00   90.00  640.00
   27.00    1.00
 5000.00 4000.00    5.75  100.0012000.00 1500.00     0.0  840.00   90.00  660.00
   27.00    1.00
```

FIG. 8 SAMPLE CASE INPUT

DATA CARDS (1ST RESERVE SEAM)

```
5000.00 4000.00    5.75  100.0012000.00 1500.00    0.0   840.00   90.00  540.00
  30.00    1.00
5000.00 4000.00    5.75  100.0012000.00 1500.00    0.0   840.00   60.00  570.00
  36.00    1.00
5000.00 4000.00    5.75  100.0012000.00 1500.00   80.00  840.00   80.00  570.00
  29.00    1.00
5000.00 1500.00    5.75   90.0012000.00 1500.00  160.00  840.00   90.00  630.00
  27.00    1.00
5000.00 4000.00    5.75  100.0012000.00 1500.00   60.00  840.00   90.00  430.00
  26.00    1.00
5000.00 1500.00    5.75   40.0012000.00 1500.00   70.00  120.00   80.00  580.00
  25.00    1.00
5000.00 1500.00    5.75   70.0012000.00 1500.00   90.00  650.00   90.00  640.00
   0.0     1.00
5000.00 1500.00    5.75  100.0012000.00 1500.00    0.0   840.00   90.00  600.00
  27.00    1.00
5000.00 1500.00    5.75   20.0012000.00 1500.00  125.00   40.00   70.00  620.00
  28.00    0.70
5000.00 1500.00    5.75   65.0012000.00 1500.00    0.0   600.00   90.00  680.00
  29.00    0.90
5000.00 4000.00    5.75   75.0012000.00 1500.00   60.00  540.00   90.00  400.00
  26.00    1.00
5000.00 1500.00    5.75   40.0012000.00 1500.00   70.00  160.00   90.00  650.00
  33.00    0.80
5000.00 1500.00    5.75   30.0012000.00 1500.00   45.00   40.00   30.00  600.00
  28.00    0.90
5000.00 1500.00    5.75   50.0012000.00 1500.00   70.00  400.00   80.00  490.00
  26.00    0.90
5000.00 1500.00    5.75   45.0012000.00 1500.00   80.00  340.00   90.00  500.00
  33.00    0.70
5000.00 1500.00    5.75   35.0012000.00 1500.00   80.00  320.00  100.00  520.00
  32.00    0.80
5000.00 1500.00    5.75   90.0012000.00 1500.00   55.00  440.00  100.00  560.00
  32.00    1.00
5000.00 1500.00    5.75   45.0012000.00 1500.00  100.00  280.00   90.00  630.00
  33.00    0.90
5000.00 1500.00    5.75   50.0012000.00 1500.00   40.00  400.00   90.00  650.00
  34.00    1.00
5000.00 4000.00    5.75   65.0012000.00 1500.00   70.00  540.00   90.00  470.00
  32.00    0.90
5000.00 1500.00    5.75   15.0012000.00 1500.00   70.00  120.00   90.00  540.00
  32.00    0.70
5000.00 1500.00    5.75   15.0012000.00 1500.00   45.00   40.00   80.00  480.00
  33.00    0.70
5000.00 1500.00    5.75   85.0012000.00 1500.00   12.00  740.00  120.00  660.00
  35.00    1.00
```

PARAMETER CARD →

```
074 D  LOWER FREEPORT                 1
```

FORMAT CARD NO. 2 →

```
(5F10.0)
```

DATA CARD (2ND RESERVE SEAM) →

```
    6000.     4000.      140.     479.0      36.0
```

FIG. 8 SAMPLE CASE INPUT (CONT'D)

```
CLCM....SAMPLE RUN

UNDERMINED CONDITION
--------------------

076  C'  UPPER KITTANNING          CURRENTLY MINED OR RESERVE SEAM

084  D   LOWER KITTANNING          PREVIOUSLY MINED SEAM
```

FIG. 9 SAMPLE CASE TITLE PAGE - FIRST RESERVE SEAM

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	28.00	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	33.00	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. 10 SAMPLE CASE INPUT DATA - FIRST RESERVE SEAM

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	PREDICTED 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	2.39	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	298.00	144.00	4.40	0.53	3.05	0.17	0.15	0.17
45	2.75	8.00	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. 11 SAMPLE CASE PROGRAM CALCULATIONS - FIRST RESERVE SEAM

UNDERMINED CONDITION

074 D LOWER FREEPORT CURRENTLY MINED OR RESERVE SEAM

084 D LOWER KITTANNING PREVIOUSLY MINED SEAM

FIG. 12 TITLE PAGE - SECOND RESERVE SEAM

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	6000.00	4000.00	5.75	75.10	8500.00	2550.00	63.61	576.60	140.00	479.00	36.00	0.92
AVERAGE	6000.00	4000.00	5.75	75.10	8500.00	2550.00	63.61	576.60	140.00	479.00	36.00	0.92

FIG. 13 SAMPLE CASE INPUT DATA - SECOND RESERVE SEAM

074 D LOWER FREEPORT

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

SAMPLE	PMS STREN/LOAD RATIO	PMS ROOF/FLR RATIO	CMS ROOF/FLR RATIO	MAX VERT EXTENT PR. APCH	MAX HORIZ EXTENT PR. ARCH	PMS WID/DEPTH RATIO	PERCENT SUBSIDENCE	MAXIMUM SUBSIDENCE	SUB-SIDENCE COAL LOSS	HIGH STRESS COAL LOSS	PREDICTED COAL LOSS
1	1.33	3.33	1.50	263.70	131.85	4.12	0.44	2.53	0.0	0.05	0.05
AVERAGE	1.33	3.33	1.50	263.70	131.85	4.12	0.44	2.53	0.0	0.05	0.05

FIG. 14 SAMPLE CASE PROGRAM CALCULATIONS - SECOND RESERVE SEAM

Appendix C or the program listing in Appendix D are followed through using the input data from observation number one, the results will be 5 percent coal loss due to subsidence and a 3 percent coal loss due to the effects of high stress zones. This results in a predicted coal loss in observation number one of 5 percent, the higher of the two calculated percentage coal loss values.

Note in Figure 11 the presence of conditions which may result in a bump in the currently mined or reserve seam. The asterisks note the specific observations in question.

V. PROGRAM MODIFICATION

Program capacity can be increased or decreased by making changes in the dimension statements. If the program capacity is to be increased, the dimension of the following variable arrays must be changed: DATA, SUB, PILRAT, CMSCL, YES, PMSRAT, HSTRES, X, SUBCL, HORIZ, VERT, CMSRAT, WDRAT, PSUB, and BUMP.

If a standard format for data input is desired, the variable format card could be eliminated and replaced by a standard format card.

VI. OPERATING INSTRUCTIONS

A. DATA SETS

The input data set number, eg. 5, must be equivalenced to the variable name IRD in the beginning of the program. This allows all read statements to operate under the correct data set number without changing the number in each read statement. Likewise, the output data set number must be equivalenced to the variable name IPR.

B. JOB CONTROL LANGUAGE

Any computer system will require some job control cards (JCL cards) at the beginning and end of any program. These JCL cards must be provided by the user in accordance with the system under which his computer operates.

VII. ERROR MESSAGES

The following error conditions will result in these messages:

1. The previously mined seam thickness for the ith observation is greater than 50 feet.

2. The previously mined seam percentage of extraction for the ith observation is greater than 100 percent.

3. The previously mined seam depth for the ith observation is greater than 2,000 feet.

4. The previously mined seam pillar pattern for the ith observation is greater than 1.

5. The maximum subsidence for the ith observation is greater than the previously mined seam thickness.

6. The percentage of subsidence for the ith observation is greater than 60 percent.

- Other Messages

When a condition is present which may result in a bump, the following message is printed: "Conditions are present which may result in a bump in the currently mined or reserve seam" (Figure 11).

VIII. TIMING

The execution time of the CLCM program with one reserve seam of fifty observations is listed below:

CPU seconds	75
I/O seconds	20

These times were recorded using an IBM 360/40 computer with an IBM 2540 card reader and IBM 1403 N-1 printer.

APPENDIX A

FORMULAS

The CLCM uses the following equations:

a. Maximum subsidence measure in feet expected in the overlying seam (SMAX)[1]

(1) SMAX = (.6) (t - .001) (DT) f(W/DT) (E) for all values of SMAX $\geq$ 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 $\leq$ 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 ration must first be calculated. These values are then used in the algorithm to calculate f(W/DT) which is set equal to 1.0 when W/DT $\geq$ 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.

[1] This predictive equation was developed by HRB-Singer, Inc. on ARC Contract 73-11-2552 "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 equation came from British National Coal Board data and the Subsidence Engineers Handbook. The packing factor .001 DT has been modified from .01D in the original formula 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.

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

$$PSUB = SMAX/t$$

b. Pillar Strength, Pillar Load Ratio

(1) Pillar strength[1] (PMS)

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

W = pillar width minimum

h = pillar height = t (seam thickness)

(2) Pillar Load[1] (PMS)

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

D = Depth to floor of seam

E = % Extraction

(3) Pillar strength to pillar load ratio (PILRAT)

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

c. Roof strength, Floor strength Ratio[2] (PMS, CMS)

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

---

1 Salamon (1967), Denkhaus (1962).

2 Unconfined compressive strengths of different lithologies were approximated using various sources, e.g. NCB Working Party Report - 1972 - Design of Mine Layouts; Adler and Sun, 1968. These are general numbers and are used to approximate the ratio of roof to floor strengths with varying lithologies. Where exact data is available, these should be substituted.

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

d. Critical Span[1] (feet) (HORIZ)

$W = 0.15 (D) + 60$

D = Depth to floor of seam

e. Vertical Extent of Pillar Pressure[2] (PMS) (VERT)

$DT < 0.3 (D) + 120$

D = Depth to floor of PMS

DT = Distance between seams

The coefficients used in the formulas are modified to fit conditions existing in coal Region IIIB (Figure 1). The CLCM was tested against data in Region IIIB and IB.

It is anticipated that if any adjustments are needed among the regions, a 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 (Section I-C).

The CLCM does not take into account the total lithology existing between seams, but concentrates on the roof and floor lithologies of both seams. It is felt 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.

---

[1] 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.

[2] 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.

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APPENDIX B

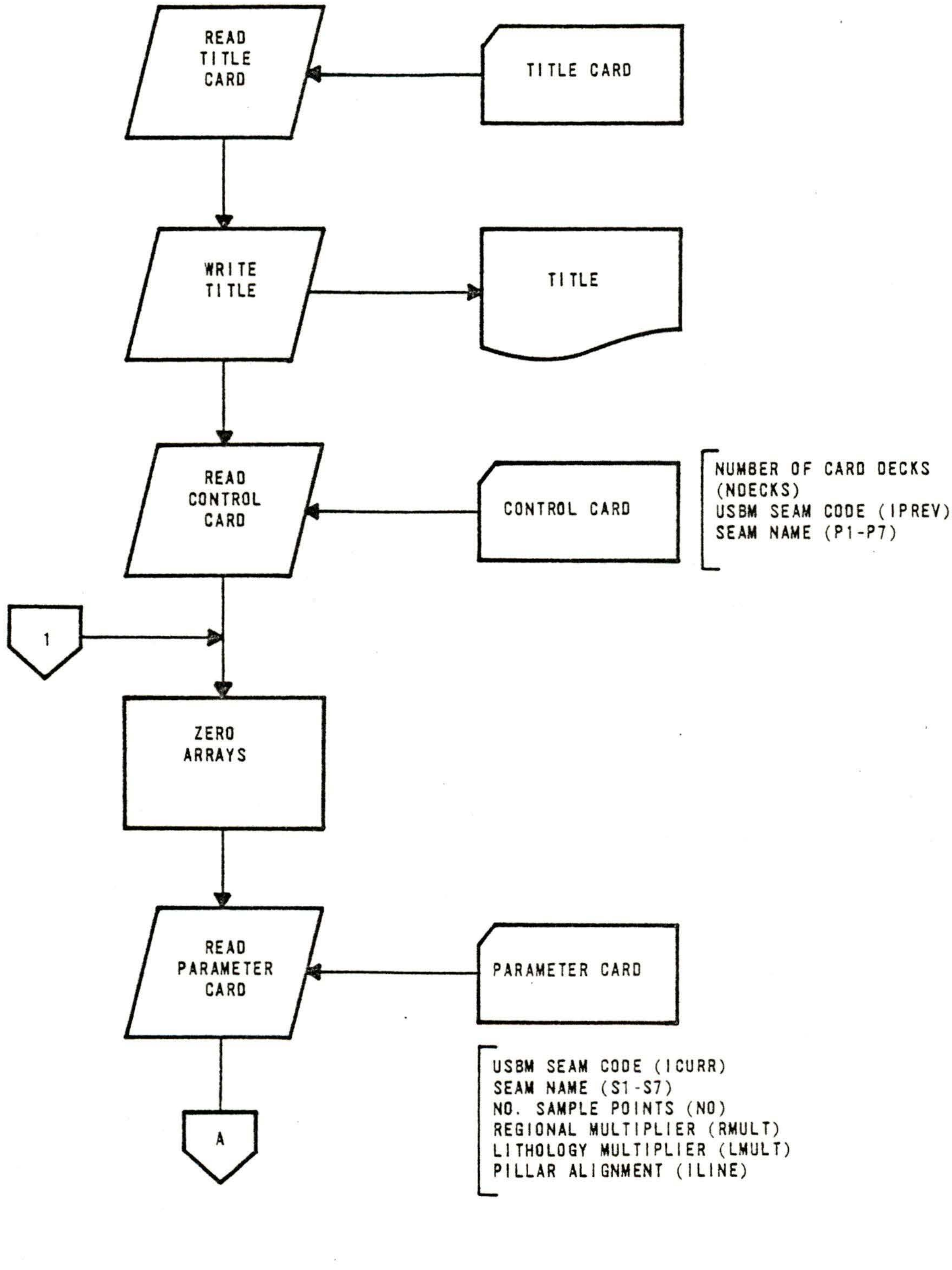
GLOSSARY OF VARIABLE NAMES

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
CMSDT	=	CMS Depth
CMSRAT(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 of 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

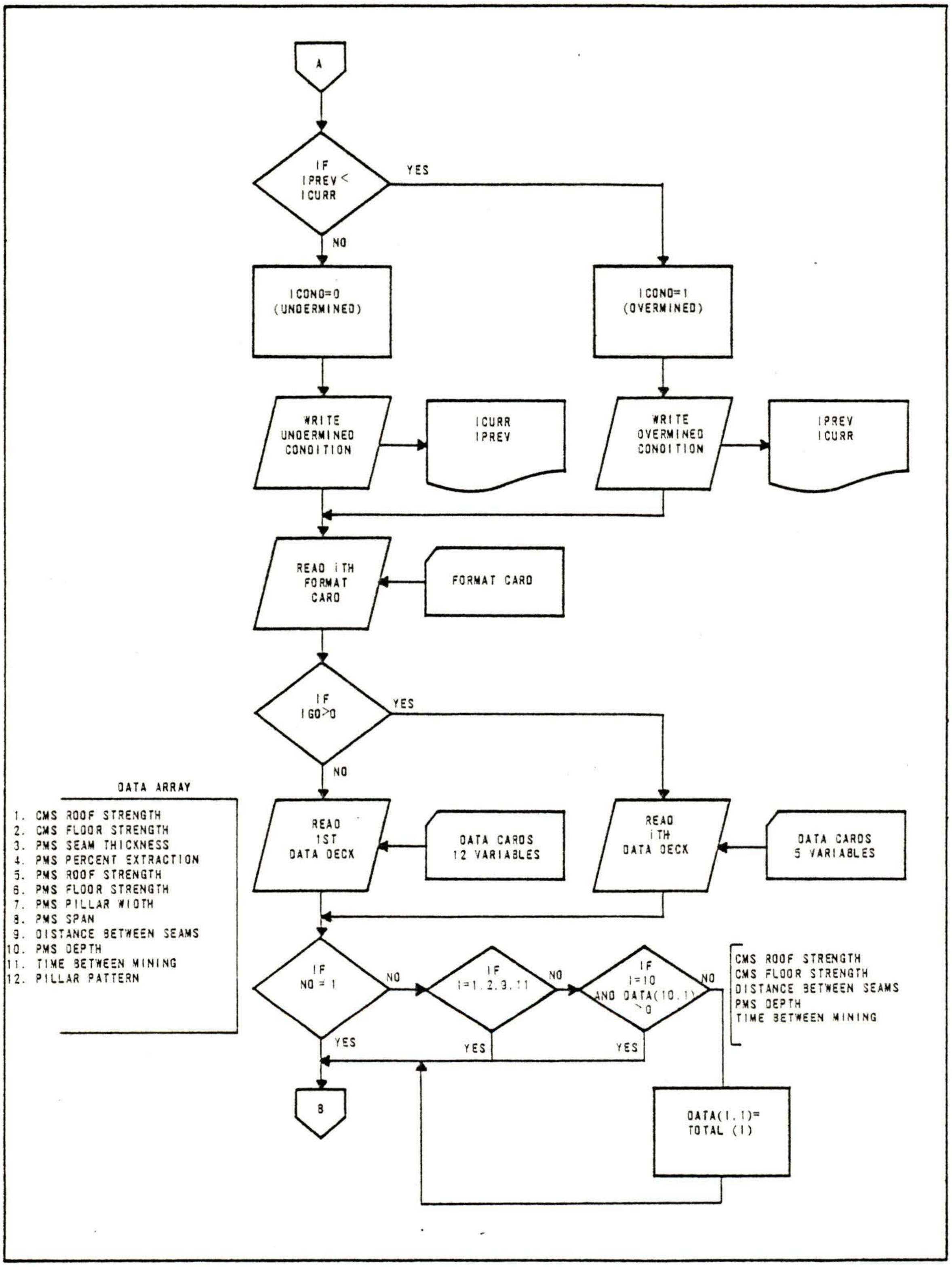
NOTE: (I) and (I,J) are subscripts of array variables.

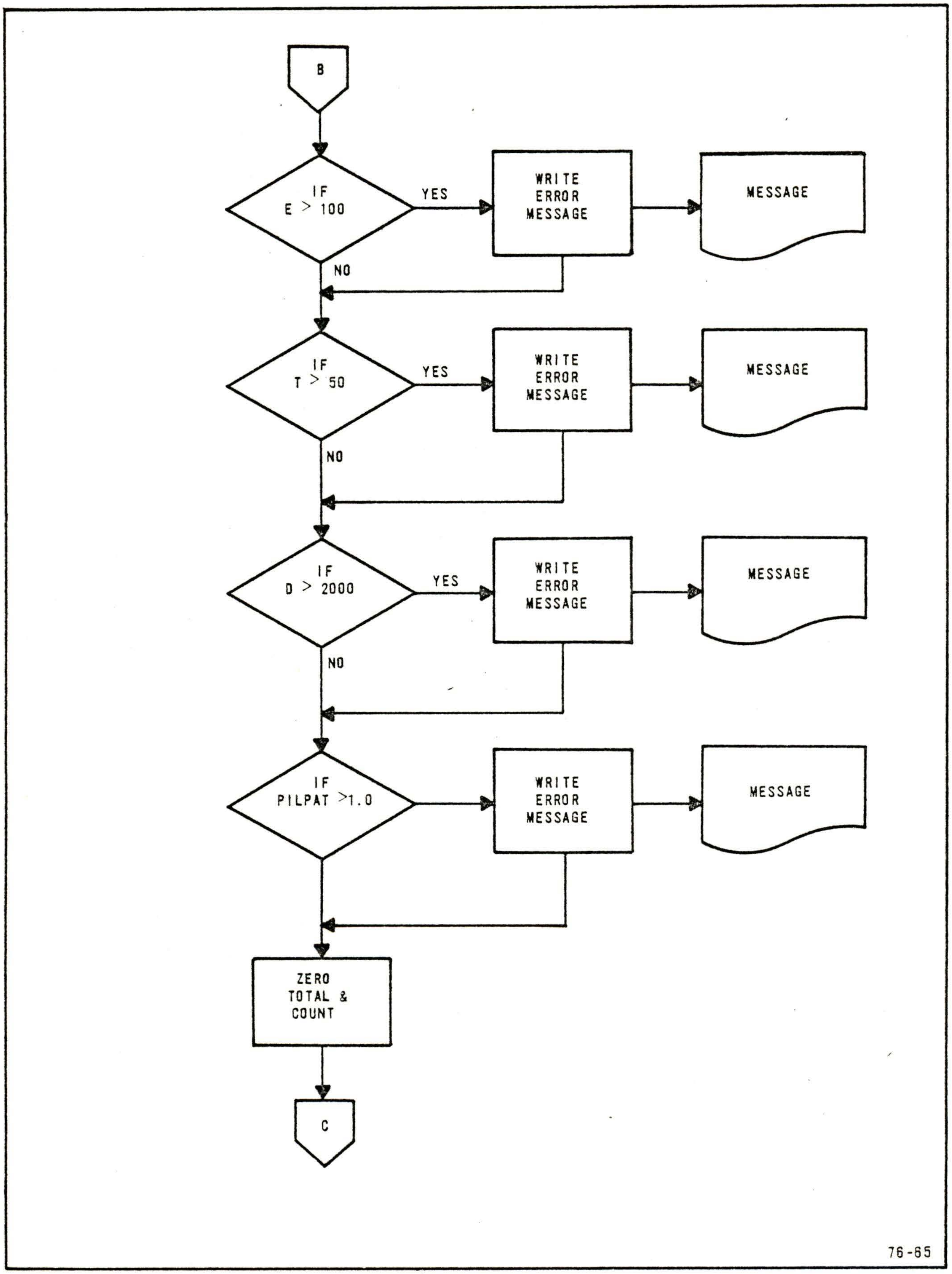
APPENDIX C

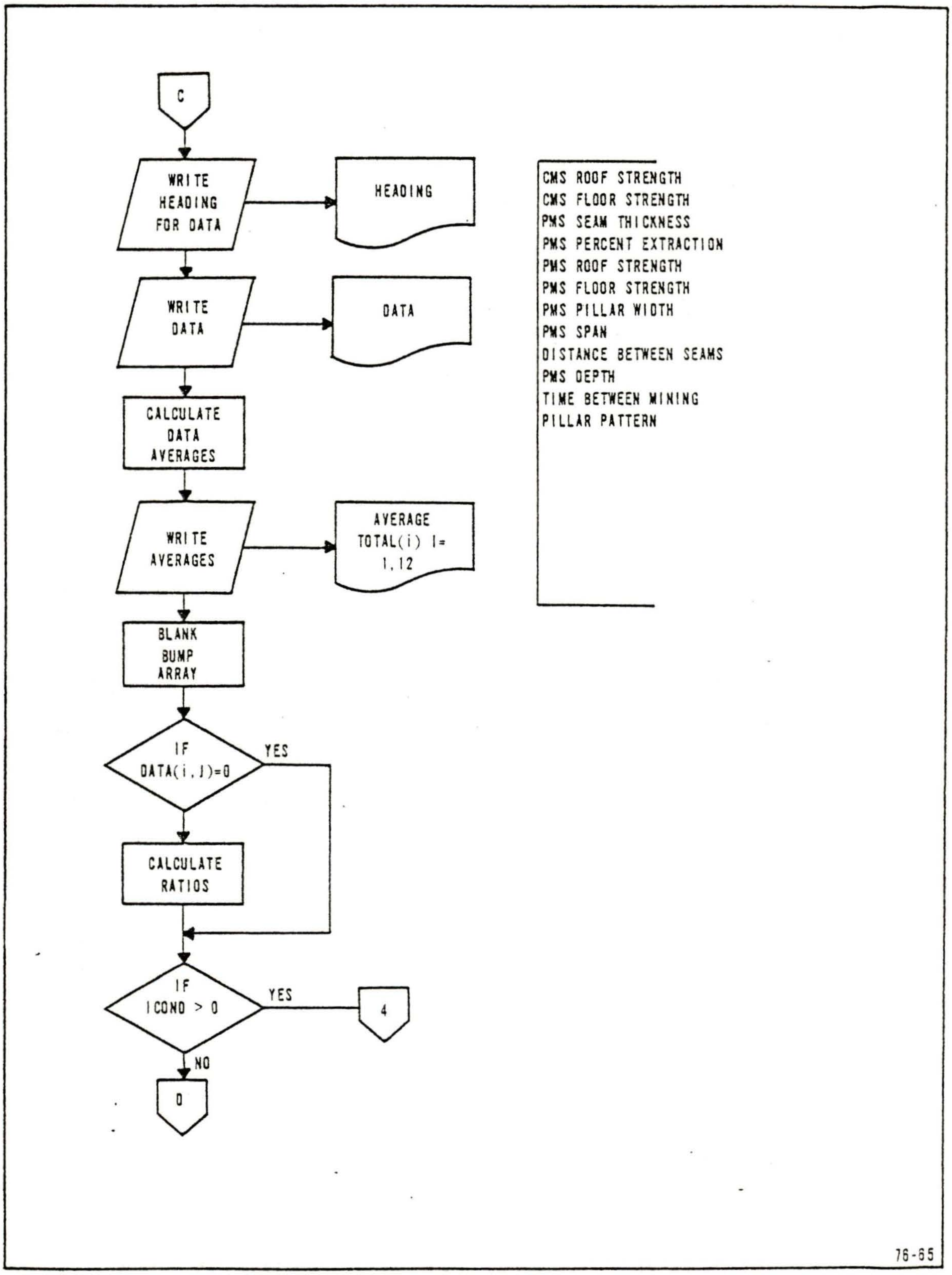
PROGRAM FLOW DIAGRAM

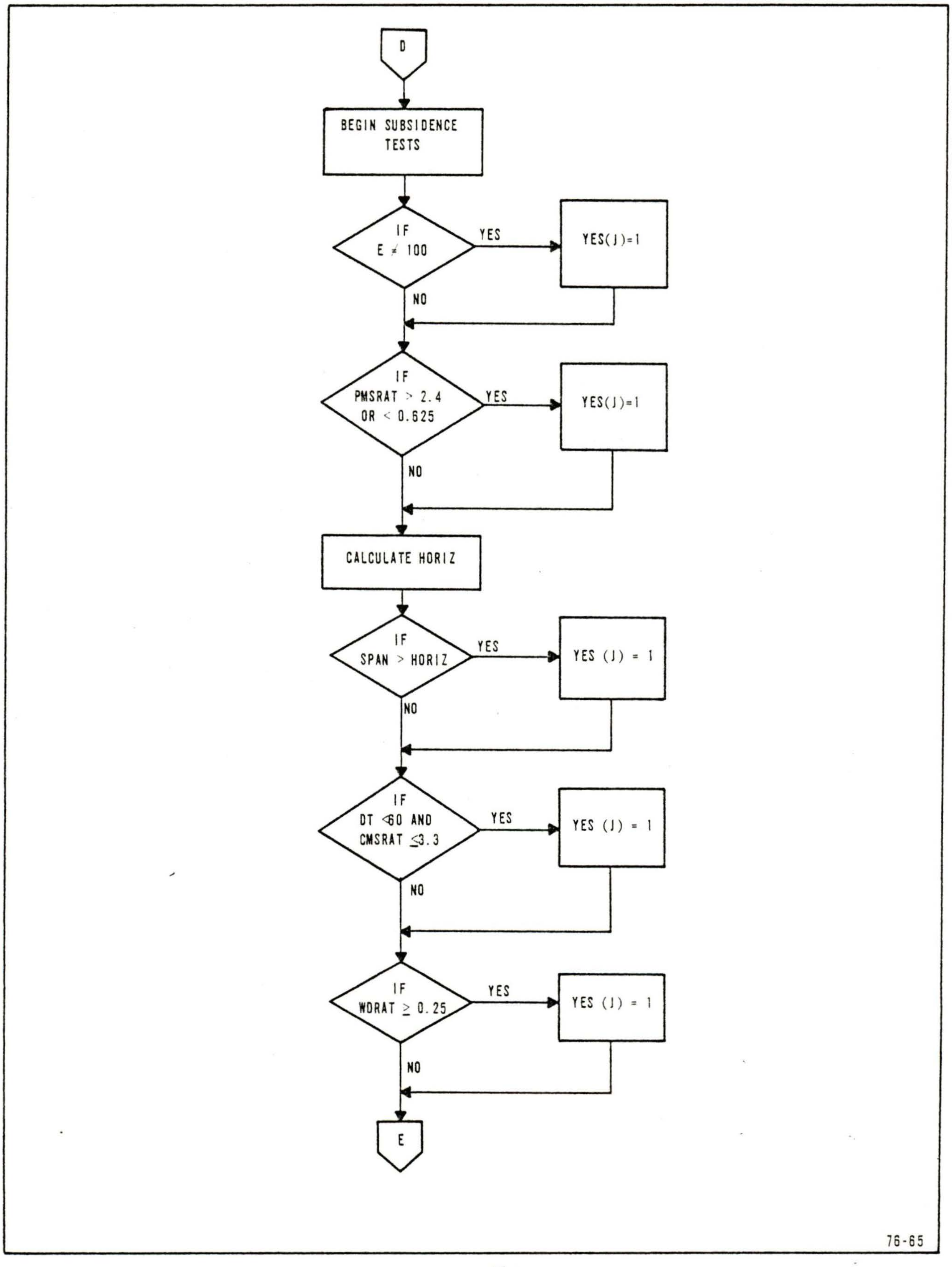


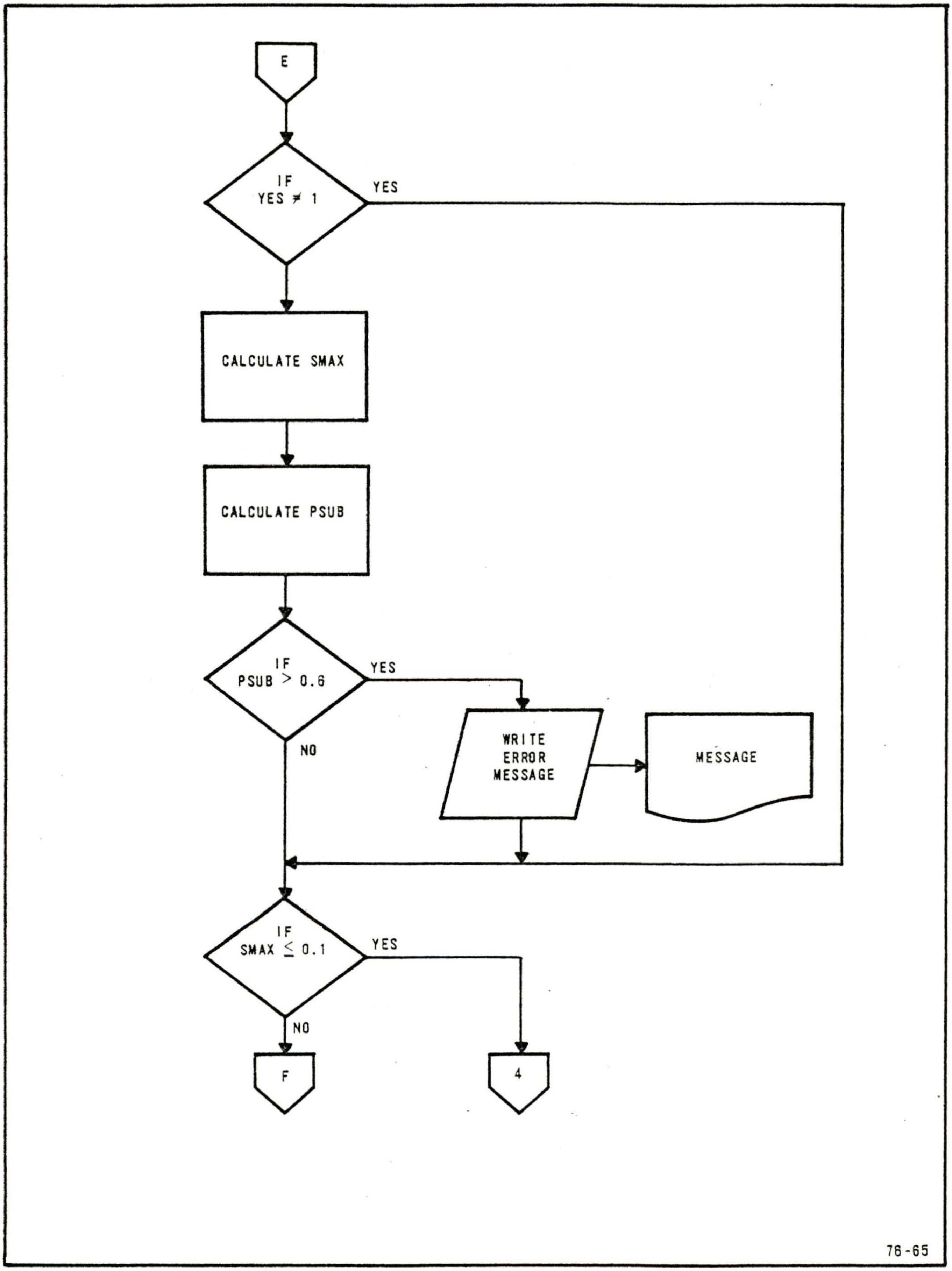
APPENDIX C PROGRAM FLOW DIAGRAM

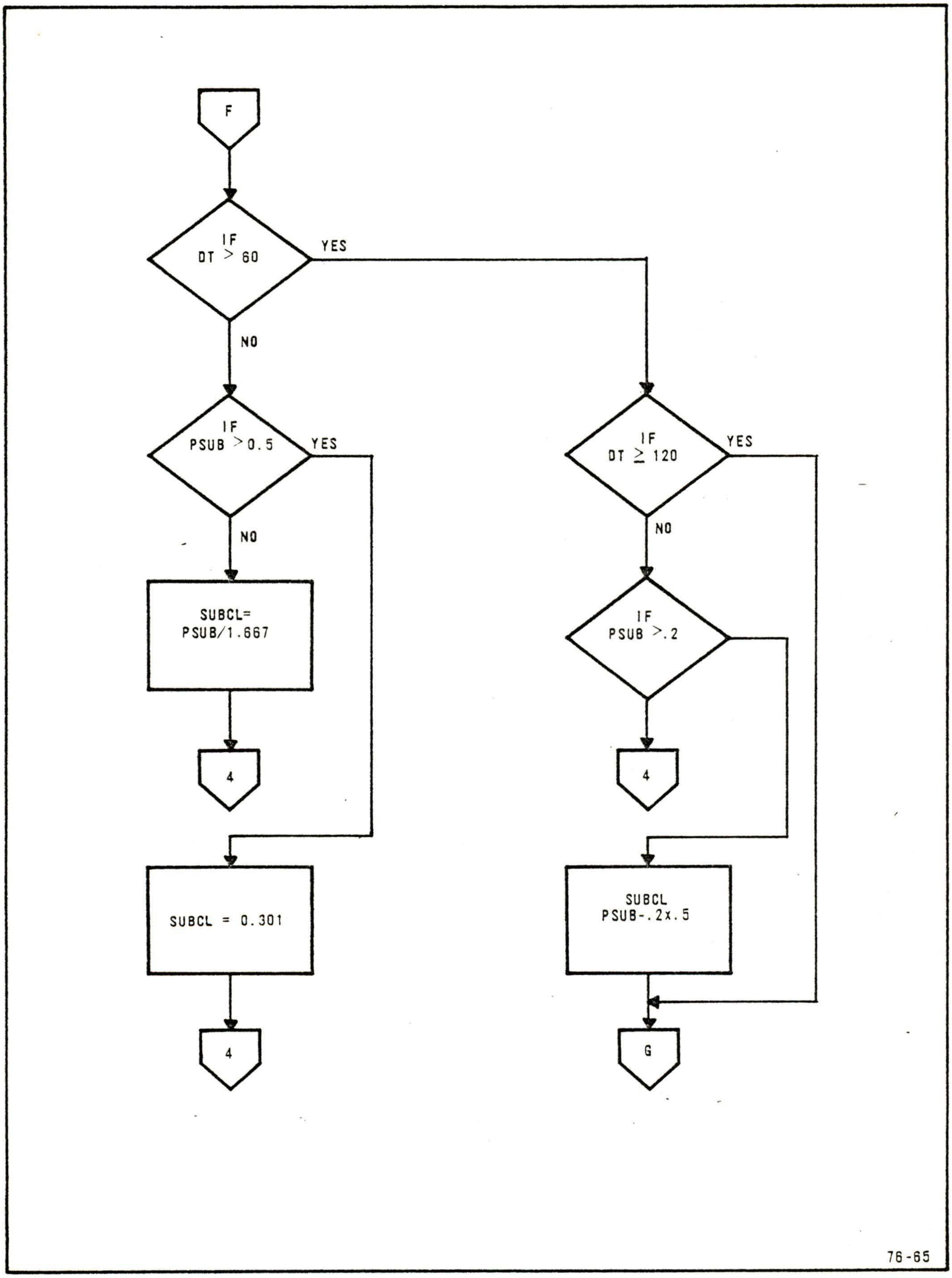

A
IF IPREV < ICURR
YES
NO
ICOND=0 (UNDERMINED)
ICOND=1 (OVERMINED)
WRITE UNDERMINED CONDITION
ICURR IPREV
WRITE OVERMINED CONDITION
IPREV ICURR
READ iTH FORMAT CARD
FORMAT CARD
IF IGO>0
YES
NO
DATA ARRAY
1. CMS ROOF STRENGTH
2. CMS FLOOR STRENGTH
3. PMS SEAM THICKNESS
4. PMS PERCENT EXTRACTION
5. PMS 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
READ 1ST DATA DECK
DATA CARDS 12 VARIABLES
READ iTH DATA DECK
DATA CARDS 5 VARIABLES
IF NO = 1
NO
IF I=1,2,9,11
NO
IF I=10 AND DATA(10,1) >0
NO
CMS ROOF STRENGTH
CMS FLOOR STRENGTH
DISTANCE BETWEEN SEAMS
PMS DEPTH
TIME BETWEEN MINING
YES
YES
YES
B
DATA(I,1)= TOTAL (I)

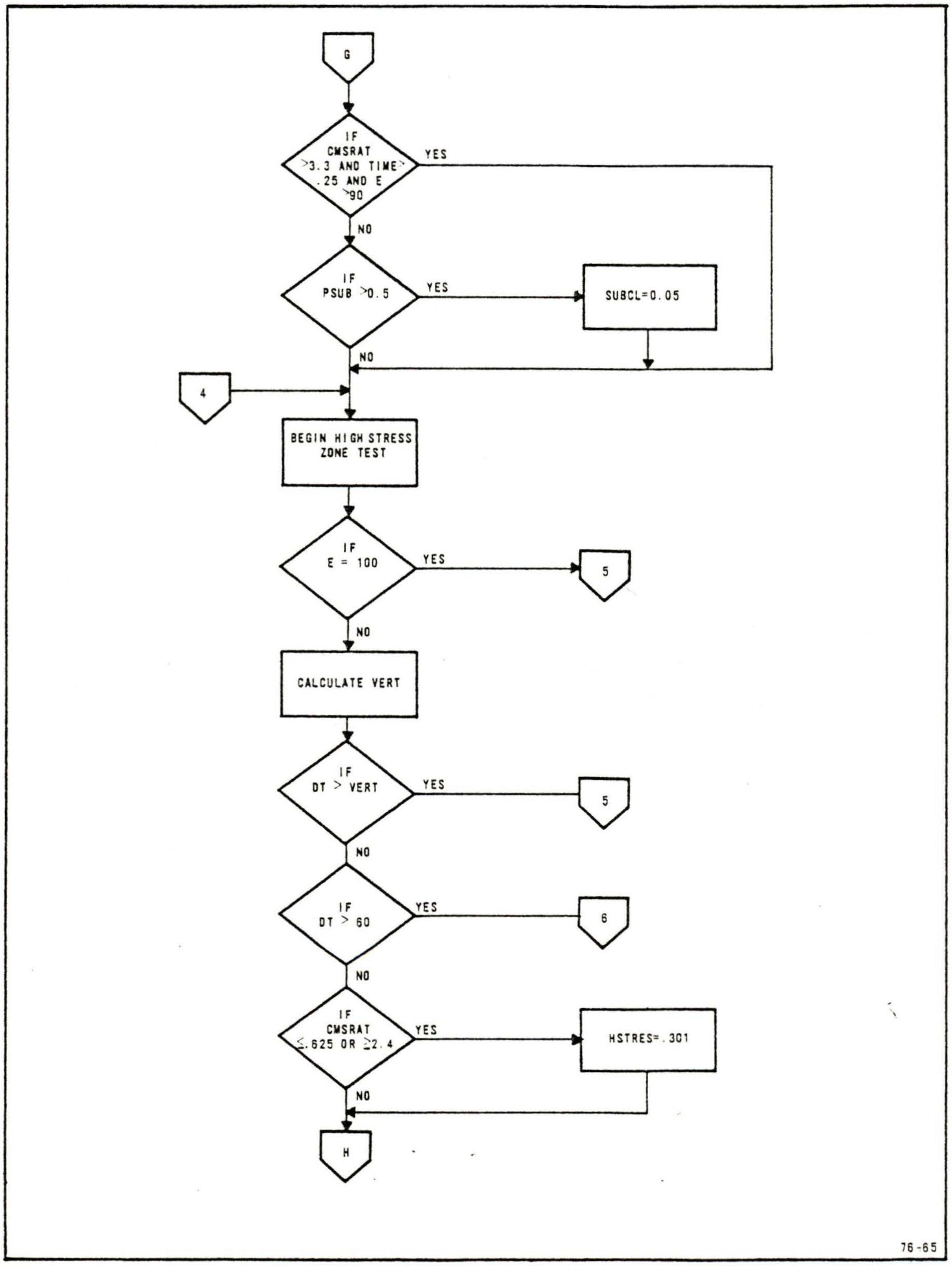

B
IF
E > 100
YES
WRITE
ERROR
MESSAGE
MESSAGE
NO
IF
T > 50
YES
WRITE
ERROR
MESSAGE
MESSAGE
NO
IF
D > 2000
YES
WRITE
ERROR
MESSAGE
MESSAGE
NO
IF
PILPAT >1.0
WRITE
ERROR
MESSAGE
MESSAGE
ZERO
TOTAL &
COUNT
C
76-65

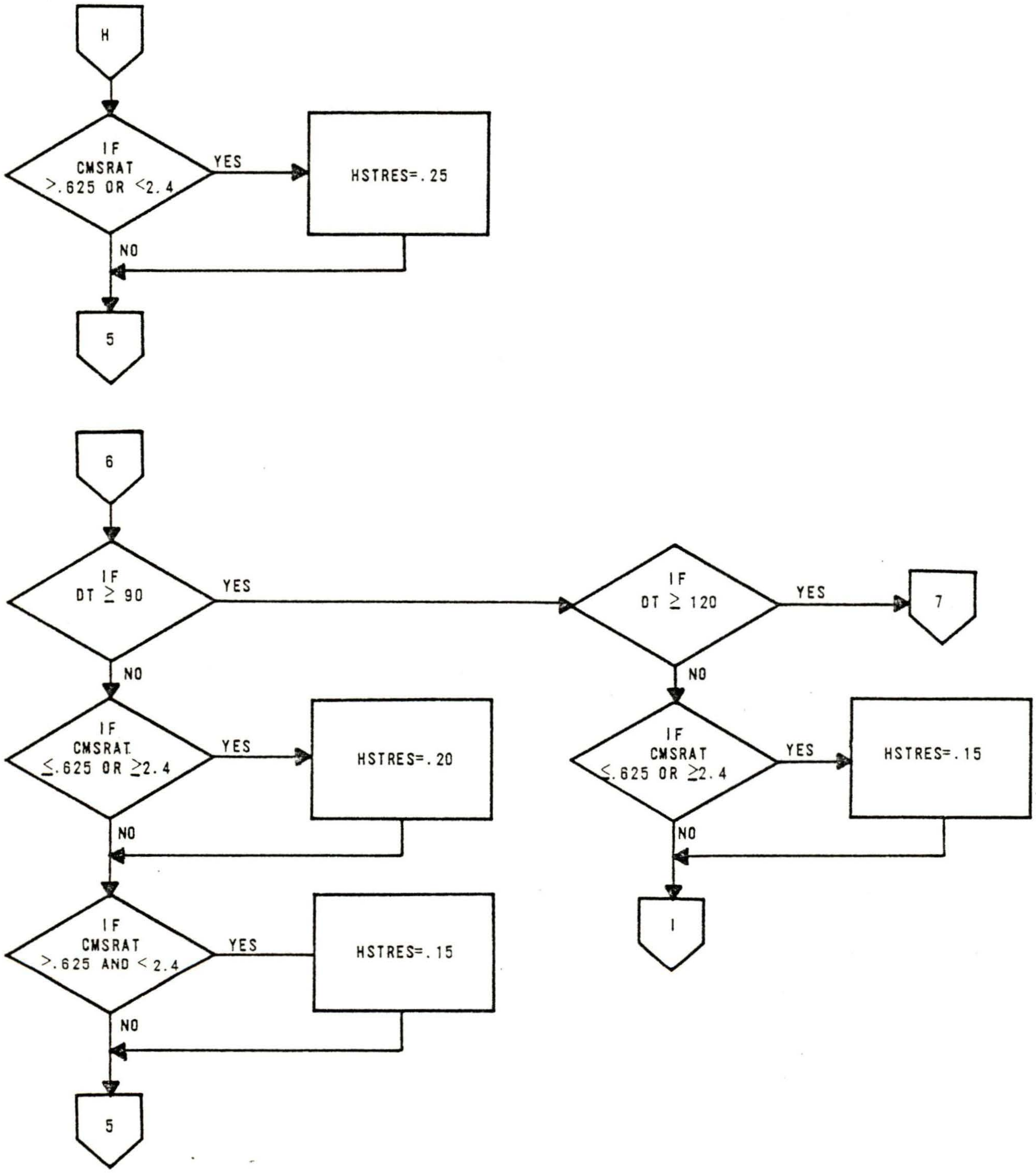

C
WRITE HEADING FOR DATA
HEADING
CMS ROOF STRENGTH
CMS FLOOR STRENGTH
PMS SEAM THICKNESS
PMS PERCENT EXTRACTION
PMS ROOF STRENGTH
PMS FLOOR STRENGTH
PMS PILLAR WIDTH
PMS SPAN
DISTANCE BETWEEN SEAMS
PMS DEPTH
TIME BETWEEN MINING
PILLAR PATTERN
WRITE DATA
DATA
CALCULATE DATA AVERAGES
WRITE AVERAGES
AVERAGE TOTAL(i) I= 1,12
BLANK BUMP ARRAY
IF DATA(i,J)=0
YES
CALCULATE RATIOS
IF ICOND > 0
YES
4
NO
D
76-65


D
BEGIN SUBSIDENCE TESTS
IF E ≠ 100
YES
YES(J)=1
NO
IF PMSRAT > 2.4 OR < 0.625
YES
YES(J)=1
NO
CALCULATE HORIZ
IF SPAN > HORIZ
YES
YES (J) = 1
NO
IF DT <60 AND CMSRAT ≤3.3
YES
YES (J) = 1
NO
IF WDRAT ≥ 0.25
YES
YES (J) = 1
NO
E
76-65

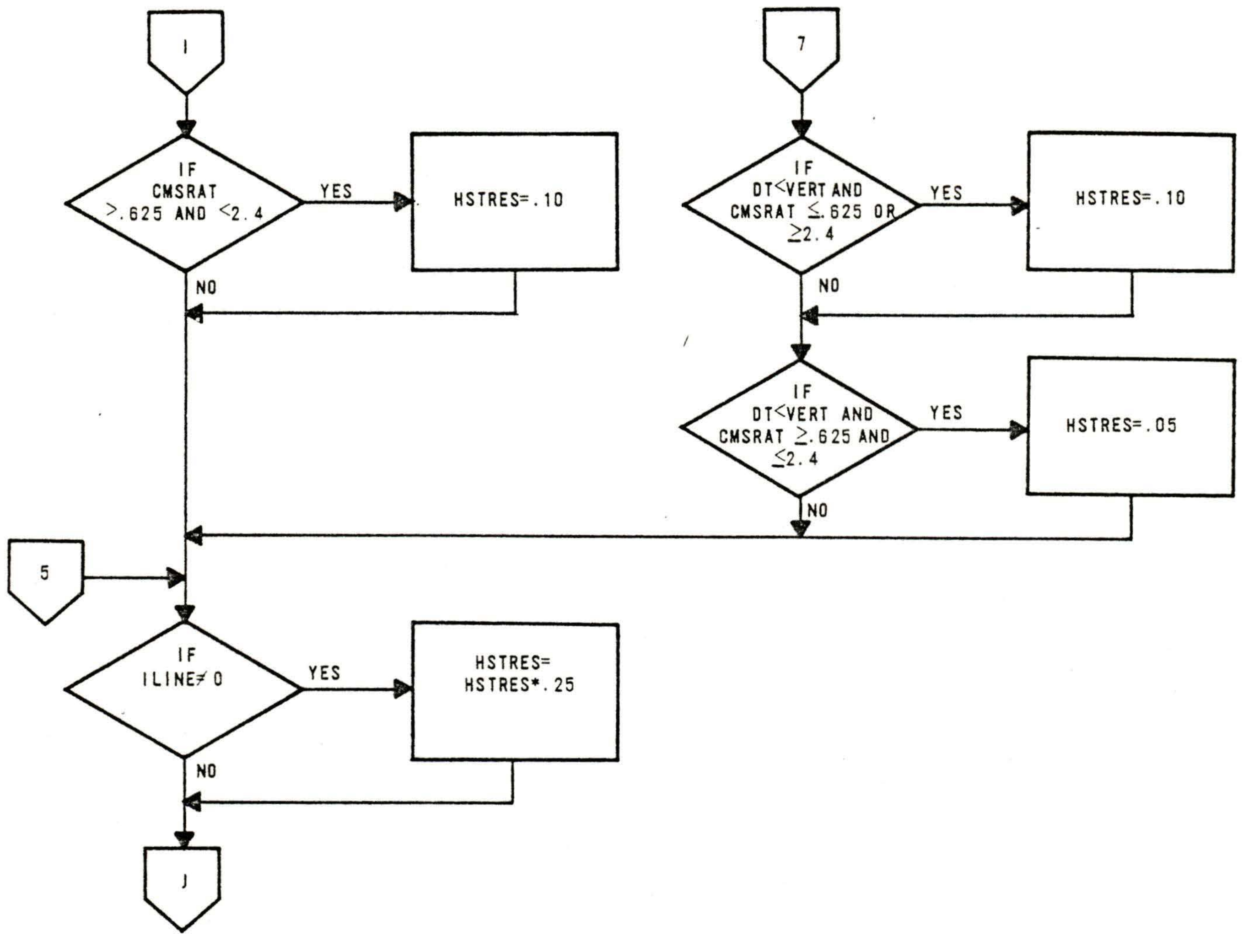

E
IF
YES ≠ 1
YES
CALCULATE SMAX
CALCULATE PSUB
IF
PSUB > 0.6
YES
NO
WRITE
ERROR
MESSAGE
MESSAGE
IF
SMAX ≤ 0.1
YES
NO
F
4
76-65

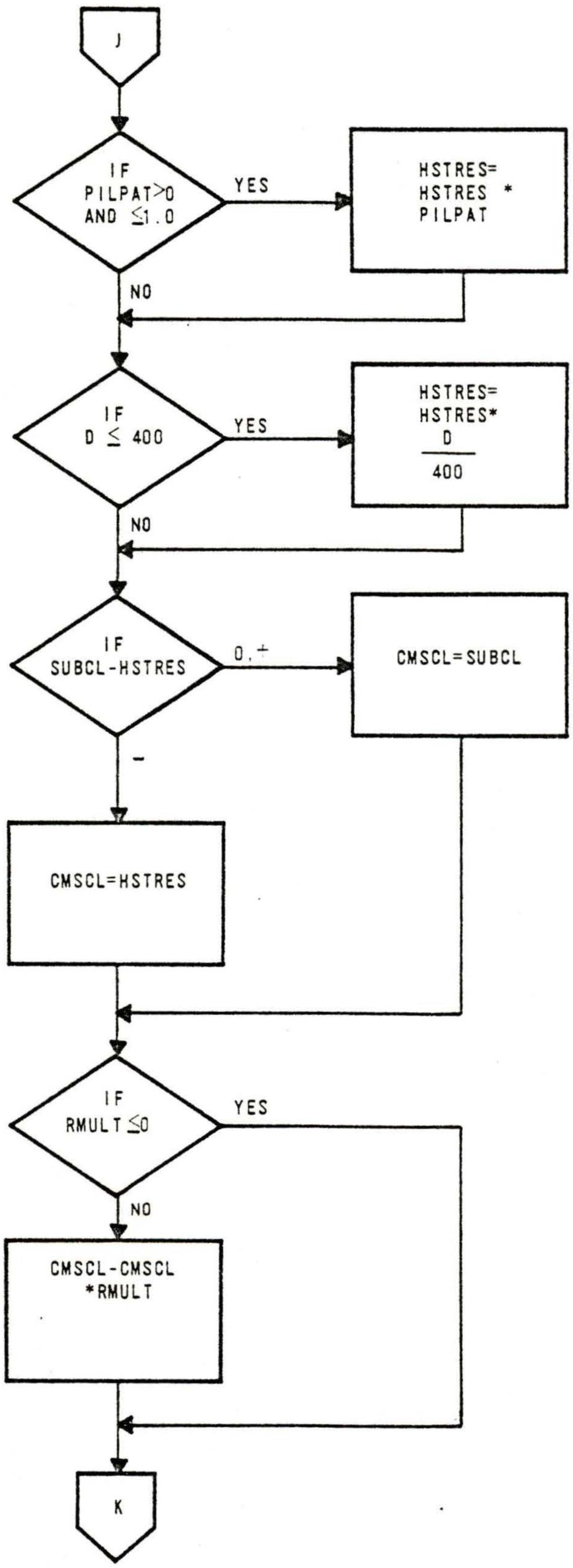

F
IF
DT > 60
YES
NO
IF
PSUB > 0.5
YES
NO
SUBCL=
PSUB/1.667
4
SUBCL = 0.301
4
IF
DT ≥ 120
YES
NO
IF
PSUB >.2
4
SUBCL
PSUB-.2x.5
G
76-65


G
IF CMSRAT >3.3 AND TIME >.25 AND E >90
YES
NO
IF PSUB >0.5
YES
SUBCL=0.05
NO
4
BEGIN HIGH STRESS ZONE TEST
IF E = 100
YES
5
NO
CALCULATE VERT
IF DT > VERT
YES
5
NO
IF DT > 60
YES
6
NO
IF CMSRAT ≤.625 OR ≥2.4
YES
HSTRES=.301
NO
H
76-65

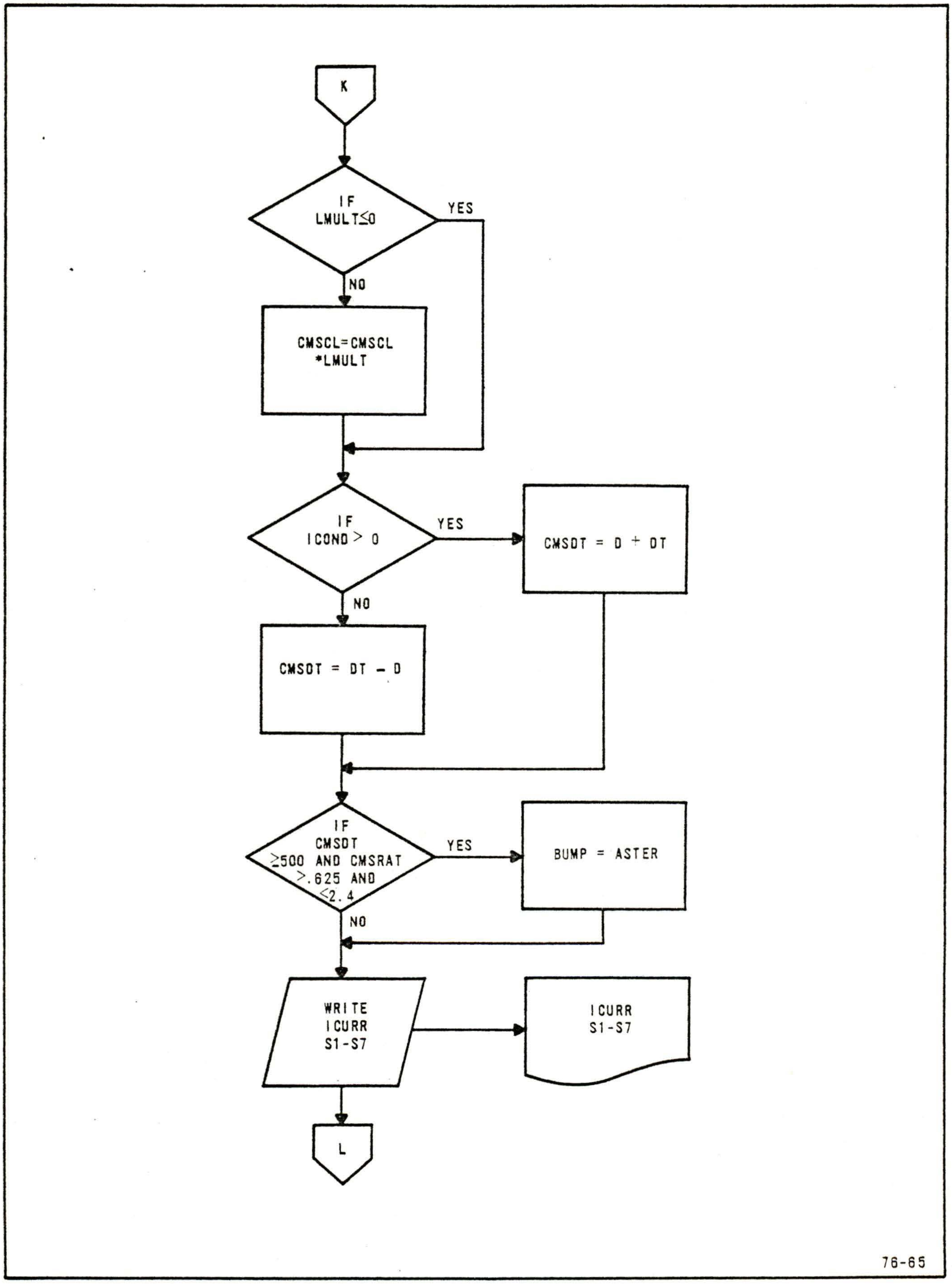

H
IF CMSRAT >.625 OR <2.4
YES
HSTRES=.25
NO
5
6
IF DT ≥ 90
YES
IF DT ≥ 120
YES
7
NO
IF CMSRAT ≤.625 OR ≥2.4
YES
HSTRES=.20
NO
IF CMSRAT >.625 AND <2.4
YES
HSTRES=.15
NO
5
IF CMSRAT ≤.625 OR ≥2.4
YES
HSTRES=.15
NO
I

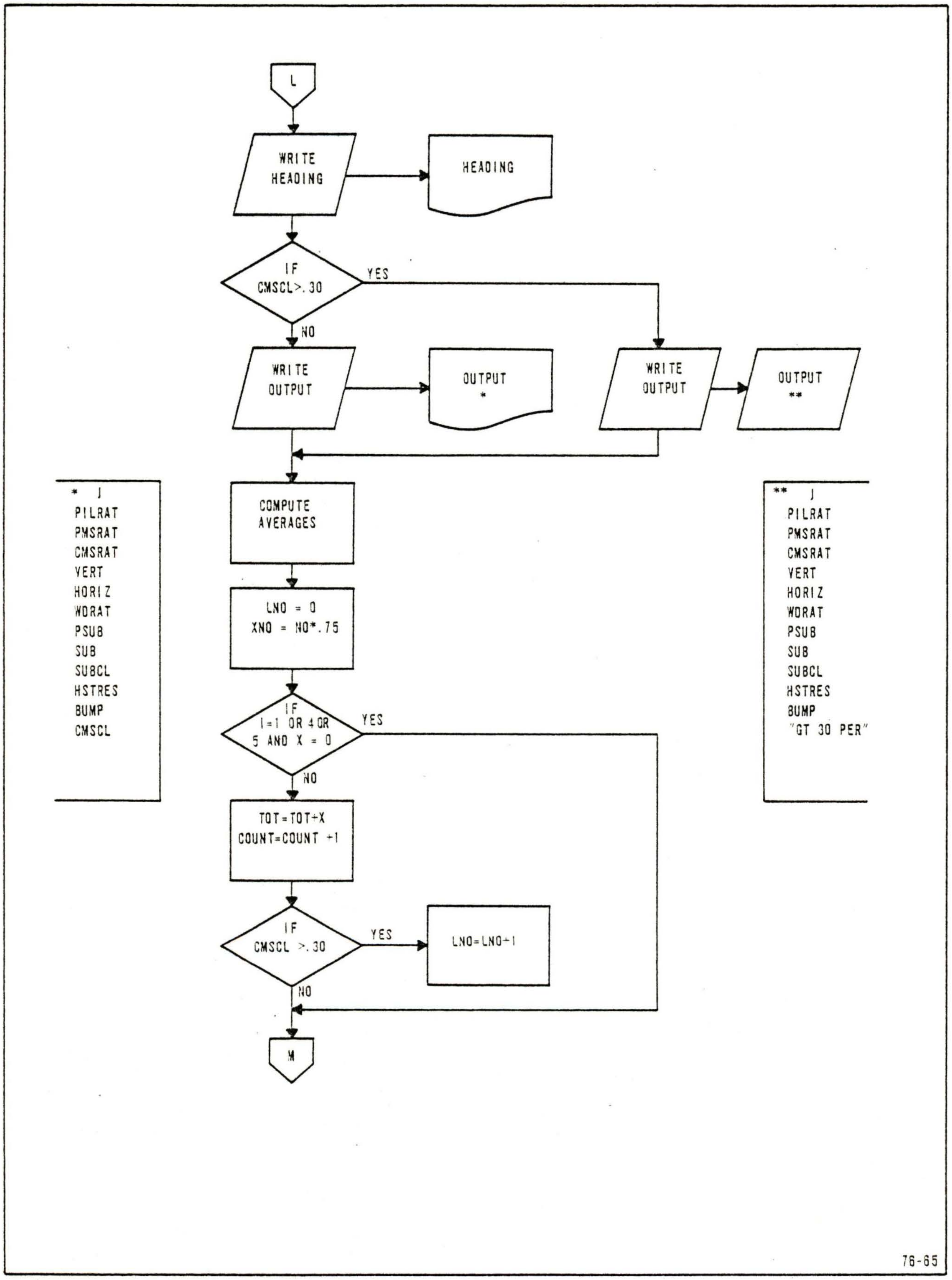
76-65

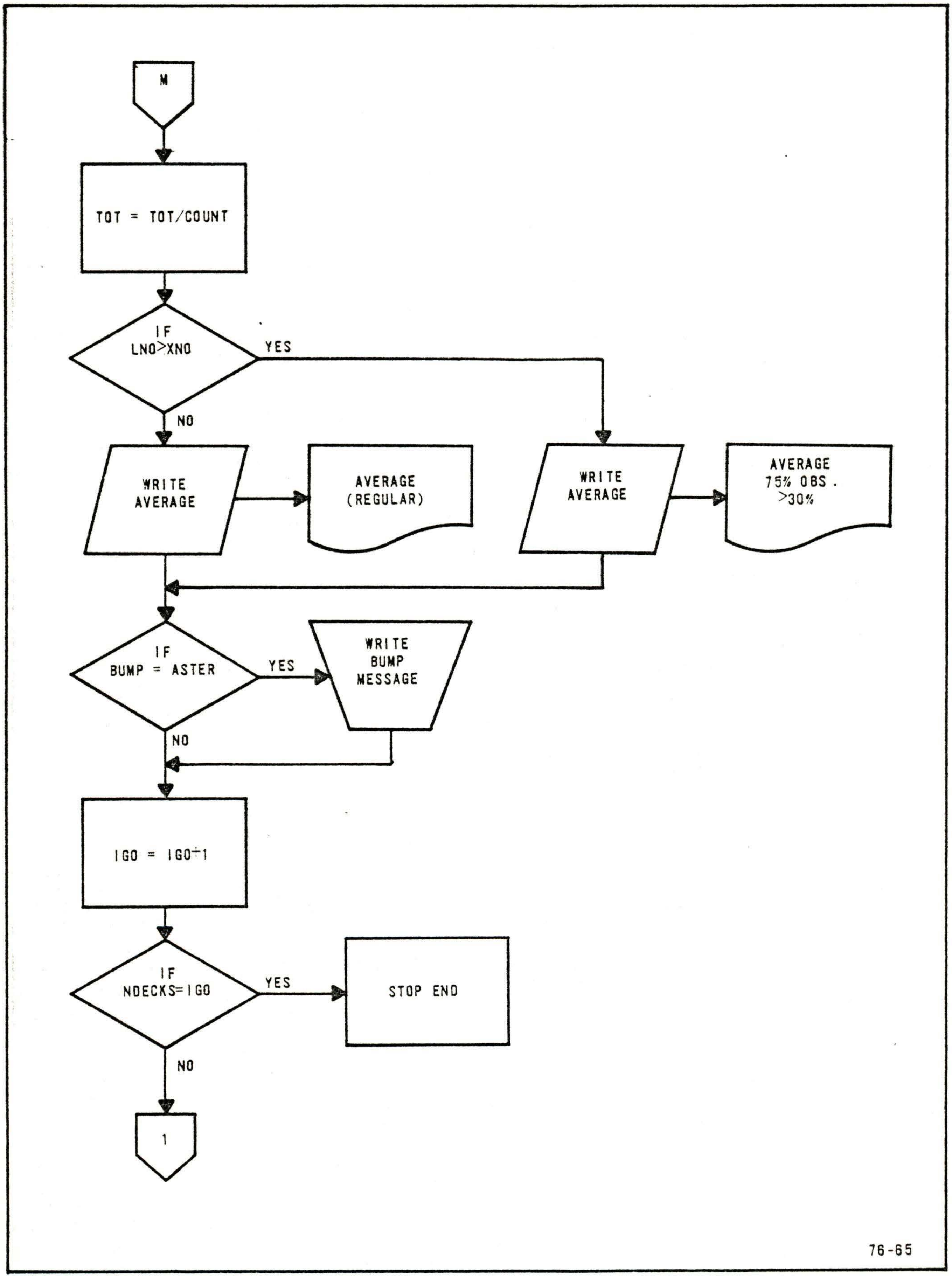

I
IF CMSRAT >.625 AND <2.4
YES
HSTRES=.10
NO
7
IF DT<VERT AND CMSRAT ≤.625 OR ≥2.4
YES
HSTRES=.10
NO
IF DT<VERT AND CMSRAT ≥.625 AND ≤2.4
YES
HSTRES=.05
NO
5
IF ILINE≠0
YES
HSTRES= HSTRES*.25
NO
J
76!76


J
IF
PILPAT>0
AND ≤1.0
YES
HSTRES=
HSTRES *
PILPAT
NO
IF
D ≤ 400
YES
HSTRES=
HSTRES*
D
400
NO
IF
SUBCL-HSTRES
0,+
CMSCL=SUBCL
-
CMSCL=HSTRES
IF
RMULT ≤0
YES
NO
CMSCL-CMSCL
*RMULT
K

76-65


K
IF
LMULT≤0
YES
NO
CMSCL=CMSCL
*LMULT
IF
ICOND > 0
YES
CMSDT = D + DT
NO
CMSDT = DT − D
IF
CMSDT
≥500 AND CMSRAT
>.625 AND
<2.4
YES
BUMP = ASTER
NO
WRITE
ICURR
S1-S7
ICURR
S1-S7
L
76-65


L
WRITE HEADING
HEADING
IF CMSCL>.30
YES
NO
WRITE OUTPUT
OUTPUT *
WRITE OUTPUT
OUTPUT **
* J
PILRAT
PMSRAT
CMSRAT
VERT
HORIZ
WDRAT
PSUB
SUB
SUBCL
HSTRES
BUMP
CMSCL
COMPUTE AVERAGES
LNO = 0
XNO = NO*.75
IF I=1 OR 4 OR 5 AND X = 0
YES
NO
** J
PILRAT
PMSRAT
CMSRAT
VERT
HORIZ
WDRAT
PSUB
SUB
SUBCL
HSTRES
BUMP
"GT 30 PER"
TOT=TOT+X
COUNT=COUNT +1
IF CMSCL >.30
YES
LNO=LNO+1
NO
M
76-65


M
TOT = TOT/COUNT
IF
LNO>XNO
YES
NO
WRITE
AVERAGE
AVERAGE
(REGULAR)
WRITE
AVERAGE
AVERAGE
75% OBS.
>30%
IF
BUMP = ASTER
YES
WRITE
BUMP
MESSAGE
NO
IGO = IGO+1
IF
NDECKS=IGO
YES
STOP END
NO
1
76-65

APPENDIX D

PROGRAM LISTING

```
                 C
                 C
                 C  COAL LOSS CALCULATION MODEL
                 C
                 C
0001                   DIMENSION TITLE(20), FMT(20), DATA(12,50), SUB(50), PILRAT(50),
                      1CMSCL(50), YES(50), PMSRAT(50), HSTRES(50),X(50,11), SUBCL(50),
                      2HORIZ(50),VERT(50),CMSRAT(50),WDRAT(50),PSUB(50),BUMP(50),
                      3TOT(11),     TOTAL(12),COUNT(12)
0002                   EQUIVALENCE(X(1,1),PILRAT(1)),(X(1,2),PMSRAT(1)),(X(1,3),CMSRAT(1)
                      1),(X(1,4),VERT(1)),(X(1,5),HORIZ(1)),(X(1,6),WDRAT(1)),(X(1,7),
                      2PSUB(1)),(X(1,8),SUB(1)),(X(1,9),SUBCL(1)),(X(1,10),HSTRES(1)),
                      3(X(1,11),CMSCL(1))
0003                   DATA BLANK/4H    /,ASTER/1H*/
0004                   REAL LMULT
                 C
                 C  GLOSSARY OF VARIABLES
                 C
                 C    ASTER= ASTERISK VALUE
                 C    BLANK= BLANK VALUE
                 C    BUMP(I)= INDICATION OF POTENTIAL BUMP DUE TO EXISTING CONDITIONS
                 C    CMS = CURRENTLY MINED SEAM OR RESERVE SEAM
                 C    CMSCL(I)= CMS COAL LOSS
                 C    CMSDT= CMS DEPTH
                 C    CMSRAT(I)= CMS ROOF TO FLOOR STRENGTH RATIO
                 C    DATA(I,J)= DATA VALUES
                 C    FUNC= CALCULATION TO DETERMINE SUBSIDENCE FOR A GIVEN W/D RATIO
                 C    HORIZ(I)= CRITICAL SPAN OR MAXIMUM HORIZONTAL EXTENT OF THE PRESSURE ARCH
                 C    HSTRES(I)= HIGH STRESS COAL LOSS
                 C    ICOND= OVERMINED OR UNDERMINED CONDITION
                 C    ICURR = USBM SEAM CODE (CURRENTLY MINED OR RESERVE SEAM)
                 C    ILINE= PILLAR ALIGNMENT
                 C    IPREV= USBM SEAM CODE (PREVIOUSLY MINED SEAM)
                 C    LMULT = LITHOLOGY MULTIPLIER
                 C    NDECKS = NUMBER OF DATA SETS OR RESERVE SEAMS
                 C    NO = NUMBER OF SAMPLE POINTS
                 C    PILPAT(J)= PILLAR PATTERN AND UNIFORMITY MULTIPLIER
                 C    PILRAT(I)= PMS PILLAR STRENGTH TO LOAD RATIO
                 C    PMS = PREVIOUSLY MINED SEAM
                 C    PMSRAT(I)= PMS ROOF TO FLOOR STRENGTH RATIO
                 C    PSUB(I)=  MAXIMUM SUBSIDENCE DIVIDED BY SEAM THICKNESS (SMAX/T)
                 C    RMULT = REGIONAL MULTIPLIER
                 C    SNAME= SEAM NAME
                 C    SUB(J)= MAXIMUM SUBSIDENCE
                 C    SUBCL(I)= SUBSIDENCE COAL LOSS
                 C    TOT = TOTAL COAL LOSS
                 C    VERT(I)= MAXIMUM VERTICAL EXTENT OF THE PRESSURE ARCH
                 C    WDRAT(I)= PMS WIDTH TO DEPTH RATIO
                 C
                 C*************************************************
                 C
                 C
0005                   IRD=5
0006                   IPR=6
                 C*************** CARD INPUT ***************
                 C
                 C  A TITLE CARD MUST BE INCLUDED.  IT IS THE 1ST CARD READ.  COLS. 1-80
                 C    CAN BE ANY DESIRED TITLE.
```

```
            C
            C  CONTROL CARD. (ONE CONTROL CARD PER RUN)
            C    COL 1-2   NUMBER OF CARD DECKS.(EQUALS NO. OF RESERVE SEAMS)
            C    COL 4-6   USBM SEAM CODE  (PREVIOUSLY MINED SEAM)
            C    COL 8-35  SEAM NAME  (PREVIOUSLY MINED SEAM)
            C
            C  PARAMETER CARD. (INCLUDE ONE FOR EACH RESERVE SEAM BEFORE EACH CARD DECK)
            C    COL 1-3   USBM SEAM CODE (CURRENTLY MINED OR RESERVE SEAM)
            C    COL 5-30  SEAM NAME  (CURRENTLY MINED OR RESERVE SEAM)
            C    COL 39-40 NUMBER OF SAMPLE POINTS
            C    COL 46-50 REGIONAL MULTIPLIER (IF NONE, LEAVE BLANK)
            C    COL 56-60 LITHOLOGY MULTIPLIER (IF NONE, LEAVE BLANK)
            C    COL 70    ALIGNMENT OF PILLARS = 1
            C              (IF NOT ALIGNED, LEAVE BLANK)
            C
            C  INPUT DATA FORMAT CARD NO. 1.  COL 1-80  EG. (10F8.0/2F8.0)
            C
            C  FIRST SEAM DATA CARDS
            C              (THESE DATA ARE ONLY INPUT ONCE EVEN THOUGH DATA FROM SEVERAL
            C              RESERVE SEAMS MAY FOLLOW)
            C              CMS ROOF STRENGTH
            C              CMS FLOOR STRENGTH
            C              PMS SEAM THICKNESS
            C              PMS PERCENT EXTRACTION
            C              PMS FLOOR STRENGTH
            C              PMS ROOF STRENGTH
            C              PMS PILLAR WIDTH
            C              PMS SPAN
            C              PMS DEPTH BELOW THE SURFACE
            C              VERTICAL DISTANCE BETWEEN THE SEAMS
            C              TIME ELAPSED BETWEEN MINING  (IF THE SEAM IS A RESERVE SEAM...
            C                INCLUDE TIME ELAPSED FROM PMS MINING TO PRESENT DATE)
            C              PILLAR PATTERN MULTIPLIER (LEAVE BLANK IF NOT DESIRED)
            C
            C
            C  SECOND OR SUCCESSIVE PARAMETER CARD
            C
            C  INPUT DATA FORMAT CARD NO. 2   COL 1-80  EG. (5F10.0)
            C
            C  SUCCESSIVE SEAM DATA CARDS
            C              CMS ROOF STRENGTH
            C              CMS FLOOR STRENGTH
            C              VERTICAL DISTANCE BETWEEN THE SEAMS
            C              PMS DEPTH BELOW THE SURFACE
            C              TIME ELAPSED BETWEEN MINING  (IF THE SEAM IS A RESERVE SEAM...
            C                INCLUDE TIME ELAPSED FROM PMS MINING TO PRESENT DATE)
            C
            C***************************************************
            C
            C
            C  READ AND WRITE TITLE CARD
            C
0007              READ(IRD,1) TITLE
0008            1 FORMAT(20A4)
0009              WRITE(IPR,2) TITLE
0010            2 FORMAT(1H1///////////////////////////50X,20A4)
            C
            C  READ CONTROL CARD
```

```
C
      READ(IRD,7) NDECKS, IPREV, P1,P2,P3,P4,P5,P6,P7
    7 FORMAT(I2,1X,I3,1X,7A4)
      IGO=0
C
C  ZERO ARRAYS
C
  508 DO 9005 J= 1,50
      DO 9006 I= 1,11
      X(J,I)=0.0
 9006 CONTINUE
 9005 CONTINUE
      DO 500 I= 1,50
      YES(I)=0.0
  500 CONTINUE
C
C  READ PARAMETER CARD
C
      READ(IRD,3) ICURR, S1,S2,S3,S4,S5,S6,S7,        NO, RMULT, LMULT,
     1      ILINE
    3 FORMAT(I3,1X,6A4,A2,8X,I2,5X,F5.0,5X,F5.0,9X,I1)
C
C  TEST FOR CONDITION
C
      IF(IPREV.LT.ICURR) GO TO 1010
      ICOND =0
      GO TO 1011
 1010 ICOND=1
 1011 CONTINUE
      IF(IGO.LE.0) GO TO 2049
      WRITE(IPR,2048)
 2048 FORMAT(1H1,/////////////////////////)
 2049 IF(ICOND.NE.0) GO TO 2050
C
C  UNDERMINED CONDITION
C
      WRITE(IPR,2051)
 2051 FORMAT(//,52X,'UNDERMINED CONDITION'/ 52X,20(1H-)//)
      IF(ICURR.LT.100) GO TO 8075
      WRITE(IPR,2052) ICURR, S1,S2,S3,S4,S5,S6,S7
 2052 FORMAT(35X,I3,2X,6A4,A2,2X,'CURRENTLY MINED OR RESERVE SEAM'//)
      GO TO 8077
 8075 IF(ICURR.LT.10)WRITE(IPR,9890) ICURR,S1,S2,S3,S4,S5,S6,S7
 9890 FORMAT(34X,'00',I1,2X,6A4,A2,2X,'CURRENTLY MINED OR RESERVE SEAM'/
     1/)
      IF(ICURR.GT.9)WRITE(IPR,8078)ICURR,S1,S2,S3,S4,S5,S6,S7
 8078 FORMAT(34X,'0',I2,2X,6A4,A2,2X,'CURRENTLY MINED OR RESERVE SEAM'//
     1)
 8077 IF(IPREV.LT.100) GO TO 8080
      WRITE(IPR,2057)IPREV,P1,P2,P3,P4,P5,P6,P7
      GO TO 2055
 8080 IF(IPREV.LT.10)WRITE(IPR,9891) IPREV,P1,P2,P3,P4,P5,P6,P7
 9891 FORMAT(34X,'00',I1,2X,7A4,2X,'PREVIOUSLY MINED SEAM'//)
      IF(IPREV.GT.9)WRITE(IPR,8081)IPREV,P1,P2,P3,P4,P5,P6,P7
 8081 FORMAT(34X,'0',I2,2X,7A4,2X,'PREVIOUSLY MINED SEAM'//)
      GO TO 2055
 2050 CONTINUE
C
```

```
C   OVERMINED CONDITION
C
      WRITE(IPR,2056)
 2056 FORMAT(// 52X,'OVERMINED CONDITION'/ 52X 19(1H-)//)
      IF(IPREV.LT.100) GO TO 8082
      WRITE(IPR,2057) IPREV,P1,P2,P3,P4,P5,P6,P7
 2057 FORMAT(35X,I3,2X,7A4,2X,'PREVIOUSLY MINED SEAM'//)
      GO TO 8083
 8082 IF(IPREV.LT.10)WRITE(IPR,9891)IPREV,P1,P2,P3,P4,P5,P6,P7
      IF(IPREV.GT.9)WRITE(IPR,8081)IPREV,P1,P2,P3,P4,P5,P6,P7
 8083 IF(ICURR.LT.100) GO TO 8084
      WRITE(IPR,2052)ICURR,S1,S2,S3,S4,S5,S6,S7
      GO TO 2055
 8084 IF(ICURR.LT.10)WRITE(IPR,9890)ICURR,S1,S2,S3,S4,S5,S6,S7
      IF(ICURR.GT.9)WRITE(IPR,8078)ICURR,S1,S2,S3,S4,S5,S6,S7
 2055 CONTINUE
C
C   READ FORMAT CARD FOR DATA
C
      READ(IRD,1) FMT
C
C   READ DATA CARDS
C
      IF(IGO.GT.0) GO TO 910
      DO 10 J=1,NO
      READ(IRD,FMT)          (DATA(I,J), I=1,12)
   10 CONTINUE
      GO TO 912
C
C      READ CARDS FOR 2ND TO NTH SEAM
C
  910 DO 911 J=1,NO
      READ(IRD,FMT) DATA(1,J),DATA(2,J),DATA(9,J),DATA(10,J),DATA(11,J)
  911 CONTINUE
C
C   FOR A SEAM WITH ONLY ONE OBSERVATION , TRANSFER AVERAGE PMS DATA VALUES
C     IN TO DATA(I,J)
C
      IF(NO.NE.1) GO TO 912
      DO 3000 I= 1,12
      IF(I.EQ.1.OR.I.EQ.2.OR.I.EQ.9.OR.I.EQ.11) GO TO 3000
      IF(I.EQ.10.AND.DATA(10,1).GT.0.0)GO TO 3000
      DATA(I,1) = TOTAL(I)
 3000 CONTINUE
  912 CONTINUE
C
C   CHECK DATA INPUT
C
      DO 8056 J= 1,NO
      IF(DATA(4,J).GT.100.0) WRITE(IPR,8057) J
 8057 FORMAT(/////40X,'PERCENTAGE EXTRACTION GREATER THAN 100--SAMPLE NO
     1. ',I2)
C
      IF(DATA(3,J).GT.50.0) WRITE(IPR,8058) J
 8058 FORMAT(/////40X,'PMS SEAM THICKNESS GREATER THAN 50 FEET--SAMPLE N
     1O. ',I2)
C
      IF(DATA(10,J).GT.2000.0) WRITE(IPR,8059) J
```

```
0088        8059 FORMAT(/////45X,'PMS DEPTH GREATER THAN 2000 FEET--SAMPLE NO. ',I2
                1)
            C
0089             IF(DATA(12,J).GT.1.0) WRITE(IPR,8060) J
0090        8060 FORMAT(////40X,'PMS PILLAR PATTERN VALUE GREATER THAN 1.0--SAMPLE
                1NO. ',I2)
0091        8056 CONTINUE
0092             DO 1015 I= 1,12
0093             TOTAL(I)= 0.0
0094             COUNT(I)= 0.0
0095        1015 CONTINUE
            C
            C  WRITE DATA CARDS
            C
0096             WRITE(IPR,4)
0097           4 FORMAT(1H1,56X,'THE INPUT DATA CARDS'     /)
            C
            C     HEADING
            C
0098             WRITE(IPR,699)
0099         699 FORMAT(13X,'1',9X,'2',9X,'3',9X,'4',9X,'5',9X,'6',9X,'7',9X,'8',9X
                1,'9',8X,'10',8X,'11',8X,'12')
0100             WRITE(IPR,701)
0101         701 FORMAT(12X,'CMS',7X,'CMS',7X,'PMS',7X,'PMS',7X,'PMS',7X,'PMS',7X,
                1'PMS',14X,'DISTANCE',14X,'TIME'/11X,'ROOF',6X,'FLOOR',6X,'SEAM',4X
                2,'PERCENT',5X,'ROOF',5X,'FLOOR',5X,'PILLAR',5X,'PMS',4X,'BETWEEN',
                35X,'PMS',5X,'BETWEEN',5X,'PILLAR'/6X,'NO',2X,'STRENGTH',2X,'STRENG
                4TH',2X,'THICKNESS EXTRACT   STRENGTH  STRENGTH   WIDTH',5X,'SPAN',
                55X,'SEAMS',5X,'DEPTH',5X,'MINING',4X,'PATTERN'/,6X,121(1H-))
            C
0102             DO 5 J=1,NO
0103             WRITE(IPR,6)      J , (DATA(I,J), I=1,12)
0104           6 FORMAT(6X,I2,F9.2,11F10.2)
0105           5 CONTINUE
            C
            C  CALCULATE AVERAGES
            C
0106             DO 1001 I= 1,12
0107             DO 1002 J =1,NO
0108             IF (DATA(I,J).LE.0.0) GO TO 1002
0109             TOTAL(I) = TOTAL(I) + DATA(I,J)
0110             COUNT (I) = COUNT (I)+ 1
0111        1002 CONTINUE
0112        1001 CONTINUE
0113             DO 1003 I = 1,12
0114             TOTAL(I)= TOTAL(I)/ COUNT(I)
0115        1003 CONTINUE
0116             WRITE(IPR,1020) (TOTAL(I),I=1,12)
0117        1020 FORMAT(1X,126(1H-)/1X,'AVERAGE',F9.2,11F10.2)
            C
            C  BLANK OUT BUMP ARRAY
            C
0118             DO 950 J= 1,NO
0119             BUMP(J) = BLANK
0120         950 CONTINUE
            C
            C  CALCULATE RATIOS
            C
```

```
0121          DO 600 J= 1, NO
0122          IF(DATA(2,J).LE.0.0) GO TO 971
0123          CMSRAT(J)= DATA(1,J)/ DATA(2,J)
0124      971 IF(DATA(6,J).LE.0.0) GO TO 972
0125          PMSRAT(J)= DATA(5,J)/DATA(6,J)
0126      972 IF(DATA(9,J).LE.0.0) GO TO 973
0127          WDRAT(J)= DATA(8,J)/DATA(9,J)
0128      973 IF(DATA(4,J).EQ.100.0) GO TO 600
0129          PILST = (DATA(7,J)**0.46/DATA(3,J)**0.66)* 1320.0
0130          PILLD = (1.1*DATA(10,J))/ ((100.0-DATA(4,J))*.01)
0131          IF(PILLD.LE.0.0) GO TO 10000
0132          PILRAT(J)=PILST/PILLD
0133    10000 IF(DATA(4,J).EQ.100.0) GO TO 600
0134          VERT(J)= 0.3*DATA(10,J) + 120.0
0135      600 CONTINUE
        C
0136          IF(ICOND.GT.0) GO TO 50
        C
        C****************** S U B S I D E N C E   T E S T ********************
        C
0137          DO 15 J = 1,NO
0138          IF(DATA(4,J).NE.100.0) GO TO 200
0139          YES(J)= 1.0
0140          GO TO 15
        C
0141      200 CONTINUE
0142          IF(PILRAT(J).LT.1.0) YES(J)= 1.0
0143          IF(PMSRAT(J).GT.2.4.OR.PMSRAT(J).LT.0.625) YES(J)=1.0
        C
0144          HORIZ(J) = 0.15*DATA(10,J) + 60.0
0145          IF(DATA(8,J).GT.HORIZ(J)) YES(J) = 1.0
        C
0146          IF(DATA(9,J).LT.60.0.AND.CMSRAT(J).LE.3.3) YES(J)=1.0
0147          IF(WDRAT(J).GE.0.25) YES(J)=1.0
0148       15 CONTINUE
        C
        C  CHECK FOR INDICATION OF SUBSIDENCE
        C
0149          DO 16 J=1,NO
0150          IF(YES(J).NE.1.0) GO TO 16
        C
        C  CALCULATE SMAX
        C
0151          IF(WDRAT(J).GE.1.2) GO TO 17
0152          FUNC= (((2.15909*WDRAT(J)-6.26136)*WDRAT(J)+5.51136)*WDRAT(J)-
             10.469091)* WDRAT(J)
0153          GO TO 18
0154       17 FUNC= 1.0
0155       18 SUB(J)= 0.6*(DATA(3,J)-0.001* DATA(9,J)) * FUNC * (DATA(4,J) /100.
             10)
0156          IF(SUB(J).GT.DATA(3,J))WRITE(IPR,8061) J
0157     8061 FORMAT(/////40X,'SMAX IS GREATER THAN PMS SEAM THICKNESS--SAMPLE N
             1O. ',I2)
        C
        C  CALCULATE PSUB (SMAX/T)
        C
0158          PSUB(J)= SUB(J)/DATA(3,J)
0159          IF(PSUB(J).GT.0.6) WRITE(IPR,8062) J
```

```
0160         8062 FORMAT(/////40X,'PERCENT SUBSIDENCE IS GREATER THAN 60 %--SAMPLE N
                 1O. ',I2)
0161           16 CONTINUE
            C
            C  CALCULATE AMOUNT OF COAL LOSS DUE TO SUBSIDENCE
            C
0162              DO 20 J=1,NO
            C     NO COAL LOSS
0163              IF(SUB(J).LE.0.1)GO TO  20
            C
            C     COAL LOSS
            C
            C  DT .LE. 60 FT.
            C
0164              IF(DATA(9,J).GT.60.0) GO TO 900
0165              IF(PSUB(J).GT.0.5) GO TO 901
0166              SUBCL(J)= PSUB(J)/1.667
0167              GO TO 20
0168          901 SUBCL(J)= 0.301
0169              GO TO 20
0170          900 CONTINUE
            C
            C  DT .GT. 60 FT. AND .LT. 120 FT.
            C
0171              IF(DATA(9,J).GE.120.0) GO TO 903
0172              IF(PSUB(J).GT.0.2)  GO TO 902
0173              GO TO 20
0174          902 SUBCL(J)= (PSUB(J)-0.2)* 0.5
0175              GO TO 20
0176          903 CONTINUE
            C
            C  DT .GE. 120 FT.
            C
0177              IF( CMSRAT(J).GT.3.3.AND.DATA(11,J).GT.0.25.
                 1AND.DATA(4,J).GT.90.0) GO TO  20
0178              IF(PSUB(J).GT.0.50) SUBCL(J)=0.05
0179           20 CONTINUE
            C
0180           50 CONTINUE
            C
            C****************** H I G H  S T R E S S  Z O N E  T E S T *****************
            C
0181              DO 51 J=1,NO
0182              IF(DATA(4,J).EQ.100.0) GO TO 51
            C  REMNANT PILLARS ARE PRESENT
0183              IF(DATA(9,J).GT.VERT(J)) GO TO 51
            C
            C  DT .LE. 60 FT.
            C
0184              IF(DATA(9,J).GT.60.0) GO TO 800
0185              IF(CMSRAT(J).LE.0.625.OR.CMSRAT(J).GE.2.4) HSTRES(J)=0.301
0186              IF(CMSRAT(J).GT.0.625.AND.CMSRAT(J).LT.2.4)HSTRES(J)=0.25
0187              GO TO 51
            C
            C  DT .GT. 60 AND .LT. 90 FT.
            C
0188          800 IF(DATA(9,J).GE.90.0) GO TO 801
0189              IF(CMSRAT(J).LE.0.625.OR. CMSRAT(J).GE.2.4)HSTRES(J)=0.20
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```
            IF(CMSRAT(J).GT.0.625.AND.CMSRAT(J).LT.2.4)HSTRES(J)=0.15
            GO TO 51
      C
      C  DT .GE. 90 AND .LT. 120 FT.
      C
        801 IF(DATA(9,J).GE.120.0) GO TO 802
            IF(CMSRAT(J).LE.0.625.OR. CMSRAT(J).GE.2.4)HSTRES(J)=0.15
            IF(CMSRAT(J).GT.0.625.AND.CMSRAT(J).LT.2.4)HSTRES(J)=0.10
            GO TO 51
      C
      C  DT .GE. 120 FT.
      C
        802 IF(DATA(9,J).LT.VERT(J).AND.(CMSRAT(J).LE.0.625.OR.CMSRAT(J).GE.2.
           14)) HSTRES(J)=0.10
            IF(DATA(9,J).LT.VERT(J).AND.(CMSRAT(J),GT.0.625.AND.CMSRAT(J).LT.2
           1.4)) HSTRES(J)=0.05
         51 CONTINUE
      C***************************************************************
      C
      C  MAKE ADJUSTMENTS TO HIGH STRESS COAL LOSS
      C
            DO 60 J=1,NO
      C  PILLAR ALIGNMENT
            IF(ILINE.NE.0) HSTRES(J)=HSTRES(J)*0.25
      C     PILLAR PATTERN CALCULATION
            IF(DATA(12,J).GT.0.0.AND.DATA(12,J).LE.1.0)HSTRES(J)=HSTRES(J)*
           1DATA(12,J)
      C     CALCULATION FOR HIGH STRESS COAL LOSSES WITH LITTLE OVERBURDEN
            IF(DATA(10,J).LE.400.0) HSTRES(J)=HSTRES(J)*(DATA(10,J)/400.0)
      C
      C  COMPARE COAL LOSSES
      C
            IF(SUBCL(J)-HSTRES(J))61,63,63
      C
      C  HIGH STRESS COAL LOSS
         61 CMSCL(J)=HSTRES (J)
      C
            GO TO 59
      C
      C  SUBSIDENCE COAL LOSS
      C
         63 CMSCL(J)=SUBCL(J)
         59 CONTINUE
      C     REGIONAL MULTIPLIER CALCULATION
            IF(RMULT.LE.0.0) GO TO 931
            CMSCL(J)= CMSCL(J)* RMULT
      C     LITHOLOGY MULTIPLIER CALCULATION
        931 IF(LMULT.LE.0.0) GO TO 60
            CMSCL(J)= CMSCL(J)* LMULT
         60 CONTINUE
      C
      C  BUMP WARNING
      C
            DO 920 J=1,NO
            IF(ICOND.GT.0) GO TO 904
            CMSDT= DATA(10,J) - DATA(9,J)
            GO TO 905
        904 CMSDT= DATA(10,J) + DATA(9,J)
```

```
0218           905 IF(CMSDT.GE.500.0.AND.(CMSRAT(J).GT.0.625.AND.CMSRAT(J).LT.2.4))
                  1BUMP(J)= ASTER
0219           920 CONTINUE
         C
         C   PRINT RESULTS ***********************************************
         C
         C
         C   HEADING
         C
0220               IF(ICURR.LT.10) GO TO 12000
0221               IF(ICURR.LT.100) GO TO 12001
0222               WRITE(IPR,930) ICURR,S1,S2,S3,S4,S5,S6,S7
0223           930 FORMAT(1H1,50X,I3,2X,6A4,A2)
0224               GO TO 12002
0225         12000 WRITE(IPR,12003) ICURR,S1,S2,S3,S4,S5,S6,S7
0226         12003 FORMAT(1H1,50X,'00',I1,2X,6A4,A2)
0227               GO TO 12002
0228         12001 WRITE(IPR,12004) ICURR,S1,S2,S3,S4,S5,S6,S7
0229         12004 FORMAT(1H1,50X,'0',I2,2X,6A4,A2)
0230         12002 WRITE(IPR,65)
0231            65 FORMAT(35X,11(1H*),1X,'COAL LOSS FOR CURRENT OR RESERVE SEAM',1X,
                  111(1H*)//,15X,'PMS',7X,'PMS',7X,'CMS',5X,'MAX VERT MAX HORIZ',4X,
                  2'PMS',29X,'SUB-',4X,'HIGH',4X,' PREDICTED '/,12X,'STREN/LOAD ROOF/
                  3FLR',2X,'ROOF/FLR',3X,'EXTENT',4X,'EXTENT',2X,'WID/DEPTH',2X,'PERC
                  4ENT',3X,'MAXIMUM',5X,'SIDENCE',2X,'STRESS',6X,'COAL'/4X,'SAMPLE',
                  55X,'RATIO',5X,'RATIO',5X,'RATIO',3X,'PR. ARCH',2X,'PR. ARCH',4X,
                  6'RATIO',2X,'SUBSIDENCE',1X,'SUBSIDENCE',1X,'COAL LOSS',1X,'COAL LO
                  7SS',3X,'LOSS'/,4X,120(1H-)/)
         C
0232               DO 100 J=1,NO
         C
0233               IF(CMSCL(J).GT.0.30) GO TO 80
         C
0234               WRITE(IPR,90)        J ,PILRAT(J),PMSRAT(J),CMSRAT(J),VERT(J),
                  1HORIZ(J),WDRAT(J),PSUB(J),SUB(J),             SUBCL(J),HSTRES(J),
                  2BUMP(J),CMSCL(J)
0235            90 FORMAT(6X,I2,1X,10(2X,F8.2),A1,2X,F8.2)
0236               GO TO 100
         C
         C
0237            80 WRITE(IPR,92)        J ,PILRAT(J),PMSRAT(J),CMSRAT(J),VERT(J),
                  1HORIZ(J),WDRAT(J),PSUB(J),SUB(J),             SUBCL(J),HSTRES(J),
                  2BUMP(J)
0238            92 FORMAT(6X,I2,1X,10(2X,F8.2),A1,3X,'GT 30 PER')
0239           100 CONTINUE
         C
         C   COMPUTE AVERAGE FOR MINE
         C
0240               DO 3010 I= 1,11
0241               TOT   (I)= 0.0
0242               COUNT(I)= 0.0
0243          3010 CONTINUE
0244               LNO=0
0245               XNO = NO*.75
0246               DO 3011 I=1,11
0247               DO 3012 J=1,NO
0248               IF((I.EQ.1.OR.I.EQ.4.OR.I.EQ.5).AND.X    (J,I).EQ.0.0) GO TO 3012
0249               TOT(I)=TOT(I)+X(J,I)
```

```
                COUNT(I)= COUNT(I)+1
          C
          C     CHECK FOR VALUES GT 30 %
          C
                IF(CMSCL(J).GT.0.30) LNO=LNO+1
           3012 CONTINUE
           3011 CONTINUE
          C
                DO 3013 I=1,11
                IF(COUNT(I).EQ.0.0) GO TO 3013
                TOT(I)=TOT(I)/COUNT(I)
           3013 CONTINUE
                IF(LNO.GT.XNO)GO TO 8070
          C
                WRITE(IPR,110) (TOT  (I),I=1,11)
            110 FORMAT(3X,119(1H-)/3X,'AVERAGE',1X,F8.2,9(2X,F8.2),3X,F8.2)
                GO TO 8071
           8070 WRITE(IPR,8072) (TOT(I), I=1,10)
           8072 FORMAT(3X,119(1H-)/3X,'AVERAGE',1X,F8.2,9(2X,F8.2),1X,'GT 30 PER')
           8071 CONTINUE
          C
                DO 960 J= 1,NO
                IF(BUMP(J).EQ.ASTER) GO TO 961
            960 CONTINUE
                GO TO 962
            961 WRITE(IPR,963)
            963 FORMAT(/                     6X,'* CONDITIONS ARE PRESENT WHICH MAY R
               1ESULT IN A BUMP IN THE CURRENTLY MINED OR RESERVE SEAM')
            962 IGO = IGO+1
          C
          C  CHECK FOR ADDITONAL DATA DECKS (SEAMS)
          C
                IF(NDECKS-IGO) 906,906,907
            907 WRITE(IPR,909)
            909 FORMAT(1H1)
                GO TO 908
            906 STOP
                END
```