Analysis of Coal Pillar Stability (ACPS): A New Generation of Pillar Design Software

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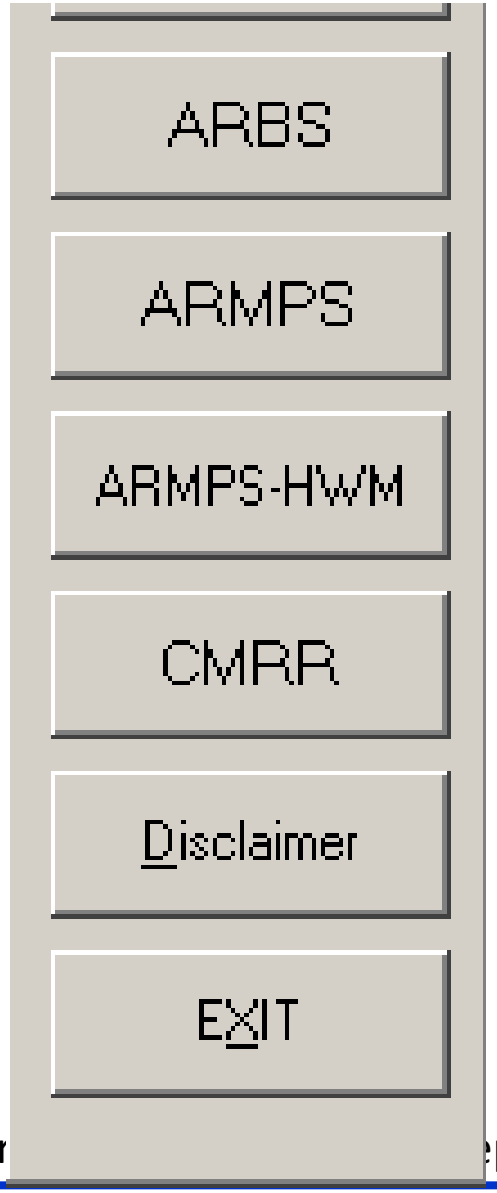
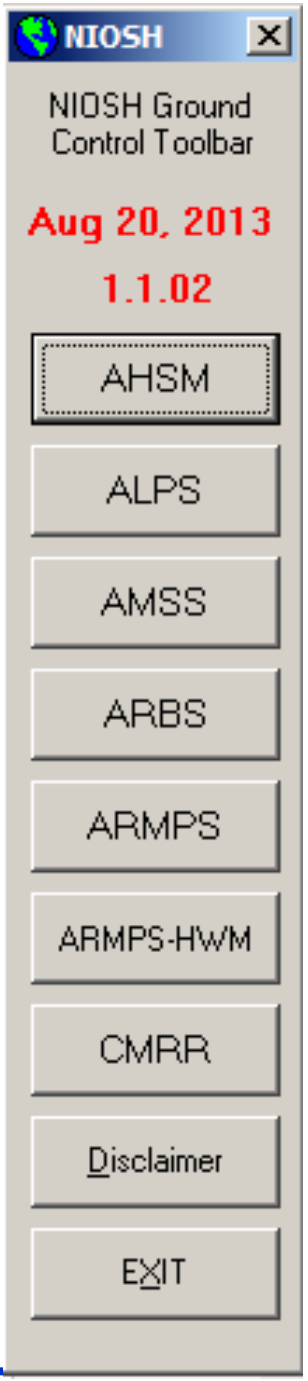
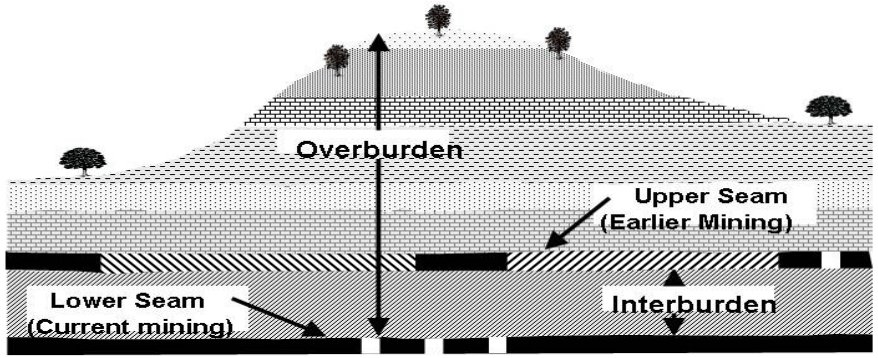
Christopher Mark, MSHA

The NIOSH Ground Control Toolbar





NIOSH Pillar Design Software



ANALYSIS OF MULTIPLE SEAM STABILITY (AMSS)

About ARMPS

The "Analysis of Retreat Mining Pillar Stability" (ARMPS) program was originally created by Dr. Christopher Mark, Mining Engineer, of the United States Bureau of Mines, Pittsburgh Research Center, (now NIOSH), in MS Basic.

It was later updated to version 4 for the Windows environment. Version 5.x was created by Dr. Zach Agioutantis. ARMPS 2010 (ARMPS version 6) was also created by Dr. Zach Agioutantis.

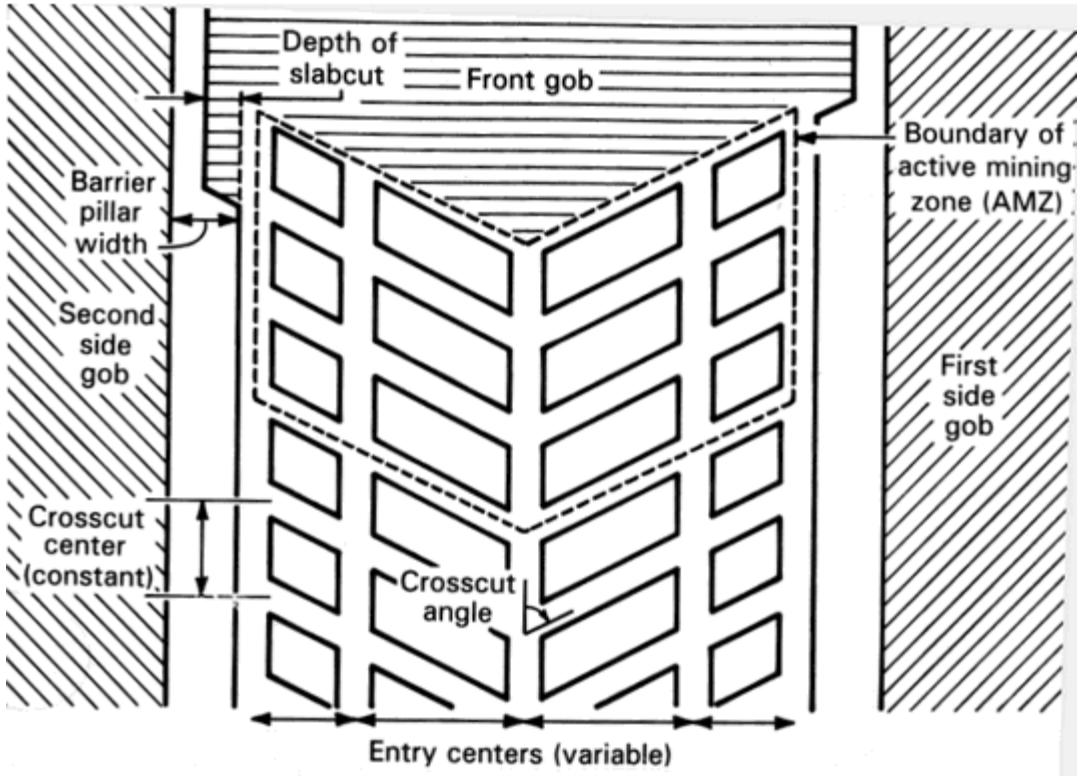
The help and support of Dr. Chris Mark during all development and debugging stages is greatly appreciated.

NIOSH Pillar Design Software

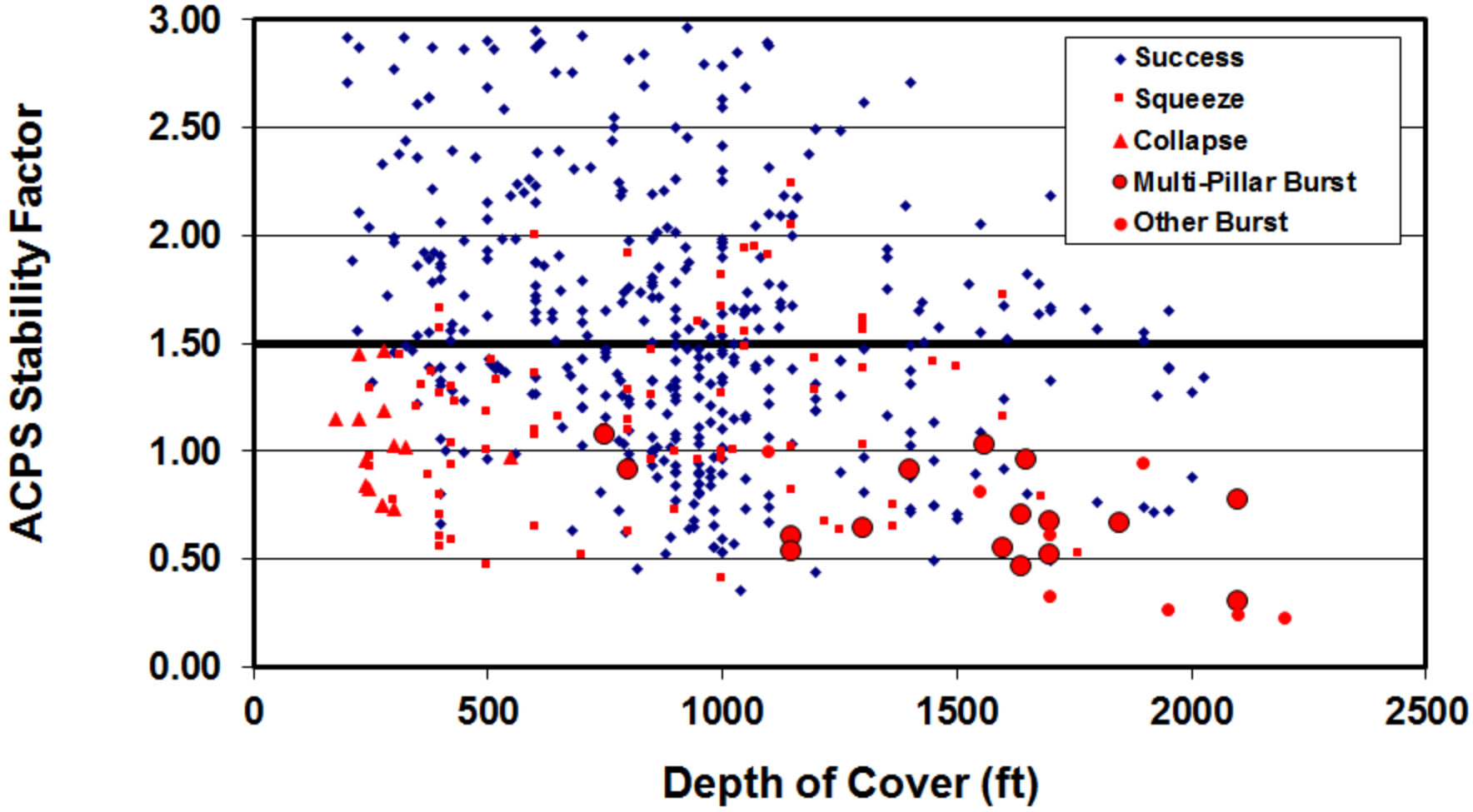
- ARMPS is used for any development mining, retreat mining, and most bleeder pillar analyses.
- ALPS is used only for the tailgate corner of longwall panels.
- AMSS is for multiple seam interactions, and it incorporates ARMPS and ALPS evaluations.

Inconsistencies

- ALPS had an advanced geometry module (variable cross cut angle, variable cross cut spacing per pillar row)
- ARMPS did not have an advanced geometry module (only allowed for uniform cross cut angle)
- AMSS used the same logic when implementing these algorithms.

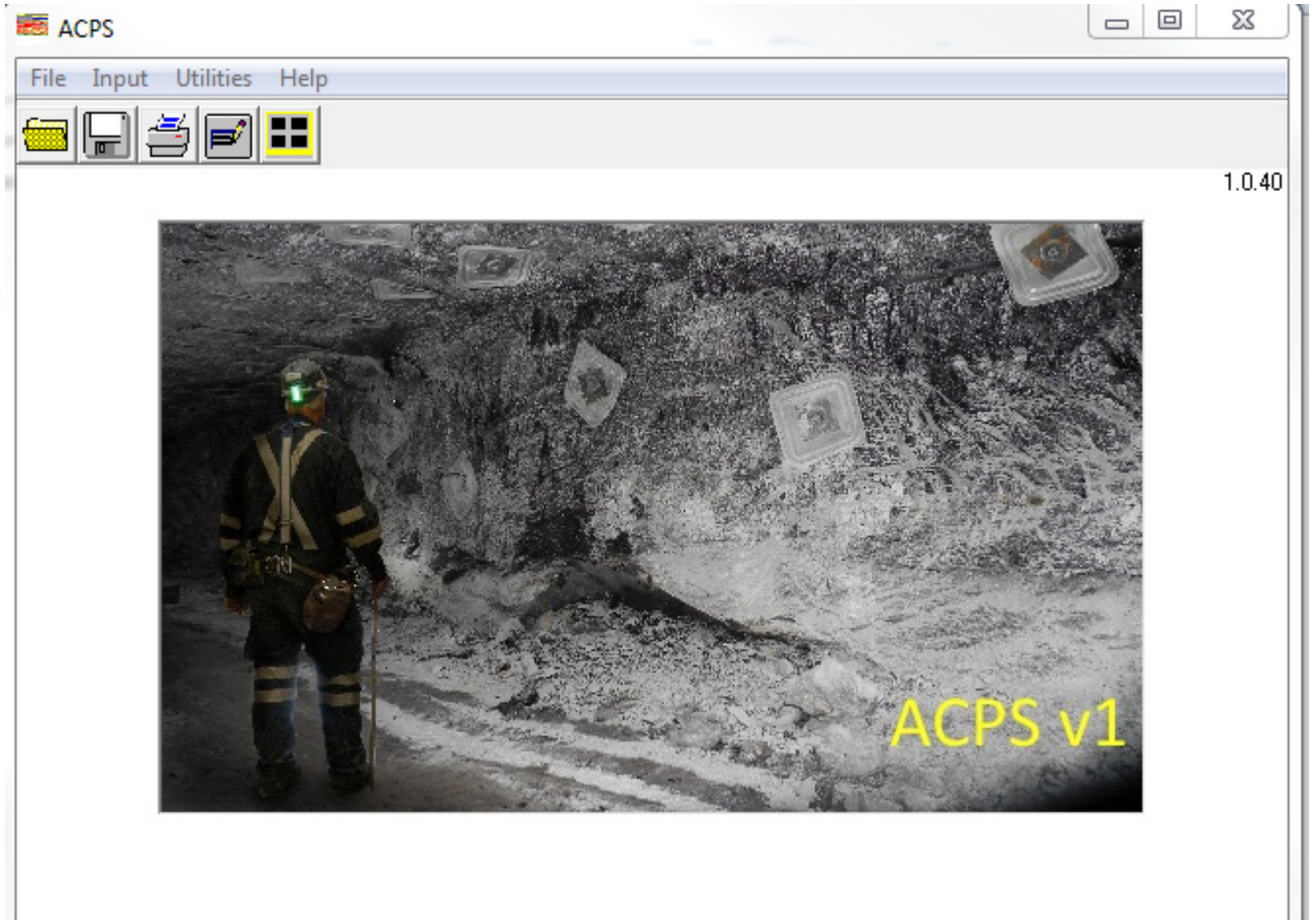


Empirical Criteria



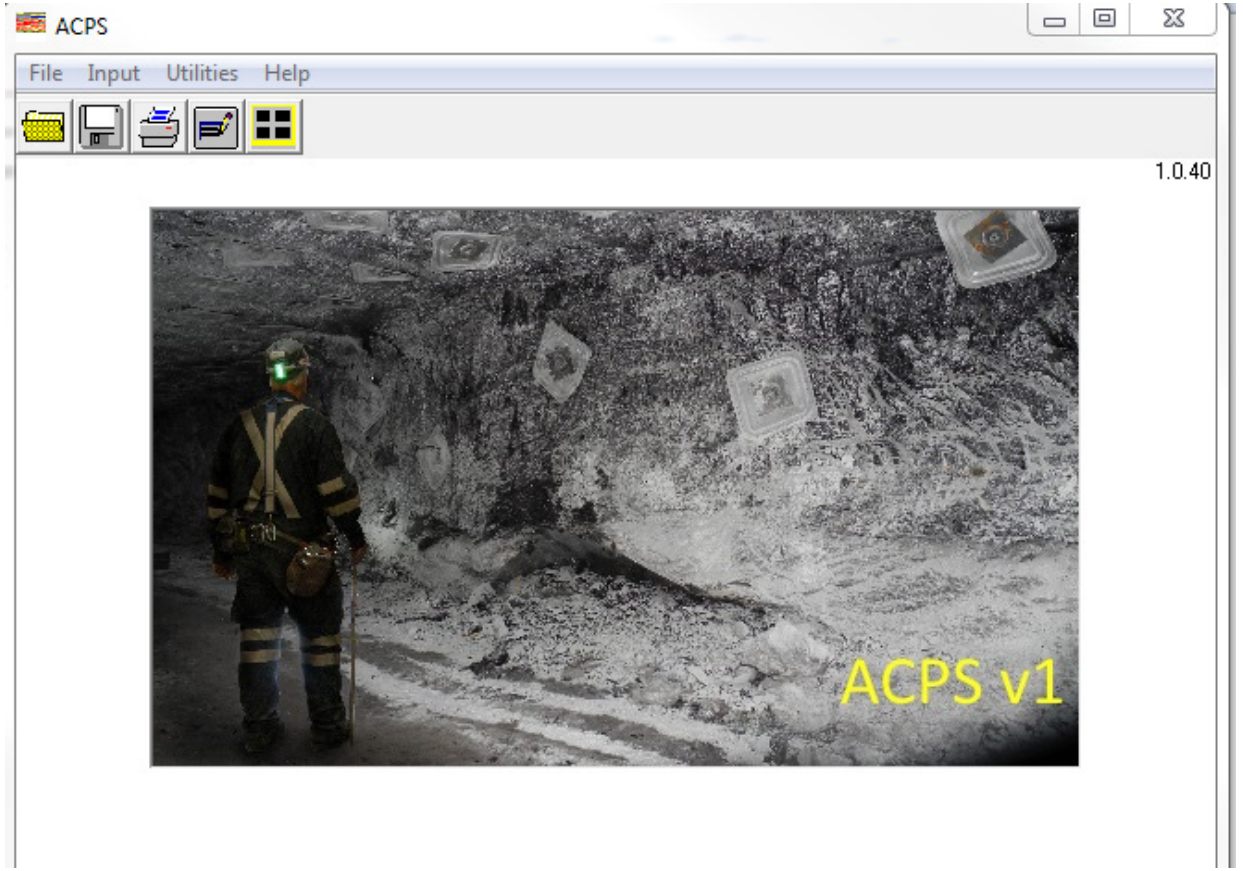
The case history data bases are the heart of these methods.

Goals for ACPS



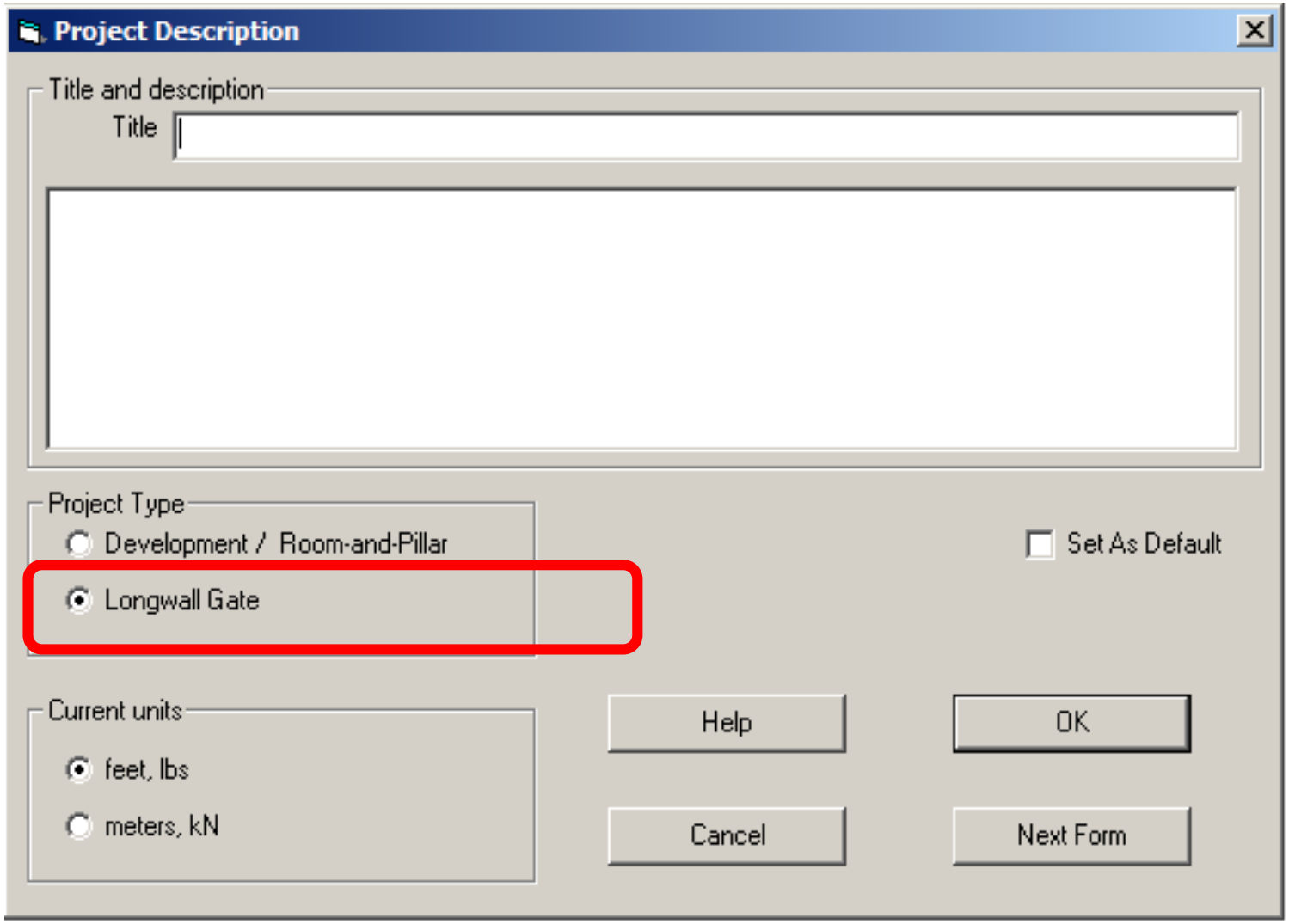
- Simplify pillar design process
- Consistent and uniform results
- Improved and updated methods

New Features in ACPS



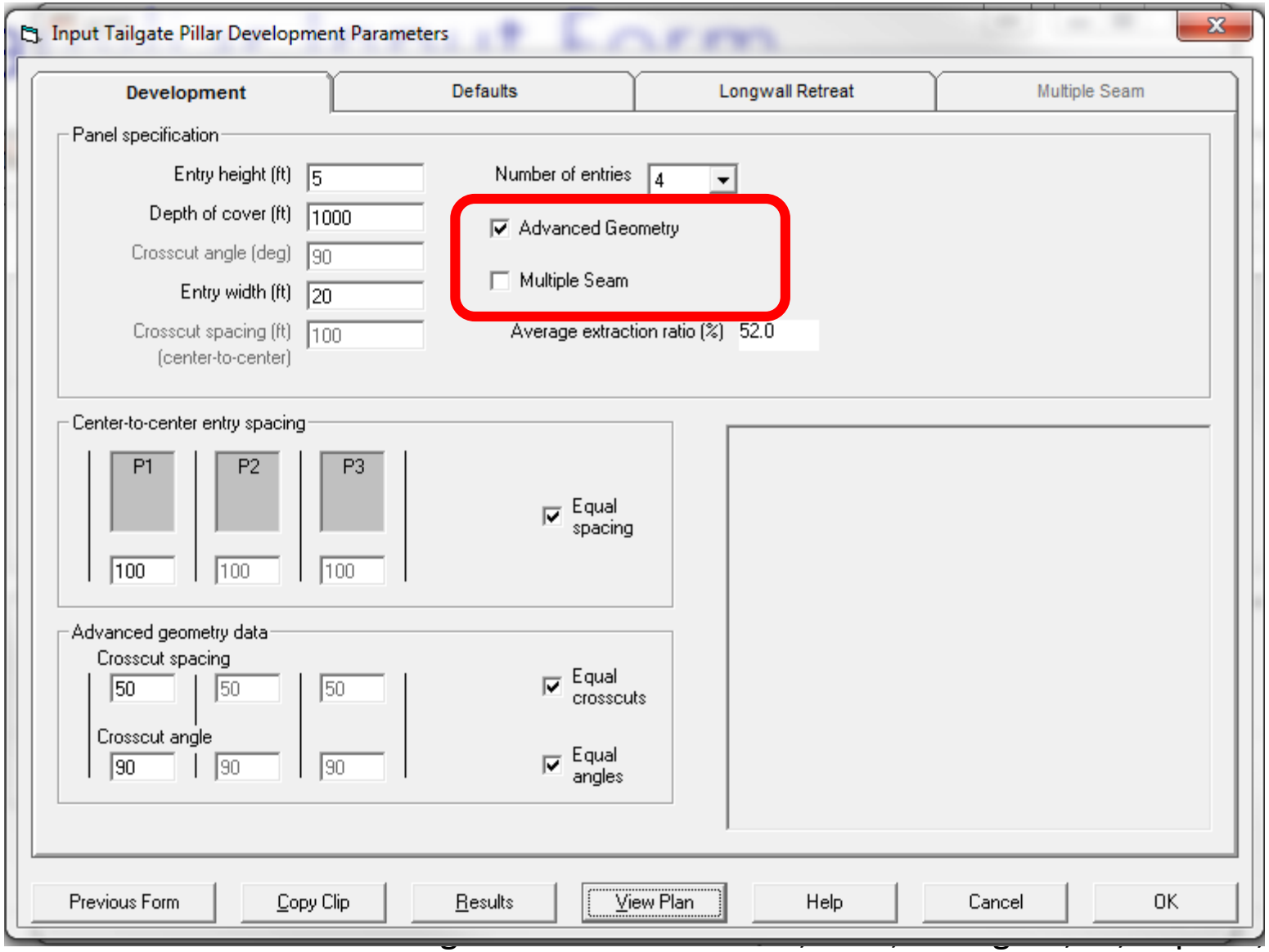
- "Advanced Geometry" for complex mining layouts
- More flexibility with "Leave Pillars" for retreat mining
- New multiple seam guidelines using expanded data base
- New CMRR "Estimator"
- New Help file

ACPS Program Flow

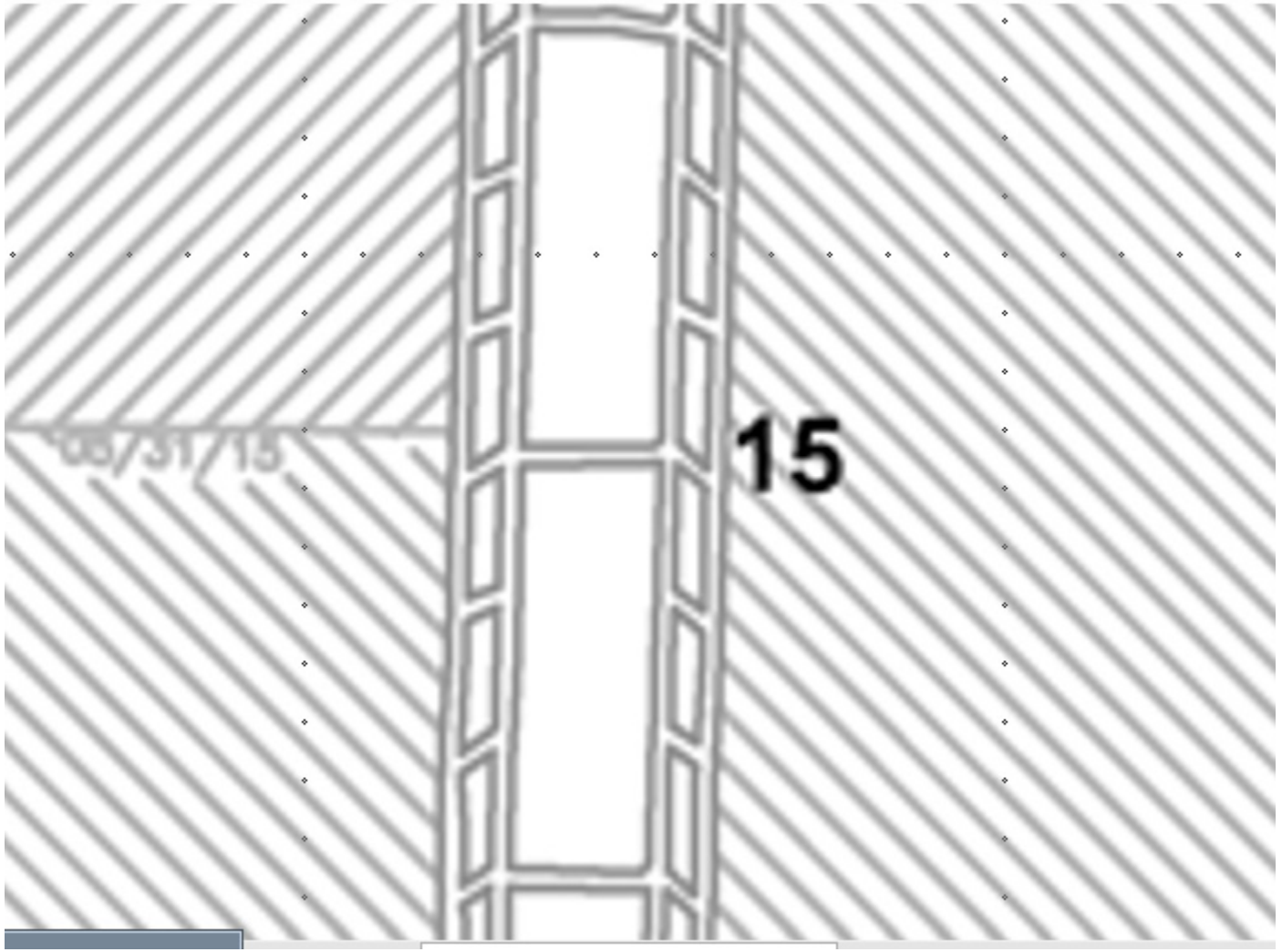


- Choose project type
- Choose project units
- Additional options within each project type

Familiar Input Form



Variable Center-to-Center, Xcut Angle, Xcut Spacing



Input Tailgate Pillar Development Parameters

Development | Defaults | **Longwall Retreat** | Multiple Seam

Only for Development

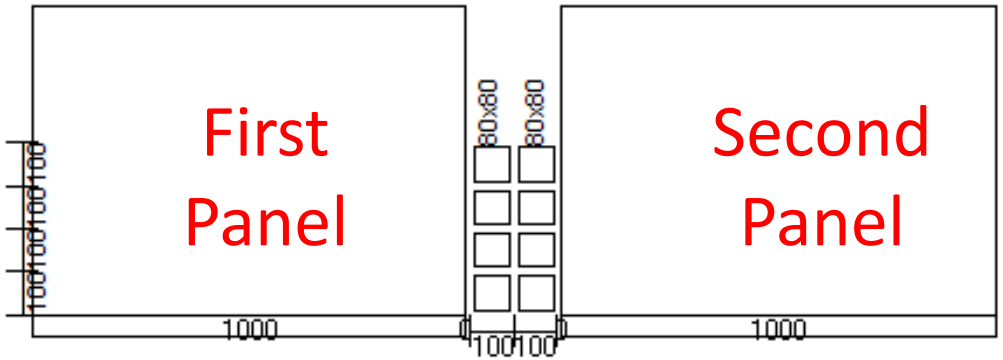
Panel Widths and Abutment Angles

First panel width (ft): 1000

Abutment angle for first panel: 21

Second panel width (ft): 1000

Abutment angle for second panel: 21



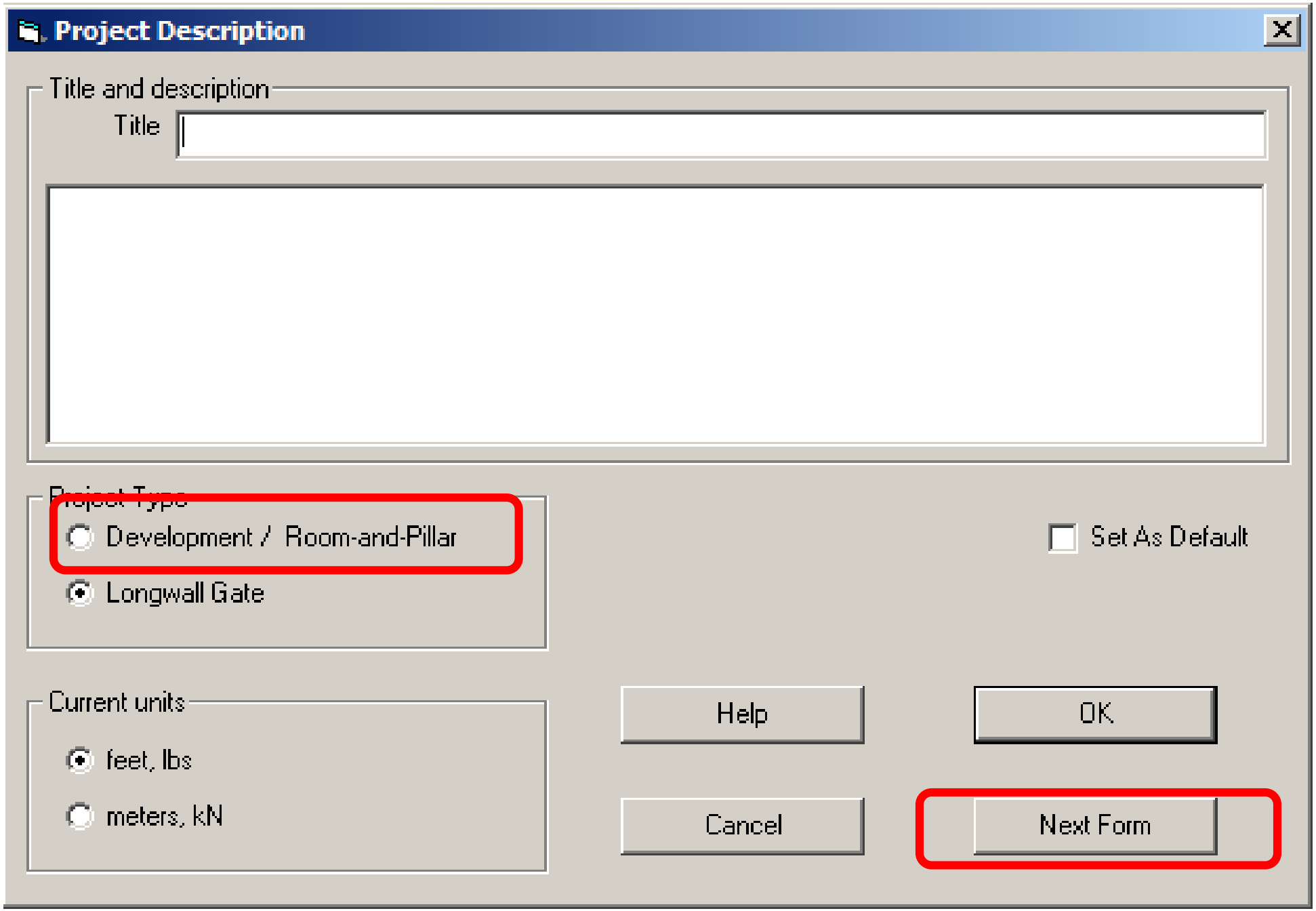
CMRR

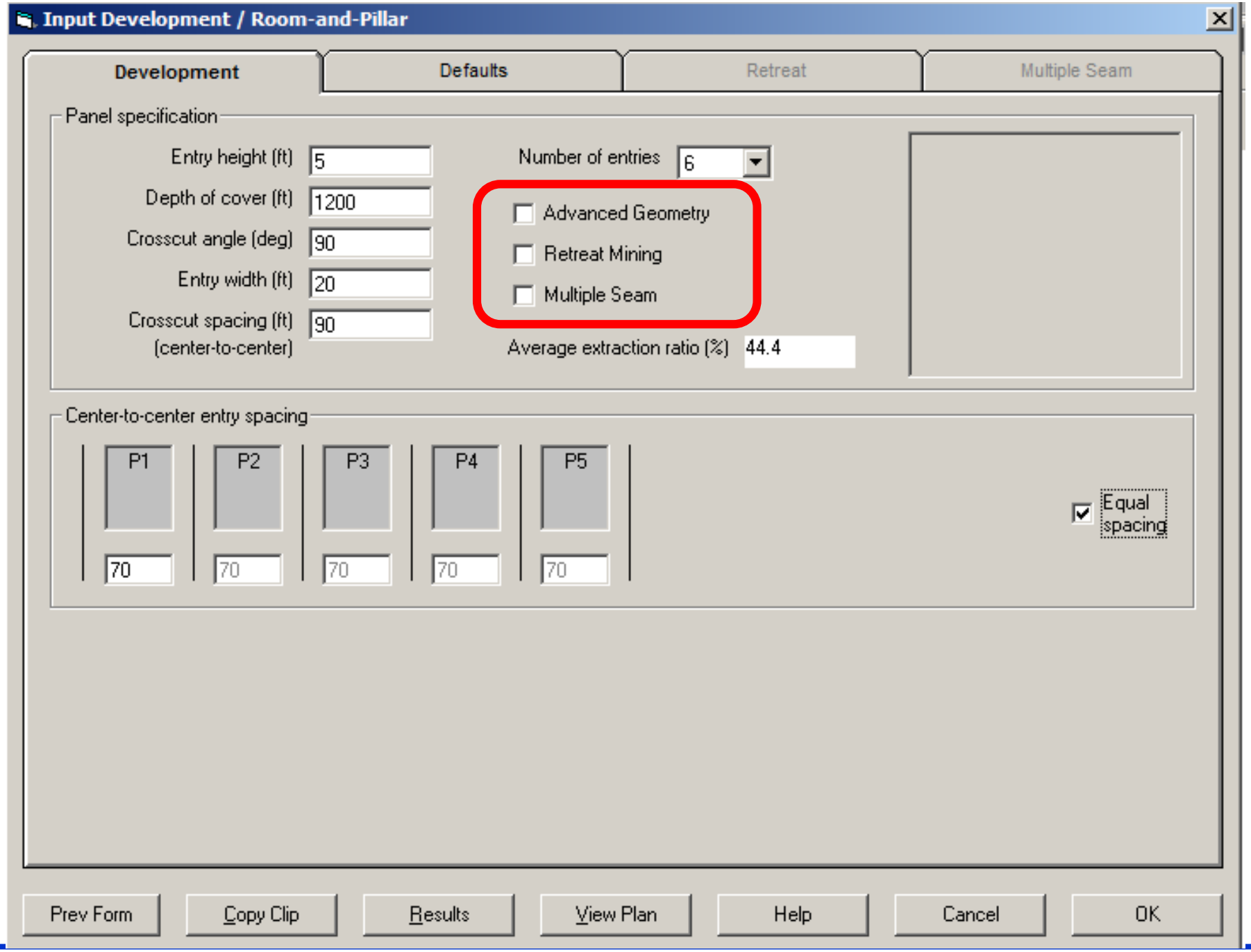
CMRR: 35

Suggested Tailgate SF based on CMRR: 1.44

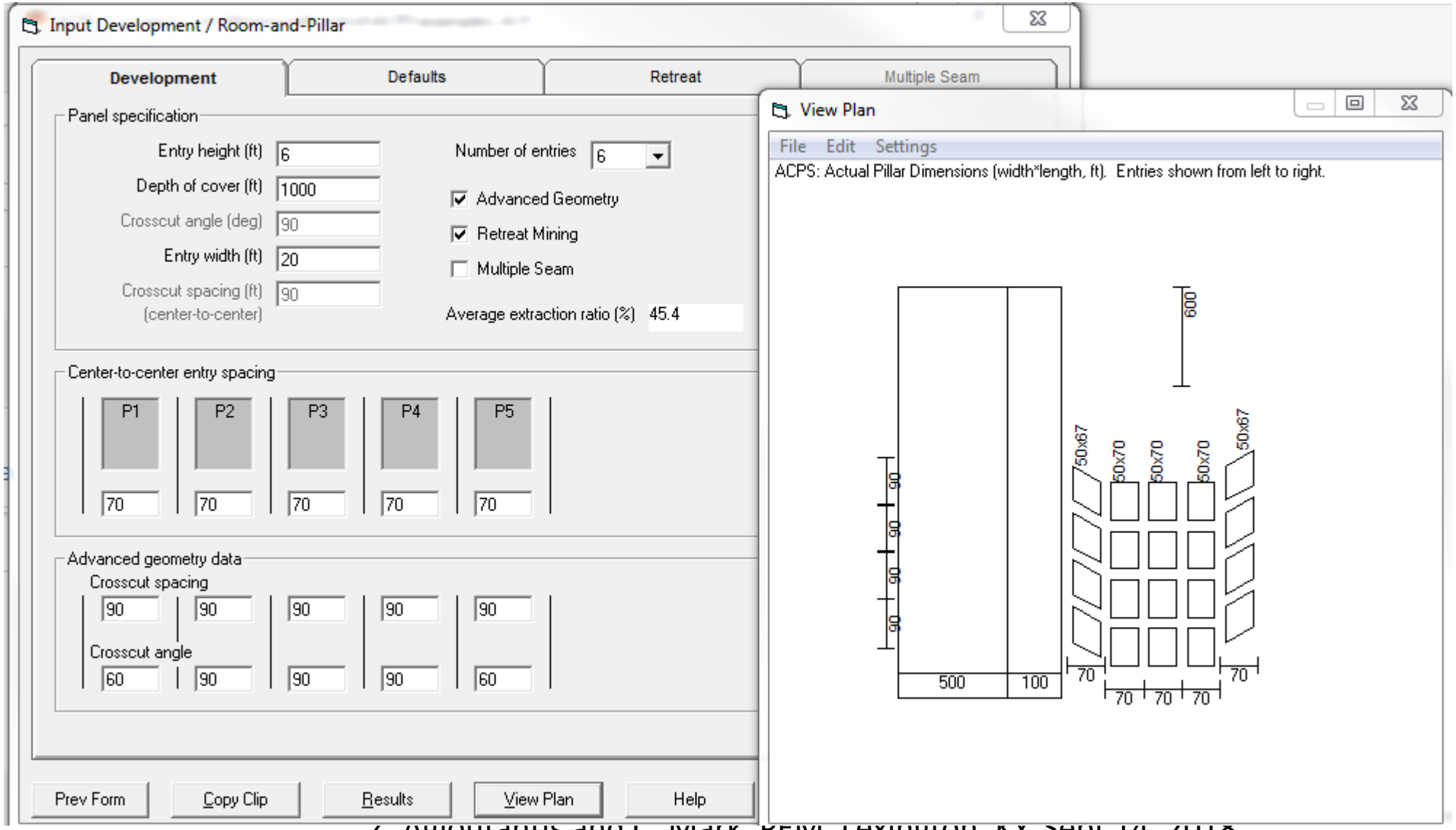
CMRR Estimator

Previous Form | Copy Clip | Results | View Plan | Help | Cancel | OK

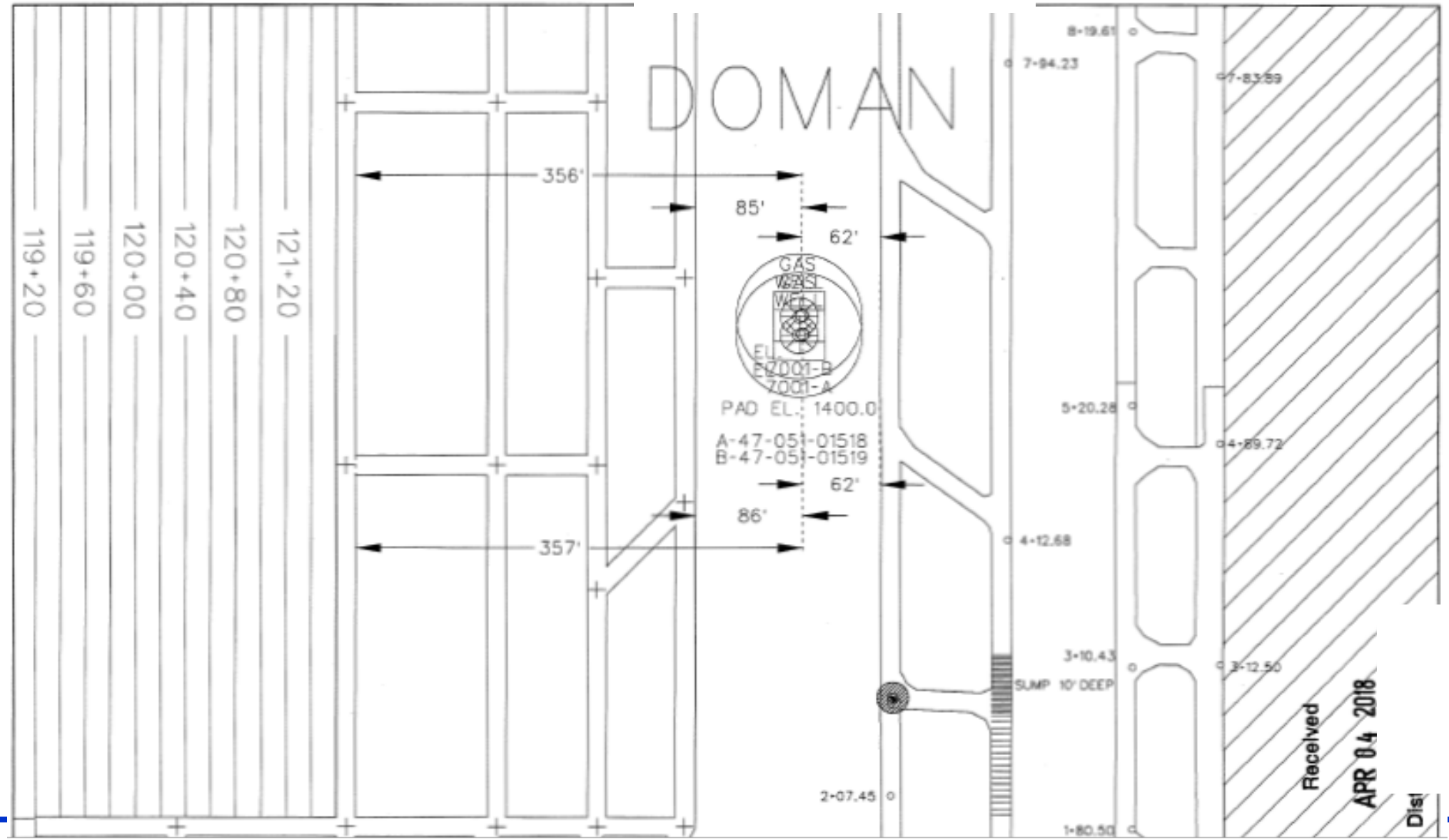

Project Description
Title and description
Title
Project Type
Development / Room-and-Pillar
Longwall Gate
Set As Default
Current units
feet, lbs
meters, kN
Help
OK
Cancel
Next Form


Input Development / Room-and-Pillar
Development
Defaults
Retreat
Multiple Seam
Panel specification
Entry height (ft)
5
Depth of cover (ft)
1200
Crosscut angle (deg)
90
Entry width (ft)
20
Crosscut spacing (ft)
(center-to-center)
90
Number of entries
6
Advanced Geometry
Retreat Mining
Multiple Seam
Average extraction ratio (%)
44.4
Center-to-center entry spacing
P1
P2
P3
P4
P5
70
70
70
70
70
Equal spacing
Prev Form
Copy Clip
Results
View Plan
Help
Cancel
OK

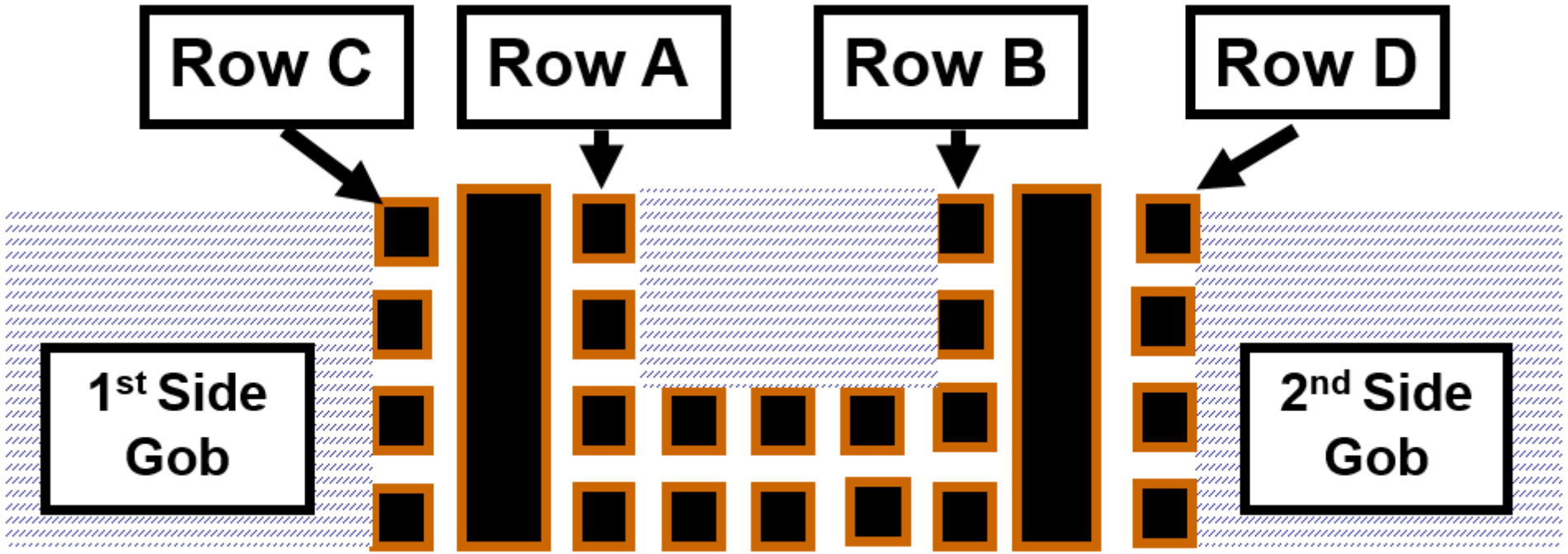
Advanced Geometry Options



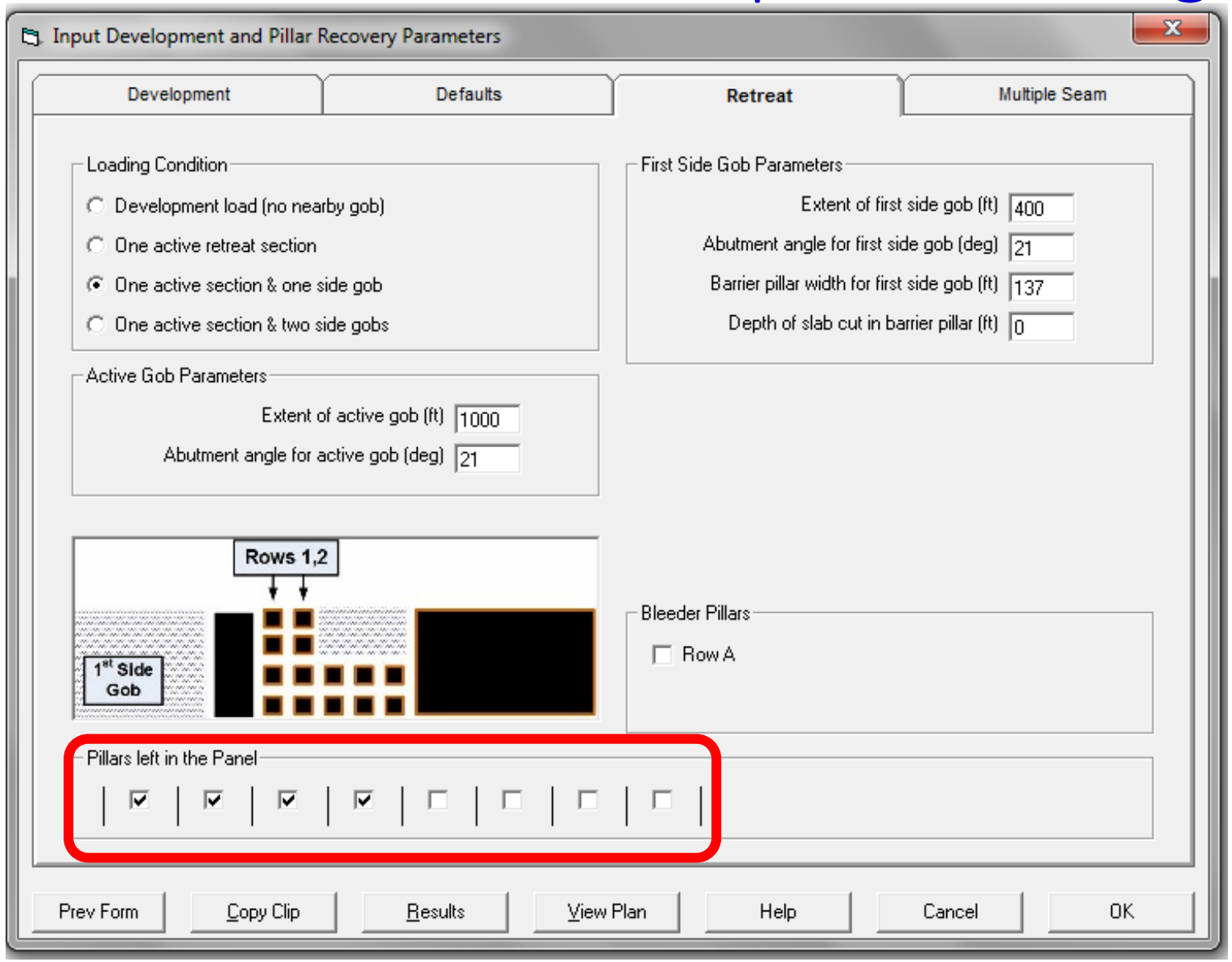
Modeling Complex Geometries is Easy



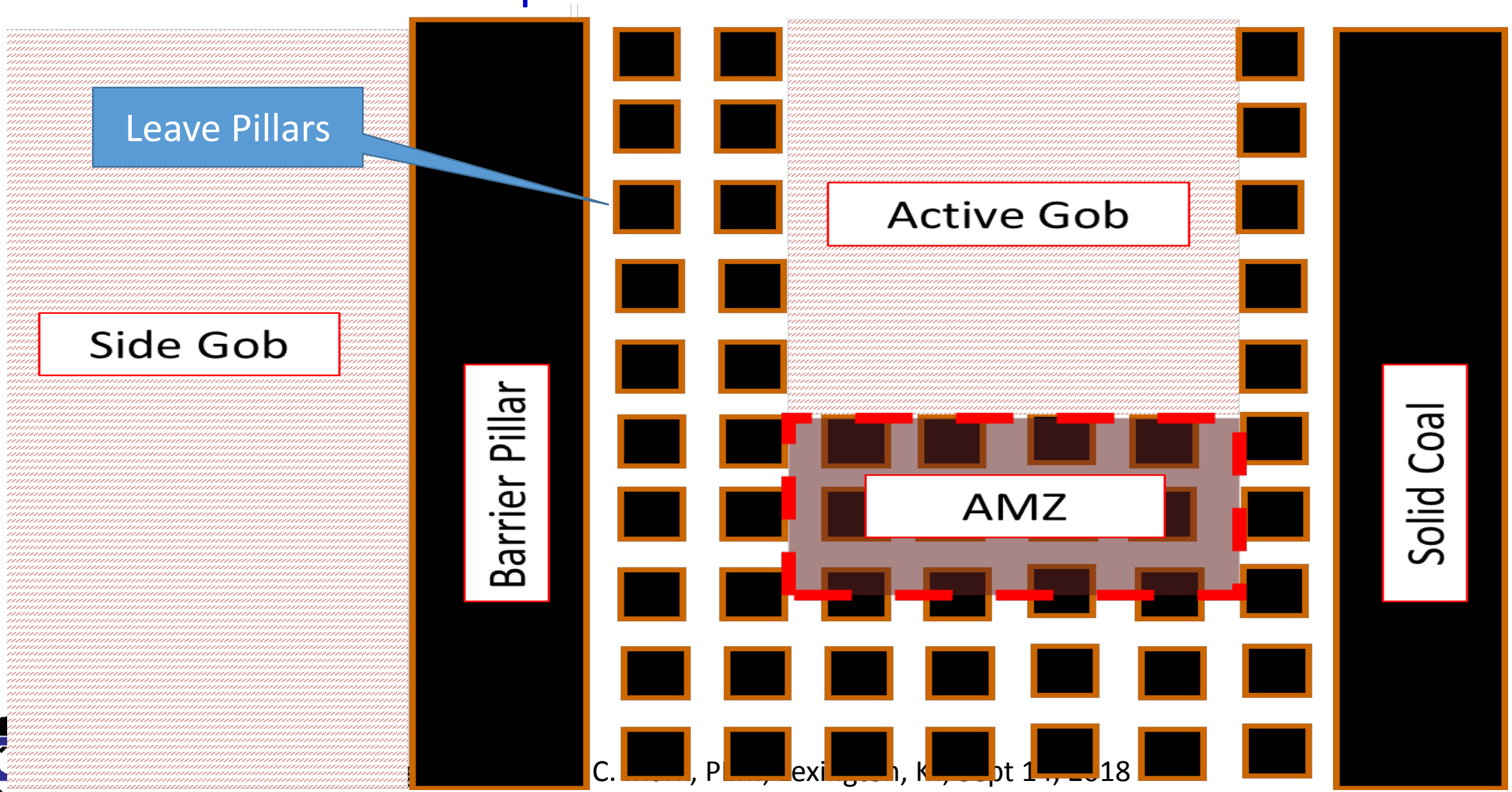
ARMPS 2010 “Leave Pillar” Options



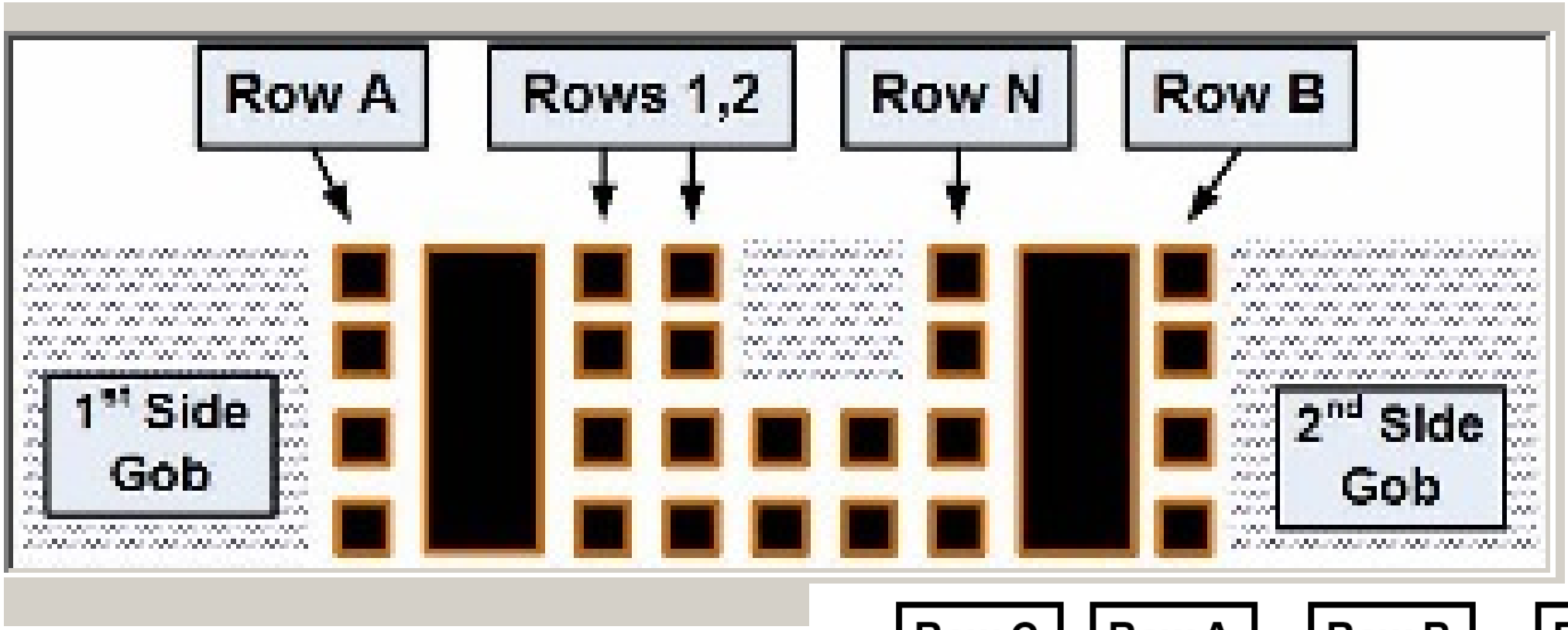
ACPS “Leave Pillar” Options During Retreat Mining

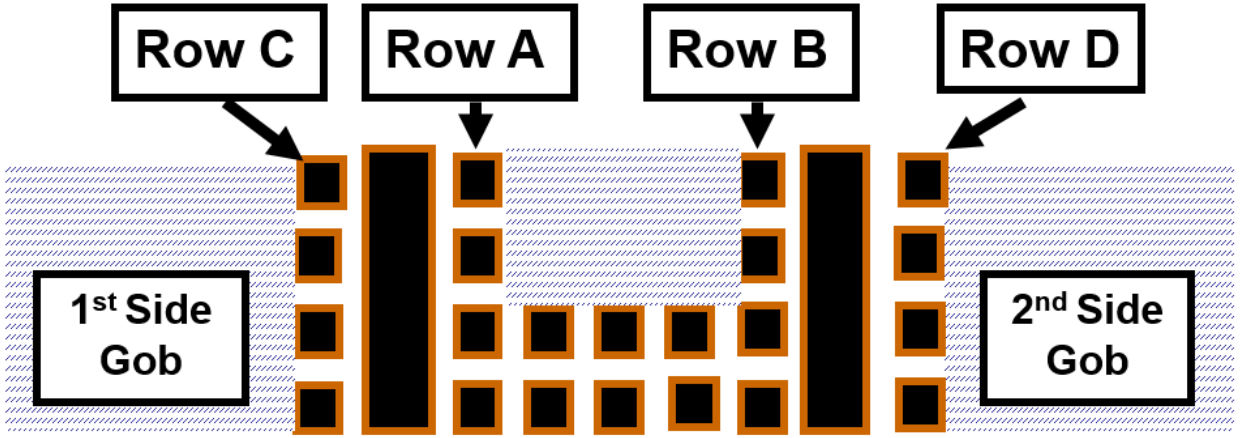


“Leave Pillar” Options for ACPS

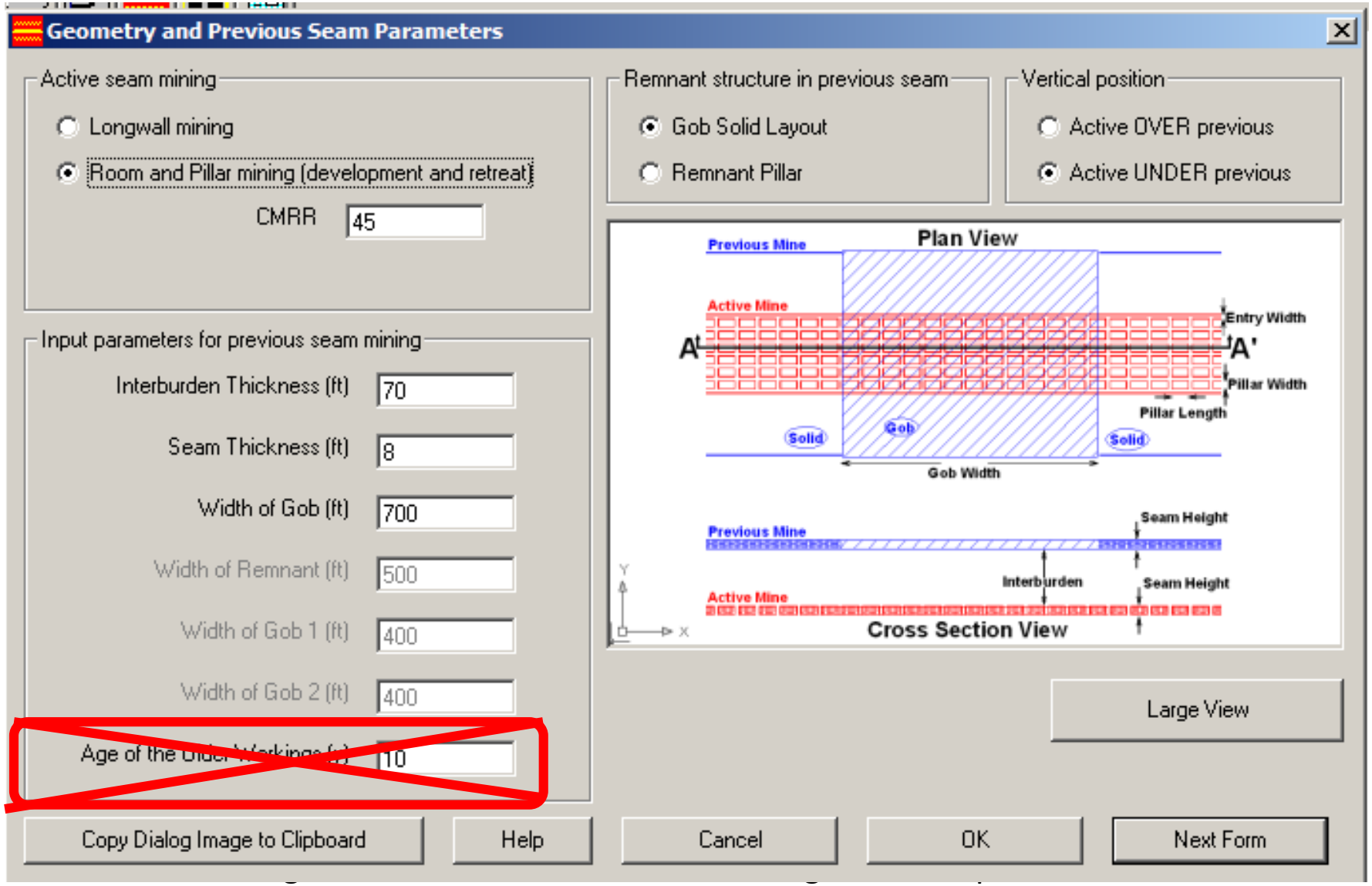


Comparison “Leave Pillar” Options: ACPS vs ARMPS 2010

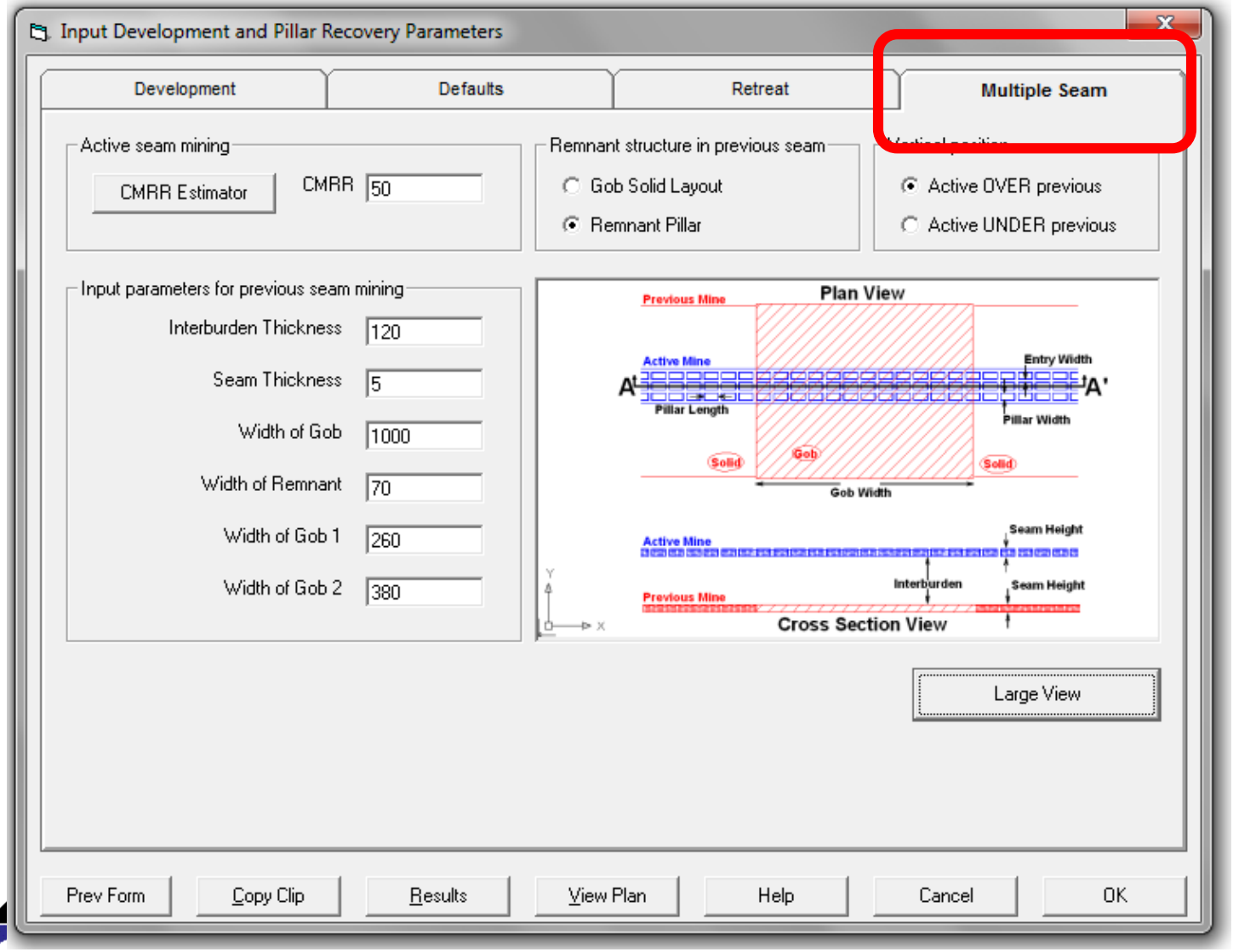




Original Multiple Seam Module (AMSS)

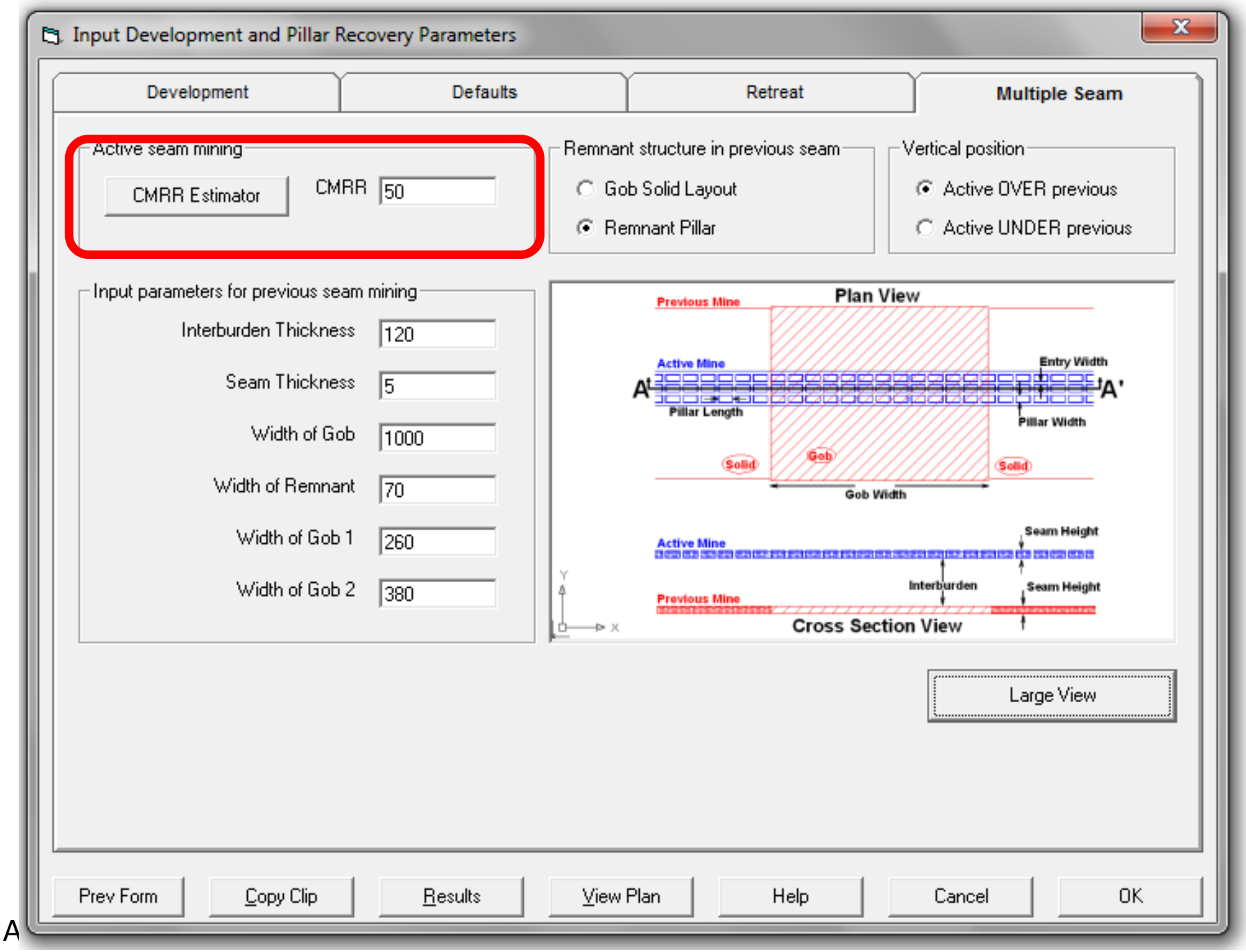


Updated Multiple Seam Analysis



- Statistics were updated
- The Multiple Seam option is now on the same form as a the rest of the input data.

CMRR Estimator



ACPS: C:\Users

The Coal Mine Roof Rating (CMRR) Estimator for ACPS

Coalfield Location

- Northern Appalachia
- Central Appalachia
- Southern Appalachia
- Illinois Basin
- Utah
- Other Western

45

1	Thick Claystone	40
2	Thick Shale	45
3	Stackrock (laminated sandstone/shale)	45
4	Siltstone	50
5	Bedded Sandstone	55
6	Massive Sandstone	55
7	Unknown	45

Help

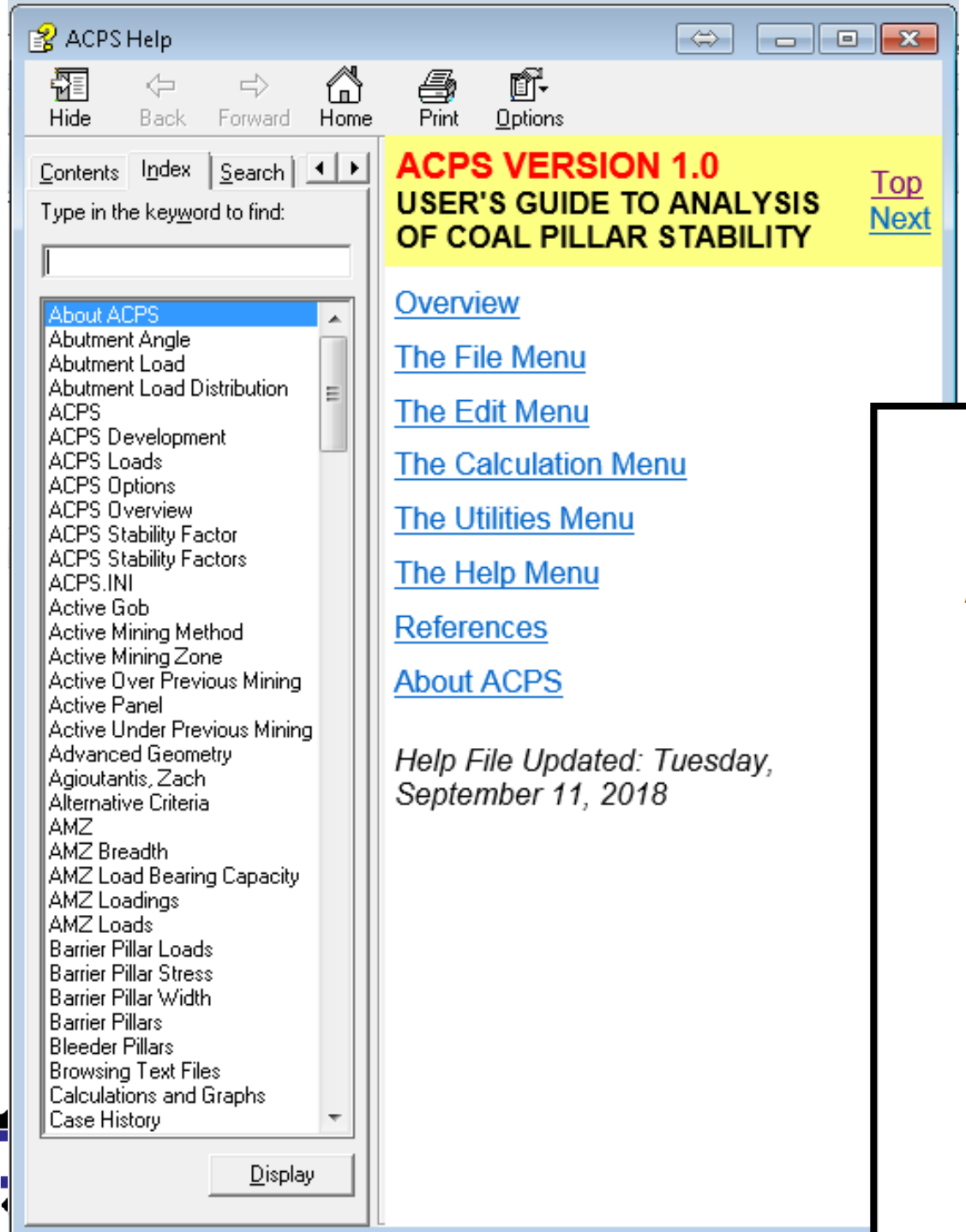
Cancel

OK

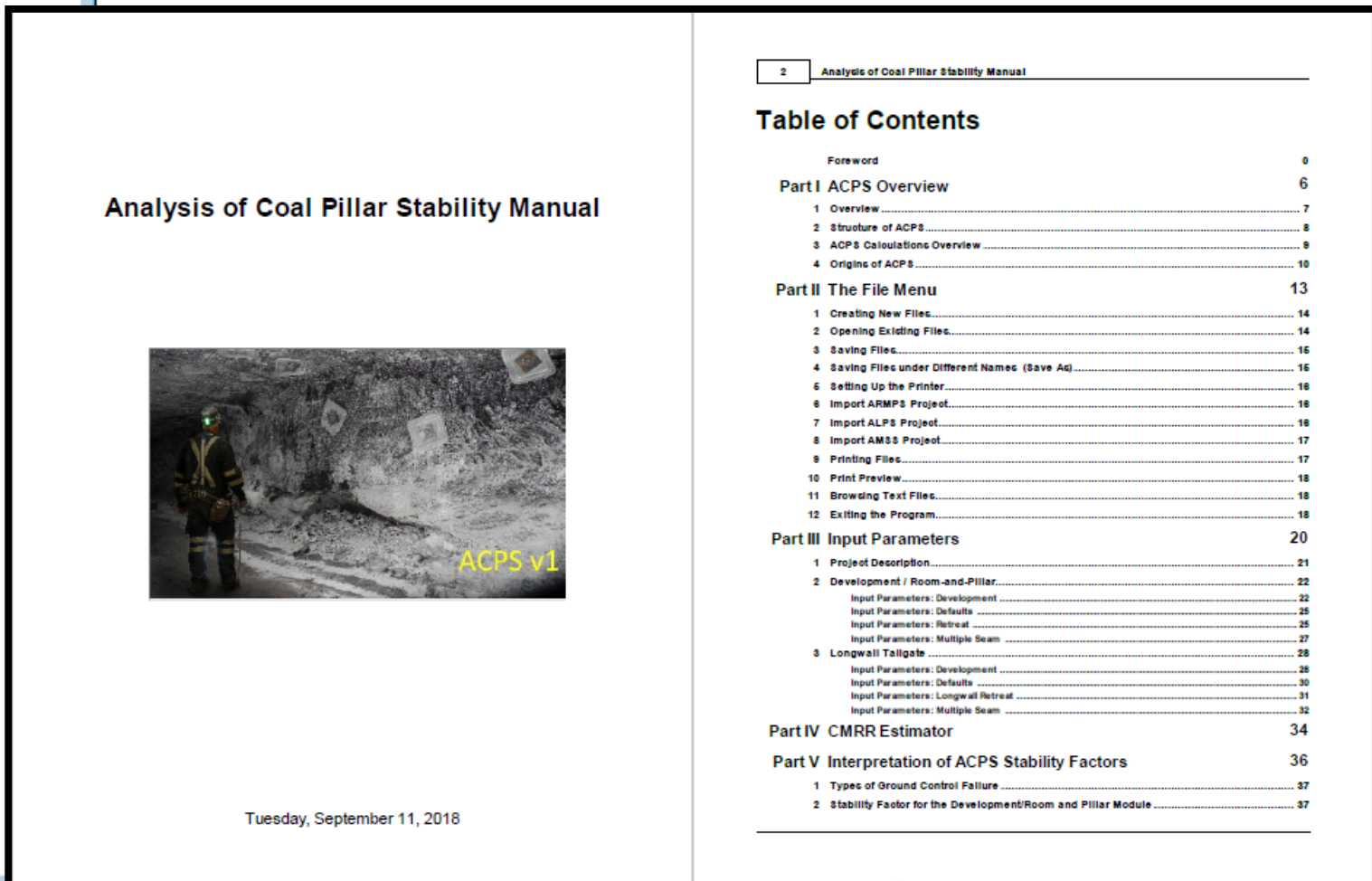
CMRR Estimates for CENTRAL APPALACHIAN COALFIELDS

Dominant Rock Type in Primary Bolt Horizon	CMRR
Thick Claystone	40
Thick shale	45
Stackrock (laminated sandstone/shale)	45
Siltstone	50
Bedded Sandstone	55
Massive Sandstone	65

Roof rock type must be validated with known geologic data. If data is unavailable, then a conservative CMRR = 45 should be assigned.



- Context Sensitive Help
- PDF Help File



Conclusions

- Integrated approach covering all pillar design formulations
- Updated multiple seam analysis
- Familiar interface
- Free software for the international mining community
- Ability to import data directly from ARMPS, ALPS and AMSS files
- New comprehensive help file

Current Status and Outlook

- ACPS is currently in version 1.0.49 and … its almost done
- MSHA tech support personnel have already been trained on ACPS (April 2018)
- ACPS was also shared with industry during the ground control meeting in Morgantown in July 2018
- MSHA is currently accepting roof control plans with ACPS
- ACPS is almost ready for wide distribution – a few minor bug fixes remain

Website for downloading the program

- http://www.minegroundcontrol.com/ground-control/