Crandall Canyon Mine Roof Control Plan Review

ENERGY, MINING, AND ENVIRONMENTAL CONSULTANTS

NORWEST
CORPORATION

CRANDALL CANYON MINE ROOF CONTROL PLAN REVIEW

Submitted to:
US HOUSE COMMITTEE ON EDUCATION AND LABOR

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EXECUTIVE SUMMARY

The United States House of Representatives Committee on Education and Labor (Committee) has retained Norwest Corporation (Norwest) to perform an independent examination of the Crandall Canyon Mine (CCM) roof control plan amendment approved June 15, 2007 by the Mine Safety and Health Administration (MSHA). A bounce in the South Barrier section on August 6, 2007 trapped six miners.

Norwest has performed this examination in the same manner as knowledgeable mine technical personnel would determine pillar sizes and related stresses. Of course, Norwest had the disadvantage of not having visually inspected the mining conditions as they existed at the relevant times. Nonetheless, Norwest performed numerical modeling of mining areas relative to the August 2007 bounce. Two commonly used and generally accepted National Institute for Occupational Safety and Health (NIOSH) software programs (LaModel and LaM2D) were used for this modeling.

The modeling results and the assumptions incorporated have been used to form the following opinions.

MODELING

Pillar stabilities and other associated parameters were modeled in the Main West mining area for the two following cases.

Original Support Characteristics
Assuming the pillars within the Main West retained originally mined support characteristics when mining was completed in the Main West in 1995, Norwest concluded the following.

- Areas of elevated risk indicators were not indentified.
- Some modeling results indicated more investigation was required to further analyze barrier pillar safety factors.
- Retreat mining in the North and South Barrier results indicated higher stress loading on the pillars adjacent to the forming gob as expected. No elevated risk indicators were indentified.
- Some modeling results indicated the Main West sealed area contained the weakest area of pillars.
- More investigation was necessary regarding the condition of the Main West pillars.

Deteriorated Support Characteristics

The second modeling scenario assumed deterioration to the weakest pillars in the Main West. Using this assumption, Norwest concluded from modeling results the following.

- Areas of elevated risk indicators were identified in the North Barrier retreat mining.
- These indicators were especially evident in the area where retreat mining was re-initiated after several pillars were not mined.

The extent of any deterioration or damage to the Main West pillars is not definitely known as the Main West was sealed in 2004. A Bureau of Land Management (BLM) inspection before the sealing however indicated pillar deterioration.

Modeling results are influenced by assumptions regarding coal strength and element size.

The NIOSH coal strength default of 900 psi assisted in the determination of weak stability areas through seam convergence and pillar strain safety factor. The use of a mine specific coal strength (higher than the default) assisted in identifying the location of high vertical stresses and the potential of bounce situations. The determination of mine specific coal strength would benefit design review in bounce prone mine locations such as CCM.

The use of different element sizes (5x5 ft or 10x10 ft) produced different results depending on the software. The LaModel results should be verified on a small test area before concluding that smaller element size results are comparable with larger element sizes.

ROOF CONTROL PLAN

Adequacy

Norwest's modeling results identified, under the assumption of deteriorated Main West pillars, indicators that showed increased potential for pillar failures. Based upon the indicators identified in these analyses and the actual occurrence of the August 2007 bounce, the roof control plan amendment was not considered adequate under this assumption of deteriorated Main West pillars.

Due Diligence

The following procedures and efforts could have improved the roof control plan submittal and review process.

- Review of the BLM inspection report of the Main West, prior to its sealing.
- Detailed review of the output (plot) files modeling process and results.
- Detailed review of the modeling input.
- Review of the process to determine mine specific coal strengths and safety factors.
- Further investigation is necessary when plan stability relies on conditions within a sealed area such as the Main West.
- Further review of the March 2007 bounce discussed in the April 18, 2007 Agapito report.

Impact of the March 2007 Bounce

The March 2007 bounce in the North Barrier section was an indication of questionable design of the North Barrier roof control plan. More investigation of the March 2007 bounce at that time would have been necessary to determine the cause and the effect on future mining including the roof control plan for the South Barrier.

The March 2007 bounce prompted additional Agapito analysis that resulted in longer pillars in the South Barrier. The Agapito report (from the MSHA website) did not include key details and assumptions incorporated into the revised modeling. Norwest therefore did not review the details of this Agapito modeling.

CONCLUSION

Due to the assumed deterioration of the Main West pillars in the modeled scenario combined with the actual occurrence of the August 2007 bounce, the roof control plan was inadequate. This assumption of pillar deterioration in the Main West, as noted in the BLM inspection report, is a likely factor that contributed to the August 2007 bounce.

The details of the examination and modeling results are in the following sections of this report. A Glossary of Terms used in this report is included in Section 6.

TECHNICAL SUMMARY

The United States House of Representatives Committee on Education and Labor (Committee) has retained Norwest Corporation (Norwest) to perform an independent examination of the Crandall Canyon Mine (CCM) roof control plan amendment approved June 15, 2007 by the Mine Safety and Health Administration (MSHA). Figure T.1 shows the location of CCM in Emery County, Utah.

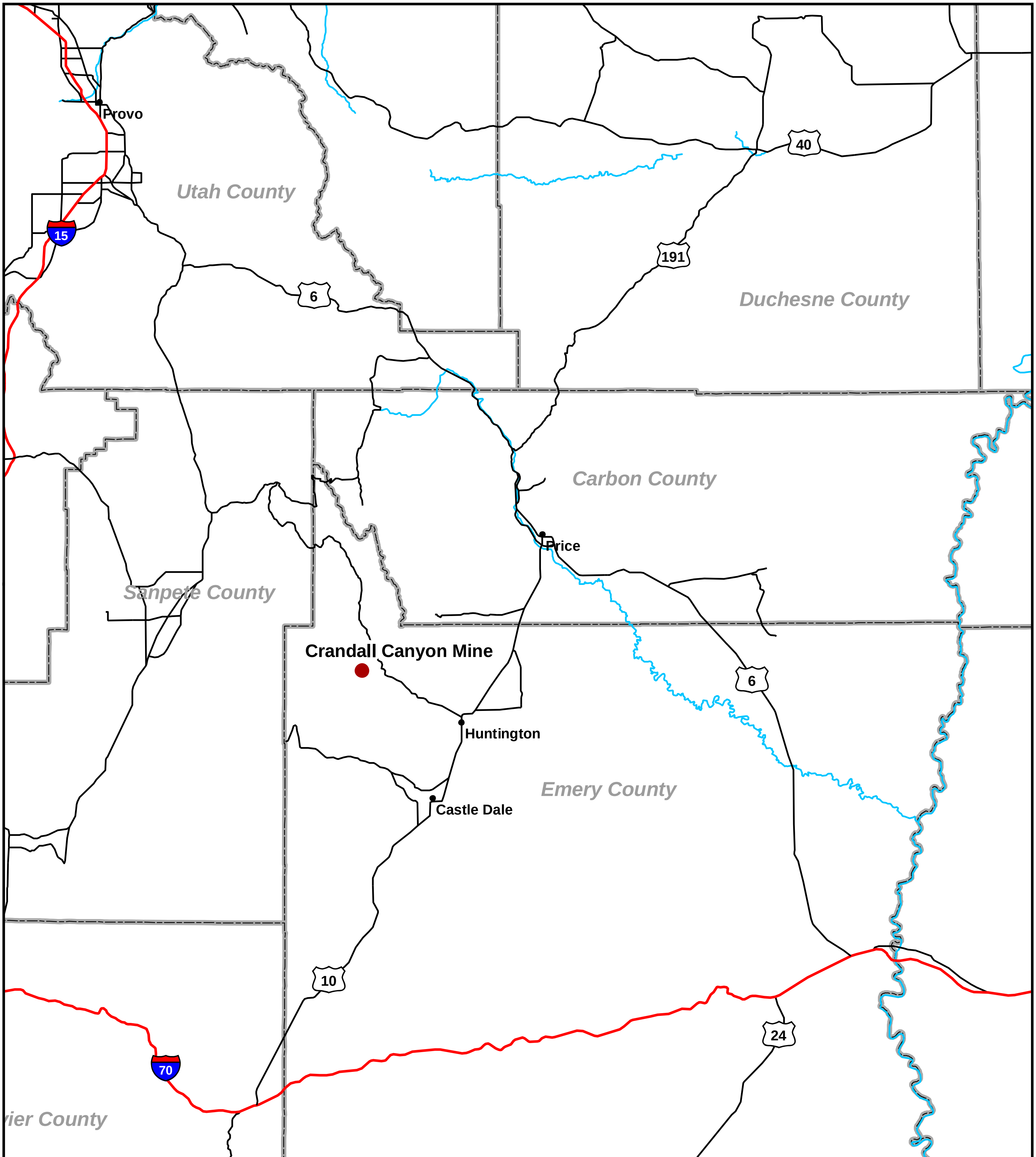
BACKGROUND

UtahAmerican Energy, Inc. (UEI) submitted to MSHA on May 16, 2007 a site-specific roof control plan for pillar recovery in the South Barrier of the Main West of the CCM. The previous operator of the CCM, GENWAL Resources (GENWAL), had begun in May 2006 to obtain roof control plan approval from MSHA to mine the North and South Barrier pillars of the Main West. GENWAL and UEI contracted a geotechnical engineering consultancy, Agapito Associates, Inc. (Agapito), to provide modeling and engineering reports in support of roof control plan submittals for development and retreat mining of the North and South Barrier pillars of the Main West prior to the plans being submitted to MSHA.

Mining in the North Barrier pillar section stopped in March 2007 as a result of a large bounce. Mining started in the South Barrier section in late March 2007. On August 6, 2007 a bounce occurred in the South Barrier section. This bounce resulted in the entrapment and deaths of six coal miners.

Figure T.2 is a location reference map of the different mining areas of the Main West referred to in this report. Figure T.2 shows the Main West mining area which includes the South Barrier pillar.

The Main West entries were initially mined in 1995. The 1st West Longwall panel north of the Main West was mined in 1999 and the 9th West Longwall panel to the south was mined in the second half of 1999 and early 2000. The North and South Barrier pillars were left unmined to protect the Main West. The Main West was sealed at the end of 2004.



N

0 5 10 15 20
Miles

Figure T.1
Crandall Canyon Mine
Location Map

Date: 3/27/08

File: 3717 Location.mxd

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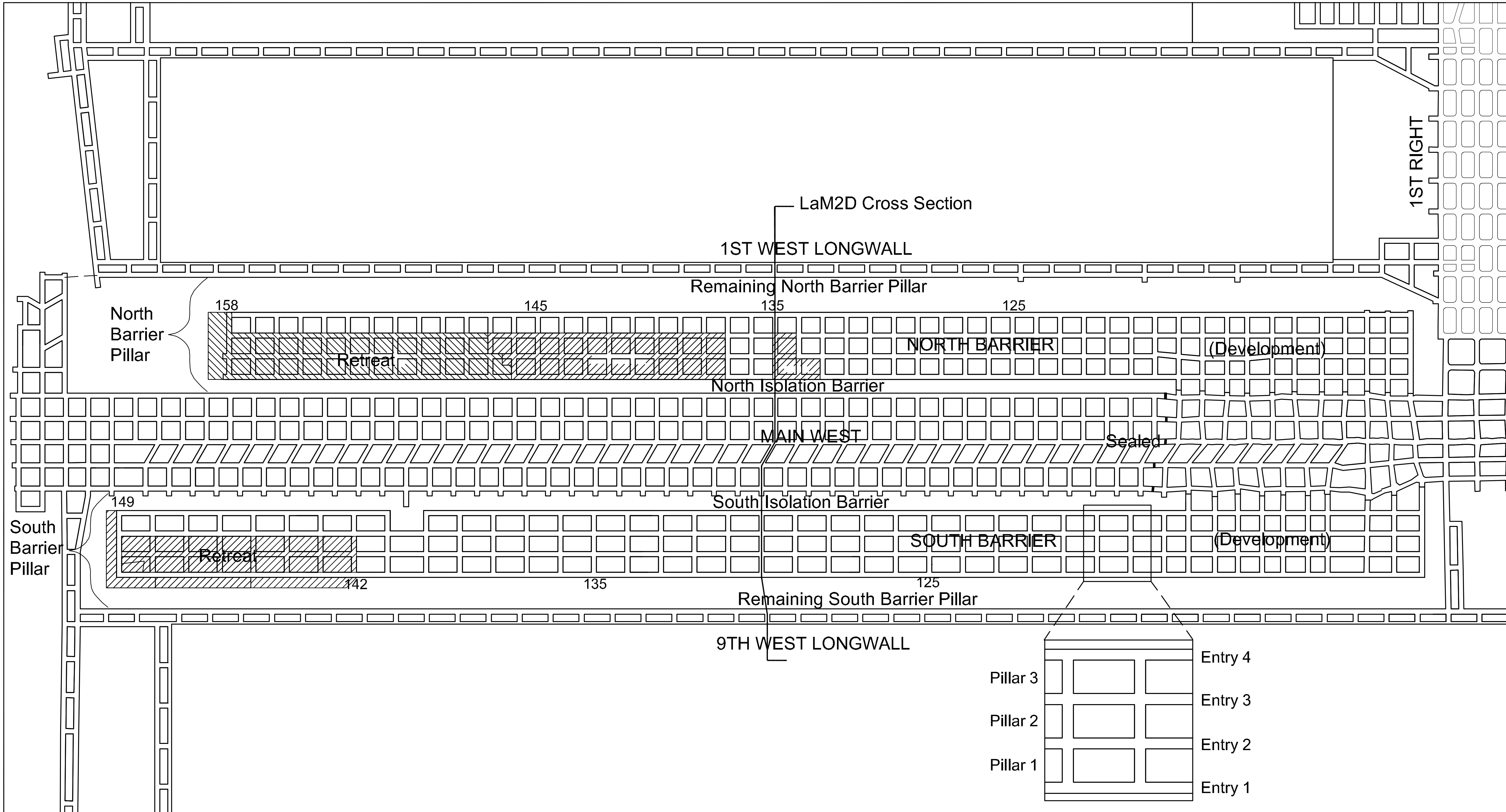

LEGEND

125 Crosscut Number

Seal

Retreat in Room and Pillar Area

FIGURE T.2

Main West Area of Interest Mining Area Reference Map

DATE: 04/16/2008
FILE: 3717\basela
SCALE: 1"=370'

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UEI began development mining of the North Barrier in September 2006 and continued into February 2007. Retreat mining in the North Barrier started in mid-February 2007. A bounce occurred in March 2007 that stopped all mining in the North Barrier. The North Barrier was ultimately sealed in that same month.

Development mining of the South Barrier was initiated in late March 2007 and continued to the middle of July 2007. UEI started retreat mining in mid-July. Retreat mining ceased in the South Barrier on August 6, 2007 as a result of the fatal bounce.

Mining terms used in this report are defined in the Glossary of Terms located in Section 6 of this report.

ROOF CONTROL PLAN

The Federal Coal Mine Health and Safety Act of 1969 and the superseding Federal Mine Health and Safety Act of 1977 (Act) require all underground coal mines, including CCM, to have an approved roof control plan. A roof control plan is intended to control the roof, face, ribs, and coal or rock bursts in underground coal mines. Coal mine operators submit roof control plans to MSHA for approval. The roof control plans for CCM were submitted to MSHA District 9 headquarters in Denver, Colorado. CCM, at the time of the August 2007 bounce, was operating under a roof control plan amendment approved June 15, 2007. This amendment addressed the site-specific mining in the Main West South Barrier.

Roof Control Plan Adequacy

The basic process for roof control plan amendments includes a pillar stability modeling review performed by the operator's consultant or engineer in support of the plan submittal. MSHA then performs a modeling review to affirm the projected pillar stability before the plan amendment approval or denial.

Norwest performed an independent modeling review using the same commonly used and generally accepted modeling software. The Norwest modeling sequence was constructed to incorporate key assumptions in establishing the adequacy of the roof control plan amendments submitted and approved for the South Barrier. Norwest's modeling results suggested that under some assumed conditions in the Main West pillars, indicators revealed the potential for pillar failures. Based upon the indicators raised by these analyses and the actual occurrence of the August 2007 bounce, the roof control plan amendment was not considered adequate under certain assumptions.

ROOF CONTROL PLAN IMPROVEMENTS AND OTHER DUE DILIGENCE EFFORTS

The Committee requested Norwest identify other procedures and diligent efforts that could have improved the roof control plan submittal and review process. Procedural information and intermediate documentation was not provided for Norwest to review. The resulting Norwest opinions come from the independent modeling process and the questions invoked through the review process. The findings within this report led Norwest to identify these additional due diligence measures:

- Detailed review of the output (plot) files modeling process and results
- Have available the modeling input and plot files as necessary for a detailed review
- Mine specific coal strengths and safety factors (based from multiple examples as successes and failures) provided for comparison
- Further investigation is necessary when plan stability relies on conditions within a sealed area.

MODELING

NIOSH Modeling Programs

The National Institute for Occupational Safety and Health (NIOSH) and the University of West Virginia make available several software programs to assist the mining industry to model pillar stability and mining interactions that effect stability. These programs have been developed using historical information from mining successes and failures throughout the US. Two of these programs are commonly used and generally accepted for stability evaluations similar to those completed for CCM. Norwest in this review of the CCM roof control plan used the following software modeling programs, LaM2D and LaModel.

These modeling tools take a numerical approach that includes sufficient geologic information to simulate the proper constitutive behavior of the modeled mining situation. Numerical models attempt to predict the behavior of the rock mass and indicate whether adverse mining interactions might occur. The two modeling software programs are described as follows.

LaM2D

LaM2D ". . . implements a simplified two-dimensional (2-D) boundary – element method in order to model the complex multiple-seam stress and displacement interactions. The program incorporates automatic coal and gob properties generation to simplify the input and inherently calculates pillar safety factors to enhance the output."[1] LaM2D provides a cross-sectional review of a planned mining area.

LAMODEL

LaModel 2.1.1 ". . . is a PC-based boundary-element program for calculating the stresses and displacements in coal mine. . . . This type of mine modeling software can be used by mine design engineers in the industry to investigate and optimize the pillar sizes and pillar layouts in relation to pillar stress, multi-seam stress, and/or bump potential (energy release)."[2] LaModel is a three dimensional model. LaModel provides a plan (top down) view of a mining area.

Norwest Methodology

Norwest used these two NIOSH programs to evaluate various mining sequences within the Main West. Modeling results are shown as numerical values for safety factors, vertical stresses, and convergences. The intent of the Norwest review was not to determine precise safety factors or optimize pillar sizes for mine design.

Norwest incorporated input data relative to CCM mining characteristics obtained through document review. CCM data and NIOSH default values were input into each model of the base mining sequence. The base case sequence assumes the Main West pillar support characteristics are the same as when originally mined. The base case modeling sequence consisted of the following mining phases:

- Main West (between longwall panels)
- North Barrier (development and retreat)
- South Barrier (development and retreat).

The results of each modeling sequence were used to identify on a relative basis:

- Weakest pillars or ones having safety factors (SF) less than others
- Areas more prone to failure represented by highest seam convergence
- Vertical stresses with the potential magnitude to contribute to significant failures.

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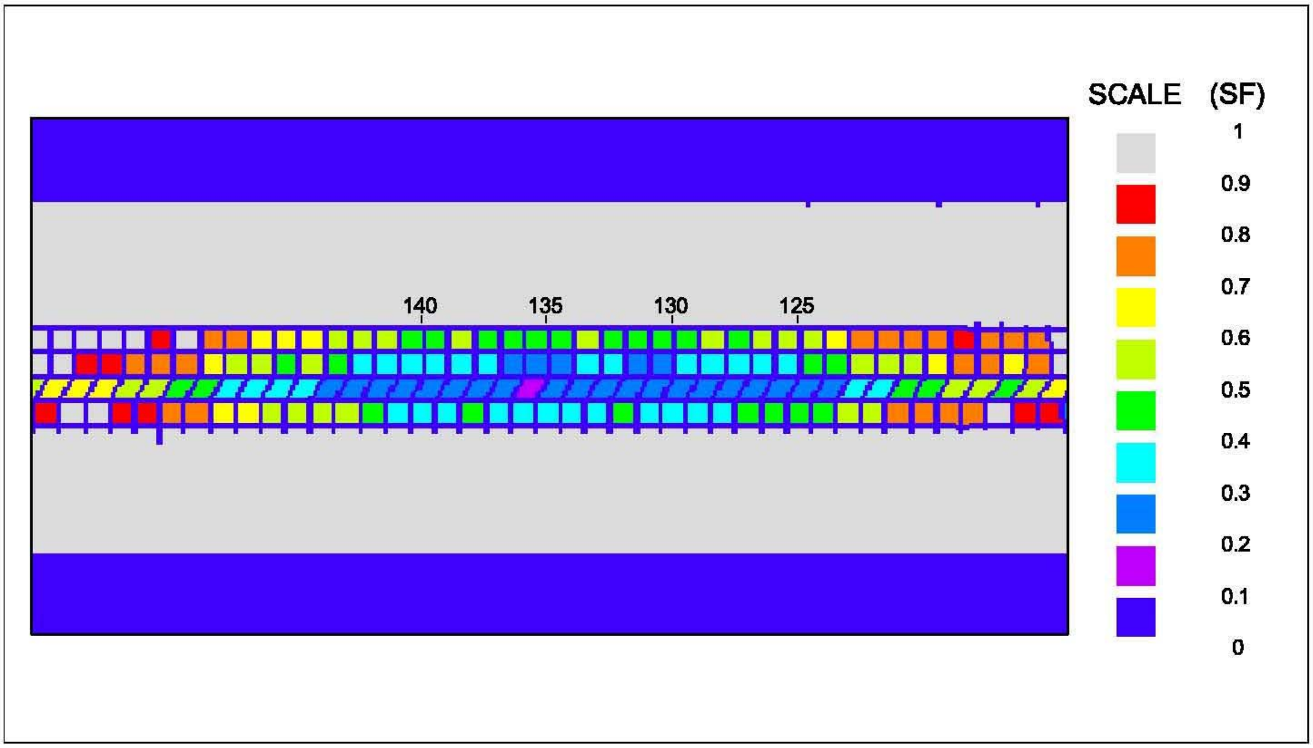
[1] IC 9495 Proceedings: New Technology for Ground Control in Multiple-Seam Mining, Edited by Christopher Mark, Ph.D., P.E. and Robert J. Tuchman, NIOSH, Pittsburgh, PA. May 2007, page 35.
[2] IC 9495 Proceedings: New Technology for Ground Control in Multiple-Seam Mining Edited by Christopher Mark, Ph.D., P.E. and Robert J. Tuchman, NIOSH, Pittsburgh, PA. May 2007, page 29.

LaM2D/LaModel Base Case Sequence Results

Norwest used NIOSH default input parameters where the program software provided a default value. Norwest utilized key input values of coal thickness, overburden depth, and pillar configuration consistently within the modeling sequences in this report. Norwest established these key input values through document review. Norwest also assumed no pillar deterioration in the Main West for the base case sequence. Norwest's reviews of modeling results for the base case follow.

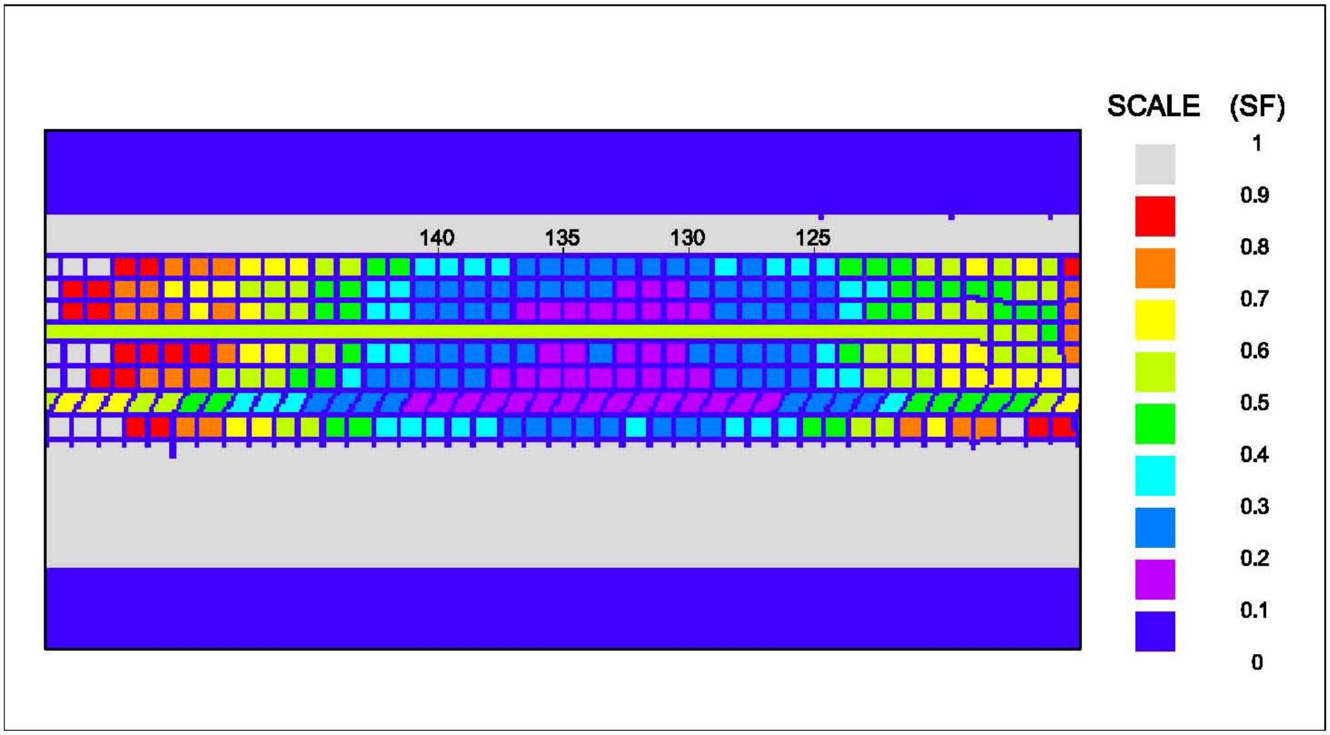
The Main West entries showed no weak zone in the LaM2D results while the LaModel results identified a weak zone of potentially deforming angled pillars (purple and blue) adjacent to the March bounce area (at crosscut 135 in the North Barrier), Figure T.3.

Figure T.3 Base Case Pillar Strain SF - Main West (LaModel)



The addition of the North Barrier development showed the north isolation barrier thickness affording little protection to the North Barrier development. Lower strain stability factors were evident in both programs results. The LaModel results showed a growing area of weaker potentially deforming pillars including pillars ultimately damaged as a result of the March 2007 bounce, Figure T.4.

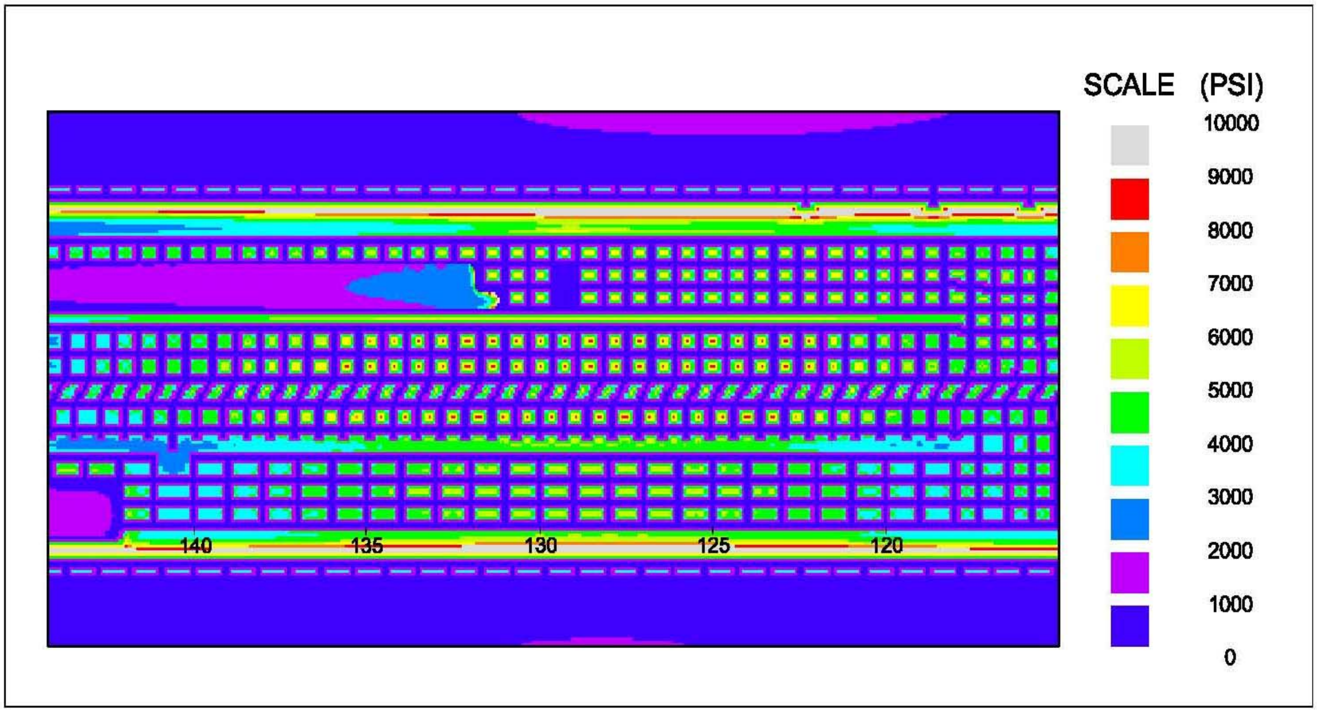
Figure T.4 Base Case Pillar Strain SF - Main West and North Barrier (LaModel)



The increased pillar size of the South Barrier pillars along with a wider south isolation barrier showed increased pillar strain safety factors in the South Barrier development. Both programs did not reflect results that would cause concern.

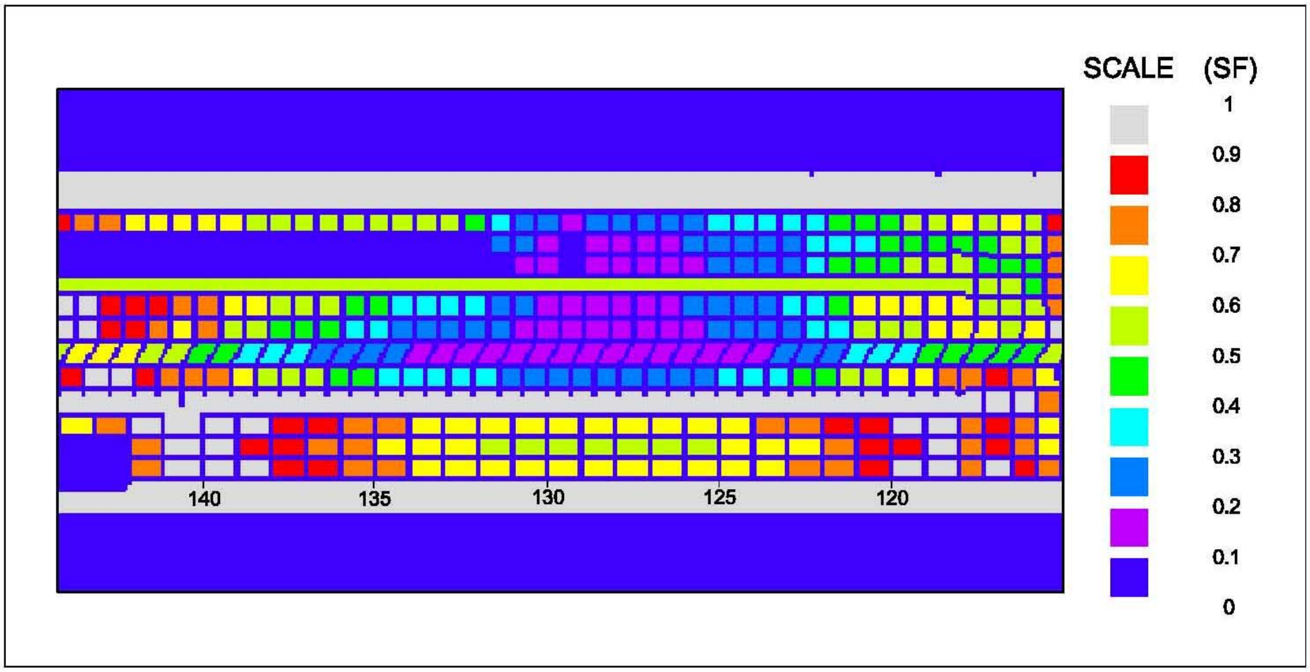
Retreat mining effects are not easily modeled in the LaM2D program. LaModel results of retreat mining indicated the increased vertical stress from retreat mining were isolated to the pillars adjacent to the gob as shown in Figure T.5. These stress levels were not projected to be at indicator levels. Vertical loading was maintained on the pillar cores.

Figure T.5 Base Case Vertical Stress - South Barrier Retreat (LaModel)



Retreat mining effects in the South Barrier were reviewed from the LaModel program results. The same interpretation was drawn that indicated the increased vertical stress from retreat mining were isolated to the pillars adjacent to the gob. These stress levels were not projected to be at indicator levels. Vertical loading was maintained on the pillar cores. The resulting pillar strain SF show the pillars from crosscut 141 to 139 are not being impacted by the retreat mining, see Figure T.6.

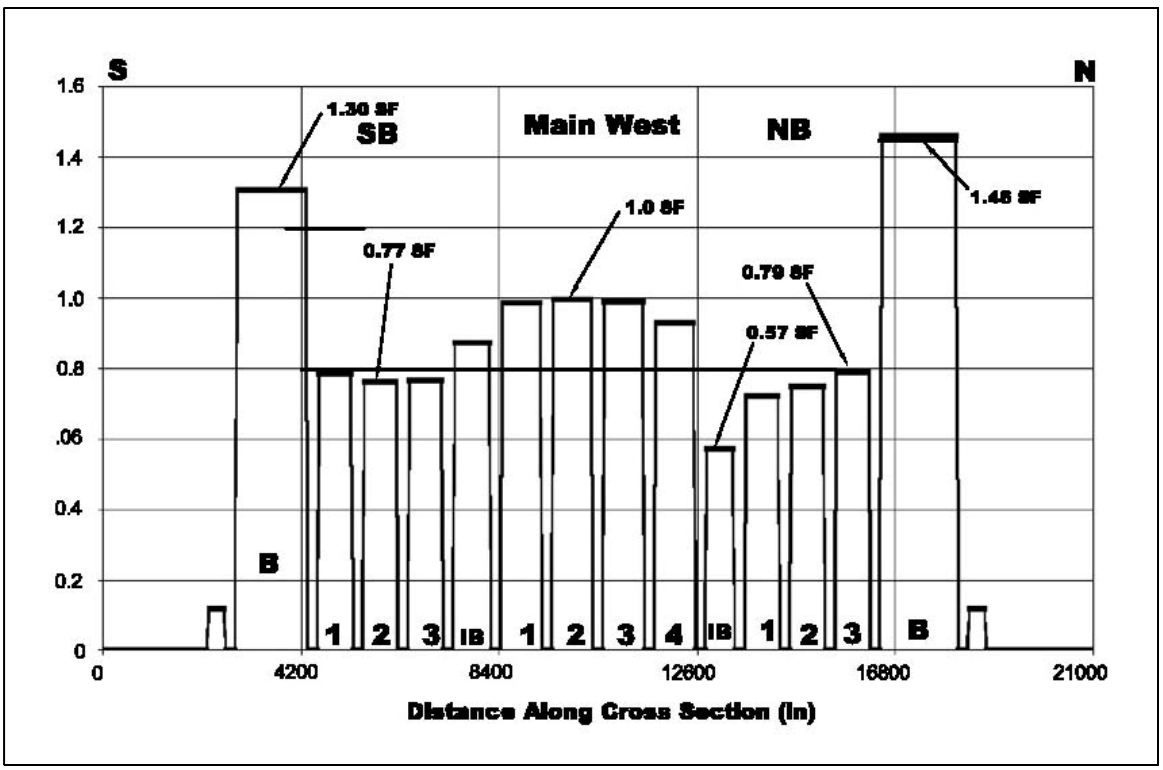
Figure T.6 Base Case Pillar Strain SF - South Barrier Retreat (LaModel)



Review of the barrier pillar safety factors identified inconsistent modeling results between the two programs. LaM2D results showed a significant reduction to the Barrier pillar safety factor in both the North and South Barriers. The LaM2D results in Figure T.7 projected the remaining barrier pillars to have below NIOSH guidelines (2.0 SF) safety factors when the North and South Barrier sections are added. The LaModel results provide different conclusions indicating barrier pillar safety factors above 2.0.

N = north
S = south
SB = South Barrier Section
NB = North Barrier Section
B = remaining barrier pillar
IB = isolation barrier pillar
1, 2, 3, 4 = numbered pillars within each mining area
SF = safety factor
Bottom scale is inches along the modeled cross-section.

Figure T.7 Strain SF Main West - North Barrier and South Barrier (LaM2D)



The Norwest base case opinions are as follows.

The review of the base case sequence results showed no suggestion in either the North Barrier or the South Barrier, that potential vertical stress levels reached an indicator level sufficient to initiate the damage sustained in the March and August 2007 bounce events.

The review of the remaining barrier pillars compared to NIOSH guidelines showed planned mining in both the North and South Barrier produced barrier pillars with strain safety factor below the 2.0 minimum recommended in the NIOSH guidelines for Analysis of Retreat Mining Pillar Stability (ARMPS) safety factor for bounce prone mines. The low barrier pillar safety factors in this case should require further investigation.

Norwest concluded that the potential vertical stress loading required to initiate the March and August 2007 bounce events was not present. The creation of high vertical stresses required additional instability not included in the base case modeling sequences.

DAMAGE/DETERIORATION EXISTENCE

The Norwest document review[3,4] and seismic events[5] review within a 1.5 mile radius of the bounce area at CCM showed information that provided a basis for the damage/deterioration assumptions made in this report.

The Main West damage area was not detailed in the Bureau of Land Management report. Therefore Norwest assumed damage/deterioration to the pillars identified by the lowest pillar strain safety factors. Mapping of the March bounce provided specific locations of pillar damage used in the damage modeling sequence.

Seismic event records are developed and maintained for the State of Utah by the University of Utah seismograph stations. Norwest reviewed this information for 2007 to identify seismic events located within a 1.5 mile radius of the review area.

[3] BLM Inspection Report – Special for the November 4, 2004 GENWAL Mine by Steve Falk, pg 1.
[4] UEI CONG 000020828 UEI-Inspection and Descriptions of March Bounce Damage, pg 1-4.
[5] University of Utah Seismograph Stations website http://www.seis.utah.edu.

All seismic events are not records of a mine pillar failures. However, the failure of a mine pillar(s) can result in a recordable seismic event. Norwest identified eight seismic events occurring in 2007 before March 10, 2007, seven events occurred during March 10 and 11, 2007, and nine events between March 11, 2007 and August 6, 2007 seismic event. These events can only be inferred as potential damage events that impacted pillar support within the CCM. Norwest ran a second case modeling pillar damage in the Main West.

LaM2D/LaModel Damage/Deterioration Case Assumption Results

Norwest incorporated assumptions that damage/deterioration effected pillars in the Main West and their resulting support capacity. No detailed damage map was available for this area. Norwest damage/deterioration assumptions affected the weakest pillars first and expanded to adjacent pillars as assumed damage/deterioration was incorporated in the modeling sequence. Norwest does not have knowledge of the chronological damage to the pillars. However, in the modeling sequence Norwest assumed damages occurred in the following order.

- Main West with North Barrier development assumes damage/deterioration to the weakest Main West pillars.
- Main West with North Barrier retreat assumes damage/deterioration to the weakest Main West pillars.
- Main West with South Barrier development assumes damage/deterioration to North Barrier weakest pillars (bounce) and additional Main West damage to weakest pillars and isolation barrier between Main West and North Barrier.
- Main West with South Barrier retreat assumes damage/deterioration to weakest pillars and isolation barrier adjacent to entry 1 in the Main West.

The following opinions have been formed after the review of the five step damage case modeling results as shown in Figure T.8 and Figure T.9.

Step 1 The damage assumed in the Main West resulted in increased vertical stresses projected for the North Barrier in the area of the March bounce. The resulting vertical stress reduced pillar strain SF in the area of the March bounce. Both modeling programs showed similar increased vertical stress effects which could result in a bounce event.

Step 2 When Norwest incorporated the assumed damage effects of the March bounce into both modeling programs, the resulting vertical stresses increased in the Main West. Interpretation of these results projected the transfer of vertical stress back into the remaining support pillars in the sealed area of the Main West was sufficient to initiate additional damage in the Main West.

Step 3 The modeling results of this sequence with the assumed damage/deterioration of the Main West pillars indicated vertical stresses transferring to the South Barrier section pillars decreasing the pillar strain safety factor in an area coinciding with the August bounce. The reduction in pillar strain SF indicated potential questions on the pillar design in this area.

Step 4 The modeling results of retreat mining in the South Barrier indicated potential vertical stresses increased by this method did not contribute to the August 2007 bounce. The Norwest interpretation of the results concludes these stresses were maintained on the pillars adjacent to the retreat mining. The bounce failure occurred approximately 400 ft (approx. 3-4 pillars) from the pillars that showed peak stress.

Step 5 The March 2007 bounce damage and the assumption that damage/deterioration to support in the Main West is necessary to create vertical stress levels sufficient to initiate a cascading pillar failure that could have contributed to the August 2007 event.

Figure T.8 Five Step Damage Sequence – Vertical Stress (LaModel)

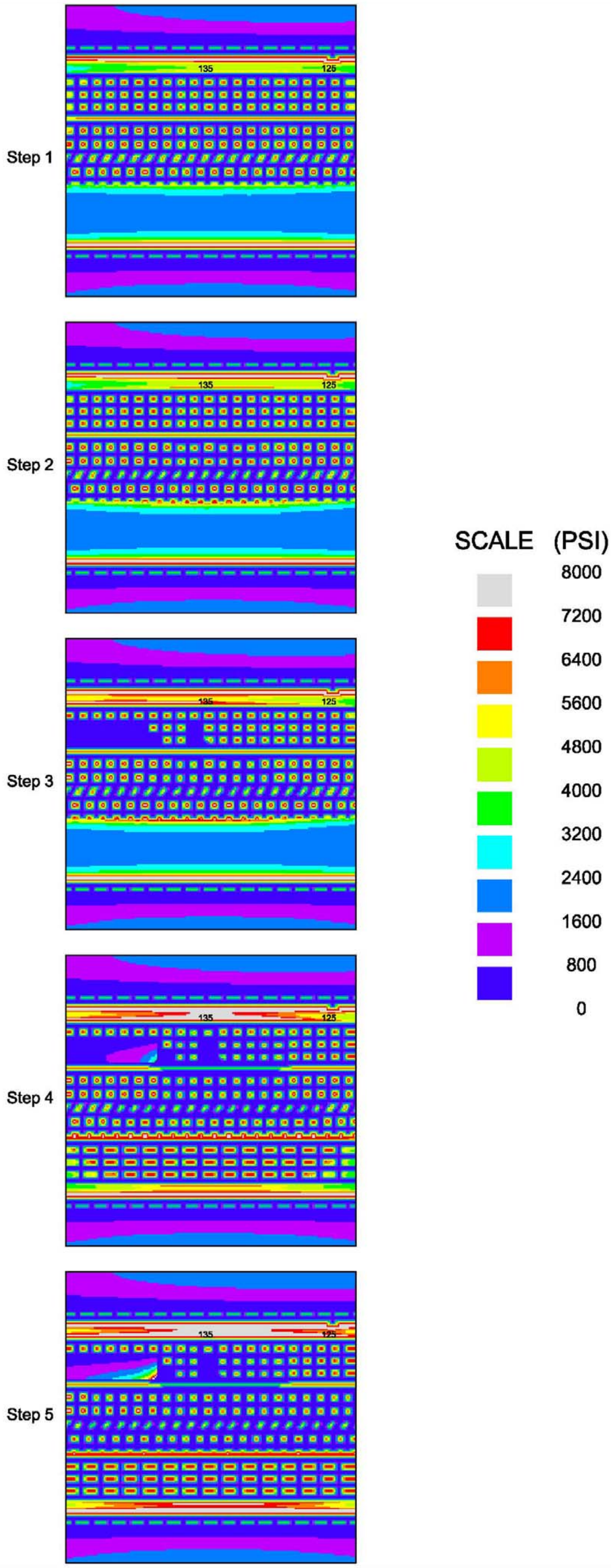
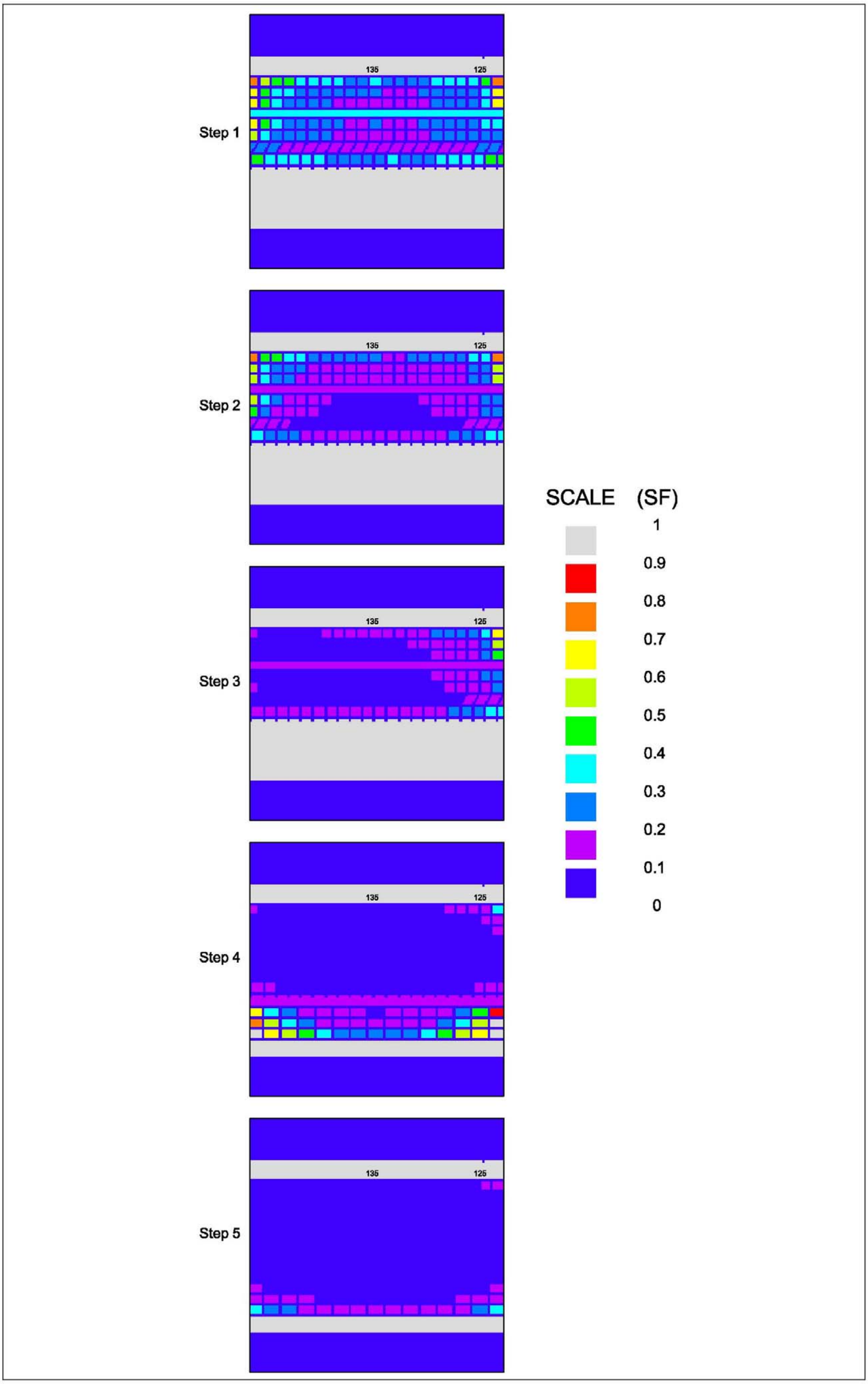


Figure T.9 Five Step Damage Sequence – Pillar Strain SF (LaModel)



LaM2D/LaModel Input Effects

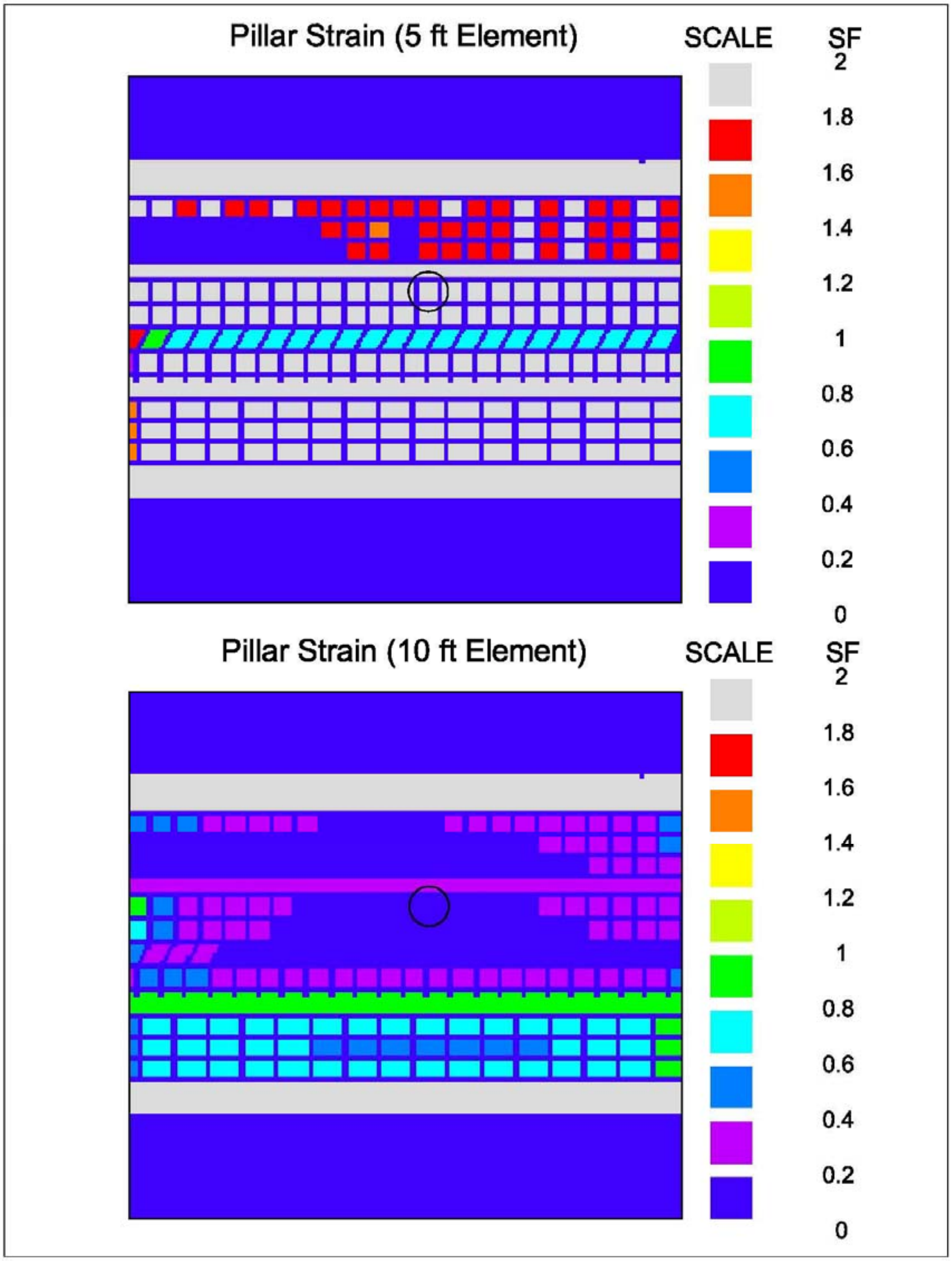
Norwest constructed two smaller model areas to determine the effects of varying the following input parameters:

- Element size
- Coal strength.

Two very commonly used element sizes (5 ft and 10 ft) were selected to evaluate the consistency of modeling results in both modeling programs. The smaller size provides more detail, while the larger size is used to evaluate larger areas. This model comparison yielded conflicting results. Norwest used ARMPS safety factors to compare the success or failure of this model. Norwest found results for the five-foot element within the LaModel produced higher pillar strain SF results for the same pillar shown in Figure T.10 while the LaM2D produced similar to identical results.

Element size variation may not always produce reliable results. A verification step on a simple area should be conducted to determine whether the results of an element size change produces consistent results and does not affect the conclusions drawn from the model results.

Figure T.10 Element Size Comparison - Pillar Strain SF (LaModel)



Norwest used two coal strengths to determine the effect on modeling results. Norwest identified beneficial results that were in both cases.

The use of the NIOSH default coal strength of 900 psi clearly identified the weakest areas within a proposed mining plan area. Both results from convergence and pillar strain SF showed the location of the weakest pillars, see Figure T.11. This default value is a good initial step when reviewing a plan design. However, the 900 psi coal strength did not identify the locations of peak vertical stresses that could indicate the potential of bounce conditions.

The higher coal strength of 1250 psi clearly identified vertical stress locations that could indicate the potential of bounce conditions as shown in Figure T.12. The use of higher coal strength is beneficial in detail convergence and vertical stress modeling in bounce prone locations.

Figure T.11 Five Step Sequence (1250 psi) – Pillar Strain SF (LaModel)

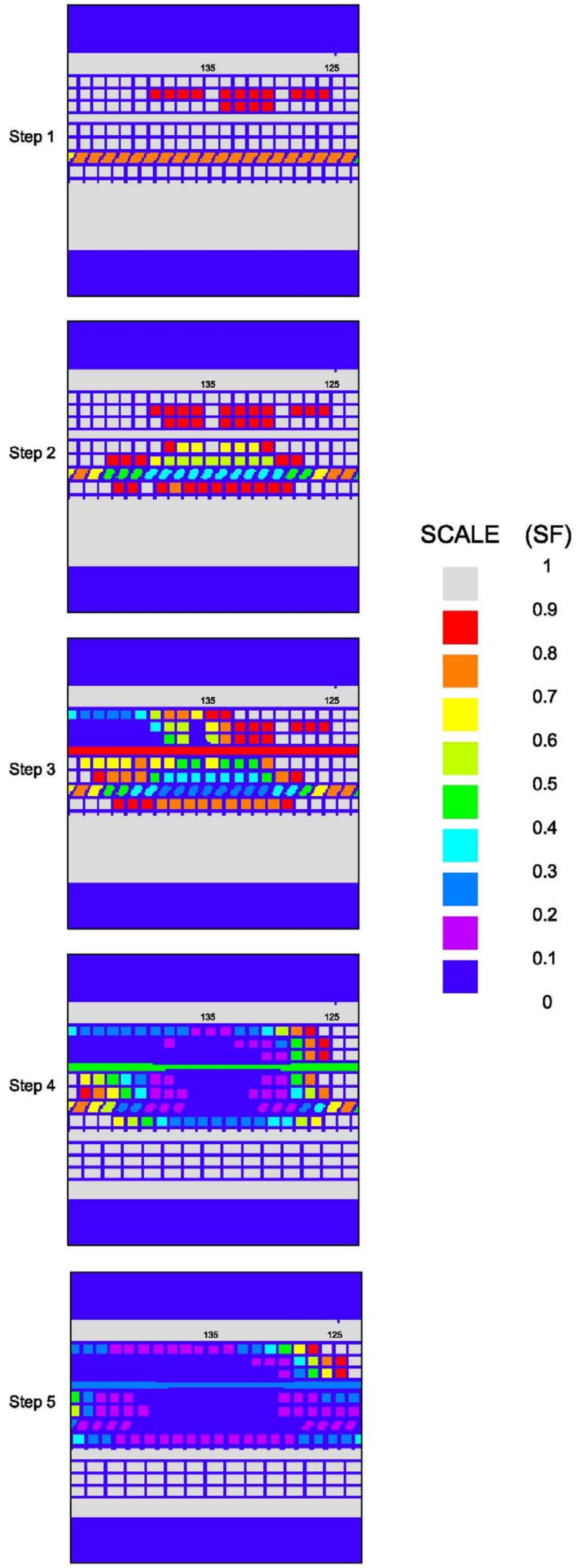
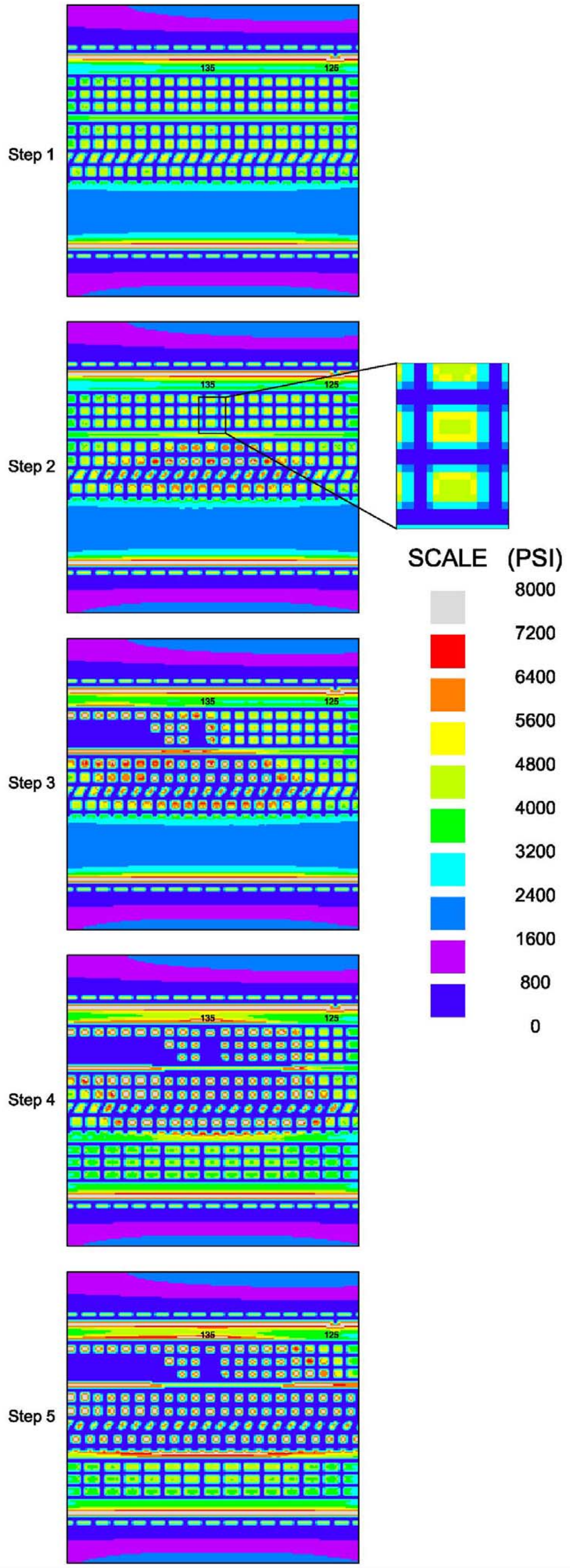


Figure T.12 Five Step Sequence (1250 psi) – Vertical Stress



MSHA ROOF CONTROL PLAN REVIEW PROCESS

Norwest reviewed the CCM roof control plan submittals and the additional pillar stability analysis provided in support of these submittals. The data provided to MSHA was not adequate to perform a detailed review of these submittals. Our review of this material generated requests for more information necessary to complete a detailed review.

INTRODUCTION

The United States House of Representatives Committee on Education and Labor (Committee) has retained Norwest Corporation (Norwest) to perform an independent examination of the Crandall Canyon Mine (CCM) roof control plan amendment approved in June 2007 by the Mine Safety and Health Administration (MSHA). This examination specifically addresses those aspects related to the recovery of pillars in the South Barrier pillar of the West Mains at CCM.

UtahAmerican Energy, Inc. (UEI) submitted to MSHA on May 16, 2007 a site-specific roof control plan for pillar recovery in the South Barrier of the Main West of the CCM. The previous operator of the CCM, GENWAL Resources (GENWAL), had begun in May 2006 to obtain roof control plan approval from MSHA to mine the North and South Barrier pillars of the Main West. GENWAL and UEI contracted a geotechnical engineering consultancy Agapito Associates, Inc. (Agapito) to provide modeling and engineering reports in support of roof control plan submittals for development and retreat mining of the North and South Barrier pillars of the Main West prior to the plans being submitted to MSHA.

Mining in the North Barrier retreat section stopped in March 2007 as a result of a large bounce. Mining started in the South Barrier section in late March 2007. On August 6, 2007 a bounce occurred in the mining section of the South Barrier Section. This resulted in the entrapment and deaths of six coal miners.

The coal in the Main West and the North and South Barrier pillars is owned by the United States Government. The Bureau of Land Management (BLM) conducted inspections of the CCM operations.

SCOPE OF WORK

The Committee seeks an opinion of the specific components related to plans covering the mining of the areas involved in the March and August 2007 bounce events at CCM as follows:

- Roof control plan adequacy
- Possible terms and conditions to improve the roof control plan adequacy
- Reasons why the roof control plan should not have been approved if the plan was inadequate

- Possible other due diligence efforts to be considered during the roof control plan approval process
- The impact of the March 2007 bounce on the roof control plan
- Potential differences in the roof control plan if the March 2007 bounce was more significant than originally reported.

Norwest cannot comment on what might have been included in the plan if the March 2007 event had been of a greater or lesser magnitude. It is Norwest's opinion that the analysis we have performed for the Committee, which is presented in this report, is the appropriate analysis that should be performed during the review and approval process for a roof control plan at a mine operating in a geologic setting similar to CCM which has experienced a bounce which results in the suspension of mining for more than one hour.

Norwest has performed the following work to establish the opinions expressed in this report.

- Reviewed roof control plan submittals and related correspondence leading up to plan approvals as provided by the Committee and the MSHA on its web site.
- Reviewed other pertinent information as provided by the Committee.
- Modeled the March 2007 bounce area, opined on roof control issues, stresses and stability factors, to the extent possible using publicly available software from National Institute of Safety and Health (NIOSH).
- Reviewed the limited data about the Agapito modeling as provided for the March 2007 bounce to determine if the Agapito modeling could be compared to the Norwest results.
- Modeled (and reviewed output of) the consequence, of the August 2007 bounce area and opined on roof control issues, stresses, and stability factors to the degree possible, using publicly available software from NIOSH.
- Reviewed the limited data about the Agapito modeling relating to the mine area of the August 2007 bounce to determine if the Agapito modeling could be compared to the Norwest results.
- Reviewed information provided by the Committee relative to the approval of the subject roof control plan.

DATA

Norwest utilized data from various sources for the roof control plan review. Some of this information is publicly available. The Committee provided additional information not publicly available. Data provided was in various forms of electronic format.

Publicly available information includes the following:

- CCM roof control plans dated from July 3, 2002 to June 15, 2007 including roof control plan evaluations by Agapito
- University of Utah seismic event records
- Other MSHA information.

The June 15, 2007 roof control plan amendment was in effect at the time of the August 2007 bounce.

The Committee provided the following not publicly available information:

- Thirty-six CCM maps or drawings in AutoCAD format
- Photos of the March 2007 bounce area in jpg format
- BLM inspection reports in pdf format
- Depositions of MSHA officials Al Davis, Billy Owens, and William Reitze in e-transcript format
- Pdf copies of emails, other correspondence, and deposition exhibits relative to CCM.

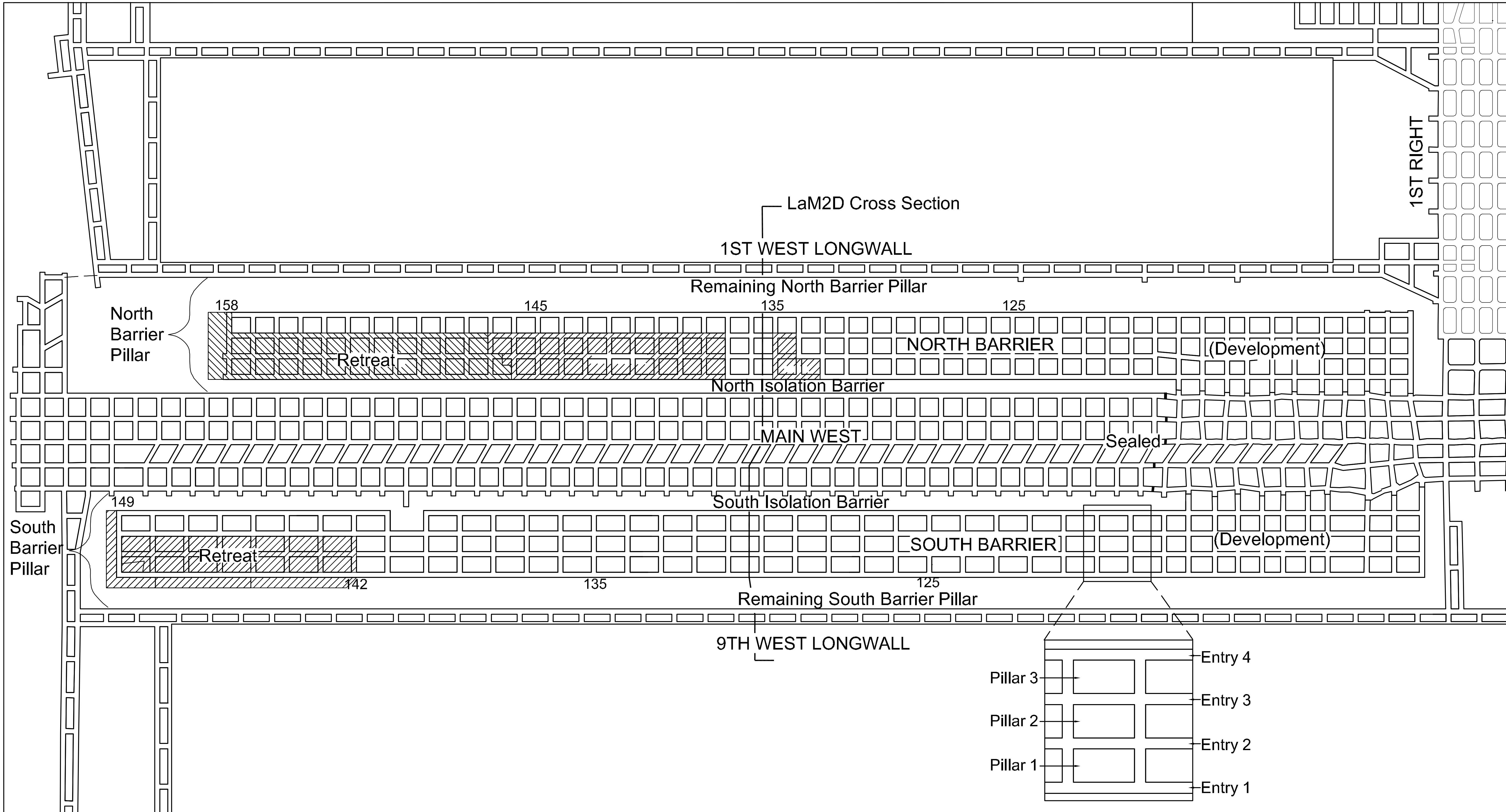
CRANDALL CANYON MINE SPECIFIC

Norwest has performed this roof control plan review solely for the CCM and the associated mine plan sequence in the area of the Main West and for the mining conducted in the adjacent North and South Barrier pillars relative to the March and August 2007 bounce events. The analysis, findings and opinions in this report pertain only to these unique circumstances of CCM. These findings are not applicable to other mines or the application of any mining method. Figure 1.1 shows the Main West and the North and South Barrier pillars.

Figure 1.1 identifies the location of mining areas and barrier pillars analyzed in this report. This figure provides location references for the data review and modeling analysis conducted in this report.

CRANDALL CANYON MINE BACKGROUND

The CCM is an underground coal mine located near Huntington, Utah. Figure 1.2 shows the mine location. This mine started operations in 1981. GENWAL Resources, Inc. (GENWAL) owns and operates the mine. GENWAL is owned by UtahAmerican Energy, Inc. (UEI) and the Intermountain Power Agency. Andalex Resources Inc. owned 50% of CCM prior to its acquisition by UEI in August 2006.



LEGEND

125 Crosscut Number

| Seal

Retreat in Room and Pillar Area

N

FIGURE 1.1

Main West Area of Interest
Mining Area Reference
Map

DATE: 04/16/2008
FILE: 3717\basela
SCALE: 1"=370'

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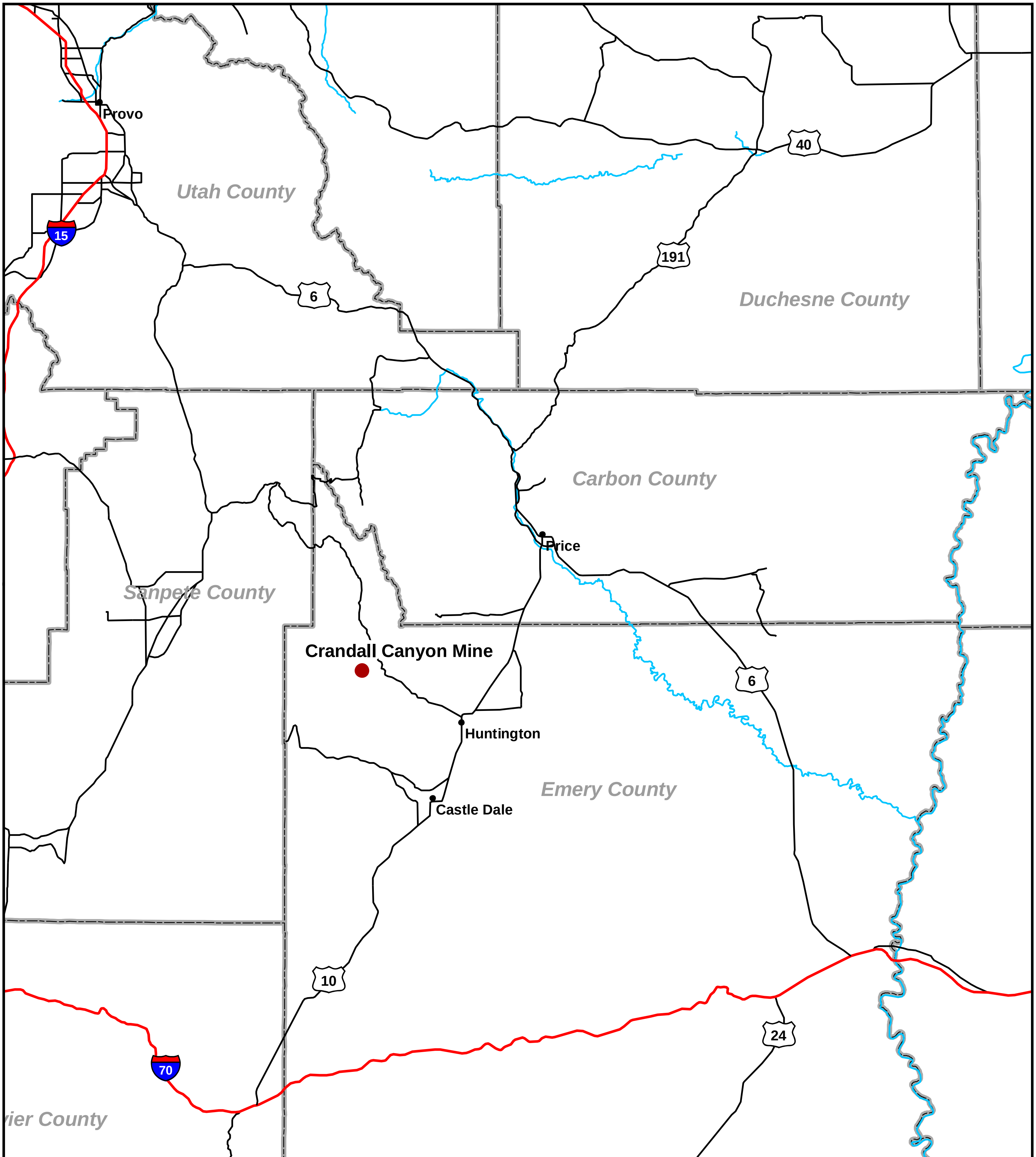


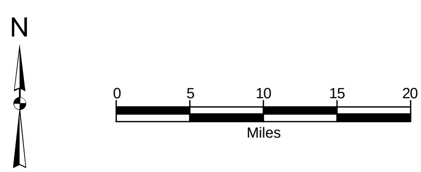


Figure 1.2
Crandall Canyon Mine
Location Map

Date: 3/27/08

File: 3717 Location.mxd

NORWEST CORPORATION

CCM initially began operations as a room and pillar mine utilizing continuous miners for production. Room and pillar operations included both main and sub main entry development, and the development and retreat mining of room and pillar panels. The first longwall mining retreat operations began in 1995 and ended in October 2005. Since the cessation of longwall operations, mining has been solely by continuous miners. During longwall mining operations, the mine has produced as much as four million (M) tons per year. The mine produced approximately 0.6M tons in 2006 and 0.4M tons in 2007.

AUGUST 2007 EVENT REVIEW

The progression of mining leading up to the August 2007 bounce is briefly summarized as follows.

CCM began development mining from the east in the South Barrier pillar in March 2007. Four entries were mined from crosscut 108 to crosscut 149, for a total distance of approximately 5,100 ft. This development mining left in place, three rectangular pillars per crosscut with dimensions of approximately 60 ft wide by 110 ft long. The depth of overburden in this section varied from over 1,000 ft at the west end to a maximum of approximately 2,000 ft. This mining was accomplished utilizing one continuous miner to cut coal and shuttle cars to haul the coal from the mining face to the belt conveyor for transportation out of the mine.

Retreat mining of the South Barrier started on July 16, 2007. This retreat mining recovered the two pillars between entry 1 and entry 3. The pillar between entry 3 and entry 4 was not mined. This pillar provided support for ventilation purposes. The barrier pillar to the left (south) of entry 1 entry was retreat mined to a maximum extraction depth of 40 ft. UEI engaged Agapito to perform the geotechnical analysis of the planned mining of the North and South Barrier pillars.

A bounce occurred on August 6, 2007. This bounce event trapped six miners.

REGULATORY ROOF CONTROL STANDARDS

Title 30 of the Code of Federal Regulations (CFR) Part 75, Subpart C 75.200 through 75.223 lists the regulations for roof support in underground coal mines. Briefly, Subpart C regulations state the following:

- A coal mine operator is to submit a roof control plan to the MSHA District Manager

- Specific information must be contained in the plan
- Approval criteria
- An operator shall submit revised plans when the current plan is not suitable to control "roof, face, ribs, or coal or rock bursts."

30CFR75.200, the scope, "This Subpart C sets forth requirements for controlling roof, face and ribs, including coal or rock bursts, in underground coal mines."

Appendix A contains 30CFR75.200 through 75.223.

NORWEST ANALYSIS METHODOLOGY

Norwest accumulated available data relative to our scope of work. Data provided was used to simulate the mining sequence of the area in question from a geotechnical perspective. Modeling was performed to simulate potential convergence, vertical stress, and resulting strain safety factors (SF) in the various sequential mining phases of the:

- Main West
- North Barrier (development and retreat)
- South Barrier (development and retreat).

The modeling results were examined to identify the weakest projected pillars and lowest strain SF areas on a relative basis. Norwest opinions were formed through comparison of the mining sequence results. The comparison review process focus was on projected factors that may have contributed to the March and August 2007 bounces. While modeling results are shown in numerical values such as safety factor, stresses, convergences etc., the intent of this methodology is not to obtain precise numbers or to determine safety factor levels that should have been used to size pillars.

This modeling examination is based upon the following:

- Use of NIOSH software with default values where possible
- Application of bounce weakened pillars.

Norwest has performed this examination in the same manner as knowledgeable mine technical personnel would determine pillar sizes and related stresses, while not having visually inspected the mining conditions.

NIOSH Modeling Programs

NIOSH and the University of West Virginia make available several software programs to assist the mining industry to model pillar stability and mining interactions that effect stability. These programs have been developed using historical information from mining successes and failures throughout the United States (US). Two of these publicly available software programs were used to model the convergence, vertical stresses, and pillar stability for CCM. The names of the programs used are:

- LaM2D
- LaModel.

LaM2D is a two-dimensional finite element modeling program. This program brings together the functions of several earlier NIOSH programs developed for pillar stability analysis. NIOSH published guidelines in the Analysis of Retreat Mining Pillar Stability (ARMPS) program and these guidelines are applicable when using this program. The ARMPS recommended SF were established using an historic database of coal mining successes and failures collected throughout the US.

LaModel 2.1.1 is a three-dimensional finite element modeling program. The three dimensional aspect allows for more detailed analysis for mining areas with varying overburden and pillar configurations.

Norwest selected the most current versions available to conduct our review. The information provided Norwest indicates that Agapito and MSHA used the LaModel program to perform evaluations associated with the roof control plans for the North and South Barriers.

Norwest constructed models of the Main West area of CCM using both modeling programs and data available from the CCM maps. The objective of the modeling was to review the mining that effected the area damaged in the March and August 2007 bounces. As a result of these reviews, Norwest attempted to determine whether indicators were present in the proposed mine plans. An indicator is an alert that elevated risk may be associated with a plan or design. An indicator alerts an engineer to reevaluate his base assumptions or design parameters.

Norwest modeled the sequence of mining events within the CCM as follows:

- Main West between the gobs of the 1st West and 9th West longwall panels
- Main West with the North Barrier development
- Main West with the North Barrier retreat
- Main West with the March 2007 bounce
- Main West with the North and South Barrier retreat.

Norwest sought to determine if the above modeling sequence revealed the presence of indicators that should have reasonably prompted further review or denial of the proposed plan prior to the August bounce.

Roof Control Plan Submittal Process Review

Norwest reviewed the available data concerning the submittal process of the roof control plan. This included the roof control plan submittals and the Agapito engineering reports. Additional information as provided by the Committee relative to the submittal and approval process as available was reviewed.

NORWEST MODELING

The evaluation of the modeling process was completed using two of the publicly available programs developed by NIOSH to review coal mine extraction plans both in proposed and active mining conditions. The software includes a disclaimer at the start of each program:

> *"West Virginia University expressly declares that there are no warranties expressed or implied which apply to the software contained herein. By accepting and use of the said software, which is conveyed to the user without consideration by the West Virginia University, the user hereof expressly waives any and all claims for damage and/or suits for or by reason of personal injury or property damage including special damages arising out of or in any way connected with the use of the software contained herein."*

The LaM2D program provides a cross-sectional review of a planned mining area. The results from the LaM2D program are graphs displaying convergence, vertical stress loading, stress safety factors and strain safety factors. This program uses the Mark-Bieniawski technical calculations to generate coal properties for pillar strength. The program addresses the percentage of coal removed by “Out-of-Plane Extraction Ratio” for the area modeled. This one number input allows for basic effects from the third dimension.

The LaModel 2.1.1 program (updated 08/01/07) provides a plan view review of a mining area. This program allows a more detailed analysis of effects of irregular pillar shapes and dimensions from previously mined and projected mining areas in a three dimensional effect. This program also uses the Mark-Bieniawski technical calculations to generate coal properties for pillar strength.

Norwest applied these two programs from the position of never having been to CCM and only relying on AutoCAD maps for key information applied in the NIOSH modeling programs. This information included:

- Depth of coal (overburden)
- Pillar dimensions (length, width, and coal mining height)
- Location of pillars removed during retreat mining
- Width of “gob” areas.

Calibration of models requires additional mine specific investigation be performed. Norwest believes it is necessary to visit the mine site to gather verbal accounts and underground observations in areas that represent successfully mined areas and areas considered as failures. Failures would be areas where conditions did not allow for the completion of planned coal extraction. Norwest did not visit CCM and did not calibrate the modeling to mine specific conditions.

Model calibration as part of the normal results comparison process would establish the safety factors that are characteristic for that individual mine. The modeling work completed in this report is not compromised by not completing the mine specific calibration. The result of modeling was not to provide an improved design, but to review the area plans for the development and retreat of the North and South Barriers adjacent to the sealed portion of the Main West.

Available map information and the established NIOSH program defaults used are as follows:

- Poisson’s ratio
- Elastic Modulus (psi)
- Lamination (Layer) Thickness

- Vertical Stress Gradient
- Coal Strength (900 psi)
- Gob Default Parameters
- Over-Relaxation Factor.

Norwest varied the element size used in both NIOSH programs for comparison of the output results. Element widths of 5 ft and 10 ft were modeled to determine if the results were repeatable.

Due to our experience in other western coal mines, it is Norwest's opinion that coal strength in the Wasatch Plateau, within which CCM sits, is greater than the 900 psi default value established by NIOSH. However, Norwest believes an adequate evaluation can be accomplished without having to determine the coal strength factor realizing the SF calculations completed in the program will determine a lower SF in both the stress and strain figures.

Identification of the weakest pillars and variance of the SF range for the pillars can provide comparable results for determining design adequacy.

A detailed analysis is required to determine representative coal strength at each mine. This detailed process is necessary to forecast the occurrence of high stress near the pillar edges and along longwall faces. These high stress concentrations could potentially result in a coal pillar bounce. The use of the NIOSH default of 900 psi for coal strength results in the vertical stress graphic profile affecting a broader area. The broader stress area tends to move the peak stress away from the edges into the pillar core.

DATA REVIEW

Norwest has not visited CCM for the purposes of this review. Therefore, this review is based upon data supplied by others. Norwest utilized data from various sources for this roof control plan review.

DATA AVAILABILITY

The comments and opinions presented in this review are based upon the data provided by the Committee and from publicly available sources. It is not certain all available data relative to our review was made available to the Committee and that all relevant data held by the Committee was provided to Norwest. We were not able to verify the accuracy and completeness of data that has been provided.

Publicly available data includes the following:

- Crandall Canyon roof control plans dated from July 3, 2002 to June 15, 2007, including roof control plan evaluations by Agapito as available on the MSHA web site
- University of Utah seismic event records
- Other data from the MSHA web site.

The roof control plan included the following Agapito reports:

- July 20, 2006 report " DRAFT – GENWAL Crandall Canyon Mine Main West Barrier Mining Evaluation"
- August 9, 2006 report " GENWAL Main West Retreat Analysis – Preliminary Results"
- December 8, 2006 report "Crandall Canyon Mine Ground Control Review for Mining in the Main West North Barrier"
- April 18, 2007 report "GENWAL Crandall Canyon Mine Main West South Barrier Mining Evaluation."

The Committee provided the following not publicly available data:

- Crandall Canyon Mine maps or drawings in AutoCAD formats
- Photos of the March 2007 bounce area
- BLM inspection reports

- Depositions of MSHA officials Al Davis, Billy Owens and William Reitze
- Pdf copies of emails, other correspondence, exhibits, etc. relative to Crandall Canyon.

DATA GAPS

Norwest's review of provided data and detection of data, which would have been utilized but was not provided, identified information gaps that narrowed our analysis.

Crandall Canyon Mine

Sufficient data was not available on past roof control issues at CCM other than some references in the Agapito work.

Data with respect to the actual condition of the pillars in the Main West entries at the time of the March and August 2007 events in the North and South Barriers respectively was not available. BLM's report of November 2004[6] prior to the Main West being sealed provided some detail to the extent of deterioration viewed.

Pictured conditions and field notes were collected four to five days after the March bounce. No information was provided if areas were cleaned up and whether subsequent recorded seismic events affected the resulting pictures.

The photographs taken of the March 2007 bounce were taken several days (March 15 -16, 2007) after the event that stopped mining. Norwest could not determine if the damage pictured is from a single or multiple bounce events.

Information from mine shift reports leading up to the March and August 2007 bounce events would be beneficial to establish the mining conditions prior to these events. This information was not available for Norwest review.

Details identifying the extent of the August 2007 bounce were not available. This includes information relative to the extent of pillar damage and roof convergence measurements.

A detailed drill log of the overburden in the vicinity of the events was not available. The massive sandstones present near the Hiawatha coal seam vary in thickness and proximity to the coal seam. Information such as this would assist in modeling input.

[6] BLM Inspection Report – Special for the November 4, 2004 GENWAL Mine by Steve Falk, pg 1.

Agapito Modeling
Limited data is available in the Agapito reports and letters that were included in the roof control plan submittals to MSHA. Missing data includes:

- Modeling assumptions
- Model inputs
- Plot output files
- Version of modeling software.

Limited data has been provided with respect to the overall process of the work performed by Agapito for UEI. Additional data that would be useful includes:

- Scope of work
- History of past work at CCM
- Details of the areas of the CCM visited by Agapito
- Data provided by GENWAL and UEI to Agapito
- Interviews of Agapito personnel involved in the project.

MSHA
Limited data was available about the MSHA review process. No modeling outputs or results of the MSHA internal analysis of the Agapito evaluations were provided. No detailed knowledge of MSHA inspections has been made available.

Data Limitations
The actual time of the March 2007 bounce was not determinable from the available data to correlate with a recorded March seismic event. Several events occurred in the March 10-11, 2007 time frame.

DATA USAGE

Model Development
Basic data from CCM maps such as coal height, pillars dimensions, overburden depth, and mining plan geometry was used as the basis for the development of the various models using the NIOSH programs. Additional data in the NIOSH programs such as default values were used and are discussed in more detail in Section 3.

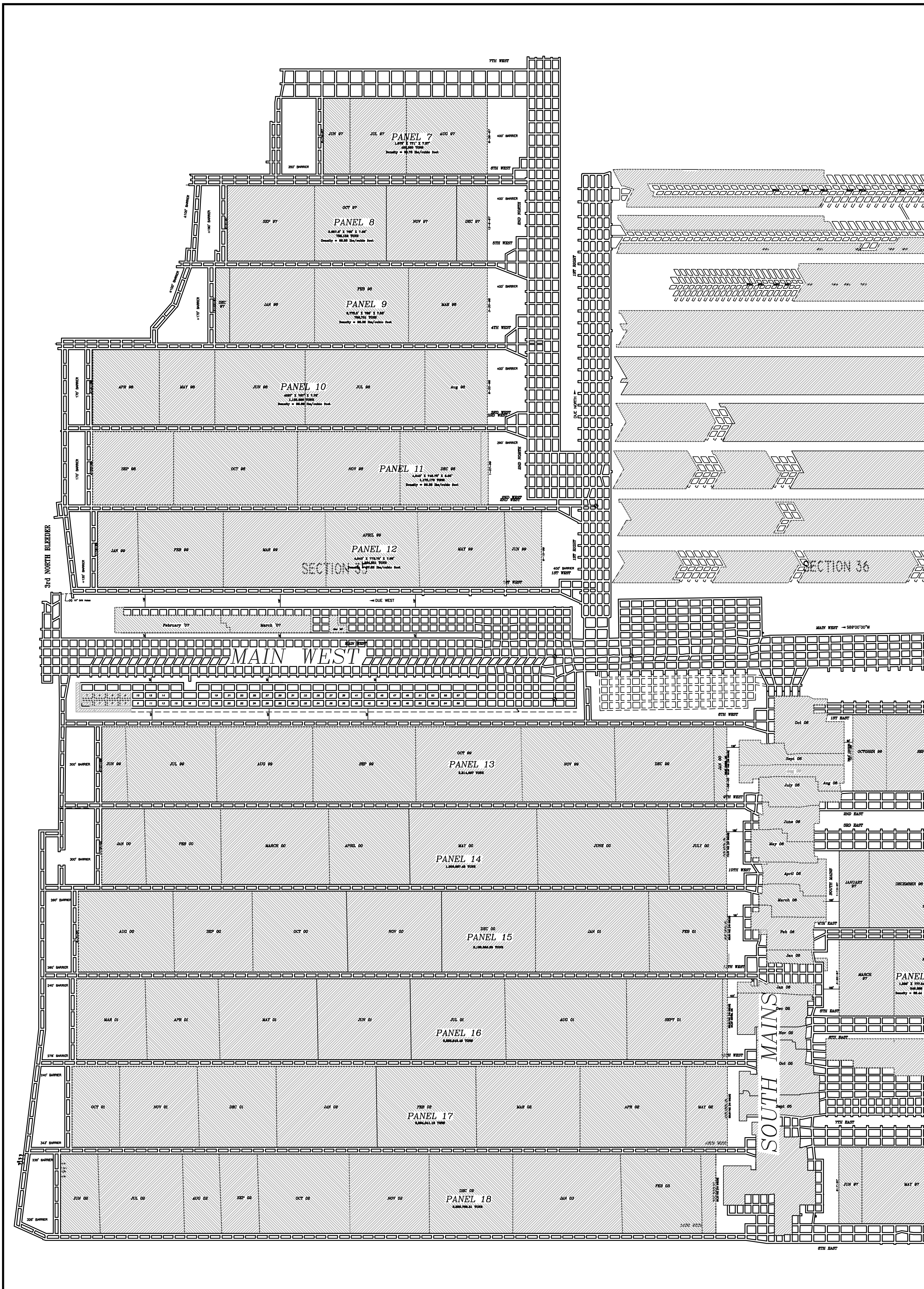
CCM Mining
Data from the mine maps and other sources was incorporated to develop an understanding of prior mining at CCM. This history has been summarized here.

Crandall Canyon practiced room and pillar retreat mining in numerous panels in the earlier years of the mine. These panels were typically driven from sub main entries and were typically short term life areas relative to the lives of main entries and barrier pillars.

SOUTH MAINS MINING

CCM retreat mined main entries and barrier pillars in the vicinity of the Main West. CCM retreat mined the South Mains between July 2005 and October 2006. This mining included retreat mining pillars in the main entries and some barrier pillar mining that reduced the width of barrier pillars. A review of a CCM map shows this mining occurred largely under overburden depths of less than 1,000 ft and only a small portion at 1,500 ft or above. The South Mains district, as shown on Figure 2.1, was developed in the 1990s as access for longwall panels. Barrier pillars were left between the main entries and the mined longwall panels to protect the South Mains.

Norwest was not given any information regarding roof control problems encountered in the mining of the South Mains. The South Mains retreat mining occurred in areas where the conditions of the barrier pillars could be routinely monitored.



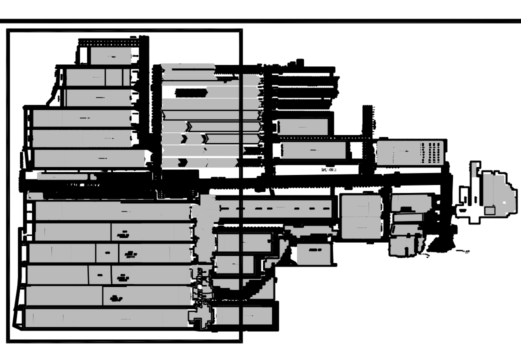


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FIGURE 2.1

SOUTH MAIN &
MAIN WEST
MINING MAP

DATE: 04/16/2008
FILE: kirkssueicong
SCALE: 1"=xxxx'

NORWEST CORPORATION

Main West, North and South Barrier Timeline

Based upon the data received, a timeline was constructed of events related to the March and August 2007 bounce events. The timeline summarizes the chronology of major activities completed by GENWAL, MSHA, Agapito, and BLM relative to the two bounces. These activities are described below.

CRANDALL CANYON MINE 1995 – OCTOBER 2006

GENWAL completed mining of the Main West entries in 1995. These entries were necessary for the ventilation of the longwall panels to the north and south of the Main West entries.

1st West longwall panel (Longwall Panel 12), north of the Main West, was mined in the first half of 1999. The completion of 1st West mining left an approximate 450 ft wide barrier pillar, now known as the "North Barrier."

Longwall mining of 9th West longwall Panel (Longwall Panel 13) to the south of the Main West was conducted in the second half of 1999 and completed in January 2000. All longwall mining was completed in the areas north and south of the Main West by the first quarter of 2003. GENWAL sealed the Main West in November 2004 after inspection by the BLM.

As longwall mining was complete in this area, GENWAL retreat mined the South Mains starting in July 2005 and finishing in October 2006.

GENWAL PREPARATIONS FOR NORTH AND SOUTH BARRIER MINING

GENWAL first discussed with MSHA, according to the data Norwest received, mining the western portions of the North and South Barrier pillars (referred to in documents as West Barriers) in May 2006.

Agapito submitted to GENWAL on July 20, 2006, "DRAFT GENWAL Main West Retreat Analysis - Preliminary Results." Agapito submitted to GENWAL on August 9, 2006, "GENWAL Main West Retreat Analysis – Preliminary Results."

GENWAL and MSHA met at the MSHA Denver, Colorado office in September 2006 to discuss mining of the West Barriers. GENWAL presented the two reports according to data reviewed by Norwest. MSHA performed an analysis of the Agapito evaluations in September and October 2006. MSHA sent their findings to GENWAL in November 2006.

GENWAL submitted a plan for development mining of the North Barrier in November 2006. GENWAL received MSHA approval for this plan in the same month.

Agapito submitted to GENWAL the "Crandall Canyon Mine Ground Condition Review for Mining in the Main West North Barrier" report in December 2006. Prior to this report, Agapito had visited the CCM to inspect the mining conditions in the developing North Barrier.

Also in December 2006, GENWAL submitted to MSHA a proposed roof control plan for pillar extraction of the North Barrier of the Main West. MSHA inspected mining conditions in the North Barrier in January 2007. MSHA approved this plan in February 2007. Retreat mining was initiated in mid-February 2007. Agapito inspected the North Barrier section on February 27, 2007. During February and early March 2007, UEI retreat mined in the North Barrier from crosscuts 158 to 133.

Also in February 2007 UEI submitted a roof control plan for Main West South Block development mining. MSHA approved this plan in March 2007.

On March 10 or 11, 2007,[7] a bounce occurred in the North Barrier pillar. The BLM inspected this area on March 15, 2007 and the associated map in the inspection report indicates pillars that were damaged. MSHA data shows that UEI, on March 12 and 13, had communicated to MSHA District 9 headquarters in Denver a request to relocate an atmospheric Monitoring Point Location (MPL) in the North Barrier. Agapito inspected the North Barrier section on March 16, 2007. UEI ceased mining activities in the North Barrier section and sealed the North Barrier in late March.

UEI commenced South Barrier development mining in the South Barrier pillar, between crosscuts 108 and 111 in late March 2007.

[7] See Affidavit of Jose Luis Payan, March 7, 2008, pg. 3-12.

Agapito submitted a report dated April 18, 2007 to UEI titled "GENWAL Crandall Canyon Mine Main West South Barrier Mining Evaluation to Crandall Canyon." UEI on May 16, 2007 submitted to MSHA District 9 a plan for retreat mining of the South Barrier. MSHA on May 22, 2007 inspected the South Barrier to observe mining conditions. MSHA approval of this roof control plan was received by UEI on June 15, 2007.

UEI started retreat mining in the South Barrier on July 16, 2007. A seismic event measuring 3.9 in magnitude occurred on August 6, 2007. This event trapped six miners.

Table 2.1 summarizes the activities of these four organizations.

Table 2.1 Crandall Canyon Timeline

Date	Crandall Canyon Mine (CCM) or UEI	MSHA	Agapito	BLM
1995	Completes mining the **Main West**			
1999	Mines Longwall Panel 12 (North of North Barrier) January thru May 1999			
1999/2000	Mines Longwall Panel 13 (South of South Barrier) June 1999 thru Jan 2000			
11/4/2004				Inspects the **Main West**
11/13/2004	Seals Main West Cross Cut 118			
~7/2005 - 10/2006	Retreat mines the **South Mains**			
5/1/2006			Discusses Main West Barrier Mining with GENWAL	
5/2006	Discusses with MSHA about mining the **barrier pillars of the Main West**			
7/20/2006			Submits to Andalex, "**DRAFT** GENWAL **Main West Retreat Analysi**s - Preliminary Results"	
8/9/2006			Submits "GENWAL **Main West Retreat Analysis** - Preliminary Results"	
9/8/2006	Meets with MSHA in Denver to discuss mining the North and South barriers -- **Agapito reports presented**			
9 &10/2006		Analyses CCM proposed retreat plan		
11/11/2006	Submits to MSHA roof control plan for **Development** of the **North Barrier** of the Main West			
11/21/2006		Approves the roof control plan for **Development** in the North Barrier		
11/21/2006		Sends analysis results to GENWAL		
12/1/2006			Visits CCM to review conditions of the **North Barrier** development mining	
12/8/2006			Submits to GENWAL "**CC Mine Ground Condition Review for Mining in the Main West North Barrier**"	
12/14/2006				Inspects the **North Barrier**
12/20/2006	Submits to MSHA roof control plan for **Pillar Extraction** of the **North Barrier** of the Main West			
1/9/2007		Inspects **North Barrier** - re leaving top coal for the roof control plan		
2/5/2007		Approves the roof control plan for **Pillar Extraction** in the North Barrier		
2&3/2007	**Retreat mines North Barrier** Feb thru March -- Cross Cut 158 to 133			
2/20/2007	Submits to MSHA roof control plan for Main West **South Block development** mining			
2/27/2007				Inspects the **North Barrier**
3/8/2007		Approves Main West **South Block development** Roof Control plan		
3/11?/2007	**North Barrier bounce** stops retreat mining			
3/12-13/07		Receives voice mail/ phone calls from CCM -- request to move MPL		
3/15/2007				Inspects the **North Barrier**
3/16/2007			Inspects the **North Barrier** Bump area	
3/27/2007	**Seals North Barrier** section between Cross Cut 118 and 119			
4/18/2007			Submits to UEI "Genwal CC Mine Main West **South Barrier Mining Evaluation"**	
5/16/2007	Submits to MSHA roof control plan for Main West **South Block pillaring** mining			
5/22/2007		Visits CCM to observe conditions in the **South Barrier**		
6/15/2007		Approves Main West **South Block pillaring** Roof Control plan		
7/16/2007	Starts **retreat mining** in the **South Barrier**			
8/6/2007	Bounce occurs in **South Barrier** trapping 6 miners			

MODELING OF THE MAIN WEST AREA

The purpose of the modeling described in this section of the report was to identify the presence of indicator results that could provide forewarning of the pillar failures that occurred at CCM in March and August 2007.

Norwest generated a base case sequence of models with information from available documentation and without the effects of pillar damage. Documents made available for Norwest's review focused on the Main West from the Main North intersection west to the Joe's Valley Fault. These documents identified vital information necessary to develop the models.

A second case was modeled by incorporating information relative to pillar damage and deterioration that may have effected the subject areas. The BLM special inspection report[8] cited deteriorating conditions in the north entry, and that intersections angled for the continuous haulage were failing. The inspection was performed down the number 1 (left most) entry and noted pillar rash occurring past crosscut 123. The report quotes from Steve Falk – BLM, "At this depth, the pillars are failing." The request for the special inspection was made on October 27, 2004, when GENWAL cited that conditions were deteriorating and access through the area to be nearly impossible.

The Main West was sealed November 13, 2004, between crosscuts 118 and 119. AutoCAD files of CCM provided by the Committee did not include map information that reflected the extent of deterioration in the area that was sealed.

Norwest continued the modeling sequence with a series of steps introducing damage assumptions. Norwest assumptions reflected the lack of information available to establish the condition of the Main West pillars prior to sealing.

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[8] BLM Inspection Report – Special for the November 4, 2004 GENWAL Mine by Steve Falk, pg 1.

LAM2D MODELING

Norwest prepared a base case modeling sequence of the Main West area. The three LaM2D models included.

- The Main West between the 1st West longwall panel to the north completed in June 1999 and the 9th West longwall panel to the south completed in January 2000.
- The development of the North Barrier starting September 2006 through February 2007.
- The development of the South Barrier starting March 2007 through July 2007.

Mining areas are identified in the Figure 1.1 reference map.

A cross-section in the north/south direction at the approximate location of crosscut 135 was selected. The following key program inputs were used in the LaM2D modeling software:

- Element width - 60 inches
- Overburden depth – 24,000 inches
- Seam Thickness – 96 inches
- Rigid Boundary conditions
- Coal Strength – 900 psi
- Out-of-Plan Extraction Ratio – 22%.

When the results from the three base case models were reviewed, a comparative process was used to identify locations of increased convergence, vertical stress levels exceeding 10,000 psi[9] which could possibly identify an overloading condition preceding a bounce, and the relative strain SF changes. The base case models were developed assuming the pillars in the Main West were not deteriorated and maintained a support characteristic similar to the shapes displayed on the CCM mine map.[10]

[9] "Gate Road Design Considerations for Mitigation of Coal Bumps in Western U.S. Longwall Operations", M. DeMarco, J. Koehler, and H. Maleki, pg 161 of Special Publication 01-95 "Proceedings: Mechanics and Mitigation of Violent Failure in Coal and Hard-Rock Mines" 1995.
[10] UEICONG-K000030390 AutoCAD drawing file.

Base Case Convergence

Figures 3.1-1 through 3.1-3 were produced by the LaM2D model output depicting the projected convergence for the three steps of the base case. Figure 3.1-1 shows the longwall panel gob on each end of the cross section with displacements in the middle of the graph representing the five entries and four pillars of the Main West. Pillar displacement in this model is approximately 1.4 inches and the openings approximately 1.85 inches.

N = north
S = south
SB = South Barrier Section
NB = North Barrier Section
B = remaining barrier pillar
IB = isolation barrier pillar
1, 2, 3, 4 = numbered pillars within each mining area
SF = safety factor
LW = longwall
Bottom scale is inches along the modeled cross-section
Left scale is convergence in inches.

Figure 3.1-1 Convergence Main West (LaM2D)

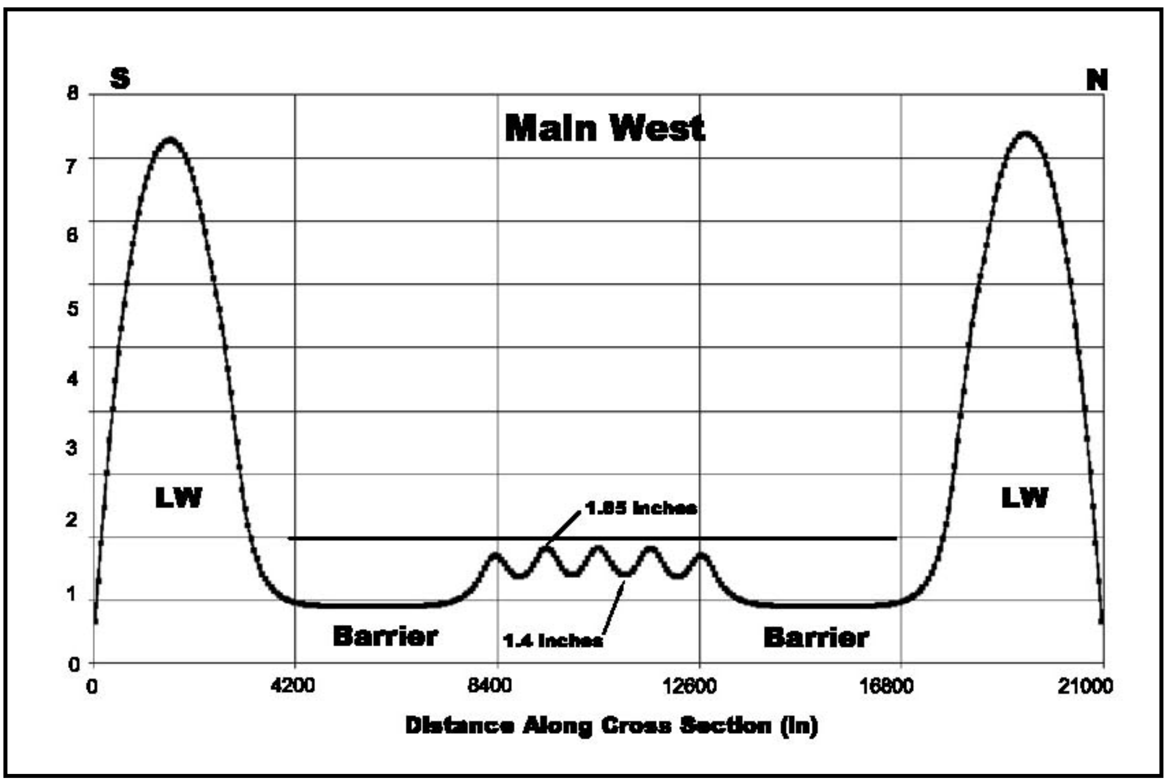


Figure 3.1-2 shows the addition of the North Barrier development. Note the convergence increase of the displacement just right of the 12600 line. This is the isolation barrier pillar between the Main West and the North Barrier development. Convergence is approximately 1.9 inches over this isolation barrier. The isolation barrier is not sufficiently sized due to a 0.5 inch increase in convergence. The convergence of the North Barrier pillars decreases as the pillars get closer to the 16800 line.

Figure 3.1-2 Convergence Main West and North Barrier (LaM2D)

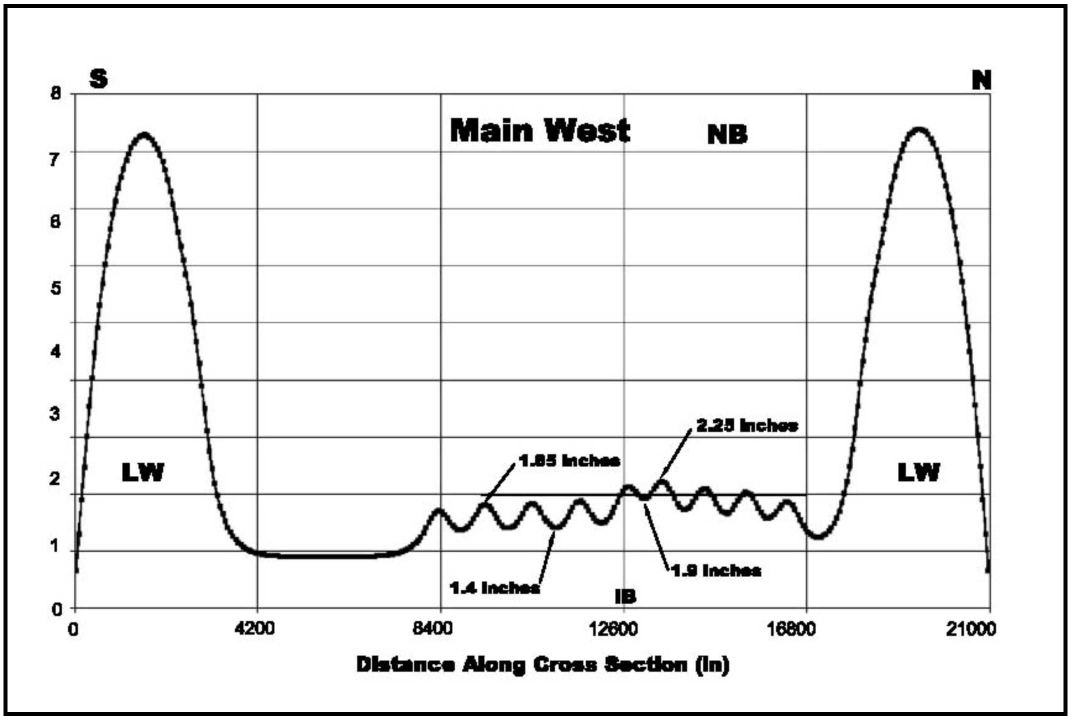
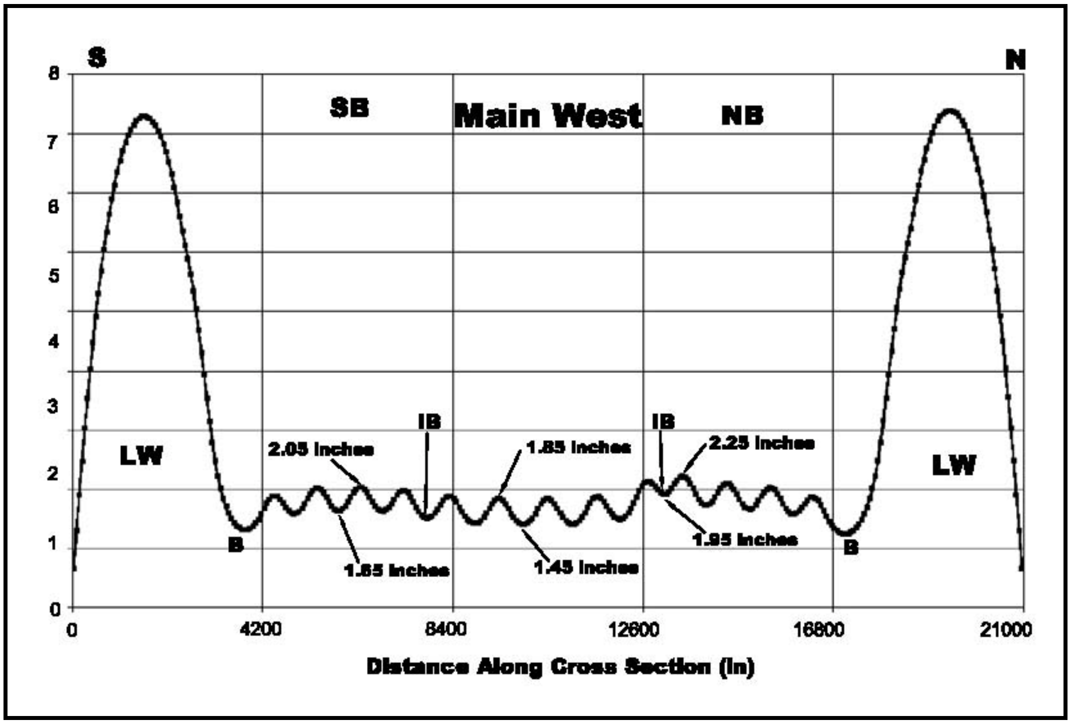


Figure 3.1-3 shows the addition of the South Barrier development. The convergence over the isolation barrier (left of 8400 line) between the Main West and the South Barrier shows very little increase in convergence above the 1.45 inches in the Main West. The convergence comparison identifies the width of the isolation barrier between the Main West and the North Barrier development to be questionable.

Figure 3.1-3 Convergence Main West, North Barrier and South Barrier (LaM2D)



Base Case Vertical Stress
Figures 3.1-4 through 3.1-6 were produced by the LaM2D model output depicting the projected vertical stress for the three steps of the base case. Figure 3.1-4 shows the vertical stress level of 4,400 psi on the pillar centers with stress levels approximately 400 psi higher on the pillar edges. The barrier pillars on either side of the Main West show core vertical stress levels of 2,800 psi.

N = north
S = south
SB = South Barrier Section
NB = North Barrier Section
B = remaining barrier pillar
IB = isolation barrier pillar
1, 2, 3, 4 = numbered pillars within each mining area
SF = safety factor
Left scale is vertical stress in psi
Bottom scale is inches along the modeled cross-section.

Figure 3.1-4 Vertical Stress Main West (LaM2D)

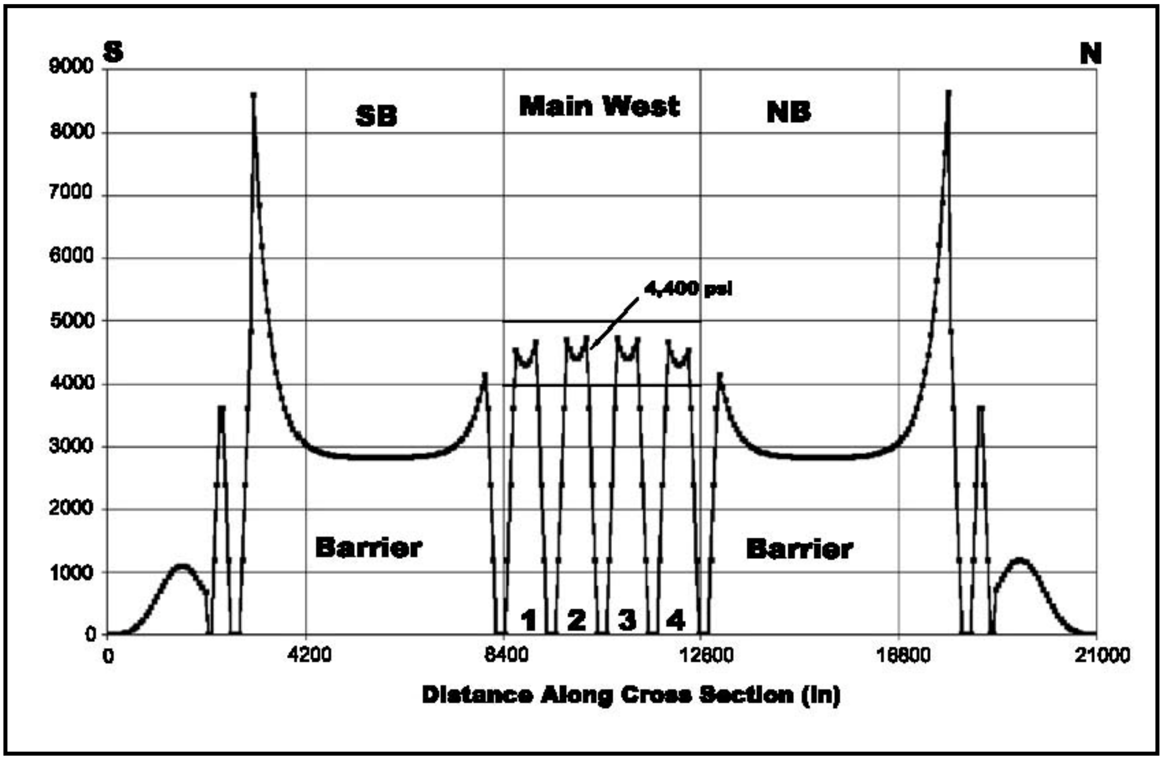


Figure 3.1-5 shows the effect of the North Barrier development on the vertical stresses. The stress level reaches 6,000 psi on the narrow core of the isolation barrier. The isolation barrier is not sufficiently sized for the depth of cover and to adequately balance the vertical stress load across the multiple developments of the Main West and the North Barrier. Stress levels have not reached the level of 10,000 psi over the North Barrier development. The barrier pillar (right of the 16800 line) shows the increase of vertical stress in the center to 3,900 psi. This vertical stress increase is due to side abutment stress from the adjacent longwall gob.

Figure 3.1-5 Vertical Stress Main West and North Barrier (LaM2D)

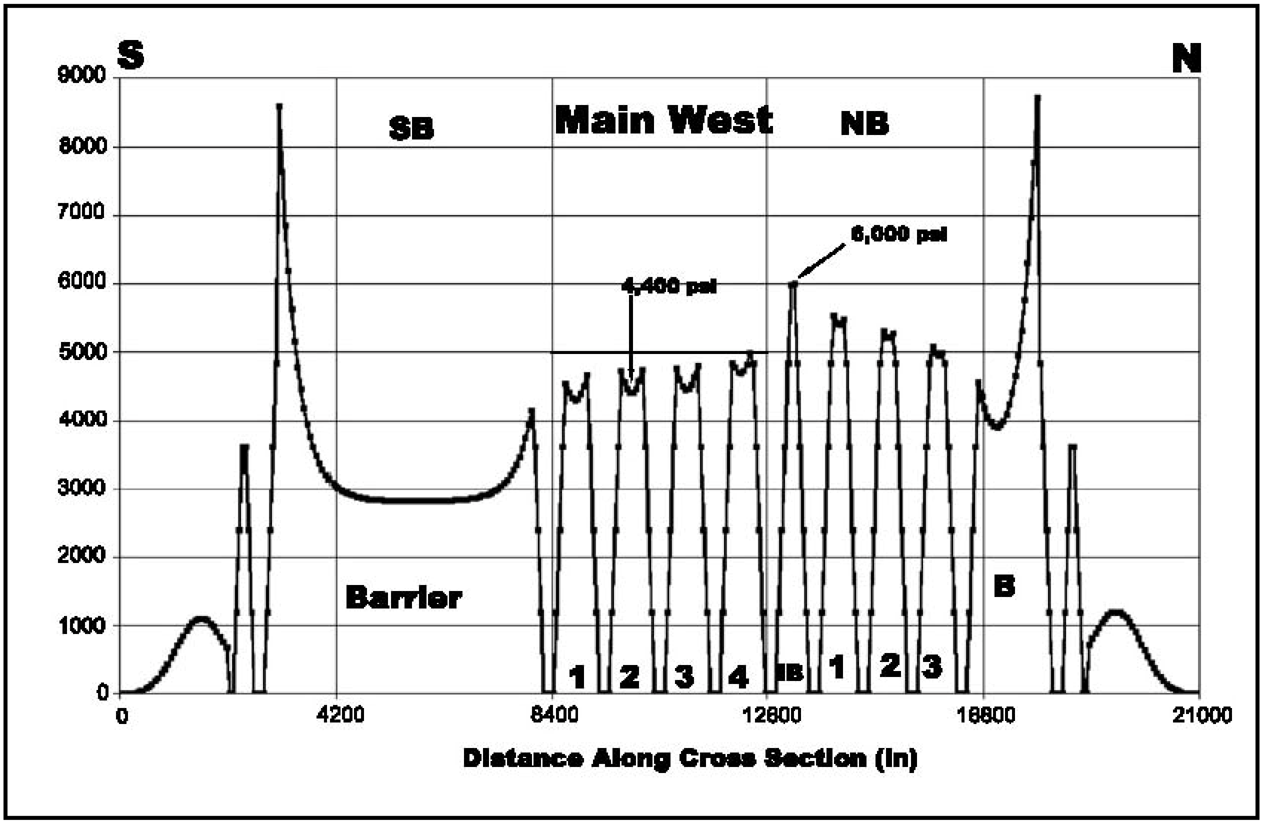
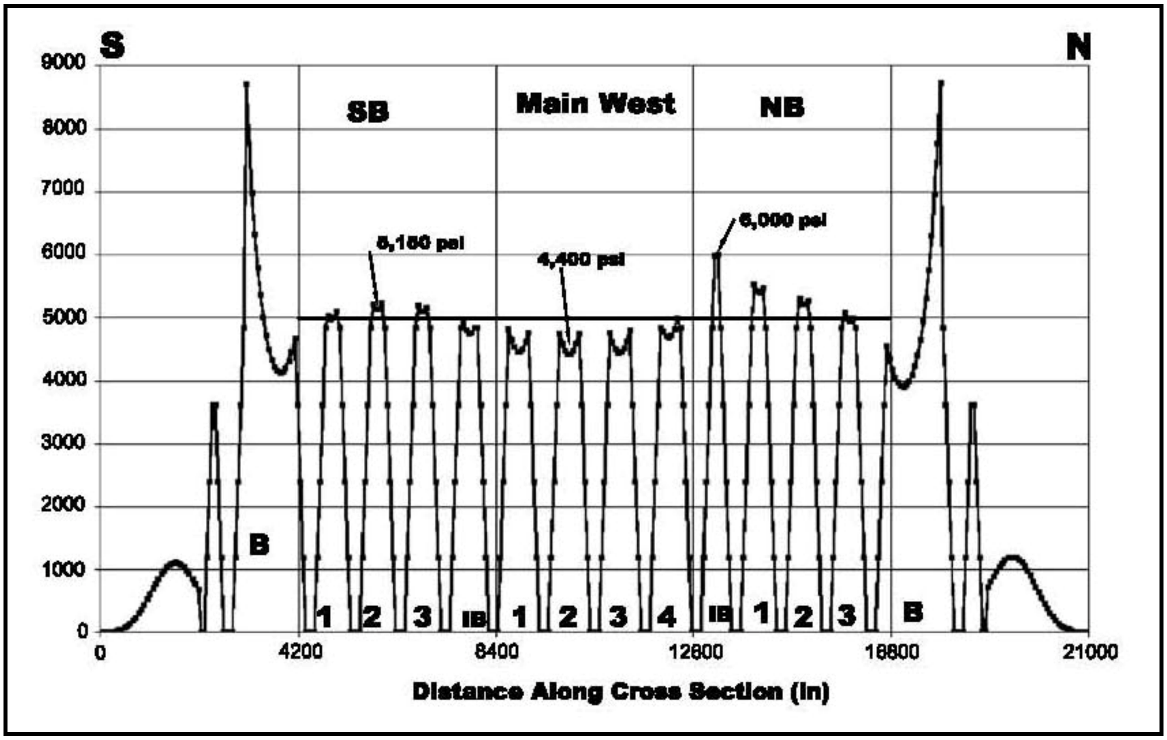


Figure 3.1-6 shows the effect of the South Barrier development on the vertical stresses. The stress level for the South Barrier is 5,150 psi on the middle pillar. The barrier pillar between the South Barrier development and the longwall panel (left of the 4200 line) shows the center vertical stress increasing to 4,100 psi. This vertical stress increase is related to side abutment stress being added from the adjacent longwall gob.

Figure 3.1-6 Vertical Stress Main West, North Barrier and South Barrier (LaM2D)



The vertical stress comparison using LaM2D is not as detailed as LaModel and therefore is not capable of adequately reflecting retreat mining in a portion of the development. However, the 6,000 psi vertical stress reflected in the active mining area is a concern for vertical stresses experienced on development. The margin between the 6,000 psi and the 10,000 psi potential for pillar failure should be considered in the development pillar design. During retreat, stresses will increase in areas where the gob caving is being re-initiated or the caved area is lagging more than one crosscut distance behind the active pillars being retreated. A lagging gob creates a cantilever effect increasing the stress carried by the closest pillars to the gob.

Base Case Stability Factors

The comparison of the strain SF for the three base case steps was sequenced in Figures 3.1-7 through 3.1-9. Norwest chose not to attempt to use a mine-specific coal strength, as none had been provided in the supplied data. We had no specific knowledge of the coal strength unique to CCM. However, by using the NIOSH default coal strength of 900 psi, the relative changes in the resulting model safety factors were compared.

Figure 3.1-7 shows the barriers on either side of the Main West to provide significant protection for the Main West with safety factor results greater than 7.0. The Main West pillars original design provides a safety factor around 1.0. The longwall panels on either side of the Main West were mined in 1999 and the Main West deteriorated to the point of being sealed in 2004. The Main West deterioration was more related to the Main West pillar size than the barrier size at this point of the base sequence.

N = north
S = south
SB = South Barrier Section
NB = North Barrier Section
B = remaining barrier pillar
IB = isolation barrier pillar
1, 2, 3, 4 = numbered pillars within each mining area
SF = safety factor
Left scale is safety factor (SF)
Bottom scale inches along the modeled cross-section.

Figure 3.1-7 Strain SF Main West (LaM2D)

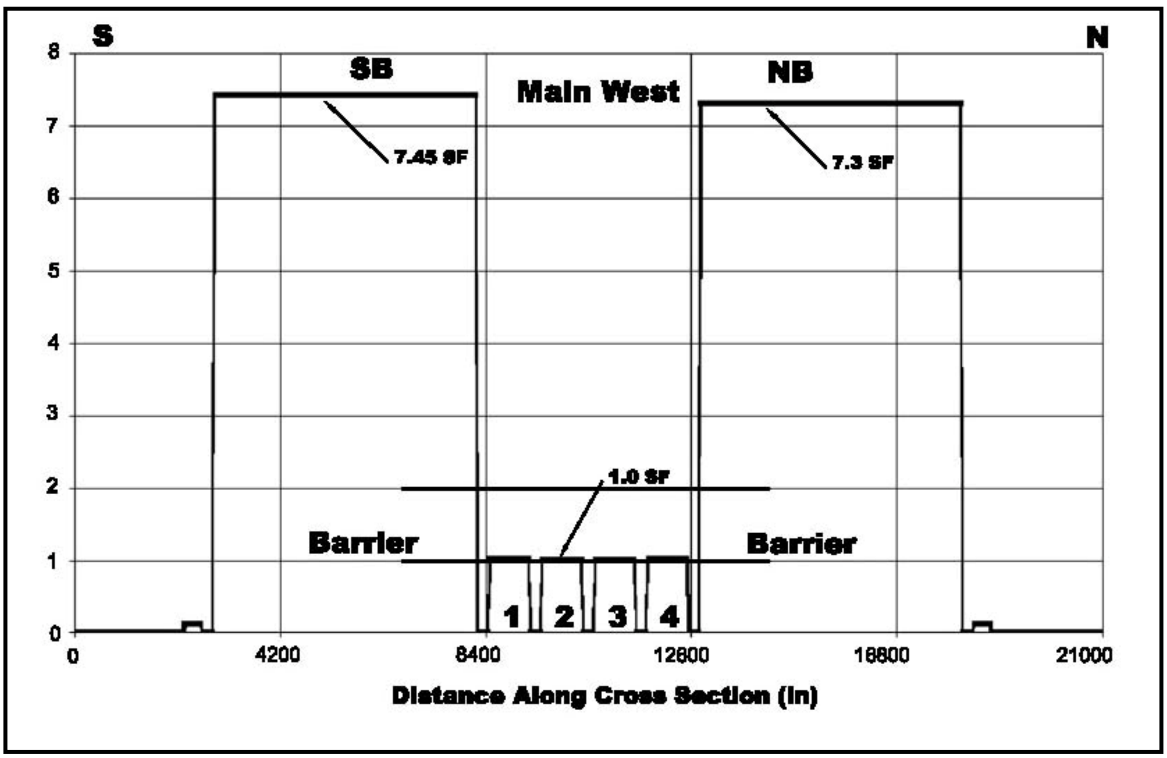


Figure 3.1-8 shows the development of the North Barrier. This mining of the northern barrier reduced the supporting width from approximately 450 ft to 135 ft, dropping the barrier SF from 7.35 to 1.46. The narrow isolation barrier between the Main West and the North Barrier possess the lowest SF in this design and results in the North Barrier pillar sharing more of the vertical stresses. Norwest identified a larger impact on the pillar strain SF adjacent to the isolation barrier than the pillars adjacent to the remaining north barrier pillar. The narrow isolation barrier required the adjacent pillars to carry more load than the potential load from side abutment across the remaining north barrier pillar. This indicates questions in the design of the isolation barrier pillar.

Figure 3.1-8 Strain SF Main West and North Barrier (LaM2D)

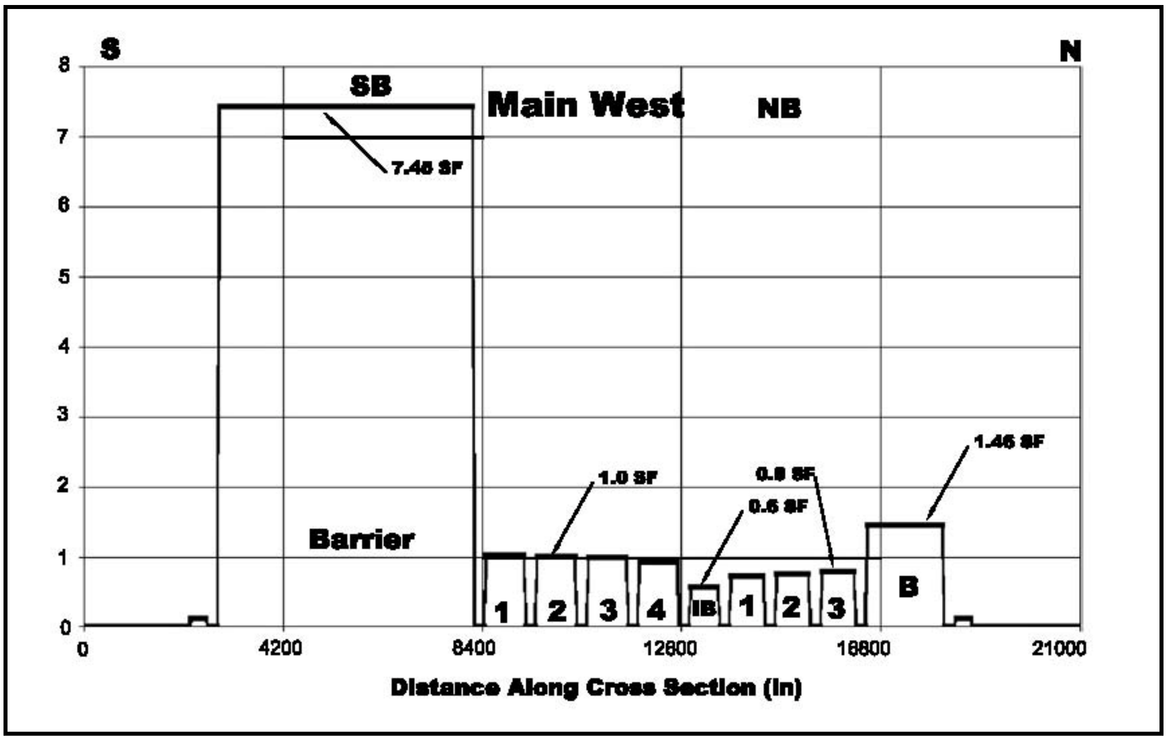
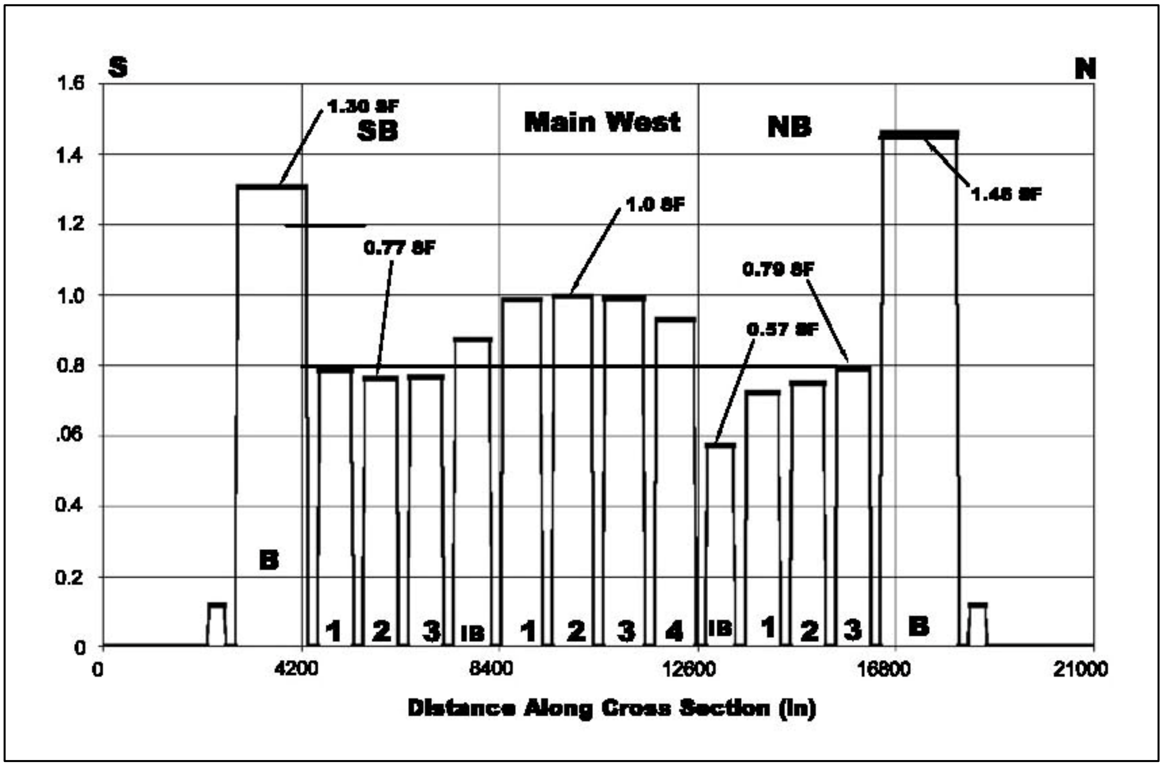


Figure 3.1-9 shows the development of the South Barrier entries. The southern barrier width is reduced from approximately 457 ft to 121 ft, dropping the barrier SF from 7.45 to 1.30. The isolation barrier separating the South Barrier from the Main West was designed approximately 20 ft wider resulting in a 0.84 SF and a better distribution of the vertical stresses. This two dimensional model does not handle a variation of extraction as is present in this sequence. The reduction of the barrier width is of more significance to the development of this section than the SF of the individual pillars in this sequence.

Figure 3.1-9 Strain SF Main West, North Barrier and South Barrier (LaM2D)



Summary of Base Case Results

Norwest established a sequence in the LaM2D program to determine if any significant results would have indicated the types of failures that occurred in March and August 2007. The following Norwest opinions were formed based on the 900 psi coal strength.

- The northern isolation barrier pillar between the Main West and the North Barrier was inadequate in width.
- The significant narrowing of the North and South Barriers on development rather than on retreat increased the vertical stresses on the development pillars.
- The maximum vertical stresses indicated in this modeling sequence are not to the level that would have indicated the failures that occurred.

These model results indicate that additional deterioration within the sealed area of the Main West would be necessary to increase the vertical loads carried by the original design. The Norwest assumption in the base case sequence was that the Main West pillars were in their original mined condition. The sealed portion of the Main West serves a critical role to provide support for mining in adjacent areas. Norwest concluded more information review was required to verify the condition of this support.

BOUNCE DAMAGE

This section of the report addressed the Committee's question of whether the effects of the March 2007 bounce were greater than reported. Norwest utilized the inspection reports from Steve Falk-BLM[11,12] which include verbal description of the Main West deterioration, the verbal description and map of the March 2007 bounce in the North Barrier, in addition to the notes, maps and photos from a joint inspection by UEI and Agapito.[13] The projection of pillar deterioration in this modeling sequence cannot be portrayed nor inferred to be chronological. Norwest only intends to depict the potential amount of pillar deterioration necessary to develop a cascading failure of pillars possibly experienced in August 2007.

The presentation of the vertical stress graphs best illustrate a critical stress level development in excess of 10,000 psi and the cascading domino failure effect that could possibly result. The

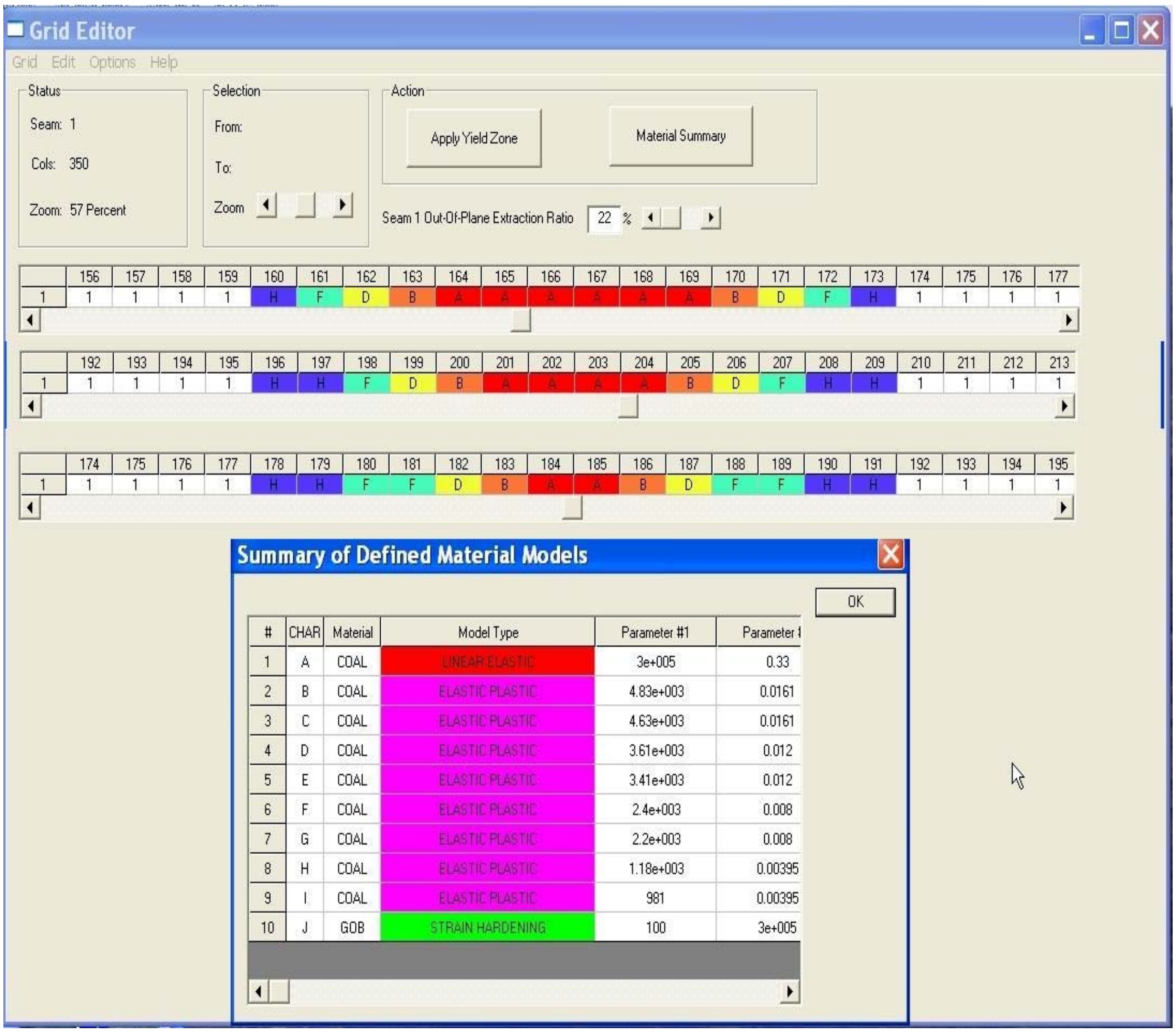
[11] BLM Inspection Report – Special for the November 4, 2004 GENWAL Mine by Steve Falk, pg 1.
[12] BLM Inspection Report – Special for the March 15, 2007 GENWAL Mine by Steve Falk, pg 1-3.
[13] UEICONG000020828 (2MSHA13369).

following sequence of graphs attempts to incorporate the observations in the Falk, UEI, and Agapito inspections and show that additional pillar damage in the Main West is necessary to result in a cascading pillar failure. The pillar deterioration sequence is depicted as follows.

- The four pillars in the Main West have experienced the reduction in strength in the outside 10 ft of coal (prior to sealing of Main West) – Sequence 2, Figure 3.2-1.
- The North Barrier development is mined adjacent to the Main West – Sequence 3, Figure 3.2-2.
- The March bounce occurs in the North Barrier. The three pillars of the North Barrier along with the isolation barrier have a reduction in strength of the outside 10 ft of coal – Sequence 4, Figure 3.2-3.
- The South Barrier development is mined adjacent to the Main West – Sequence 5, Figure 3.2-4.
- The four pillars of the Main West, the north isolation barrier and the three North Barrier pillars have experienced the reduction in strength in the outside 20 ft of coal (additional bounce damage) – Sequence 6, Figure 3.2-5.
- The north two pillars of the South Barrier and the south isolation barrier have experienced a reduction in coal strength in the outside 10 ft of coal (additional bounce damage) – Sequence 6a, Figure 3.2-6.
- The remaining south pillar of the South Barrier has experienced the reduction in strength of the outside 10 ft of coal, and the southern isolation barrier has experienced the reduction in strength in the outside 20 ft of coal (additional bounce damage) – Sequence 6b, Figure 3.2-7.

The sequence of reducing pillar strength used 5 ft element widths for the pillars. The reduction of pillar strength did not include increasing opening width, but increased the thickness of coal strength assigned, Table 3.1 below. For example: an original pillar contained a coal strength sequence of H-F-D-B-A-A-A-A-A-A-B-D-F-H; then the outside 10 ft with a reduced strength sequence of H-H-F-D-B-A-A-A-A-B-D-F-H-H was manually input; and then the outside 20 ft with a reduced strength sequence of H-H-F-F-D-B-A-A-B-D-F-F-H-H was manually input.

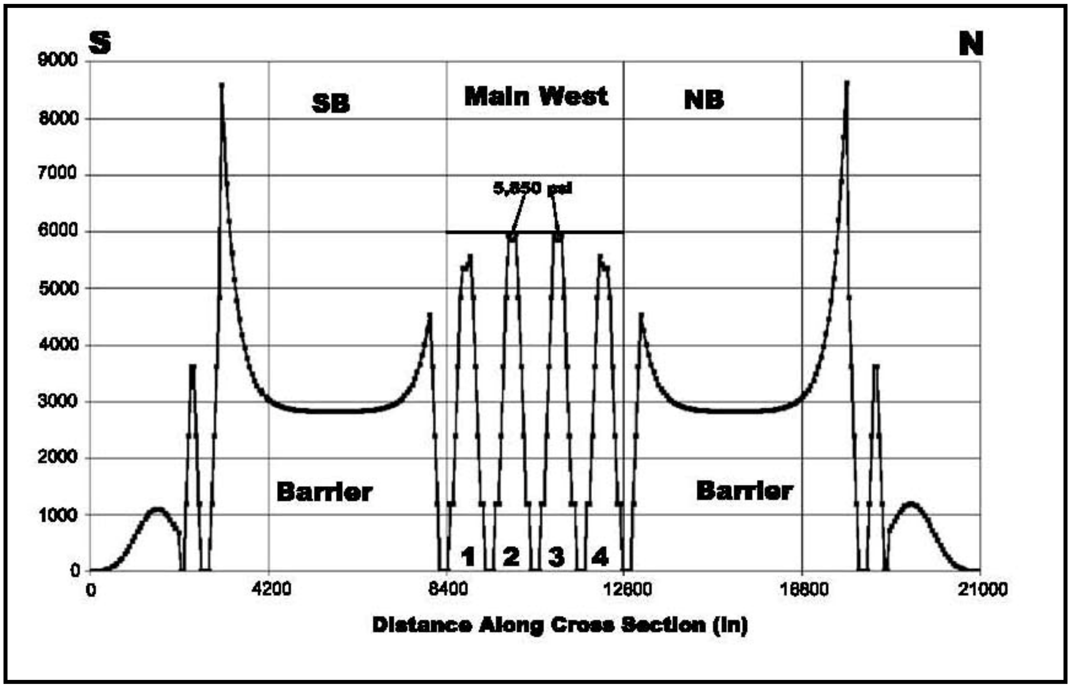
Table 3.1 Pillar Strength Reduction Sequence (LaM2D)



Sequence 2
The vertical stress in the Main West with deterioration of the pillars is shown in Figure 3.2-1. Vertical stress in excess of 5,800 psi could create conditions in this area that required the sealing of this area.

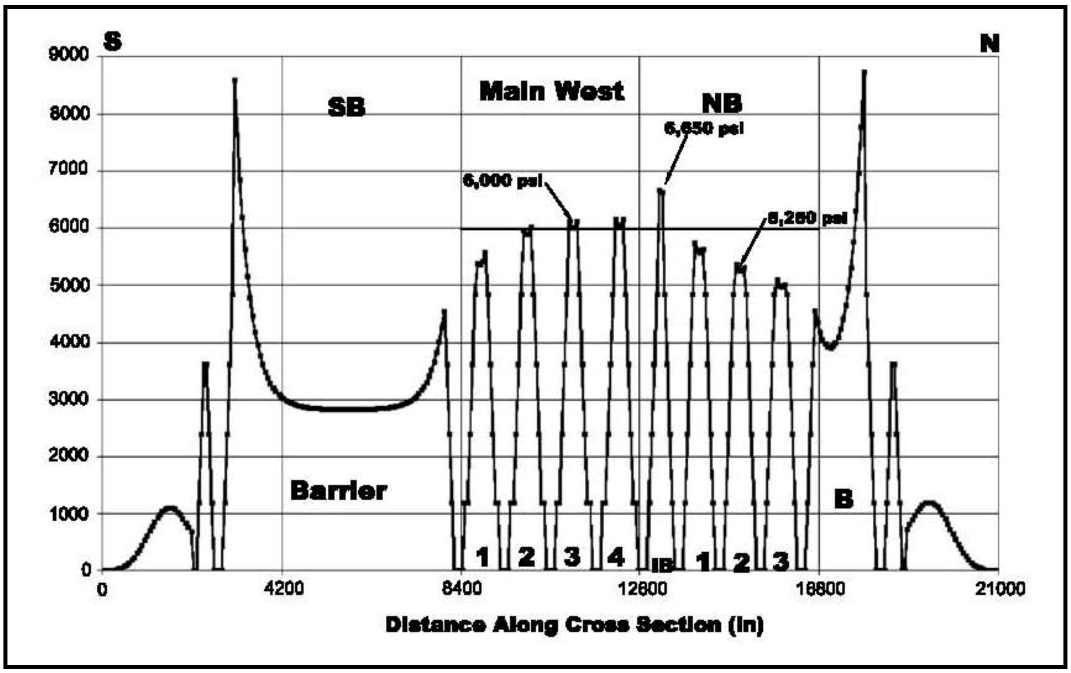
N = north
S = south
SB = South Barrier Section
NB = North Barrier Section
B = remaining barrier pillar
IB = isolation barrier pillar
1, 2, 3, 4 = numbered pillars within each mining area
SF = safety factor
Left Scale is vertical stress in psi
Bottom scale is inches along the modeled cross-section.

Figure 3.2-1 Vertical Stress Main West - Sequence 2 (LaM2D)



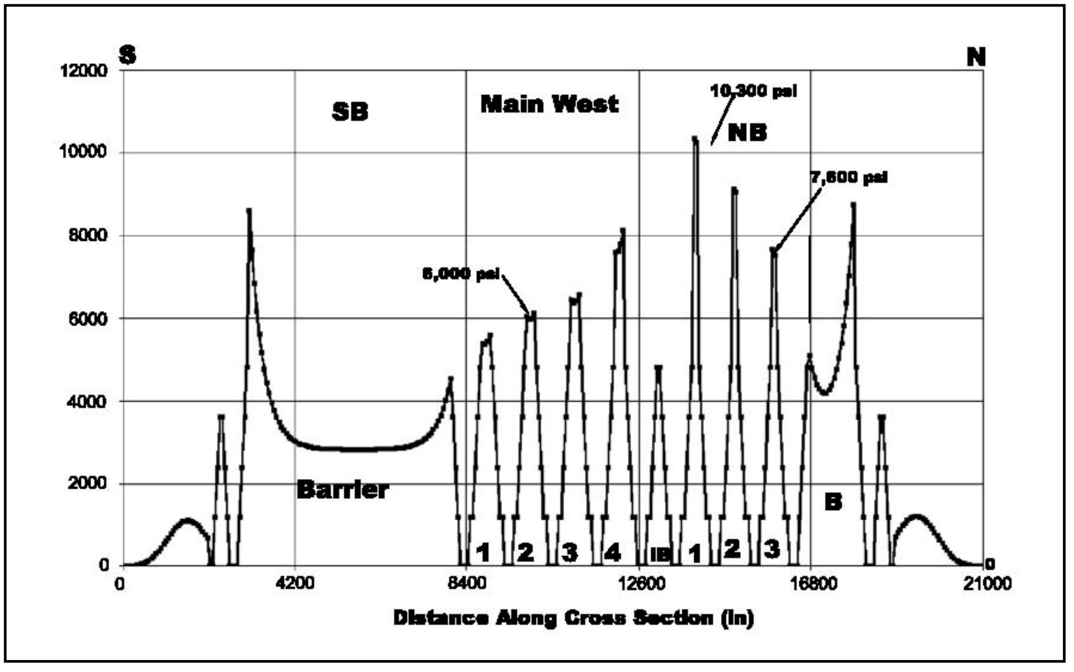
Sequence 3
The addition of the North Barrier development and a narrow isolation barrier increases the vertical stress in the Main West. Figure 3.2-2 illustrates 6,000 psi vertical stress in the Main West, and the North Barrier development pillars experience vertical stress over 5,000 psi. This level of vertical stress on development could result in deterioration of the pillar ribs. The increase in vertical stress in the area of retreat mining could take the level of development vertical stress into the critical level of bounce prone conditions.

Figure 3.2-2 Vertical Stress Main West and North Barrier - Sequence 3 (LaM2D)



Sequence 4
The deterioration of the pillars in the North Barrier panel from bounce damage is illustrated by the vertical stresses in Figure 3.2-3. A vertical stress peak in excess of 10,000 psi in the North Barrier southern pillar and the crushing of the narrow isolation barrier is a result of the vertical stress spike. The failure in the North Barrier pillars shifts vertical loading to the northern side of the Main West.

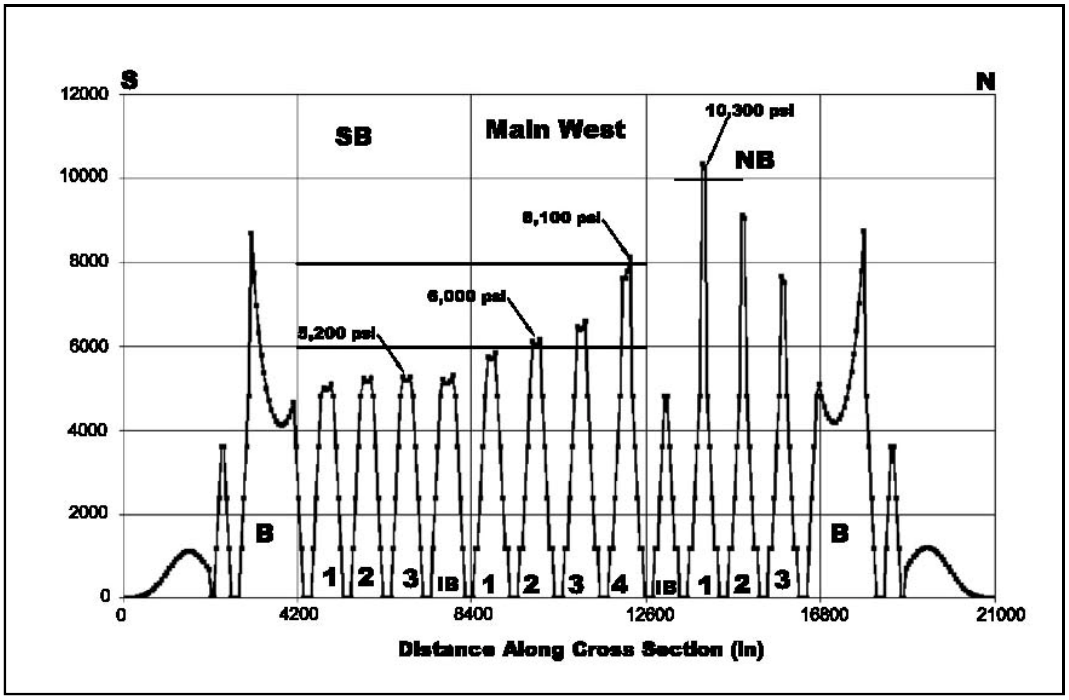
Figure 3.2-3 Vertical Stress Main West and North Barrier - Sequence 4 (LaM2D)



Sequence 5

The addition of the South Barrier development in Figure 3.2-4 does not significantly alter the vertical stresses in the Main West and North Barrier. The development pillars in the South Barrier experience vertical stress around 5,200 psi. This level of vertical stress on development could result in deterioration of the pillar ribs.

Figure 3.2-4 Vertical Stress Main West, North Barrier and South Barrier - Sequence 5 (LaM2D)



Sequence 6
The 6, 6a, and 6b sequences gradually increase the deterioration of the pillars in the Main West and South Barrier. Norwest does not have knowledge of the chronological order of the pillar failures. The three graphs in this sequence attempt to illustrate a progressive failure. However, these graphs illustrate that the Main West pillars likely failed prior to the South Barrier mining area to shift enough vertical stress to result in the failure of the South Barrier pillars. The following sequence assumes the North Barrier pillars deteriorate to a yielding state before the pillars in the Main West pillars experience peak loading from the vertical stress (simulating the March 2007 bounce damage).

Figure 3.2-5 illustrates an additional 10 ft of reduced pillar strength in the Main West and the North Barrier pillars have the core strength reduced by one strength level. Vertical stresses peak on the north side of the Main West as the pillars in the North Barrier show vertical stress dropping indicating a yielding condition. The Main West pillar “4” peak vertical stress is in excess of 18,000 psi with a pattern of declining vertical stress on adjacent pillars to the south (left). This pattern indicates a potential domino-failure effect.

Figure 3.2-5 Vertical Stress Main West, North Barrier and South Barrier - Sequence 6 (March Bounce) (LaM2D)

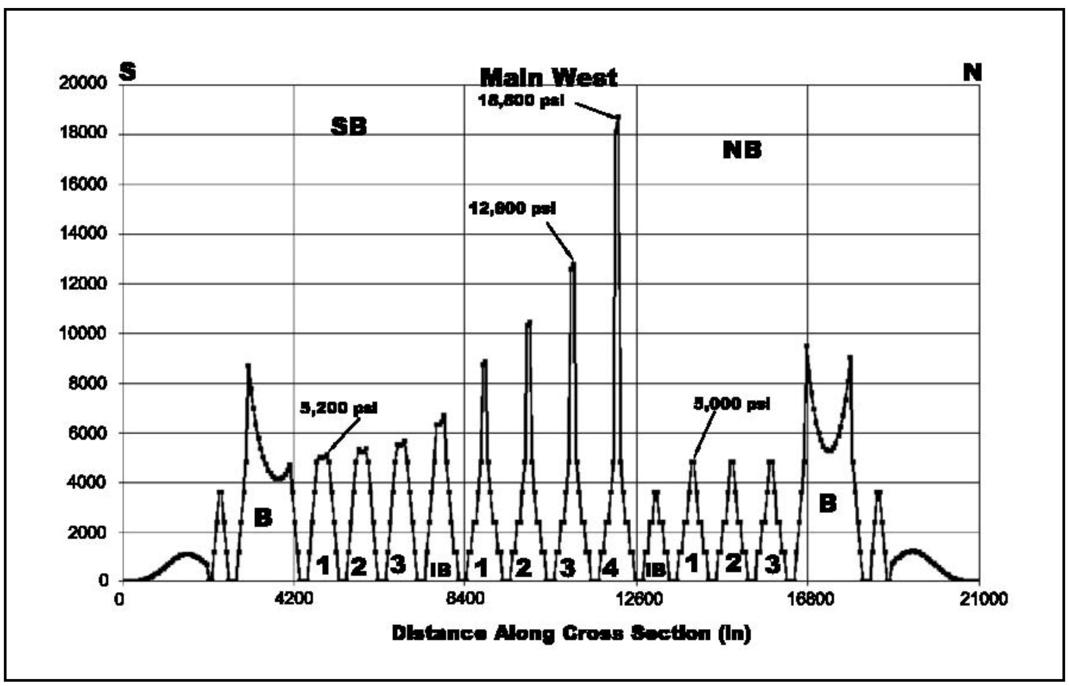


Figure 3.2-6 illustrates vertical stress increasing as each row of pillars fails. The failure of pillar "4" places a higher vertical stress on pillar "3" in excess of 20,000 psi. The domino-failure effect transfers increasing vertical stress to the adjacent pillars to the south.

Figure 3.2-6 Vertical Stress Main West, North Barrier and South Barrier - Sequence 6a (LaM2D)

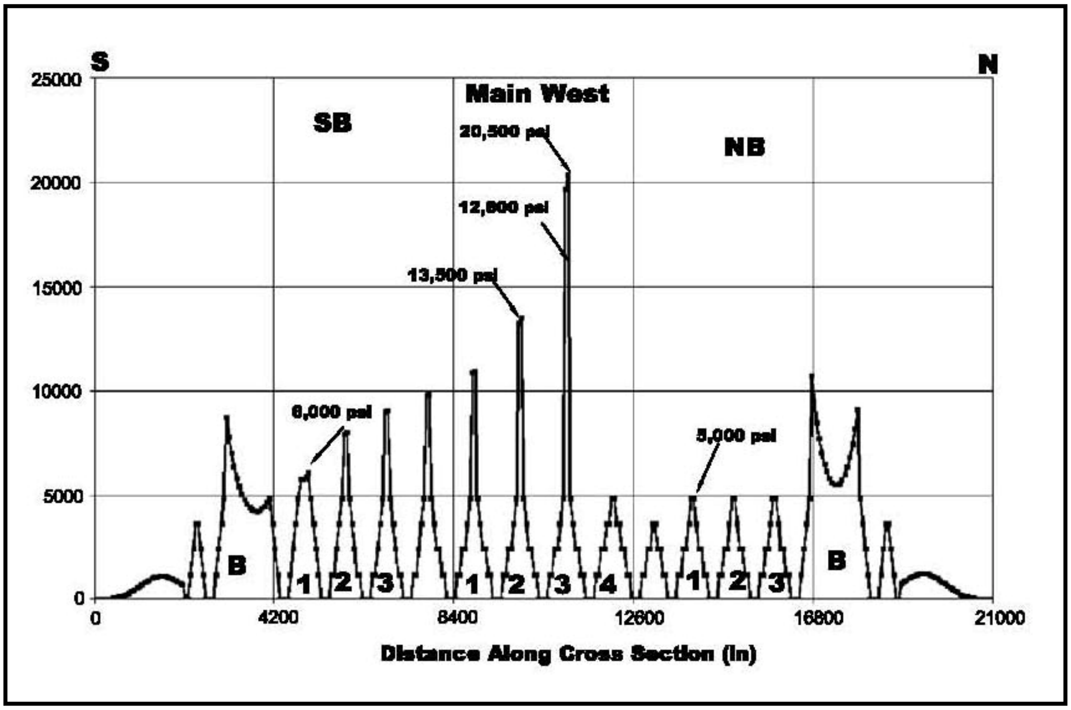
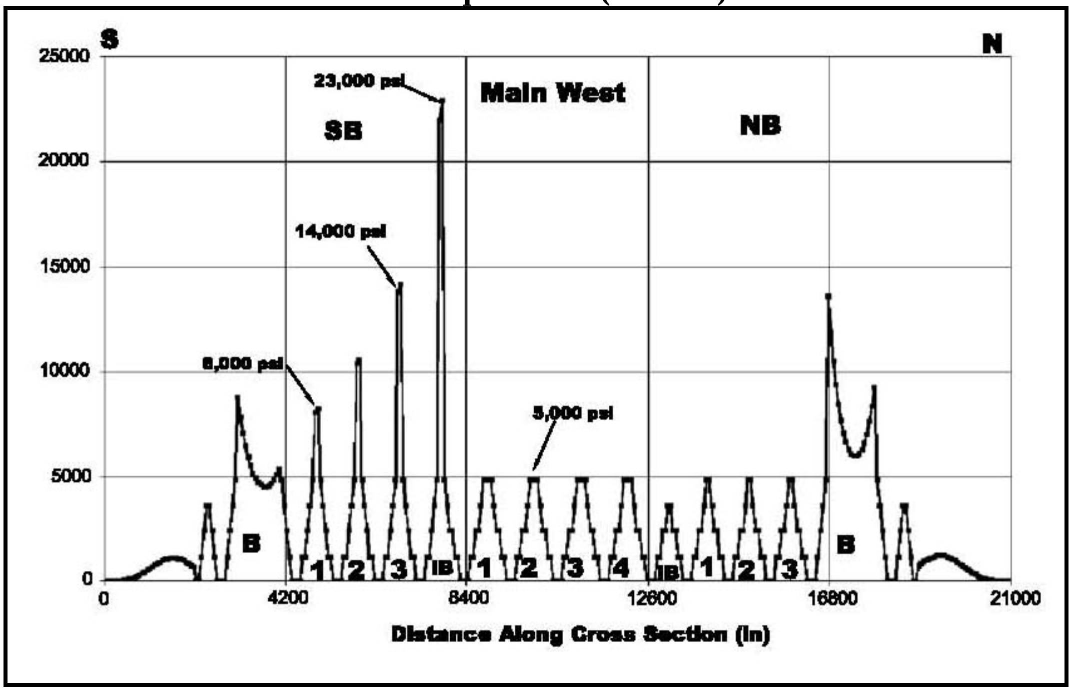


Figure 3.2-7 illustrates the reduction in coal strength of South Barrier pillars and additional reduction in coal strength of the southern isolation barrier. The isolation barrier vertical stress peaks around 23,000 psi and pillars “2 & 3” of the South Barrier exceed 10,000 psi.

Figure 3.2-7 Vertical Stress Main West, North Barrier and South Barrier - Sequence 6b (LaM2D)



Opinion Summary of Damage Sequence
The damage sequence portrayed in Figures 3.2-1 through 3.2-7 is not intended to project a chronological timeline of events. The base case sequence did not indicate high vertical stress at an indicator level. A vertical stress field increase is expected during all forms of retreat mining and this vertical stress increase is a basic fact. Successful retreat mining occurs when the increased vertical stresses are designed to be maintained on the pillars immediately adjacent to the forming gob area.

The assumption of prior damage/deterioration of the Main West pillars within the sealed area was necessary to develop an indicator level vertical stress in the North Barrier. The damage/deterioration assumptions are critical to the determination of pillar stability conditions for mining the barriers adjacent to the Main West.

The damage from the March 2007 bounce was only mapped in the North Barrier. Additional damage/deterioration in the Main West had to be assumed to create the vertical stresses necessary to initiate a failure covering a more extensive area in the South Barrier. Access to the adjacent Main West workings was not available because the area was sealed.

The sealing of the Main West area without creating damage and deterioration documentation on the mine map or in report records at the mine site prior to the sealing event contribute to the modeling uncertainty. The creation of this type record is not required by current regulations; however the lack of any records should be factored into the risk evaluation of the projected mining plan by all parties including the mine operator, the consultant modeler, and the regulatory review team.

Detailed information relating to the models generated by both the consultant modeler and the reviewing MSHA engineer was not provided to allow the review of input assumptions. Documentation was not available indicating whether damage in the North Barrier from the March bounce was incorporated in the modeling for the Barrier plan submittals. Norwest's review of Agapito's evaluation supporting the UEI submittal contained plot copies of the mining sequence. The area of the March bounce does not appear to contain pillars reduced by increased openings. However, other methods of pillar strength reduction are not discernable without more Agapito modeling details.

SEISMIC EVENT REVIEW

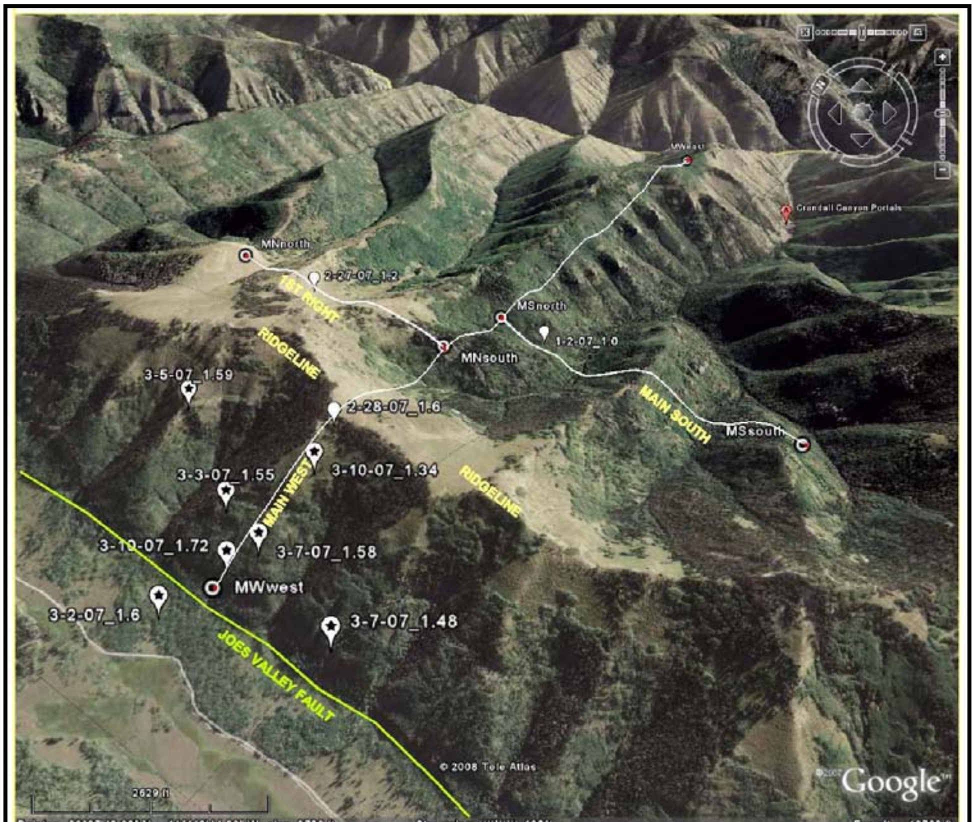
Norwest included a review of the seismic event records created by the University of Utah seismograph stations[14] (UUSS) in quarterly seismic summaries. Google Earth was used to locate the CCM portals and the approximate location of the Main West. Using the latitude and longitude function of Google Earth, a 1.5-mile radius area was identified around the western extent of the Main West. Norwest reviewed the quarterly seismic data from the UUSS website to identify seismic events that fell within the seven square mile area of interest.

A point of clarification regarding any seismic event is that all seismic events are not records of a mine pillar failure. However, the failure of a mine pillar(s) can result in a recordable seismic event.

[14] University of Utah Seismograph Stations website http://www.seis.utah.edu.

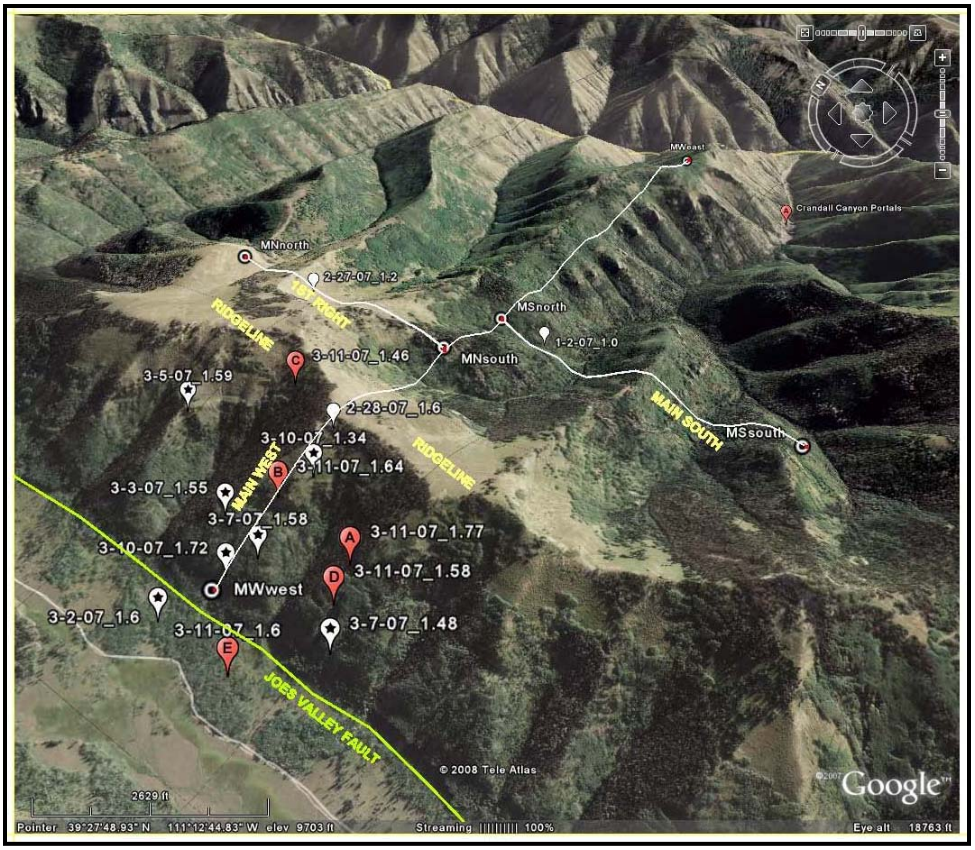
The seismic events identified in Figure 3.3-1 depict the 2007 seismic events including the March 2007 bounce in the North Barrier. The approximate centerline of the CCM development is shown as a white line. The extent of these lines is the N-S-E-W extent of mining at the CCM. The Main West area of this report is named and the ridgeline is noted. The aspect of this figure is rotated to provide topographic perspective of the CCM area. Each seismic event is identified by the date and the event magnitude. The March events are noted with a “star” in the white location indicator. The surface expression of the Joe’s Valley Fault is also identified.

Figure 3.3-1 Seismic Events January 2007 through March 10, 2007



The main March bounce that stopped mining occurred on March 10, 2007.[15] Actually, seven seismic events occurred within a 1.5 mile radius of the Main West during March 10 and 11, 2007. Figure 3.3-2 depicts the March 11, 2007 seismic events by the letters A through E in an orange location indicator. Information was not available to determine which seismic event related to the bounce in the North Barrier retreat section.

Figure 3.3-2 Seismic Events January 2007 through March 11, 2007

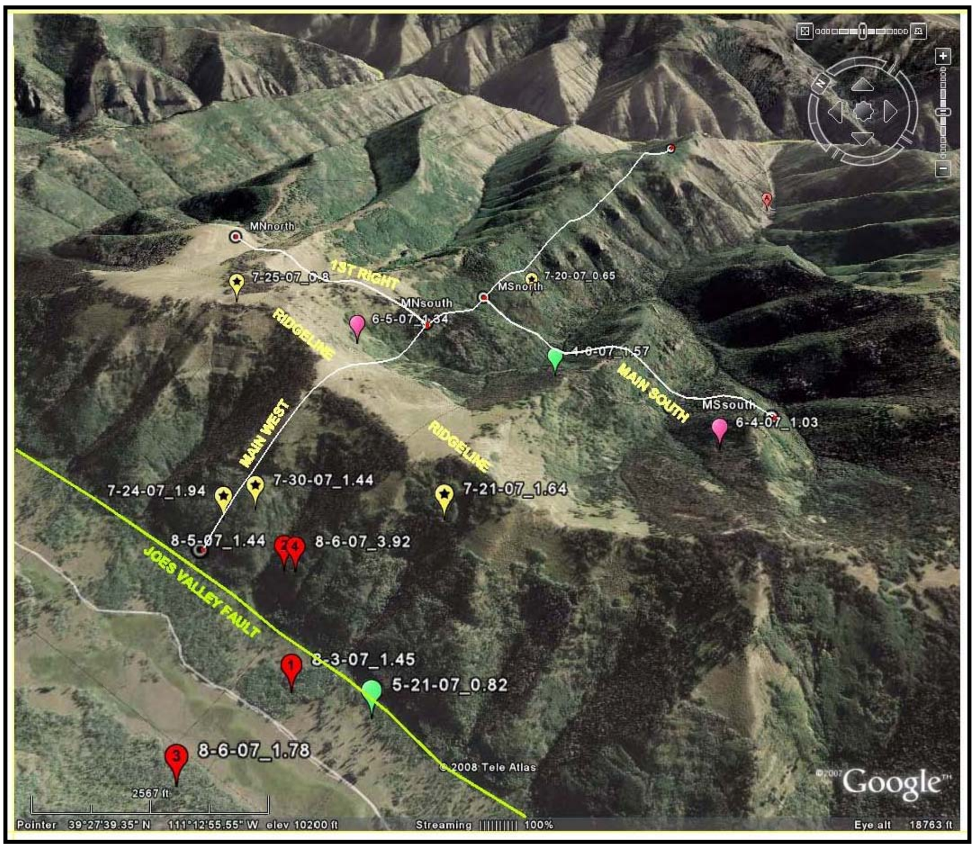


[15] Affidavit of Jose Luis Payan, March 7, 2008, pg 1.

Nine seismic events were recorded in the 1.5-mile radius of Main West after the March 2007 events and the month of August 2007. Figure 3.3-3 shows the approximate locations of these nine events. One event in April and one in May are identified with a light green location indicator, two events in June with a pink location indicator, and five events in July are located with a "star" in a yellow location indicator. Three seismic events preceded the 3.92 magnitude event on August 6, 2007. These four events are identified by a number in a red location indicator with "4" being the 3.92 magnitude seismic event.

Additional August seismic events occurred after the number 4 event. These seismic events were not included in this review. The project scope covered by this report focuses on the events leading up to the event of August 6, 2007.

Figure 3.3-3 Seismic Events March 12, 2007 through August 6, 2007 Bounce



Seismic Review Opinion
Not all seismic events are reportable incidents. No data was provided to identify damage prior to the March 2007 bounce. An investigation conducted by the most immediately available personnel after a seismic event could have provided useful information. A seismic event may disrupt ventilation, cause dust that limits vision, and displace material that disrupts travel. The time, location and extent of damage could be recorded and joined with seismic records when available. The number of seismic events prior to the March 2007 event and those leading up to the August 2007 event have no damage record for review, therefore, Norwest had to assume that some damage/deterioration could have occurred as a result of this seismic activity.

LaMODEL 2.1.1 MODELING

The latest version of this three dimensional model was provided at a NIOSH directed training class held in Grand Junction, CO on January 8, 2008. The class was conducted by Chris Mark – NIOSH and Keith Heasley – West Virginia University.

Norwest prepared a sequence of models to determine the presence of warning sign indicators in the projected mining plans for the North and South Barrier sections. The modeling sequence consisted of the following using 10 ft element sizes:

- The Main West between the 1st West and 9th West longwall panels
- The development of the North Barrier section
- The retreat of the North Barrier section to crosscut 134
- The development of the South Barrier section
- The retreat of the South Barrier section to crosscut 142.

The use of the NIOSH default of 900 psi for coal strength is integral to distinguish the results obtained in this modeling sequence. Norwest utilized AutoCAD copies of the mine map provided by the operator through a request by the Committee. The overburden depth layer provided by the operator was used to develop a depth grid over the area modeled. Seam grid information of the openings and coal pillars was also developed from information contained on these maps.

Norwest reviewed and compared the output plot files for these five sequence steps. Four types of output available in the

NIOSH LaModel 2.1.1 program were selected for the review process. The plots include:

- Seam convergence (0-1ft or 0-12 in)
- Total vertical stress (0 – 10,000 psi)
- Pillar strain SF (0 – 1)
- Element strain SF (0 – 1).

The comparative review assisted in the formulation of opinions addressing the Committee's question whether indicators were present in the proposed mining plans for the development and retreat of the North and South Barriers adjacent to the Main West from crosscuts 118 to 150.

Main West with Adjacent Longwall Panels
The initial sequence modeled the Main West between the 1st West and 9th West longwall panels. The base case assumed the Main West pillars to be in original mined condition.

Figure 3.4-1 shows projected convergence of the pillars and mined openings. The plot identifies the weakest area in the Main West, as expected, to occur under the deepest overburden. The zone of greatest projected convergence is in the angled pillars from crosscut 130 to crosscut 139 between entries 2 and 3. (Note: The use of the 900 psi coal strength magnifies the amount of convergence and may not reflect actual mine conditions. However, weakest areas are easily identified).

Figure 3.4-1 Base Case Seam Convergence Main West (LaModel)

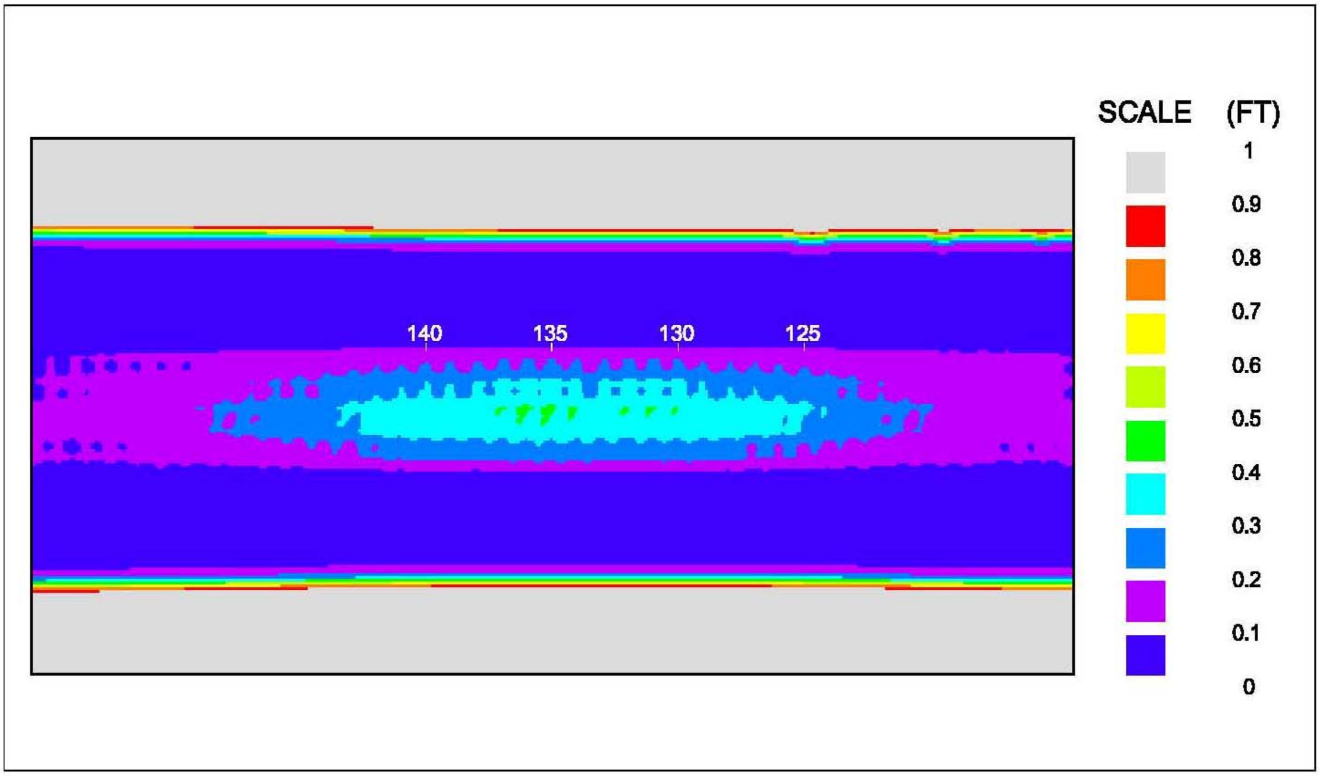


Figure 3.4-2 shows projected vertical stress. The plot identifies a greater vertical stress generated from the 1st West longwall panel (north or top of figure) on the North Barrier protecting the Main West. The weaker angled pillars have no orange or red color in their centers; however the pillars adjacent to them (top and bottom) have orange and red centers (cores). The red centers indicate increased vertical stresses at a level between 8,000 and 9,000 psi. The stresses are indicated in the core portion of the pillars.

Figure 3.4-2 Base Case Vertical Stress Main West (LaModel)

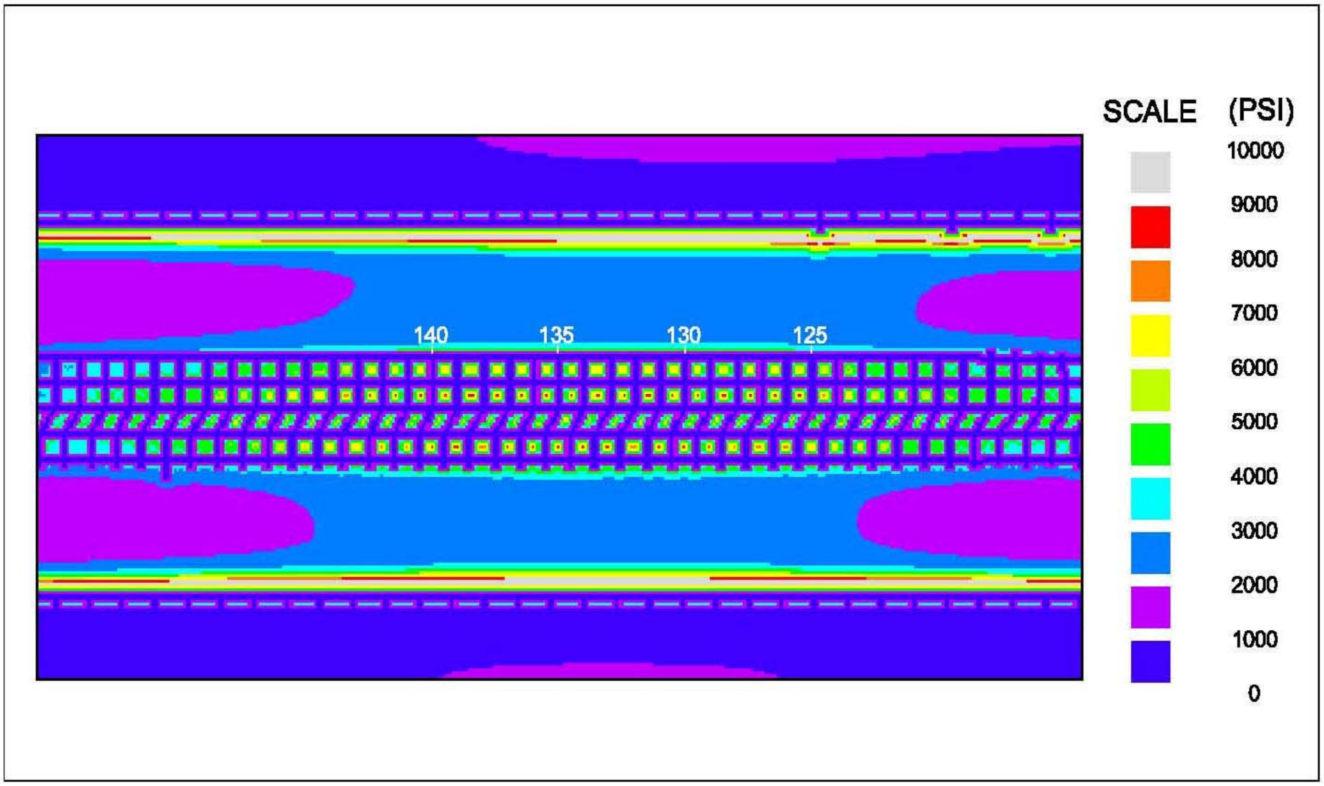


Figure 3.4-3 shows the strain SF rating of each pillar as a whole element. The plot also identifies the angled pillars as the weakest design. The openings are distinguishable from the pillars clearly identifying the crosscuts. The weak area extends from crosscut 123 to crosscut 144 with the weakest angled pillar at crosscut 135. The plot also indicates five pillars between entries 3 and 4, and crosscuts 130 and 137 are weaker than other adjacent pillars.

Figure 3.4-3 Base Case Pillar Strain SF Main West (LaModel)

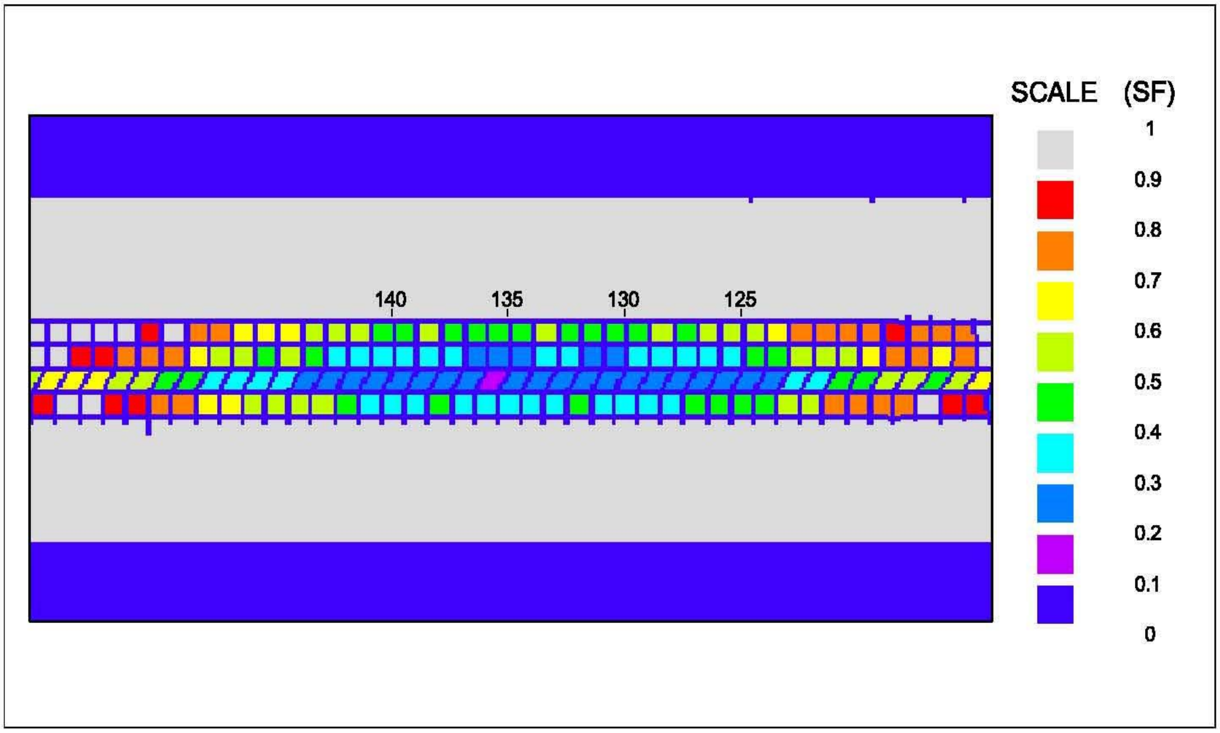
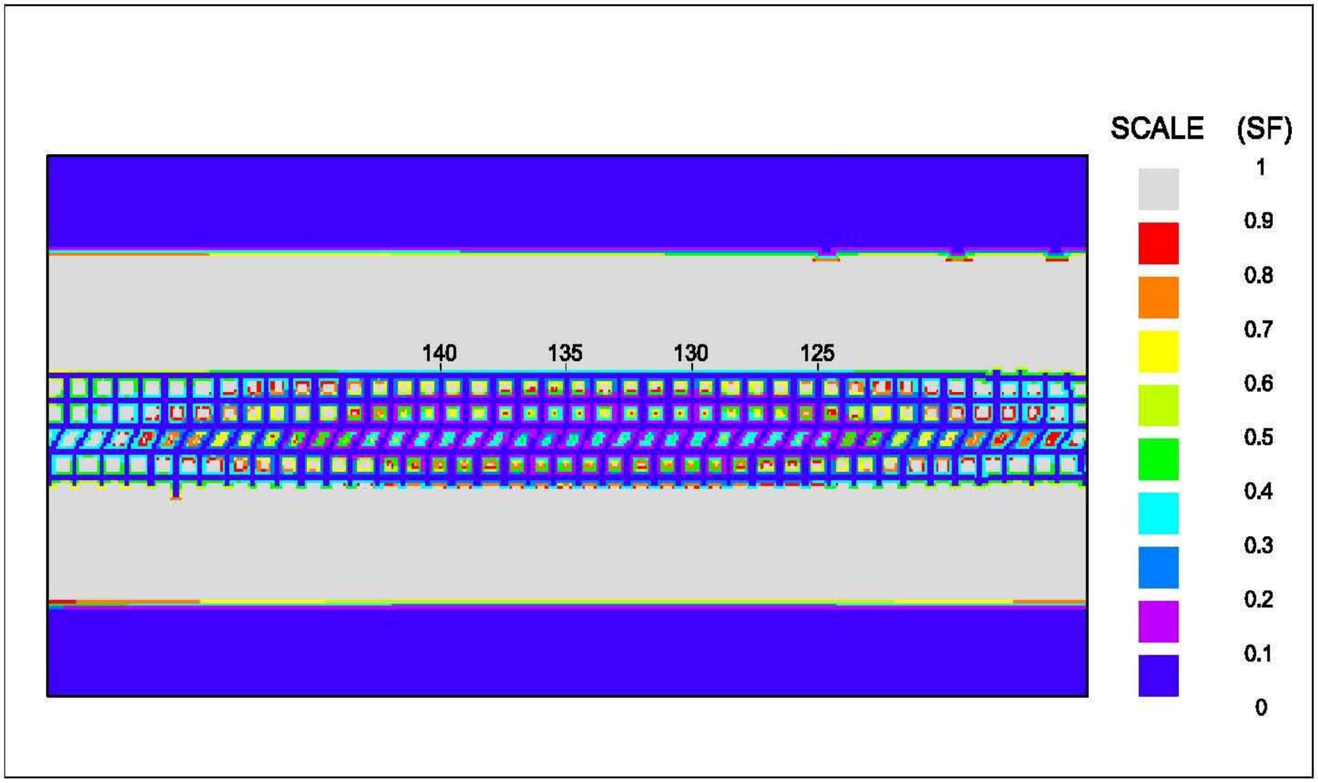


Figure 3.4-4 shows the strain SF rating of each 10 x 10 ft element within each pillar. This plot illustrates similar findings as above. The more stable pillars are red and gray in color while the weaker pillars are blue and purple.

Figure 3.4-4 Base Case Element Strain SF Main West (LaModel)



North Barrier Development

The development of the North Barrier section within the coal barrier between the Main West and the 1st West longwall was the next step in the sequence review. A narrow isolation pillar approximately 50 ft in width separates the sealed portion of the Main West from the North Barrier development. Pillar dimensions for the North Barrier are projected and mined equivalent to the Main West. No angled pillars were projected or mined in the North Barrier.

Figure 3.5-1 shows potential convergence of the pillars and mined openings. The plot identifies the weakest area expanding in the Main West and into the North Barrier under the deepest overburden. The zone of greatest projected convergence has grown in the Main West in the angled pillars from crosscut 128 to crosscut 139 between entries 2 and 3, and including entries 4 and 5 between crosscuts 130 to 137. The newly developed North Barrier shows the greatest projected convergence between entries 1 and 2 and between crosscuts 130 and 135. (Note: The use of the 900 psi coal strength magnifies the amount of convergence and may not reflect actual mine conditions. However, weakest areas are identified).

Figure 3.5-1 Base Case Seam Convergence – Main West and North Barrier (LaModel)

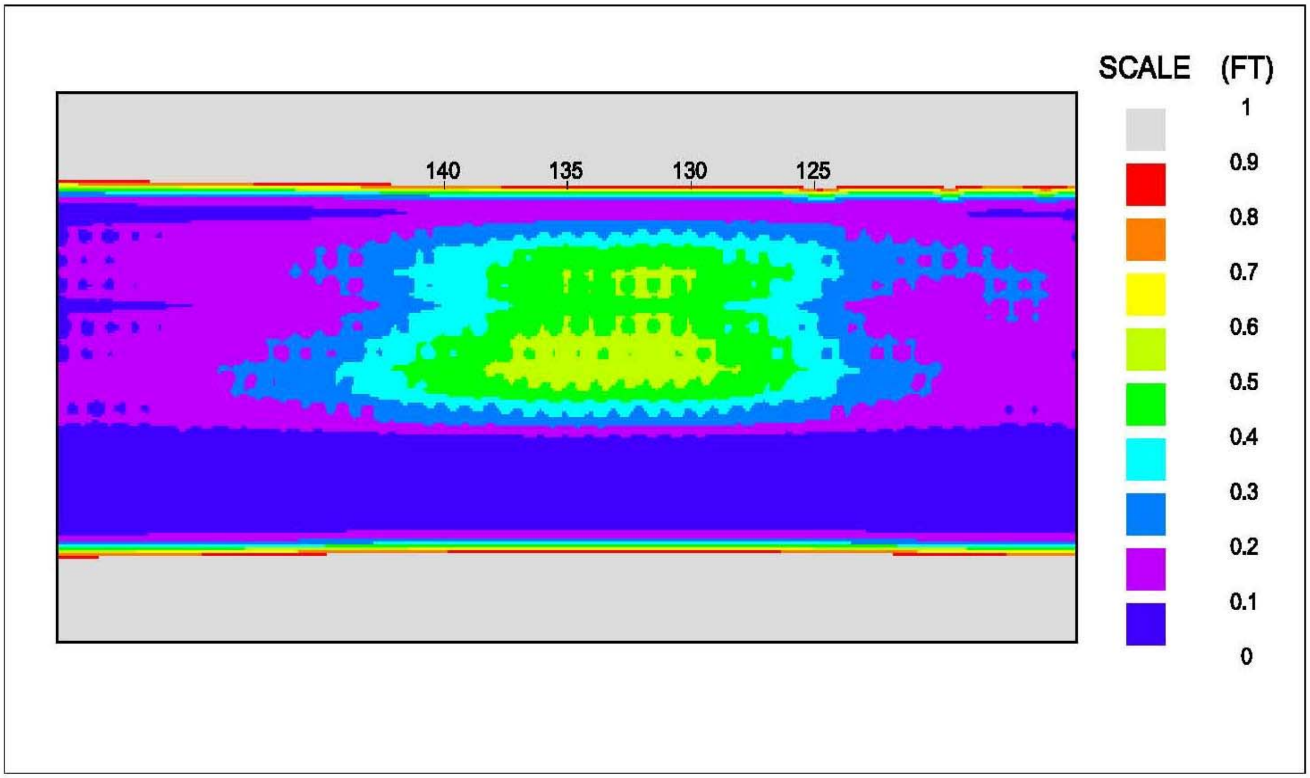


Figure 3.5-2 shows projected vertical stress. The plot identifies a greater vertical stress generated from the 1st West longwall panel (north or top of figure) in combination with the overburden on the narrow North Barrier pillar protecting the North Barrier section. The 900 psi coal strength also increases the potential effect of side abutment loading from the 1st West longwall panel (indicated by the red color between the 1st West long and the North Barrier). The peak vertical stress loading area in the Main West has increased to include eighteen pillars between entries 1 and 2 from crosscut 125 to 143, and between entries 3 and 5 from crosscut 124 to 145. The red centers indicate increased vertical stresses at a level between 8,000 and 9,000 psi. The stresses are indicated in the core portion of the pillars.

Figure 3.5-2 Base Case Vertical Stress – Main West and North Barrier (LaModel)

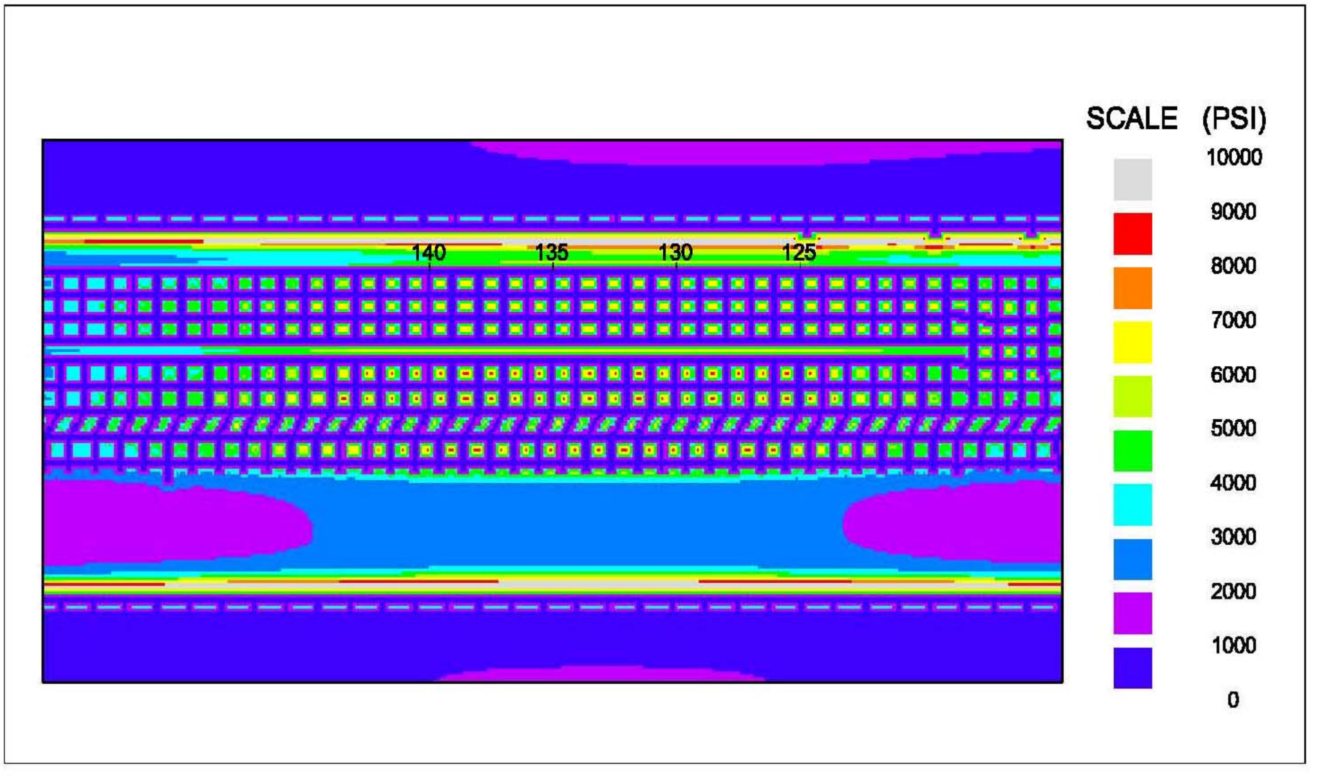


Figure 3.5-3 shows the strain SF rating of each pillar as a whole. The plot identifies a growing zone of decreasing stability. The weak area (blue) in the Main West extends from crosscut 122 to crosscut 145 with the weakest pillars (purple) increasing from one to twenty-nine between entries 2 and 5 from crosscut 126 to crosscut 141. The plot also indicates eleven pillars (purple) in the North Barrier between entries 1 and 3 from crosscuts 129 and 137 are weaker than other adjacent pillars.

Figure 3.5-3 Base Case Pillar Strain SF – Main West and North Barrier (LaModel)

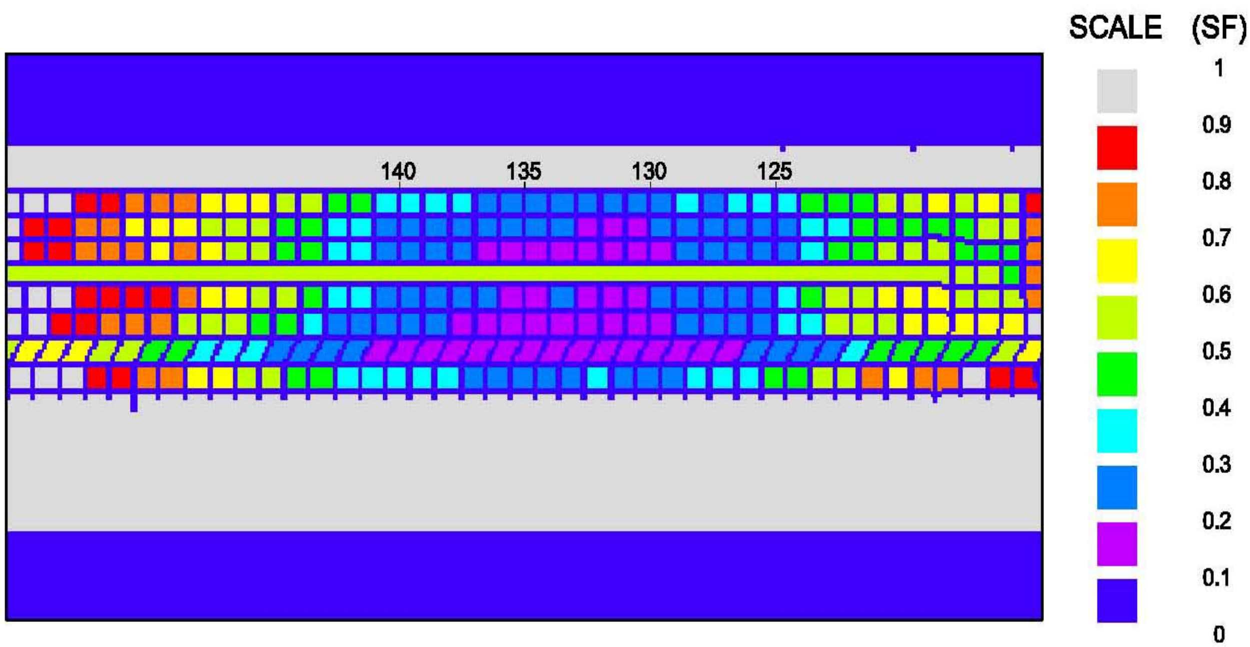
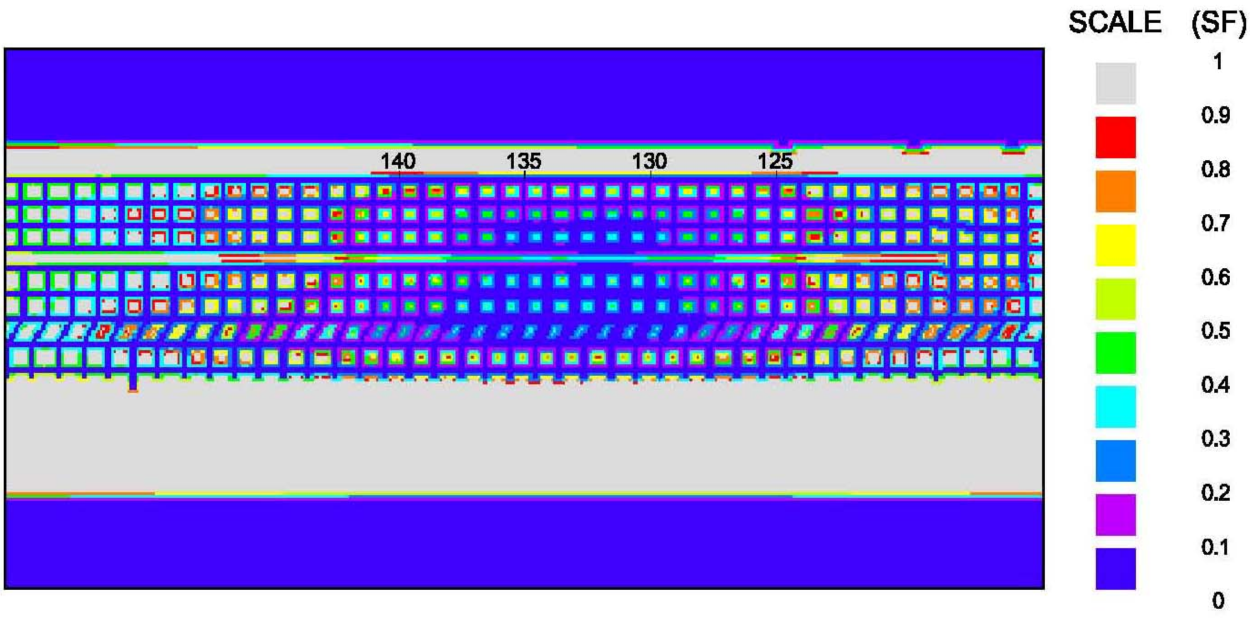


Figure 3.5-4 shows the strain SF rating of each 10 x 10 ft element within each pillar. This plot illustrates similar findings identifying the weaker areas as above. The less stable pillars are blue and purple in color reflecting the impact of increased loading. The element strain SF plot indicates the presence of elements within the pillar with higher stability.

Figure 3.5-4 Base Case Element Strain SF – Main West and North Barrier (LaModel)



North Barrier Retreat

The retreat sequence for the North Barrier is modeled at the location of the March 10, 2007 bounce. Modeling was partially based on the configuration of the pillars left in place between crosscuts 134 and 138 where five pillars were not retreated and retreat mining restarted between crosscuts 134 and 135.[16,17] Increased vertical stresses were to be expected in an area where gob caving must be re-initiated. No caving of the main roof was assumed between crosscuts 134 and 135.

[16] "Area in Main West – North Barrier Photographed on March 16, 2007 by Operator" - Gates Utah Mine Safety Commission Briefing, November 20, 2007.

[17] BLM Inspection Report – Special for the March 15, 2007, Area Map - GENWAL Mine by Steve Falk, pg 3.

Figure 3.6-1 shows potential convergence of the pillars and mined openings. The plot identifies a convergence bulls-eye in the North Barrier where the retreat mining was re-initiated between crosscuts 134 and 135, which is as expected. The southern edge (bottom-orange) of the convergence bull-eye crosses into the Main West and a majority of projected convergence focuses between crosscuts 131 to 137.

Figure 3.6-1 Base Case Seam Convergence – North Barrier Retreat (LaModel)

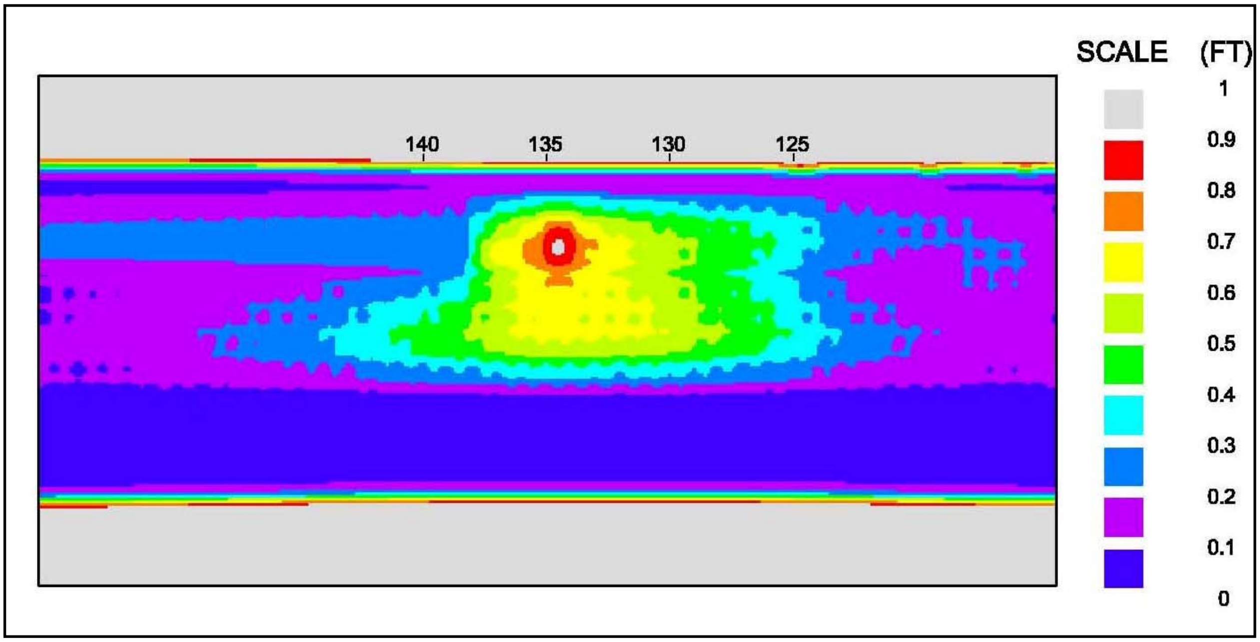


Figure 3.6-2 shows projected vertical stress. The plot identifies that higher vertical stresses remain in the Main West pillars between entries 3 and 5 from crosscuts 124 to 145. The pillars adjacent to the re-initiation of the caving barely exceed 6,000 psi. Vertical stress levels that could possibly initiate a bounce were not evident in this model sequence.

Figure 3.6-2 Base Case Vertical Stress – North Barrier Retreat (LaModel)

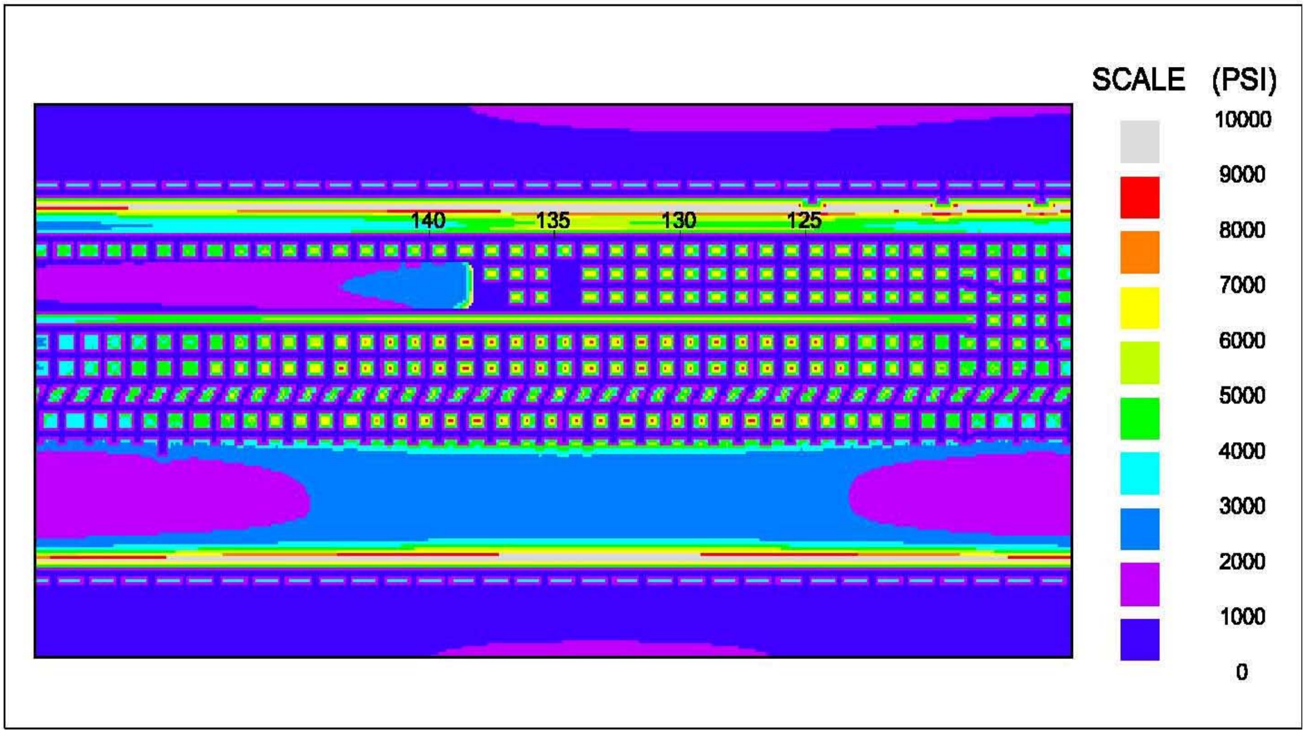


Figure 3.6-3 shows the strain SF rating of each pillar as a whole element. The plot identifies a growing zone of decreasing stability. The weak area (blue and purple) in the Main West extends from crosscut 122 to crosscut 145 with the weakest pillars (purple) growing from twenty-nine pillars to thirty-four between entries 2 and 5 from crosscut 126 to crosscut 141. The plot also indicates a growing weak zone (purple) in the North Barrier from eleven pillars to sixteen with an additional two pillars already removed from this zone between crosscuts 134 and 135. The weakest zone (purple) of North Barrier pillars is concentrated between entries 1 and 3 from crosscuts 129 and 137.

Figure 3.6-3 Base Case Pillar Strain SF – North Barrier Retreat (LaModel)

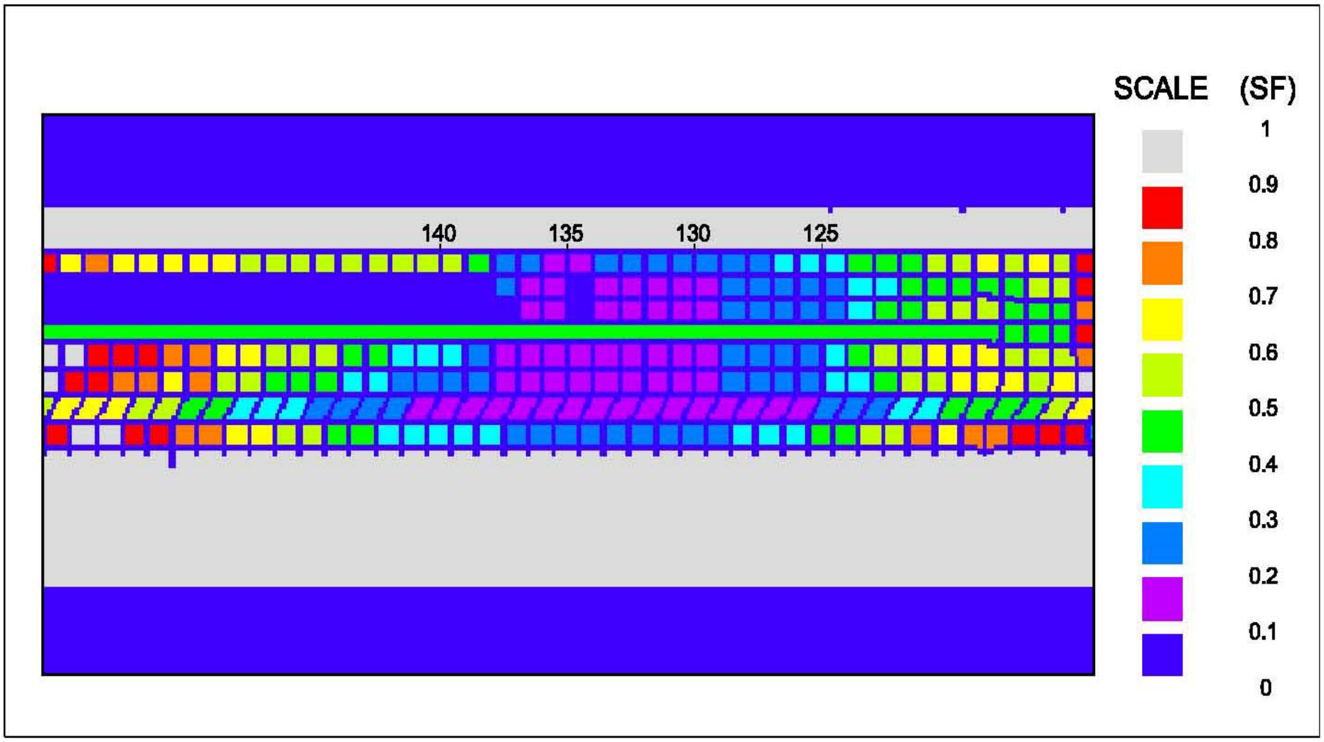
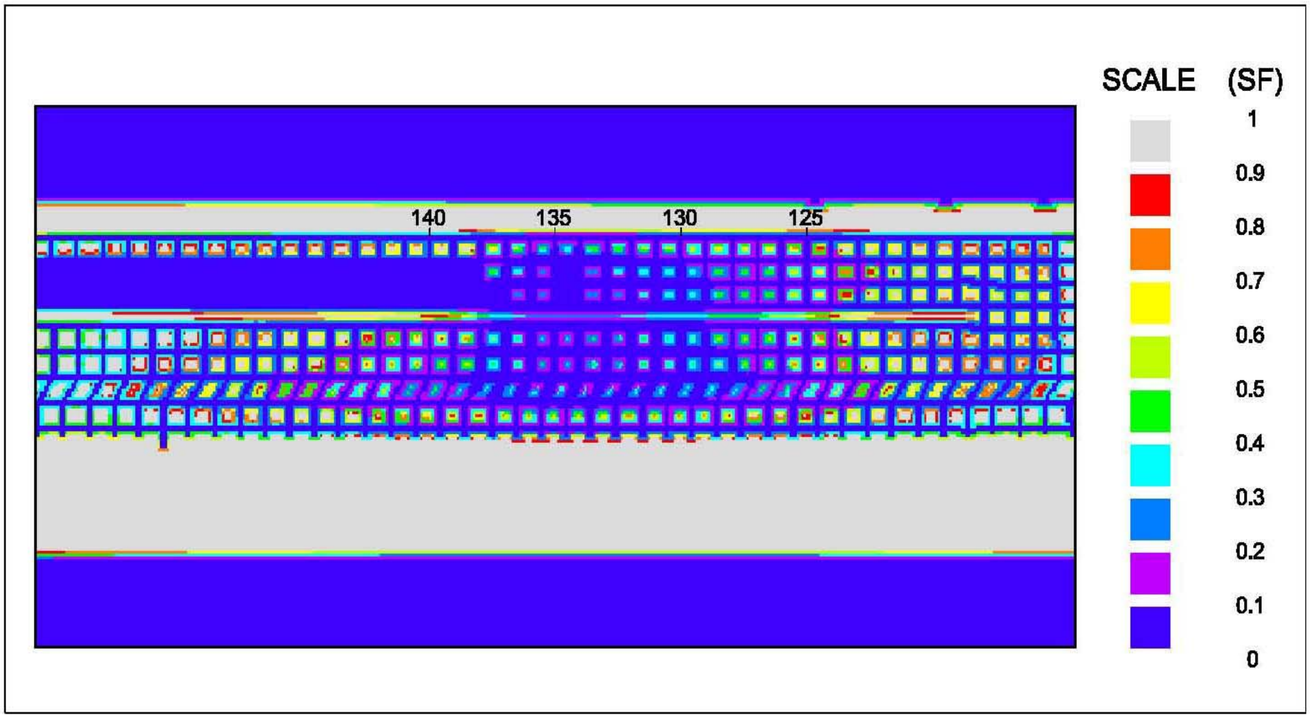


Figure 3.6-4 shows the strain SF rating of each 10 x 10 ft element within each pillar. This plot illustrates a similar weak zone of pillars as the prior figures. The isolation barrier shows an increase of strain (blue to purple) between crosscuts 129 and 138 not visible on the pillar strain SF figure.

Figure 3.6-4 Base Case Element Strain SF – North Barrier Retreat (LaModel)



South Barrier Development
The March 10, 2007 bounce event which stopped mining in the North Barrier resulted in the modification of the South Barrier pillar dimensions. The width of available coal in the south coal barrier between the Main West and the 9th West longwall panel was approximately 457 ft. The presence of sumps on the south side of the Main West prompted a wider isolation barrier between the Main West and the projected South Barrier section. The pillars in the South Barrier could not be widened so they were lengthened by 39 ft to increase stability. Norwest did not assume any pillar damage in the Main West or the North Barrier in this modeled sequence.

Figure 3.7-1 shows potential convergence of the pillars and mined openings. The plot identifies a convergence bulls-eye in the North Barrier where the retreat mining stopped. Projected convergence from the bulls-eye is starting to expand to the south. The South Barrier development shows signs of intersection convergence (blue) in entries 2 and 3 between crosscuts 124 and 133.

Figure 3.7-1 Base Case Seam Convergence – South Barrier Development (LaModel)

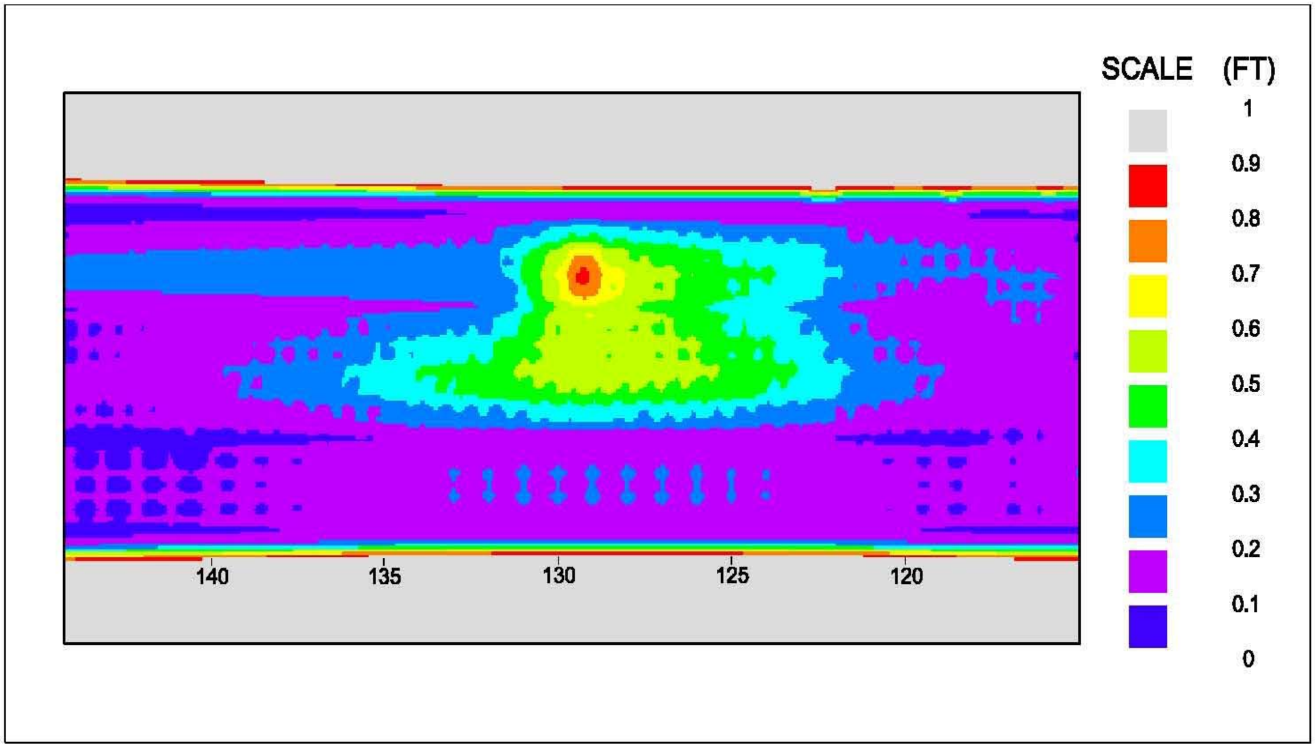


Figure 3.7-2 shows projected vertical stress. The higher vertical stresses remain in the Main West pillars between entries 1 and 2 from crosscut 123 to crosscut 143 and between entries 3 and 5 from crosscut 124 to crosscut 145. The South Barrier peak vertical stress (light green) is just below 6,000 psi and is concentrated on the center row of pillars between entries 2 and 3. The peak vertical stress in the remaining South Barrier is closest to the South Barrier development between crosscuts 124 and 133.

Figure 3.7-2 Base Case Vertical Stress – South Barrier Development (LaModel)

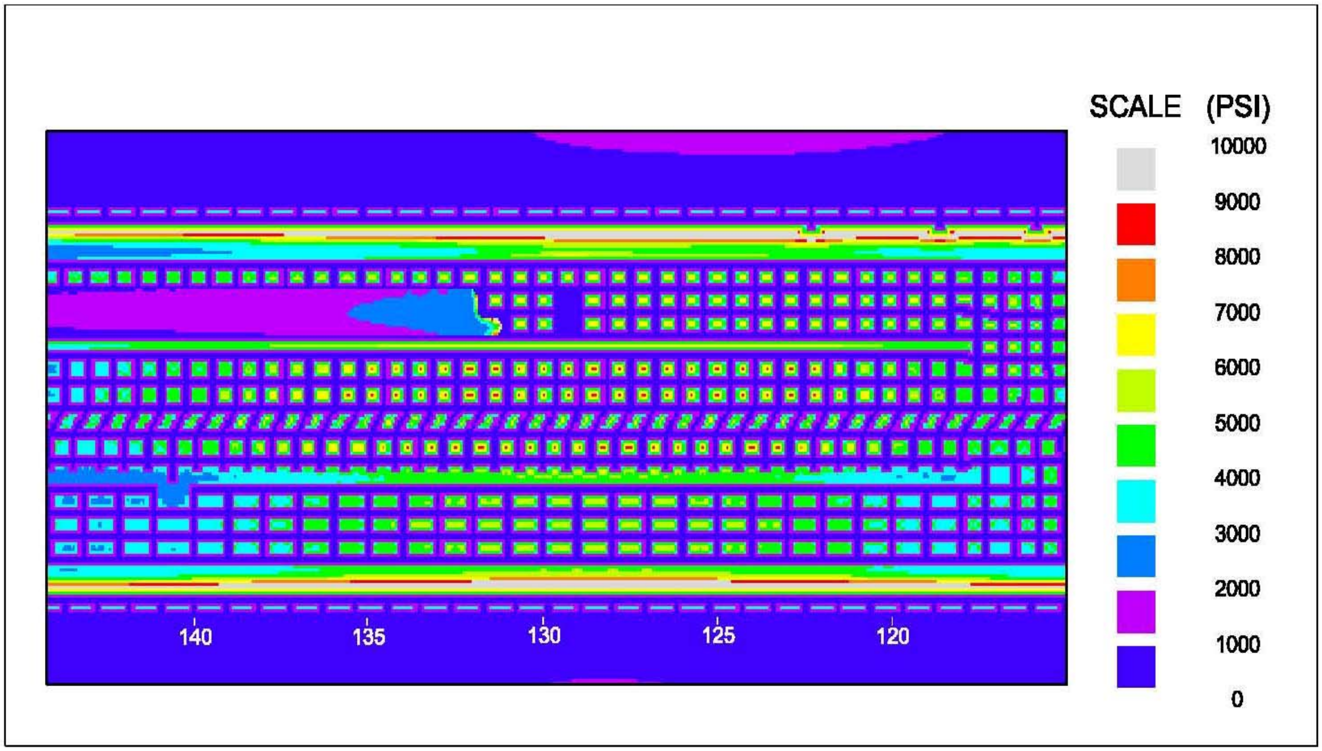


Figure 3.7-3 shows the strain SF rating of each pillar as a whole element. The plot identifies a growing zone of decreasing stability. The weak area (blue and purple) in the Main West extends from crosscut 122 to crosscut 145 with the weakest pillars (purple) growing from thirty-four pillars to thirty-five between entries 2 and 5 from crosscut 126 to crosscut 141. The plot also indicates a growing weak zone in the North Barrier from sixteen pillars to eighteen with an additional two pillars already removed from this zone between crosscuts 134 and 135. The weakest zone (purple) in the North Barrier pillars is concentrated between entries 1 and 3 from crosscuts 129 and 137. The weakest pillars in the South Barrier (light green) show an increase in SF of approximately 0.4 above the weakest pillars in the Main West and North Barrier.

Figure 3.7-3 Base Case Pillar Strain SF – South Barrier Development (LaModel)

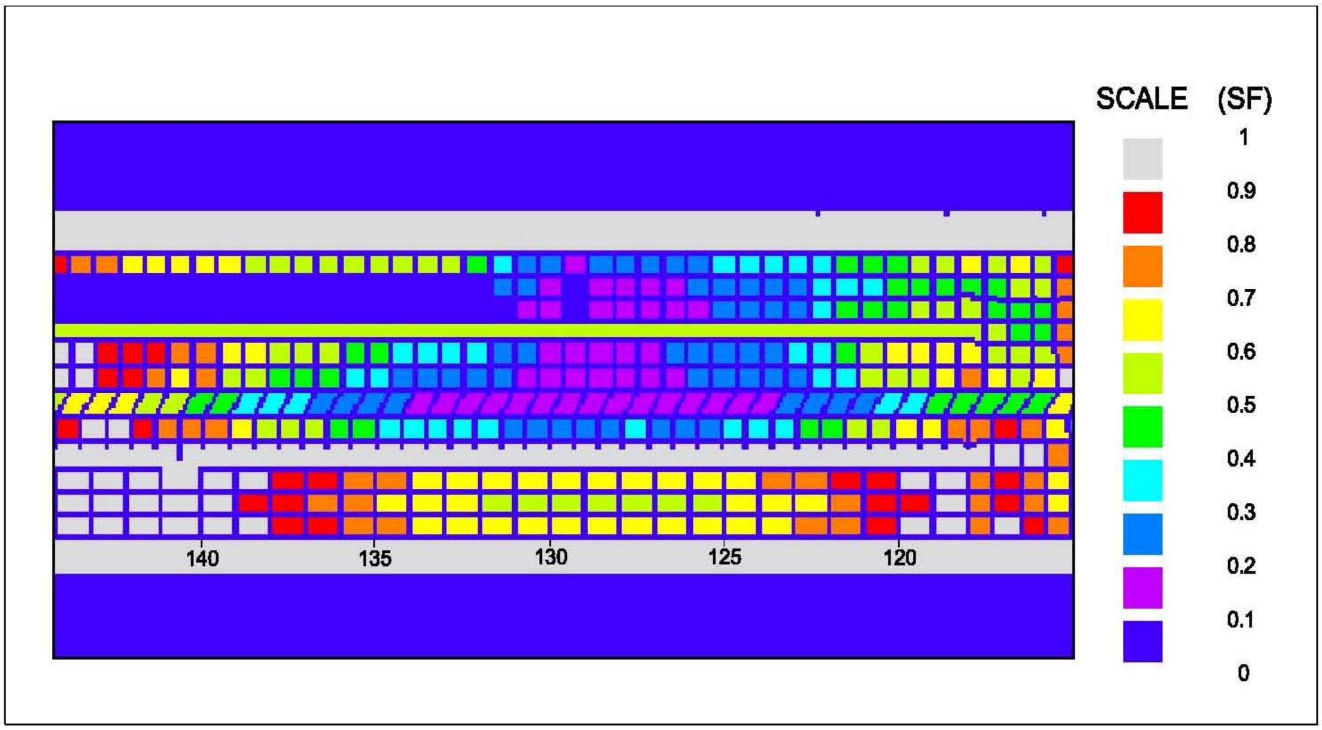
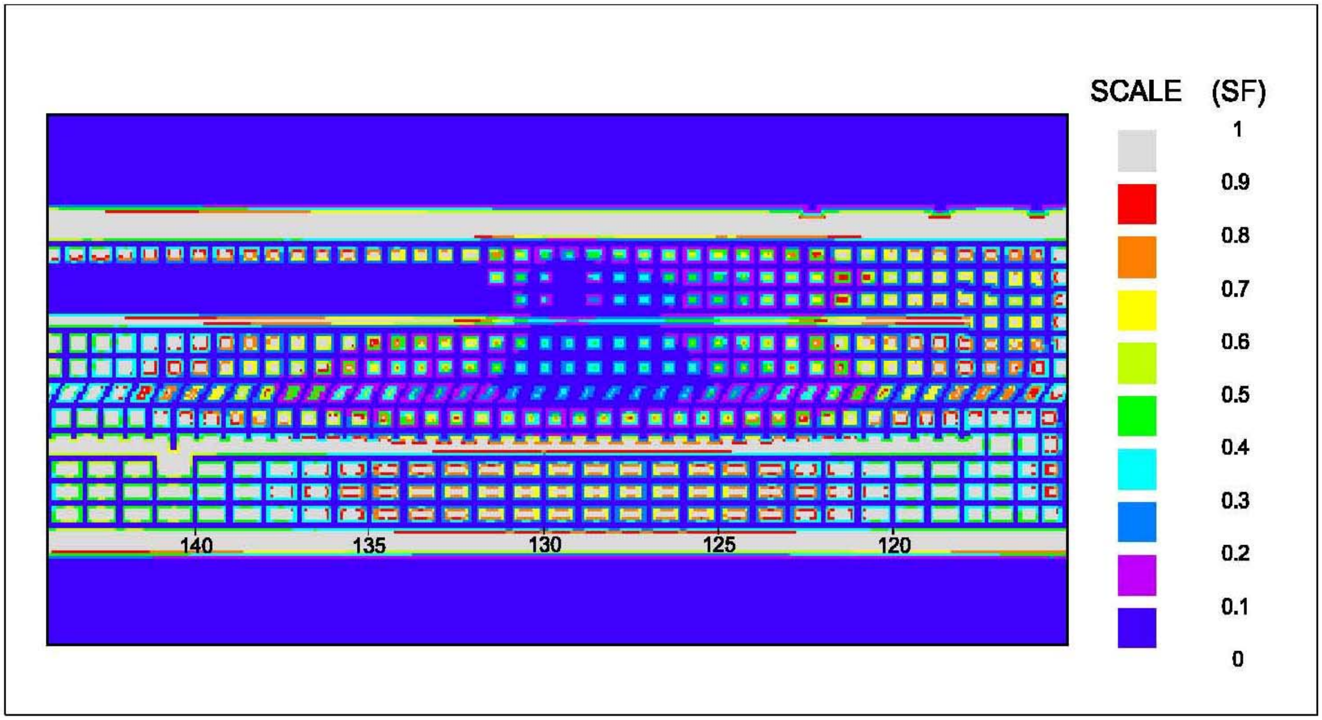


Figure 3.7-4 shows the strain SF rating of each 10 x 10 ft element within each pillar. This plot illustrates a similar weak zone (blue and purple) of pillar elements (blue and purple) as the pillar strain figure. This plot shows the stability in the South Barrier pillars increase above the Main West and North Barrier pillars.

Figure 3.7-4 Base Case Element Strain SF – South Barrier Development (LaModel)



South Barrier Retreat

Retreat mining in the South Barrier started in mid July 2007. The CCM map[18] did not include any of the August retreat mining completed prior to the August 6, 2007 bounce.[19] Norwest assumed retreat mining was completed to crosscut 142 including two pillars per row and approximately 40 ft of the remaining South Barrier between the South Barrier section and the 9th West longwall panel.

[18] UEICONG-K000030390 AutoCAD drawing file.
[19] MSHA Website Map of August 2007 publicly available.

Figure 3.8-1 shows potential convergence of the pillars and mined openings. The plot identifies the retreat mining completed to crosscut 142 in the South Barrier. The projected convergence identified in the development of this section (crosscuts 124 to 133 blue intersections) is the same for the retreat sequence. No increase in the convergence area indicates that the retreat mining in the South Barrier is not affecting the stability of the pillars between crosscuts 124 to 133.

Figure 3.8-1 Base Case Seam Convergence - South Barrier Retreat (LaModel)

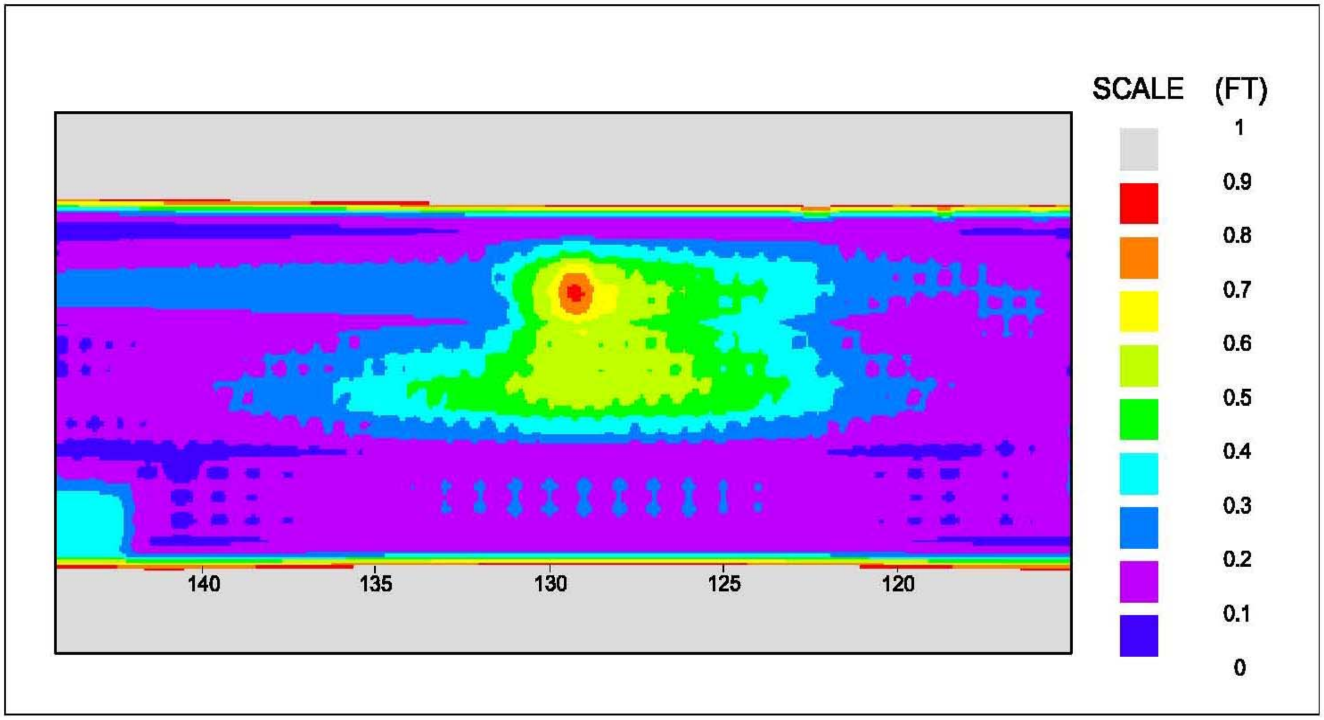


Figure 3.8-2 shows projected vertical stress. The plot identifies an increased zone immediately around the South Barrier retreat mining as expected. The lack of increased stress indicates the South Barrier between crosscuts 124 and 134 is not affected by the retreat mining in the South Barrier.

Figure 3.8-2 Base Case Vertical Stress - South Barrier Retreat (LaModel)

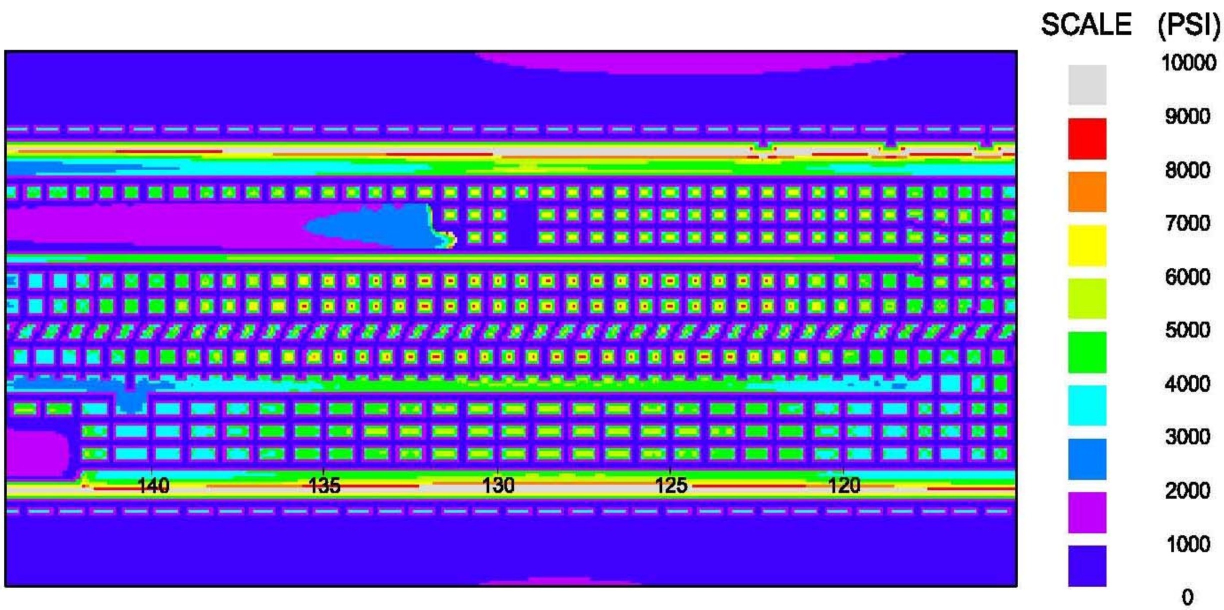


Figure 3.8-3 shows the strain SF rating of each pillar as a whole. The plot identifies the retreat mining in the lower left of the figure. The pillars immediately adjacent to the retreat mining have changed color to indicate a lower strain SF. The strain SF on the pillars between crosscuts 124 to 133 did not change, also indicating no retreat mining effect.

Figure 3.8-3 Base Case Pillar Strain SF - South Barrier Retreat (LaModel)

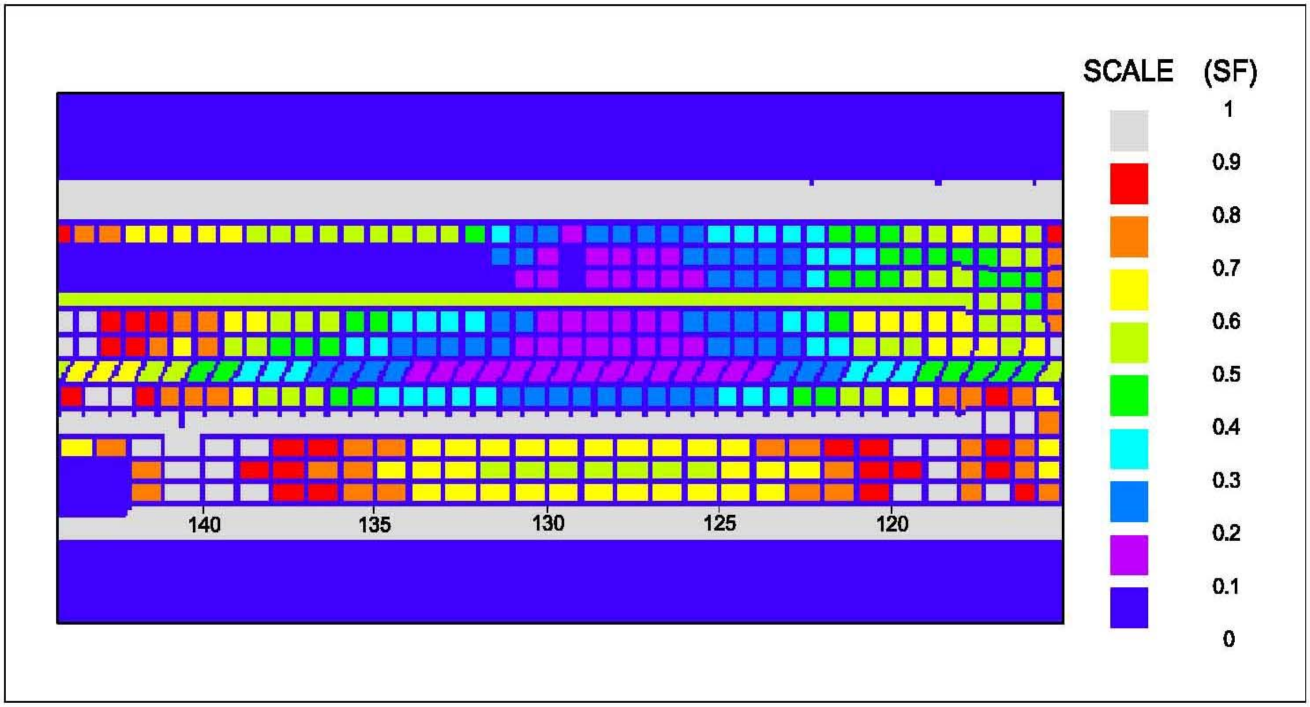
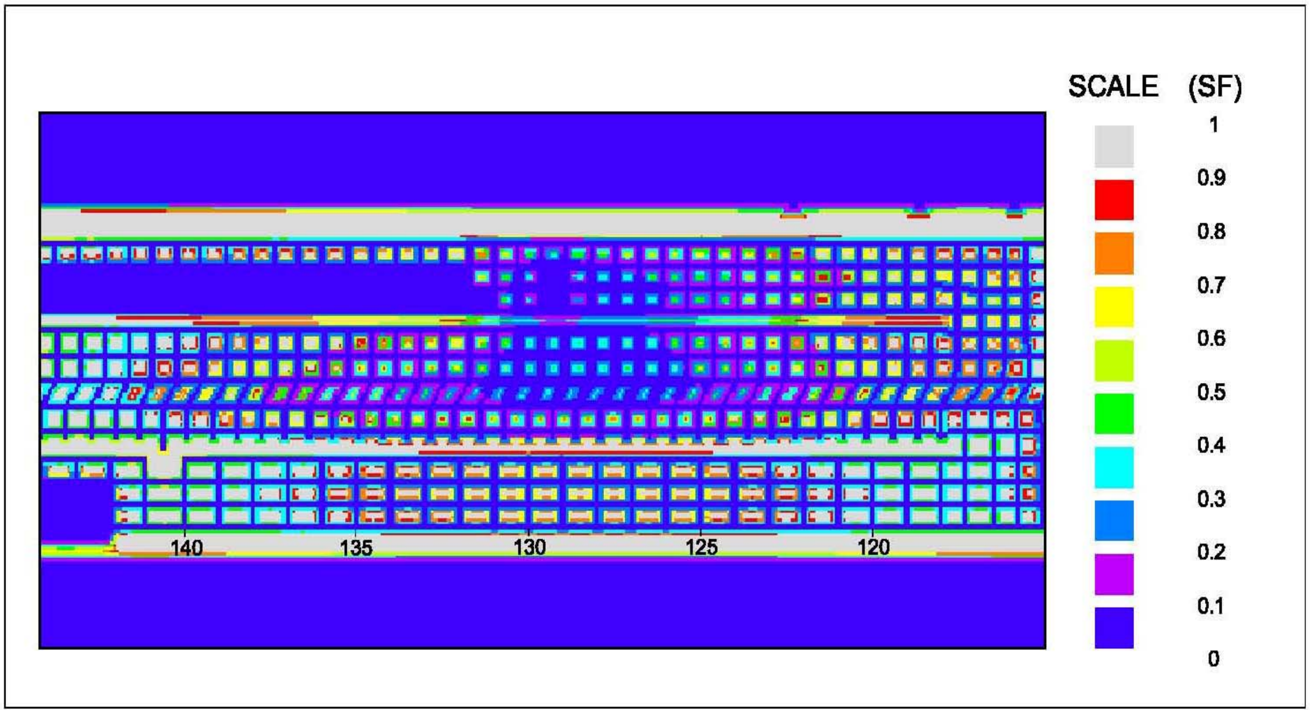


Figure 3.8-4 shows the strain SF rating of each 10 x 10 ft element within each pillar. This plot illustrates the pillars of the South Barrier provide more stability than those in the Main West and North Barrier under the assumed conditions.

Figure 3.8-4 Base Case Element Strain SF - South Barrier Retreat (LaModel)



Opinion Summary of LaModel Sequence

The sequence portrayed in the above LaModel sequence assumed no pillar deterioration in the Main West or the North Barrier and 900 psi coal strength. Norwest's opinion, after review of these output plots, is that a zone of weaker pillars is evident in the Main West prior to any additional mining. The inclusion of additional mining in the North Barrier significantly increased the area of weaker pillars in the deepest overburden. Vertical stresses generated are higher in the Main West than expected. The potential vertical stress peak prior to the March bounce occurrence was not at indicator level in the results of the North Barrier retreat model. However, the weaker pillars identified in the modeling bare a similar configuration to the pillars effected by the March bounce. The South Barrier pillars size increase shows a strain SF improvement and no evident indicator concerns were present in this area.

Norwest's opinion is that the base case sequence reflects the optimum results even when using the 900 psi coal strength as input. The deterioration of the Main West and the knowledge of the March bounce damage in the North Barrier should be included in the design and review of the North and South Barrier projected and completed mining.

MODELING PILLAR DAMAGE

The method to model pillar damage is not covered in the NIOSH documentation for the LaModel program. Norwest understands that the following sequence of assumptions may not accurately reflect any potential confinement supplied by coal material broken from the pillars that begins to fill the mine openings. Norwest accounted for the assumed pillar deterioration and damage by reducing pillar dimensions resulting in increased opening size.

Without the benefit of damage mapping or visual inspection of the sealed area in the Main West, Norwest sequentially assumed reduced pillar dimensions on two sides for rectangular pillars, and removed sharp corner elements and elements partially containing both opening and pillar components. The mining and damage sequence was reviewed in the following five steps:

- Step 1- Main West with North Barrier development original pillar dimensions
- Step 2- Main West with North Barrier development damage/deterioration to the weakest Main West pillars
- Step 3- Main West with North Barrier retreat damage/deterioration to the weakest Main West pillars
- Step 4- Main West with South Barrier development damage/deterioration to North Barrier weakest pillars (bounce) and additional Main West damage to weakest pillars and isolation barrier between Main West and North Barrier
- Step 5- Main West with South Barrier retreat damage/deterioration to weakest pillars and isolation barrier adjacent to entry 1 in the Main West.

The results of this modeling sequence are presented comparatively. The modeling steps do not imply Norwest has knowledge of any chronological damage and deterioration sequence. The steps modeled observed the weakest projected pillars and applied damage to these pillars in the next sequence step.

Five Steps – Convergence Results
The amount of convergence is relative to the 900 psi coal strength. The convergence steps are presented together in Figure 3.9-1 to illustrate visually the increasing progression of the area effected. A scale of 0 to 2 ft convergence was used to identify the potentially effected area.

Step 1 shows the convergence centrally located in the Main West prior to any damage/deterioration being applied.

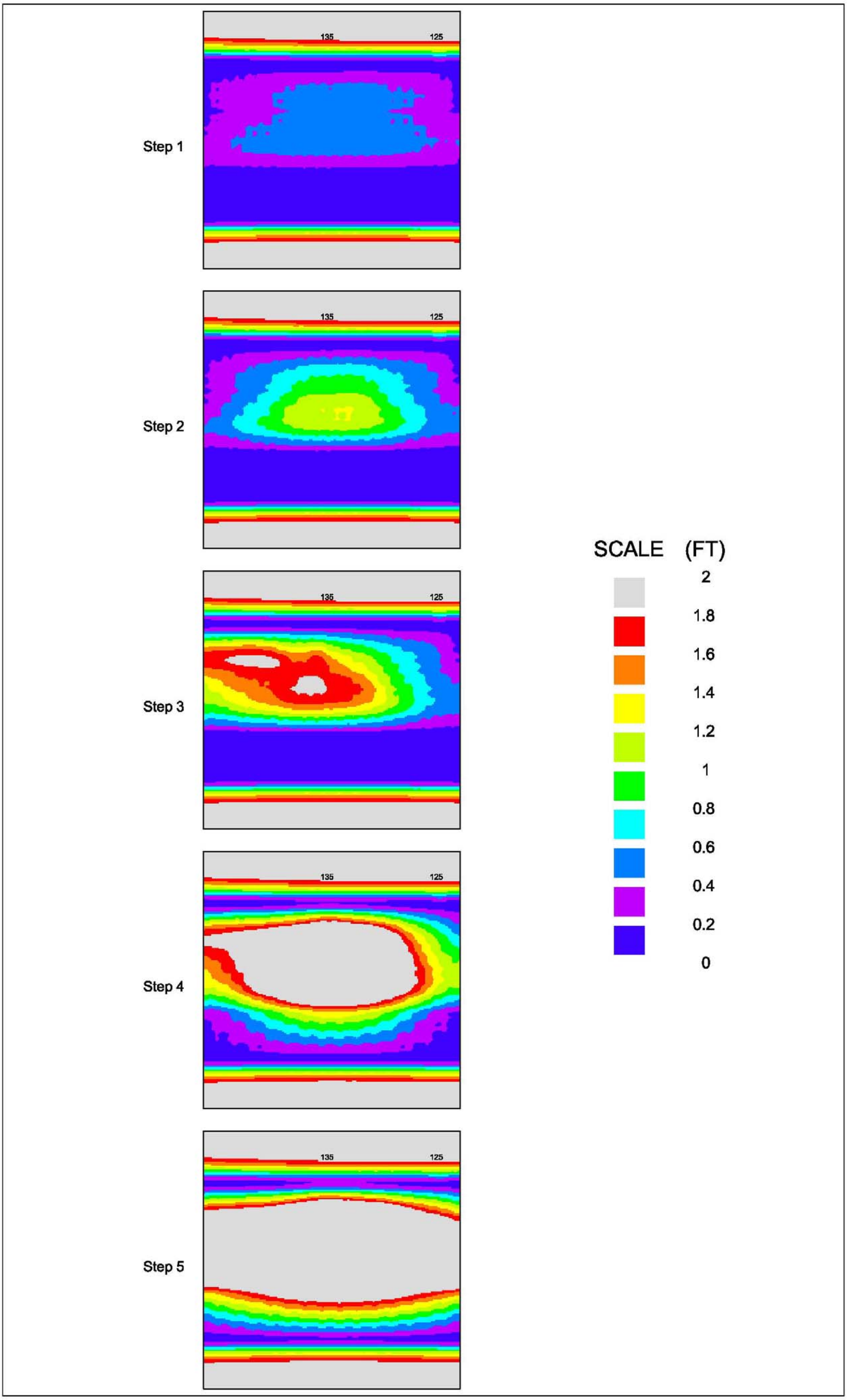
Step 2 shows a dramatic increase in convergence and effected area when just the weakest pillars in the Main West are impacted by damage/deterioration (narrowing the longest side by 10 ft and reducing angled pillar corners).

Step 3 shows the North Barrier retreat mining. The convergence area and the magnitude increases in the Main West and North Main. Additional damage/deterioration was applied to the Main West weakest pillars (narrowing the shortest side by 10 ft).

Step 4 shows the convergence effects of applying bounce damage to the weakest pillars in the North Barrier, isolation barrier, and additional weakest pillars in the Main West. The South Barrier development was added to this sequence. The convergence effects cross the south isolation barrier into the South Barrier development.

Step 5 shows the convergence effects as the last row of pillars in the Main West and the south isolation barrier were affected by damage/deterioration (narrowing the shortest and longest sides by 10 ft and narrowing the isolation barrier by 10 ft). This step clearly indicates the convergence effects moving into the South Barrier development.

Figure 3.9-1 Five Step Damage Sequence - Seam Convergence (LaModel)



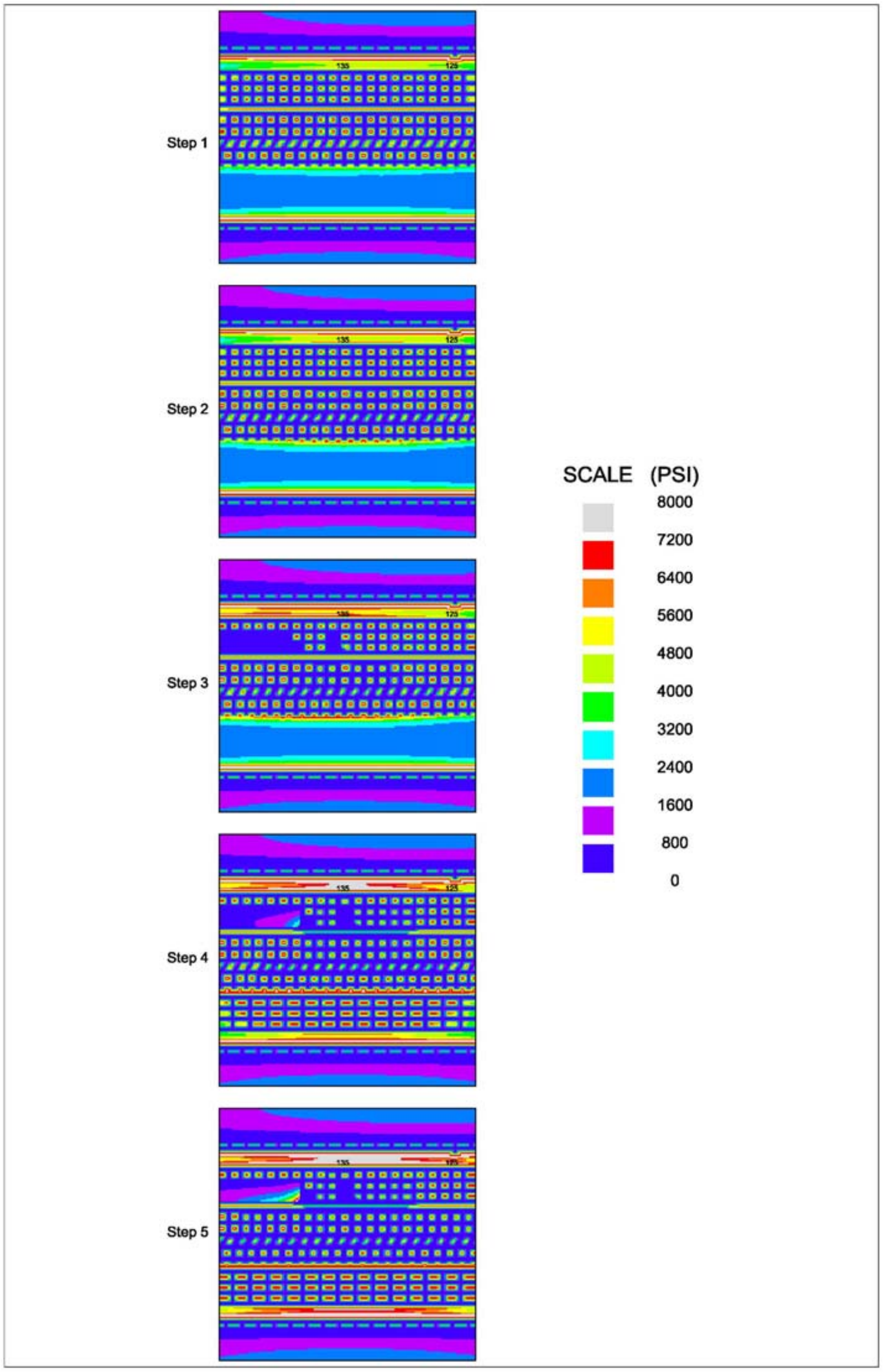
Five Steps - Vertical Stress Results

The projected vertical stresses are presented together in Figure 3.9-2 to illustrate visually the increasing progression of the area affected. A scale of 0 to 8,000 psi vertical stress was used to identify the potentially effected area.

Step 1 shows the vertical stress peaking in the centers of the pillars. In this model sequence, the Main West pillars experience a projected vertical stress load approximately 2,000 psi higher than the pillars in the North Barrier development prior to any assumed pillar damage/deterioration.

Step 2 shows the expansion of the projected higher vertical stresses in the remaining North Barrier pillar between crosscuts 130 to 137 and along the Main West in the South Barrier pillar between crosscut 126 and 141.

Figure 3.9-2 Five Step Damage Sequence – Vertical Stress (LaModel)



Step 3 shows the projected high vertical stress area continuing to expand in the remaining North Barrier pillar starting at crosscut 127 and beyond crosscut 144. A projected high vertical stress zone is almost connecting across the remaining North Barrier pillar at crosscut 139.

Step 4 shows the projected high vertical stress area expanding across the remaining North Barrier pillar between crosscuts 133 and 136. The south isolation barrier pillar between the Main West and the South Barrier development is now seeing projected vertical stress loading transferring from the Main West pillars. The shifting stresses are also transferring to the South Barrier development pillars between crosscuts 122 and 136. The remaining South Barrier pillars begin to show projected vertical stresses increasing along the South Barrier development between crosscuts 126 and 131.

Step 5 shows the vertical stress transference to all the pillars in the South Barrier development between the modeled crosscuts 121 and 136. The remaining South Barrier pillar shows the high vertical stress area continuing to expand.

Five Steps – Pillar Strain SF Results

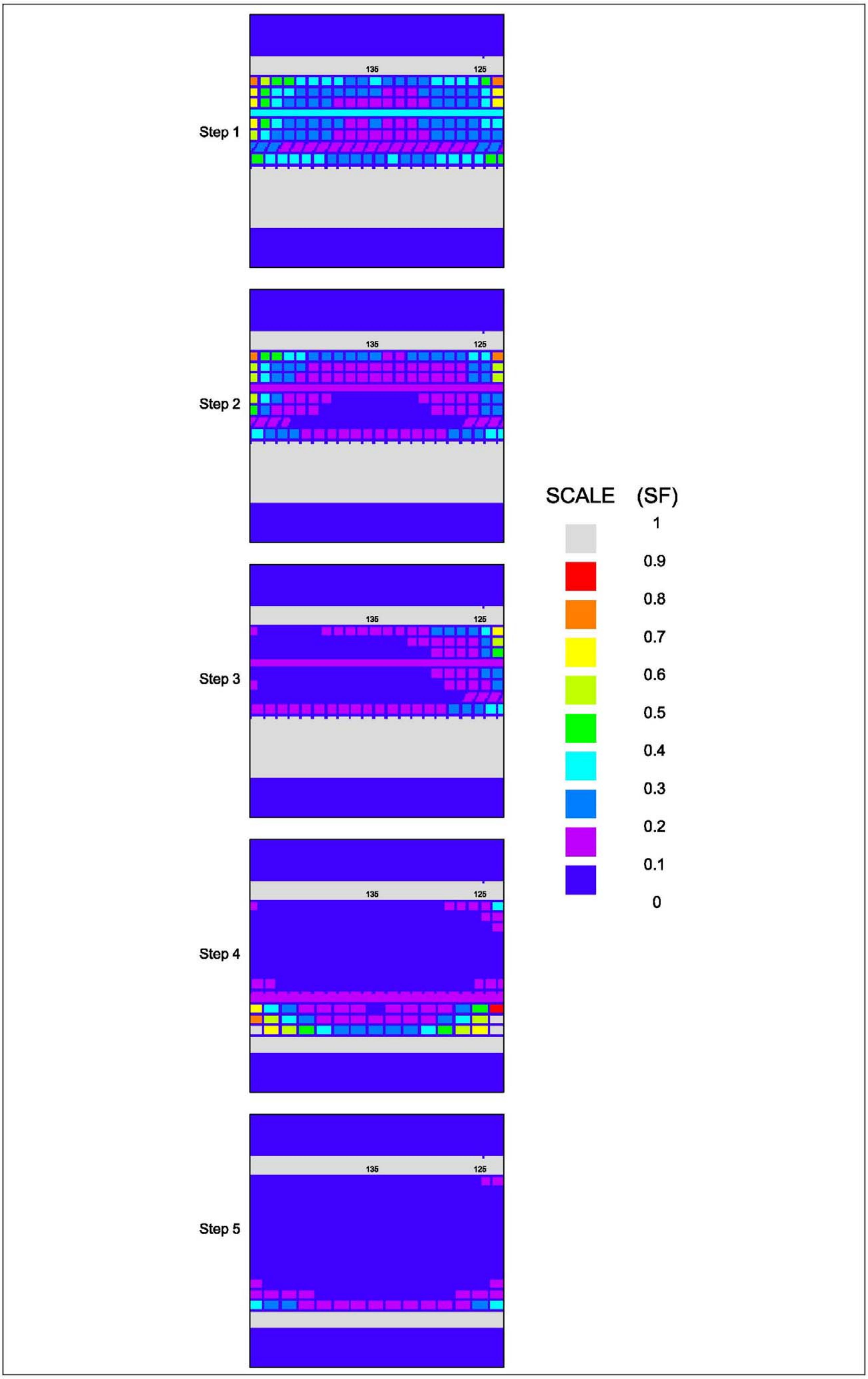
The projected pillar strain SF ratings are presented together in Figure 3.9-3 to illustrate visually the location of the weakest pillars in each step of the sequence. The weakest pillars in each step have damage/deterioration applied in the subsequent step. Each application of damage increased the projected progression of the area affected.

Step 1 shows the Main West containing twenty-nine pillars rated at the lowest strain SF. The angled pillars in the deepest overburden provide the least support. The North Barrier development contains eleven pillars with the lowest strain SF.

Step 2 shows the progression of declining pillar stain SF ratings as the pillars from Step 1 have been reduced in size. This initial pillar size reduction now affects the loading of adjacent pillars thus reducing the strain SF in thirty-five pillars in the Main West and an additional eighteen pillars in the North Barrier development.

Step 3 shows the combined effects of the retreat mining in the North Barrier and the weakened pillars in the Main West. The North Barrier has pillars between entries 1 and 3 from crosscuts 131 to 138 reduced to the lowest SF rating.

Figure 3.9-3 Five Step Damage Sequence – Pillar Strain SF (LaModel)



Step 4 shows the result of damage/deterioration to pillars in the North Barrier as a result of the March bounce and additional pillars in the Main West. The South Barrier development and the isolation barrier now show a reduced strain SF. Sixteen pillars in the South Barrier development experience the transference of load between crosscuts 124 and 133.

Step 5 shows the reduction of the pillar strain SF and the area affected have expanded. The South Barrier development pillars now show a reduced pillar strain SF in the modeled area between crosscut 121 and 136.

Opinion Summary Modeling Pillar Damage

Norwest had to assume the amount and extent of damage and deterioration in the Main West and combine that assumed damage with several accounts of the damage in the North Barrier from the March bounce.[20,21] The damage in the Main West was more crucial to the area affected by the August bounce and the retreat mining process in the South Barrier did not effect the area damaged in the August bounce.

Relevant information detailing the extent of pillar deterioration in the Main West, prior to the sealing of this area, was not available from the information provided. The verbal description in the BLM inspection report[22] only provides an indication that some pillar deterioration existed, but not the location and extent required for a detailed modeling evaluation.

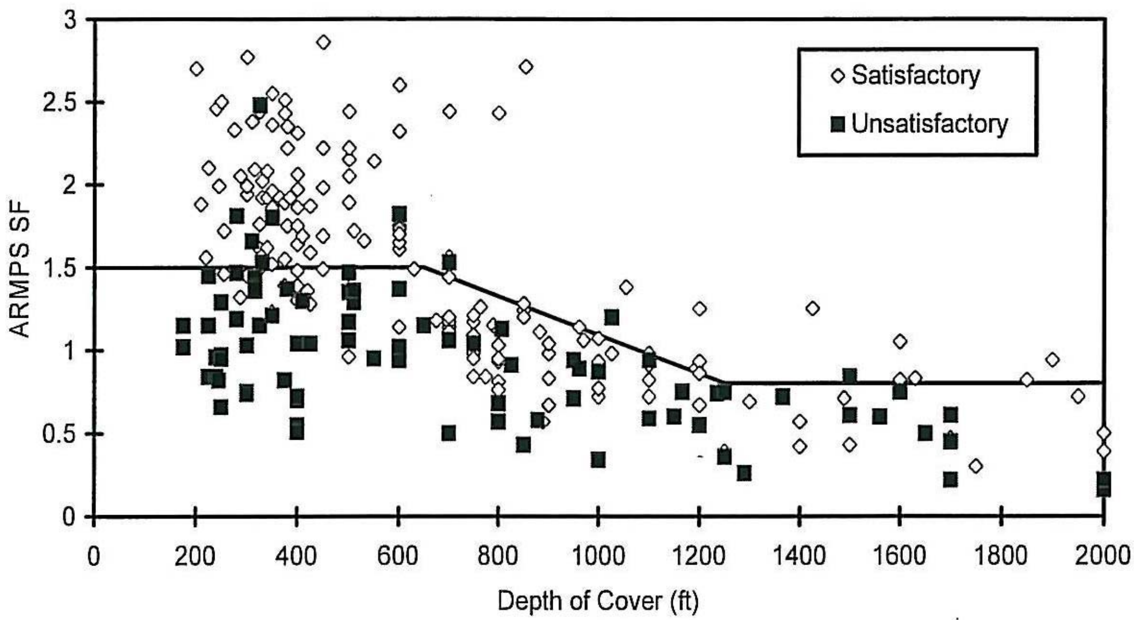
MODELING HIGHER COAL STRENGTH

The NIOSH programs provide a 900 psi default coal strength. The default strength allowed the comparison graphing of success and failure results in mines throughout the US. This section of the report seeks to determine the impact of modifying the coal strength when evaluating the CCM mining plan. Norwest utilized the five step sequence for modeling pillar damage for visual comparison of Figures 3.9-1, 3.9-2, and 3.9-3 with results of higher coal strength. The coal strength Norwest selected for comparison was 1250 psi[23] and coal material strengths were then recalculated in the LaModel program. Norwest anticipated improvements in the amount of convergence and the pillar strain SF in the results of this modeling sequence. However, Norwest also realizes that the resulting pillar

[20] BLM Inspection Report –March 15, 2007, pg 10.
[21] UEI CONG 000020828 UEI-Inspection and Descriptions of March Bounce Damage, pg 1-4.
[22] BLM Inspection Report – Special for the November 4, 2004 GENWAL Mine by Steve Falk, pg 1-3.
[23] NIOSH letter addressing "Use of ALPS, ARMPS, and LaModel and the Crandall Canyon Coal Bump."

strain SF from increasing the coal strength does not compare to SF guidelines provided by NIOSH in the ARMPS SF graph in Figure 3.10-1 that were based on 900 psi coal strength.

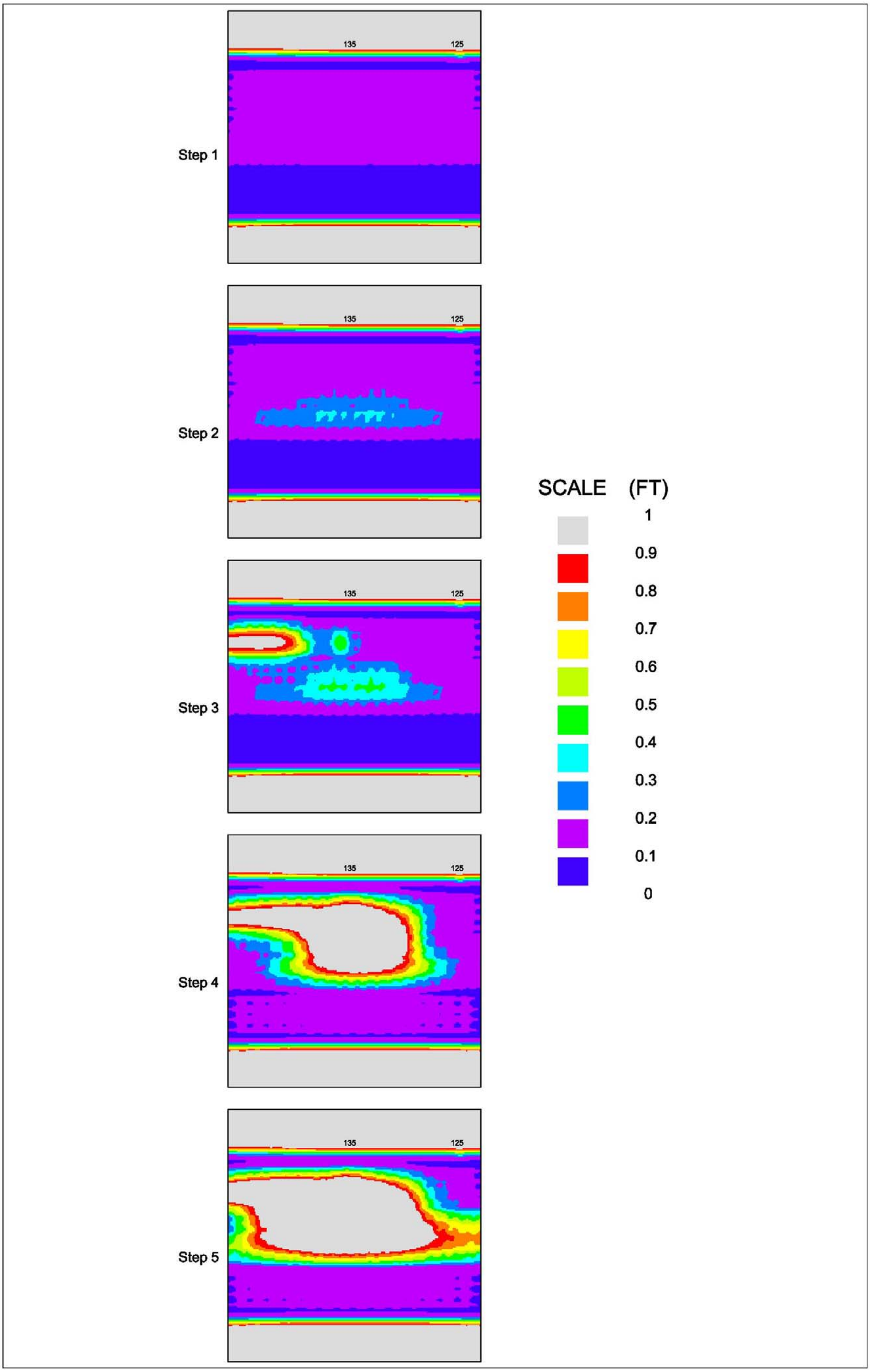
Figure 3.10-1 NIOSH ARMPS SF CHART GUIDELINE



The ARMPS case history data base collected by NIOSH, including deep cover cases, and showing the suggested pillar SF at various overburden depths.

Five Steps – Convergence 1250 psi Coal Strength
The projected convergence using the higher coal strength is shown in Figure 3.10-2. Figure 3.10-2 should be compared with Figure 3.9-1. The coal strength increase reduced the convergence substantially; the scale is changed from 0-2 ft to 0-1 ft to provide smaller increments and more color changes. This evaluation of the convergence sequence seeks to determine the relative area of convergence between the two different coal strengths.

Figure 3.10-2 Five Step Sequence (1250 psi) – Seam Convergence (LaModel)



Step 1 shows the magnitude of the convergence is less, but the area effected is similar. The purple area reflects convergence between 0.1 and 0.2 ft. This level of convergence would be a concern. The visual effect is less identifiable due to decimal input limitations within the LamPlt 2.1 program.

Step 2 shows the damage/deterioration in the Main West has increased in magnitude. However, the impact to the North Barrier is not evident.

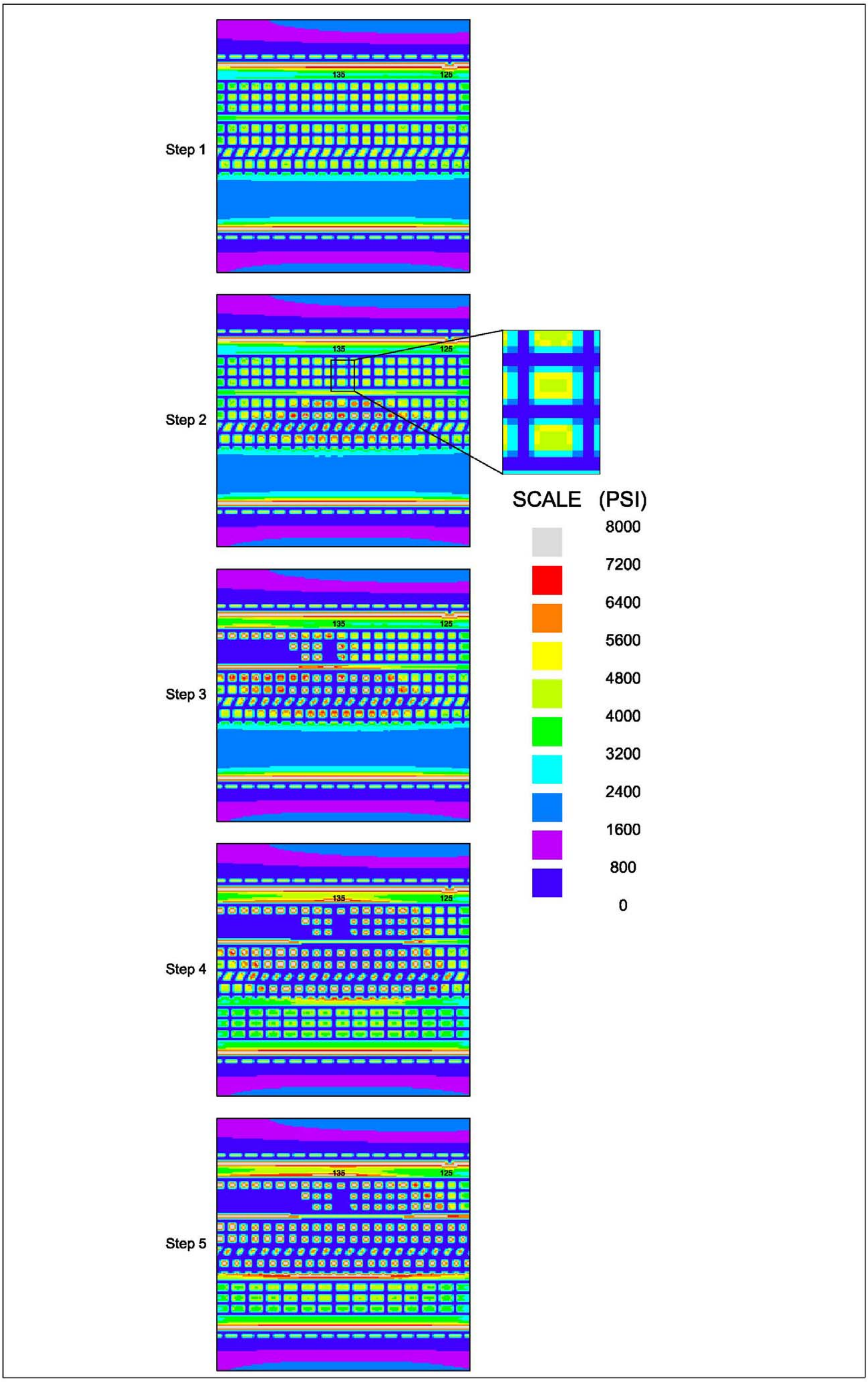
Step 3 shows the effect of the retreat mining in the North Barrier where pillars were removed and the increase of convergence in the pillars and openings immediately adjacent to the retreat mining.

Step 4 shows a smaller area of high convergence in the North Barrier and the Main West. The South Barrier development has less visual evidence of the damage/deterioration. However, Norwest notes that pillar footprints evident on the extreme ends of the modeling area have disappeared in the center of the South Barrier. This could be evidence of concern.

Step 5 shows little visual change in the South Barrier even though the convergence area in the Main West and North Barrier has increased. Without review of the detailed numerical output, there is little visual change displayed in the South Barrier.

Five Steps – Vertical Stress 1250 psi Coal Strength
The projected vertical stress using the higher coal strength is shown in Figure 3.10-3. Figure 3.10-3 should be compared with Figure 3.9-2. Both of these figures used the same scale resulting in similar coloration. In bounce prone areas, the concentration of high vertical stress near the edge of pillars aids in the identification of potential bounce areas.

Figure 3.10-3 Five Step Sequence (1250 psi) – Vertical Stress (LaModel)



Step 1 shows the vertical stress loading of the higher strength coal. The higher stress levels are closer to the pillar edges.

Step 2 shows the increasing vertical stress in the area of assumed damage/deterioration. An area of North Barrier pillars is enlarged to show the high stress level is outside the central pillar core. The damage/deterioration of pillars in the Main West resulted in the peak vertical stress moving back to the pillar core.

Step 3 shows the peaking of vertical stress in the pillars adjacent to the retreat mining cave. Projected peak stress is in excess of 9,200 psi with more pillars showing the peak vertical loading and the remaining North Barrier pillar has less area of peak vertical stress. Comparing the same pillars in the 900 psi coal strength sequence (Figure 3.9-2) projects a peak vertical stress in excess of 6,600 psi with the remaining North Barrier pillar withstanding the peak stress loading.

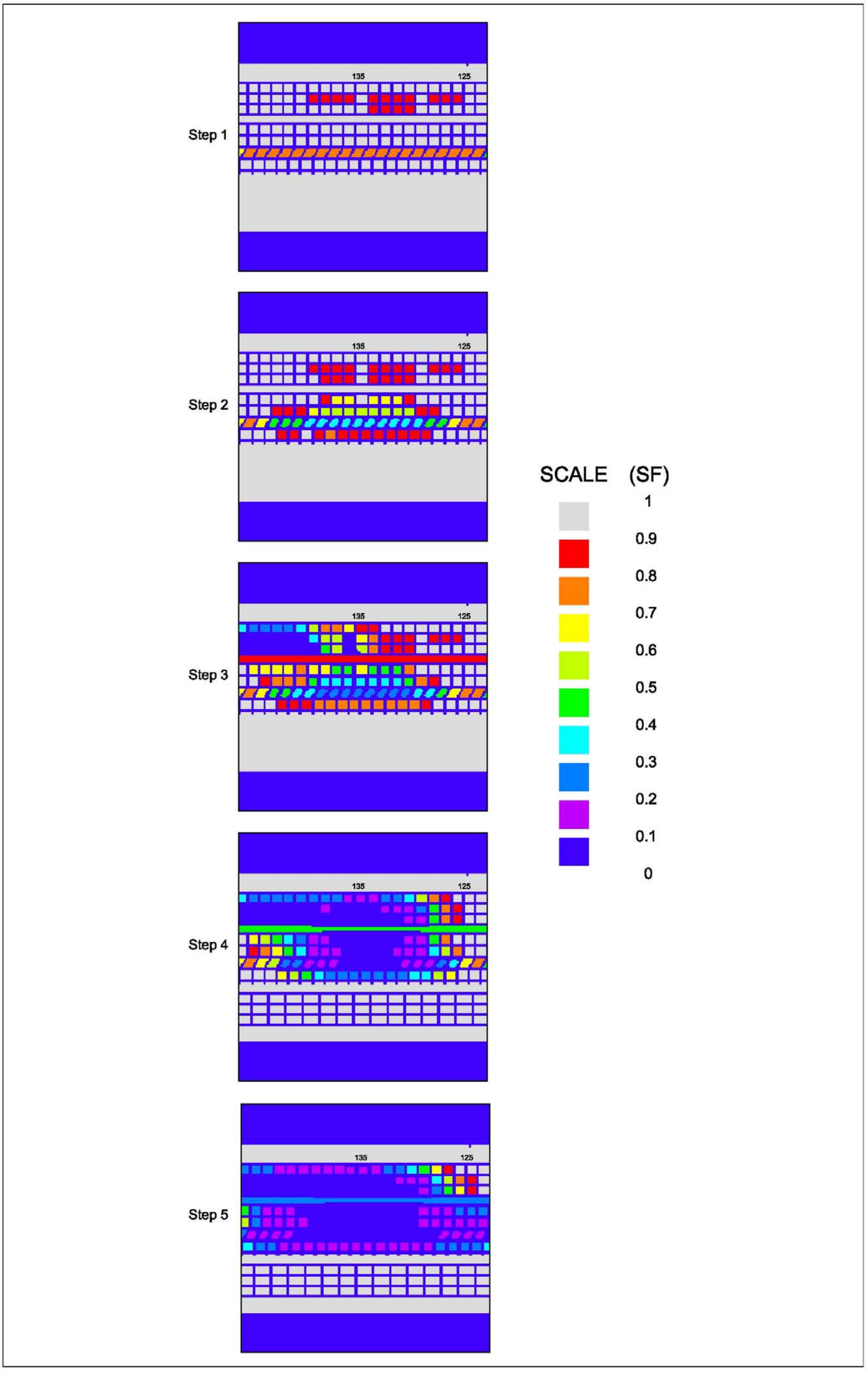
Step 4 shows the installation of the South Barrier development. The isolation barrier between the Main West and the South Barrier development shows the increase of vertical loading. Vertical stresses in the South Barrier pillars peak in excess of 4,600 psi outside the central core. The 900 psi coal strength sequence (Figure 3.9-2) shows vertical stress peaks in the core in excess of 6,600 psi.

Step 5 shows the South Barrier pillars projected peak vertical stress in excess of 5,100 psi and the south isolation barrier reaching in excess of 8,200 psi. The remaining South Barrier pillar shows side abutment peak vertical stress only adjacent to the 9th West longwall with no effect on the South Barrier development.

Five Steps – Pillar Strain SF 1250 psi

The projected pillar strain SF using the higher coal strength is shown in Figure 3.10-4. Figure 3.10-4 should be compared with Figure 3.9-3. Both of these figures use the same scale resulting in similar coloration to depict strain SF. Normally, comparison to the NIOSH case histories and 900 psi coal strength is not recommended to determine pillar design adequacy. Increasing coal strength to reflect seam and individual mine conditions is especially appropriate in bounce prone areas, if such higher values can be confirmed. The concentration of high vertical stress near the edge of pillars can aid in the identification of potential bounce areas. Lower pillar strengths move the pillar loading to the core of the pillars.

Figure 3.10-4 Five Step Sequence (1250 psi) – Pillar Strain SF (LaModel)



Norwest compared the modeling results of two coal strengths to determine the conclusions that a consultant or a knowledgeable mine technical personnel would draw.

Step 1 shows the line of angled pillars having the lowest SF. None of the rectangular pillars visually reflect factors that would cause concern. The lower coal strength in Step 1 of Figure 3.9-3 visually displays a larger area of lower pillar SF which could lead the modeler to further investigation.

Step 2 shows the effect of damage/deterioration in the Main West depicted by more coloration and lower SF results. North Barrier pillar design would most likely not be questioned at this point. The comparable step, with the lower coal strength, clearly broadens the area of lowest SF and could possibly lead to increased pillar dimensions to improve the area SF above the adjacent Main West.

Step 3 shows the retreat mining in the North Barrier in conjunction with Main West damage/deterioration. The variety of coloration indicates pillars progressing to lower safety factors, with the pillars immediately adjacent to the retreat mining showing lower strain SF. The comparative step, with the lower coal strength, clearly identifies a larger area with the lowest SF. Norwest selected a pillar in Step 1 and Step 3 that would be adjacent to retreat mining to determine the percent strain SF change. The 900 psi coal strength sequence showed approximately 73% reduction in SF while the 1250 psi sequence showed approximately 65% reduction in SF.

Step 4 shows the South Barrier development in conjunction with the approximate North Barrier bounce damage and the assumed Main West damage/deterioration. The South Barrier pillars show no visual effect that would raise concern. The comparative step, with the lower coal strength identifies sixteen pillars with safety factor levels that could raise concern.

Step 5 shows additional assumed damage/deterioration in the Main West and south isolation barrier. The South Barrier pillars still show no visual effect that would raise concern. The comparative step, with the lower coal strength shows the South Barrier pillar SF at the lowest color level in twenty-one pillars.

Opinion Summary Modeling Pillar Damage Using Higher Coal Strength

Norwest's opinion of increased coal strength to reflect individual mine conditions requires the modeler in conjunction with experienced mine personnel to establish representative strain SF for both successful and unsuccessful extractions. Establishing these baseline historic parameters in detail will allow regulatory review and acceptance prior to their use in projected mine plan submittals and regulatory reviews.

The 900 psi coal strength establishing representative pillar strain SF for mine design use is conservative. This is especially true when a pre-established safety factor number is assigned as a hurdle to be met. However, when the 900 psi coal strength is used to identify potentially weaker pillars within a projected mining area, the results are more easily distinguished and areas of concern more apparent.

Representative higher coal strength in the modeling is necessary to determine the level and location of high stress concentrations that may increase the bounce potential. Reduced coal strength moves the high stress load away from the pillar edges to the pillar cores and can mask these high stress areas.

BARRIER PILLAR SAFETY FACTOR

The modeling completed in the prior sections concentrated on the strain SF of the individual pillars of the Main West, North and South Barrier, and the smaller internal isolation barriers. NIOSH recommends barrier pillars in bounce prone areas have a minimum strain SF of 2.0 as found in Table 3.2. The results discussed in this section address the LaM2D and LaModel 2.1.1 barrier pillar safety factor using the 900 psi coal strength as established from base historic cases studies.

Table 3.2 NIOSH Recommended ARMPS SF

Immediate roof rock quality	Weak and intermediate roof strength	Strong roof
ARMPS SF		
650 ft < H < 1,250 ft	$1.5-\left(\frac{H-650}{1000}\right)$	$1.4-\left(\frac{H-650}{1000}\right)$
1,250 < H < 2,000 ft	0.9	0.8
Barrier pillar SF		
H > 1,000 ft	>2.0	>1.5[1] >2.0[2]

[1]Nonbump prone ground
[2]Bump prone ground

The LaM2D modeling results showed a reduction in the barrier pillar strain SF on the north side of the Main West as more mining was conducted. The north barrier pillar strain SF reduction in the North Barrier is projected as follows:

- Main West with adjacent 1st West longwall panel – 7.3
- North Barrier development – 1.46
- North Barrier retreat – 1.46.

The LaM2D modeling results showed a reduction in the barrier pillar strain SF on the south side of the Main West as more mining was conducted. The south barrier pillar strain SF reduction in the South Barrier is projected as follows:

- Main West with adjacent 9th West longwall panel – 7.45
- North Barrier development – 7.45
- South Barrier development – 1.3.

The LaM2D results show the remaining barrier pillars strain SF on the north and south are less than 2.0 and not recommended in bounce prone areas.

The LaModel 2.1.1 modeling results for the same sequence showed a reduction in the barrier pillar strain SF on the north side of the Main West as more mining was conducted. The north barrier pillar SF strain reduction is projected as follows:

- Main West with adjacent 1st West longwall panel – 8.36
- North Barrier development – 4.66

- North Barrier retreat – 4.64
- South Barrier development – 4.64
- South Barrier retreat – 4.64.

The LaModel 2.1.1 modeling results for the same sequence showed a reduction in the barrier pillar strain SF on the south side of the Main West as more mining was conducted. The south barrier pillar strain SF reduction is projected as follows:

- Main West with adjacent 1st West longwall panel – 8.14
- North Barrier development – 8.13
- North Barrier retreat – 8.13
- South Barrier development – 3.85
- South Barrier retreat – 3.64.

The LaModel 2.1.1 results show the remaining barrier pillars in the north and south are greater than 2.0 meeting the recommended minimum for bounce prone areas.

Norwest cannot explain the reason for the difference in the results between the two programs. Norwest assumes the main difference occurs as a result of averaging a single row of elements in two dimension analysis versus the average of the barrier pillar elements under various overburden depths and conditions in three dimensions. Norwest's opinion is that the LaModel 2.1.1 results are more accurate.

ELEMENT SIZE VARIANCE

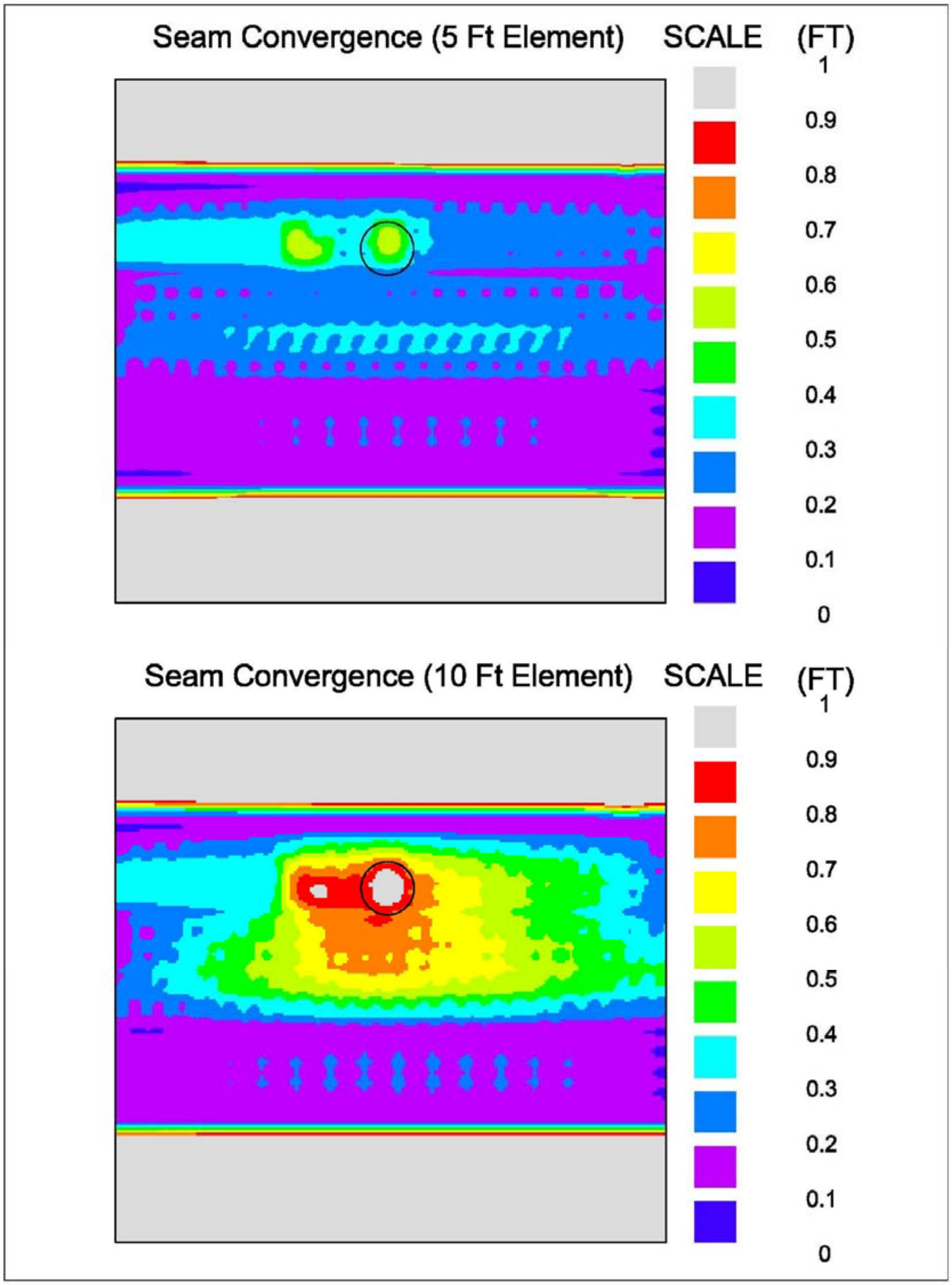
Norwest generated a modeling comparison using the LaModel 2.1.1 program on an identical area within the Main West. The element size for the initial seam grid was set at 10 ft, and then a second seam grid set created at 5 ft. Norwest selected these two element dimensions to compare the program result repeatability. Norwest performed all prior reviews of LaModel 2.1.1 using 10 ft elements.

Review of the convergence, vertical stress and pillar strain SF plots from these two models results identified the following inconsistencies:

- Maximum convergence difference in the same location (>0.4 ft)
- Pillar strain SF for the same pillar (5ft = 2.09; 10ft = 0.142).

The maximum convergence was compared in Figure 3-11-1 between crosscuts 134 and 135 at the location where two pillars were removed before the March bounce. The smaller element size resulted in less convergence.

Figure 3.11-1 Element Size Comparison – Seam Convergence (LaModel)



The vertical stress comparison was completed on a pillar in the Main West between crosscuts 133 and 134. The peak vertical stress was within 500 psi using the two element sizes with the 10 ft element stress being greater. The location of the peak vertical stress load was different. The 10 ft element model showed the peak stress in the pillar core, while the 5 ft model showed the peak stress outside the core closer to the pillar exterior.

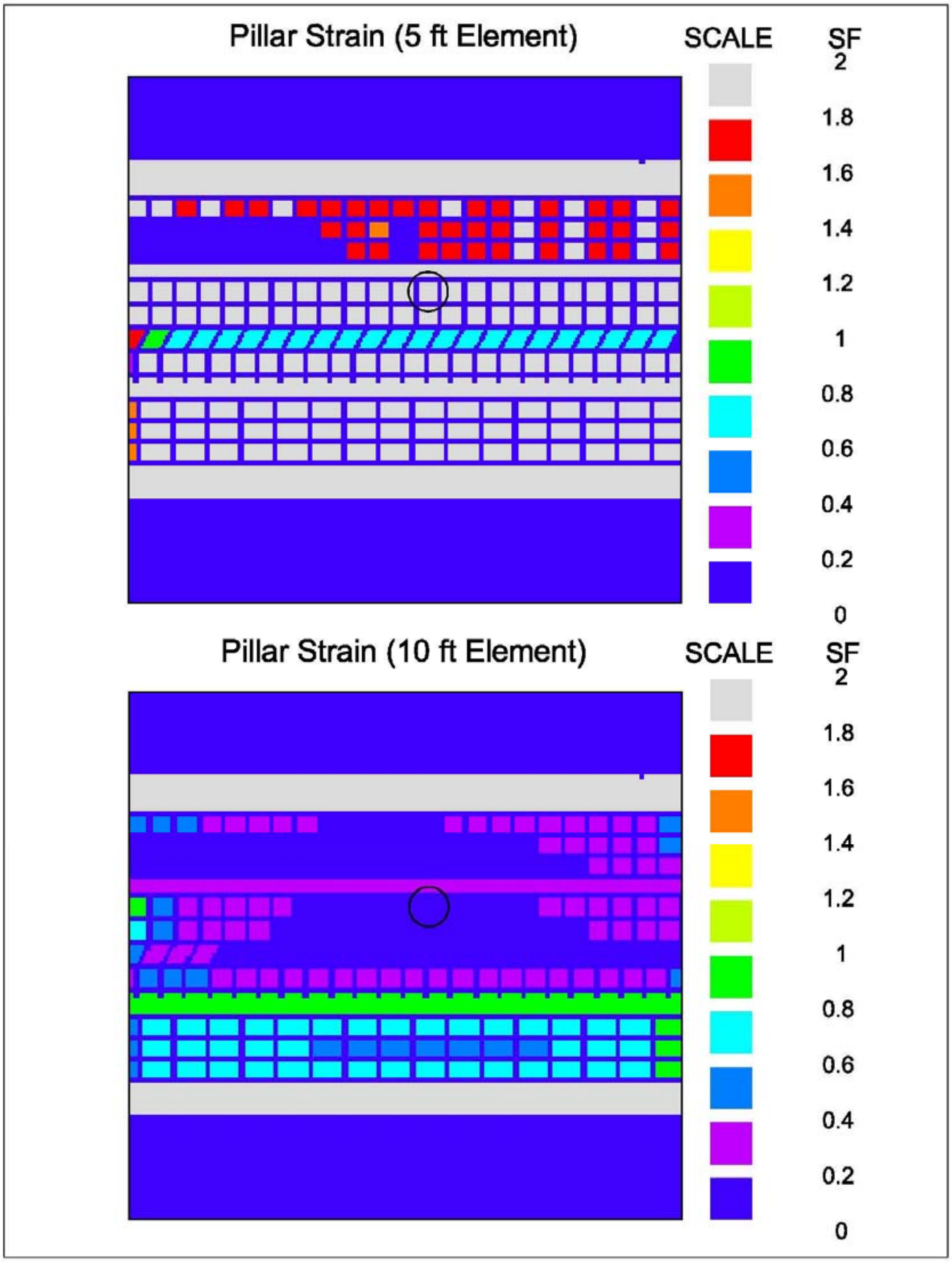
The pillar strain SF comparison would effect a decision assessing the potential success of this area. The following two figures are provided to display the visual difference in the results. The 5 ft model in Figure 3.11-2 showed the same pillar reviewed for vertical stress to have a 2.09 SF, while the 10 ft model in Figure 3.11-2 showed a 0.142 SF.

Opinion Summary of Element Size Use

The significant difference evidenced in the convergence and strain SF results in the LaModel 2.1.1 program are not acceptable reflecting the identical program input and only varying the element size. Norwest cannot surmise the effect shown in this comparison was evident in the Agapito and MSHA evaluations. Norwest was not provided details of the program versions used by both parties for their modeling. The version used by Norwest was LaModel 2.1.1 (8/01/07) and provided at a program training session coordinated by NIOSH. The LaM2D program did not produce different results when the element size was varied.

The smaller element use provides better detail such as video pixels that can better identify high stress areas. This stress detail can assist in identifying concerns in bounce prone areas. However, the evaluation of strain SF is misleading if used as a pass/fail measure of a projected mine area.

Figure 3.11-2 Element Size Comparison – Pillar Strain SF (LaModel)



ROOF CONTROL PLAN PROCESS REVIEW

Norwest reviewed the CCM roof control plans and submittal information as available on the MSHA web site. This information included (as discussed in the data review section of this report) four Agapito reports analyzing mining in the North and South Barrier pillars adjacent to the Main West. Additional information was provided by the Committee including Billy Owens' deposition and other information including a MSHA letter dated November 21, 2006[24] to GENWAL/UEI identifying inconsistencies in the proposed pillaring plan for the Main West.

GENWAL first discussed the mining of the barrier pillars in the Main West with MSHA in Denver in May 2006. In September 2006 GENWAL/UEI met with MSHA in Denver to discuss the mining of the North and South Barriers. At this meeting, the following two Agapito reports were presented and left with MSHA.

- July 20, 2006 report " DRAFT – GENWAL Crandall Canyon Mine Main West Barrier Mining Evaluation"
- August 9, 2006 report " GENWAL Main West Retreat Analysis - Preliminary Results."

The MSHA roof control group in Denver performed a "cursory review" of the projected pillaring in the Main West and identified several "inconsistencies" in the software model analysis. These inconsistencies were noted in a letter dated November 21, 2006 from MSHA to GENWAL/UEI. No information has been provided to Norwest concerning the response by GENWAL/UEI to these inconsistencies.

NORTH BARRIER DEVELOPMENT PLAN SUBMITTAL

UEI submitted a roof control plan amendment for development mining of the North Barrier on November 11, 2006. This submittal was a three-page submittal including a cover letter, site specific roof control amendment and a drawing. Consultant reports were referenced; however, there is no indication in this submittal that these reports were included with the submittal. MSHA approved this submittal on November 21, 2006.

[24] Letter from MSHA District 9 to GENWAL Resources dated November 21, 2006.

NORTH BARRIER PILLAR EXTRACTION PLAN SUBMITTAL

UEI submitted on December 20, 2006 a roof control plan amendment for pillar extraction in the North Barrier. This submittal was a three-page submittal including a cover letter, site specific roof control amendment and a drawing. Again Consultant reports were referenced; however, there is no indication in this submittal that these reports were included with the submittal. MSHA inspected the North Barrier on January 9, 2007. MSHA approved this submittal on February 5, 2007.

SOUTH BARRIER DEVELOPMENT PLAN SUBMITTAL

UEI submitted on February 20, 2007 a roof control plan amendment for development mining of the South Barrier. This submittal was a three-page submittal including a cover letter, site specific roof control amendment and a drawing. Consultant reports were referenced; however, there is no indication in this submittal that these reports were included with the submittal. This submittal did reference the proposed center to center line distances of the crosscuts and entries. MSHA approved this submittal on March 8, 2007.

SOUTH BARRIER PILLARING PLAN SUBMITTAL

UEI submitted on May 16, 2007 a roof control plan amendment for pillar extraction in the South Barrier. This submittal was a three-page submittal including a cover letter, site specific roof control amendment and a drawing. Again Consultant reports were referenced; however, there is no indication in this submittal that these reports were included with the submittal. The drawing in this submittal showed longer cross cut center line to center line dimensions than were in the drawing of the South Barrier development plan submittal of February 20, 2007. No reference was made in the text to center line dimensions. MSHA did inspect the South Barrier on May 22, 2007. MSHA approved this submittal on June 15, 2007.

The MSHA web site states “The Agapito reports which were submitted to MSHA as reference documents are also included in this posting.” The only information provided to Norwest about the review of these documents with respect to roof control plan submittals is the MSHA November 21, 2006 letter noting inconsistencies.

Without additional data about the internal MSHA review of the documents and modeling results, Norwest cannot formulate an opinion about the adequacy of the roof control plan review process.

OTHER MEASURES DURING THE ROOF CONTROL PLAN APPROVAL PROCESS

Other measures that should possibly have been considered during the roof control plan review include:

- Detailed review of the output (plot) files modeling process and results
- Have available the modeling input and plot files as necessary for a detailed review
- Mine specific coal strengths and safety factors (based from multiple examples as successes and failures) provided for comparison
- Further investigation is necessary when plan stability relies on conditions within a sealed area.

SUMMARY

Norwest reviewed the CCM roof control plan submittals and the additional pillar stability analysis provided in support of these submittals. The data provided to MSHA was not adequate to perform a detailed review of these submittals. Our review of this material generated requests for more information necessary to complete a detailed review.

RESULTS

This section summarizes the results of the modeling of the two following cases:

- Base case
- Main West pillar damage.

Also summarized are the Norwest review of the roof control plan adequacy and roof control review approval process.

MODELING

LAM2D

BASE CASE

Norwest's review of the base case sequence showed no indication in either the North Barrier or the South Barrier that potential vertical stress levels reached an indicator level to damage the area mapped in the Main West if the pillars still maintained the original support characteristics.

The review of the remaining barrier pillars compared to NIOSH guidelines showed planned mining in both the North and South Barrier sections produced barrier pillar with strain SF below the 2.0 minimum. The low barrier pillars safety factors in this case should require further investigation.

Norwest review of damage/deterioration to the North Barrier pillars resulting from the March 2007 bounce did not indicate potential vertical stress at indicator levels that could affect the South Barrier projected plans.

DAMAGE/DETERIORATION

The Norwest assumption that damage/deterioration effected the Main West prior to the March bounce indicated potential stress levels reaching an indicator level. Projected vertical stresses now increased by the re-initiation of the retreat mining could potentially initiate a bounce. The March bounce and the assumption that some additional damage/deterioration from seismic events between March and August could now create potential vertical stress levels sufficient to initiate a cascading pillar failure.

LaModel

BASE CASE

The review of the Main West mining sequence using a 900 psi coal strength showed an expanding area of deforming pillars. The Main West area adjacent to crosscut 135 was central to the weakest area.

The development of the North Barrier using comparable pillar sizes to the Main West expanded the low strain SF pillars into the newly developed area. This expanding area suggests that further investigation into pillar size is necessary.

Models of the North Barrier retreat mining did not indicate projected vertical stress at indicator levels during the retreat phase. Pillars immediately adjacent to the gob showed the highest stress loading in the core. This loading is not indicative of a bounce.

Development of the South Barrier with larger pillars indicated an increase in pillar SF indicative of an improved design. The incorporation of retreat mining indicated no adverse effects were transferred from the retreat area to the area impacted by the August bounce.

DAMAGE/DETERIORATION CASE

Norwest assumed damage/deterioration progressively applied to the pillars with the lowest strain SF starting with the Main West. The assumed damage in the Main West raised potential vertical stress in the North Barrier in the area of the March bounce.

Continuation of the damage sequence to the North Barrier section pillars affected by the March bounce increased the vertical loading in the Main West. Additional damage to the lowest strain SF pillars now indicated potential vertical stress loading transferring to the South Barrier pillars. The potential vertical stress in the South Barrier increased to a concern level resulting from the assumed damage.

The mining sequence affected the width of the barrier pillars around this mining area. The LaModel sequence results showed the remaining barrier pillars on both north and south were higher than the minimum 2.0 NIOSH guideline for bounce prone areas. These results are contrary to the LaM2D results.

A smaller area model was developed to evaluate consistency of results when different elements sizes are used in a stability evaluation. This evaluation suggested an indication for conflicting results. Using a measure of ARMPS SF to determine a projected plan success or failure, the results for the same pillar using a 5 ft element size and a 10 ft element size indicated opposite determinations. The 5 ft element size results in a 2.09 pillar strain SF result compared to a 0.142 SF result for the 10 ft element size. The ARMP recommended SF is 0.8 for strong roof at a depth less than 2,000 ft.

Seismic Events

Seismic event data is readily available in Utah to assist in correlating date, time, and magnitude information to events that may have had impact on a current mine or future projections within a mine. Records of pillar damage areas in active mine workings would provide information essential to stability modeling.

Norwest made assumptions to an area of the Main West that was sealed. Records of damage after the sealing was completed are not possible to obtain. No records were provided for this area of Main West covering the time prior and after GENWAL contacted BLM to obtain their consent to seal the Main West. GENWAL had deemed access to this area nearly impossible prior to the BLM inspection in November 2004.

Permanent map records and field notes delineating the deteriorating area of the Main West could have assisted in the modeling evaluations conducted by Agapito, MSHA and Norwest. The assumptions Norwest included in this report are based on minimal information.

ROOF CONTROL PLAN

Adequacy

The results of the Norwest modeling suggest that there were indicators that could have been raised had alternative modeling scenarios been reviewed that included the possibility that the Main West pillars could be weak. Norwest's modeling results indicated that under certain assumptions and the occurrence of the August 2007 bounce, the roof control plan amendment was not considered adequate.

Roof Control Plan Improvements and Other Due Diligence Efforts

Procedural information and intermediate documentation was not provided for Norwest to review. The resulting Norwest opinions come from the independent modeling process and the questions invoked through the review process. The findings within this report led Norwest to identify these additional due diligence measures.

- Detailed review of the output (plot) files modeling process and results.
- Have available the modeling input and plot files as necessary for a detailed review.
- Mine specific coal strengths and safety factors (based from multiple examples as successes and failures) provided for comparison.
- Further investigation is necessary when plan stability relies on conditions within a sealed area.

Impact of the March 2007 Bounce

Based upon the information Norwest reviewed, the impact of the March 2007 bounce upon the roof control plan was to increase the 90 ft cross cut centers spacing in South Barrier development plan approved March 8, 2007. The roof control plan amendment approved June 15, 2007 increased the crosscut centers to 129 ft as per the April 18, 2007 Agapito report.

MSHA ROOF CONTROL PLAN REVIEW PROCESS

Norwest reviewed the CCM roof control plan submittals and the additional pillar stability analysis provided in support of these submittals. The data provided to MSHA was not adequate to perform a detailed review of these submittals. Our review of this material generated requests for more information necessary to complete a detailed review.

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GLOSSARY OF TERMS

Active Pillar – The pillar where the retreat mining process is taking place. The active row refers to the line of pillars being removed closest to the forming gob.

Barrier – Solid blocks of coal left between two mines or mining sections to prevent accidents due to inrushes of water, gas, or from explosions or mine fires.

Barrier Pillars – Any large block entirely or relatively unbroken by mining development left unmined to protect adjacent mine areas from adverse effects of vertical stress and water.

Bounce or Bump – A sudden release of energy in a mine as a result of coal extraction and the redistribution of overburden or other stresses. The degree of severity of a bounce will vary. The effects of bounces may vary from a noise to displacement of coal and roof materials. Uncontrolled yield.

Bulls-Eye – A term to describe a concentric area where the internal area exhibits a higher value.

Cave – (see gob)

Convergence – The vertical closure of an opening as a result of movement from the top, the bottom or both top and bottom.

Crosscut – An opening driven between two entries for the purpose of ventilation and haulage.

Development – The initial removal of material to advance a mining area.

Element (Finite Element; Modeling) – The volume of material assigned the same material properties. Each element consists of an assigned length and width (size) and a corresponding thickness (coal height). The properties of each element are used in the calculations performed within a finite-element analysis.

Entry - An opening driven in the coal to advance a mining area. Entries may be used for personnel and material haulage and ventilation requirements.

Extraction – (see recovery rate)

Face – Location within a mine where coal can be extracted. Active face is the location where coal is being mined or extracted.

Gob – The area in a coal mine where the coal has been extracted and waste material such as roof rock has accumulated.

Isolation Barrier Pillars **–** Narrow block unbroken by development not necessarily designed for support, provides only separation from gas and water inrushes.

Longwall Mining – A highly mechanized mining method which extracts virtually all the coal from a rectangular block that will vary from several hundred ft wide and thousands of ft long. Access to the longwall is developed by continuous miners.

Overburden – The rock and soil above a coal seam.

Pillar – The block of material left in place usually to provide support characteristics.

Pillar Edge - The material closest to the opening around each pillar.

Recovery Factor – The percentage of material removed from a mining area.

Retreat – The secondary removal of pillars (partial or complete) after development has been completed.

Retreat Mining – A mining method which extracts the coal in pillars.

Rib – (see Pillar edge)

Roof – The rock above the top of a coal seam, typically sandstone, or shale.

Roof Bolt – A metal rod inserted into a hole drilled into the roof to support the roof.

Room and Pillar – A mining method which extracts the coal in the rooms (openings) and leaves pillars (unmined blocks of coal) to support the overburden.

Safety Factor (SF) – A measure of pillar stability relative to the vertical stress or the deformation (strain). A higher resulting number indicates more stability.

Sealed Area – An area of the mine isolated from the ventilation system, not accessible to human inspection.

Seismic Event – The emission and radiation of kinetic energy in the form of ground vibrations recorded by seismograph.

Side Abutment Stress – Additional stress from uncaved overburden material that is transferred to the adjacent supporting pillars. The most significant effect from this type of additional stress is found along the longest sides of longwall gob areas.

Stress – The force per unit area acting on any solid surface with a stress field generally expressed in pounds per square inch (psi); the external pressure that creates the internal force.

Strain – Change in shape or volume of a body as a result of stress; deformation resulting from applied force.

Vertical Stress – The downward force exerted on an object (pillar) created by the weight of material from the ground surface down to the object.

Yield – The pillar action resulting in gradual crushing of the pillar ribs resulting in convergence.

Yield Pillar – A pillar designed to gradually crumble reducing the potential to develop or carry significant vertical stress loads. Peak vertical loads are transferred to adjacent larger pillars or barriers.

APPENDIX A

30 CFR 75 ROOF CONTROL REGULATIONS

30 CFR § 75.200

Scope.

This Subpart C sets forth requirements for controlling roof, face and ribs, including coal or rock bursts, in underground coal mines. Roof control systems installed prior to the effective date of this subpart are not effected so long as the support system continues to effectively control the roof, face and ribs.

30 CFR § 75.201

Definitions.

Automated temporary roof support (ATRS) system. A device to provide temporary roof support from a location where the equipment operator is protected from roof falls.

Pillar recovery. Any reduction in pillar size during retreat mining.

30 CFR § 75.202

Protection from falls of roof, face and ribs.

(a) The roof, face and ribs of areas where persons work or travel shall be supported or otherwise controlled to protect persons from hazards related to falls of the roof, face or ribs and coal or rock bursts.

(b) No person shall work or travel under unsupported roof unless in accordance with this subpart.

30 CFR § 75.203

Mining methods.

(a) The method of mining shall not expose any person to hazards caused by excessive widths of rooms, crosscuts and entries, or faulty pillar recovery methods. Pillar dimensions shall be compatible with effective control of the roof, face and ribs and coal or rock bursts.

(b) A sightline or other method of directional control shall be used to maintain the projected direction of mining in entries, rooms, crosscuts and pillar splits.

(c) A sidecut shall be started only from an area that is supported in accordance with the roof control plan.

(d) A working face shall not be mined through into an unsupported area of active workings, except when the unsupported area is inaccessible.

(e) Additional roof support shall be installed where--

(1) The width of the opening specified in the roof control plan is exceeded by more than 12 inches; and

(2) The distance over which the excessive width exists is more than 5 feet.

30 CFR § 75.204

Roof bolting.

(a) For roof bolts and accessories addressed in ASTM F432-95, ``Standard Specification for Roof and Rock Bolts and Accessories," the mine operator shall--

(1) Obtain a manufacturer's certification that the material was manufactured and tested in accordance with the specifications of ASTM F432-95; and

(2) Make this certification available to an authorized representative of the Secretary and to the representative of miners.

(b) Roof bolts and accessories not addressed in ASTM F432-95 may be used, provided that the use of such materials is approved by the District Manager based on

(1) Demonstrations which show that the materials have successfully supported the roof in an area of a coal mine with similar strata, opening dimensions and roof stresses; or

(2) Tests which show the materials to be effective for supporting the roof in an area of the effected mine which has similar strata, opening dimensions and roof stresses as the area where the roof bolts are to be used. During the test process, access to the test area shall be limited to persons necessary to conduct the test.

(c)(1) A bearing plate shall be firmly installed with each roof bolt.

(2) Bearing plates used directly against the mine roof shall be at least 6 inches square or the equivalent, except that where the mine roof is firm and not susceptible to sloughing, bearing plates 5 inches square or the equivalent may be used.

(3) Bearing plates used with wood or metal materials shall be at least 4 inches square or the equivalent.

(4) Wooden materials that are used between a bearing plate and the mine roof in areas which will exist for three years or more shall be treated to minimize deterioration.

(d) When washers are used with roof bolts, the washers shall conform to the shape of the roof bolt head and bearing plate.

(e)(1) The diameter of finishing bits shall be within a tolerance of plus or minus 0.030 inch of the manufacturer's recommended hole diameter for the anchor used.

(2) When separate finishing bits are used, they shall be distinguishable from other bits.

(f) *Tensioned roof bolts.* (1) Roof bolts that provide support by creating a beam of laminated strata shall be at least 30 inches long. Roof bolts that provide support by suspending the roof from overlying stronger strata shall be long enough to anchor at least 12 inches into the stronger strata.

(2) Test holes, spaced at intervals specified in the roof control plan, shall be drilled to a depth of at least 12 inches above the anchorage horizon of mechanically anchored tensioned bolts being used. When a test hole indicates that bolts would not anchor in competent strata, corrective action shall be taken.

(3) The installed torque or tension ranges for roof bolts as specified in the roof control plan shall maintain the integrity of the support system and shall not exceed the yield point of the roof bolt nor anchorage capacity of the strata.

(4) In each roof bolting cycle, the actual torque or tension of the first tensioned roof bolt installed with each drill head shall be measured immediately after it is installed. Thereafter, for each drill head used, at least one roof bolt out of every four installed shall be measured for actual torque or tension. If the torque or tension of any of the roof bolts measured is not within the range specified in the roof control plan, corrective action shall be taken.

(5) In working places from which coal is produced during any portion of a 24-hour period, the actual torque or tension on at least one out of every ten previously installed mechanically anchored tensioned roof bolts shall be measured from the outby corner of the last open crosscut to the face in each advancing section. Corrective action shall be taken if the majority of the bolts measured--

(f)(5)(i) Do not maintain at least 70 percent of the minimum torque or tension specified in the roof control plan, 50 percent if the roof bolt plates bear against wood; or

(f)(5)(ii) Have exceeded the maximum specified torque or tension by 50 percent.

(6) The mine operator or a person designated by the operator shall certify by signature and date that measurements required by paragraph (f)(5) of this section have been made. This certification shall be maintained for at least one year and shall be made available to an authorized representative of the Secretary and representatives of the miners.

(7) Tensioned roof bolts installed in the roof support pattern shall not be used to anchor trailing cables or used for any other purpose that could effect the tension of the bolt. Hanging trailing cables, line brattice, telephone lines, or other similar devices which do not place sudden loads on the bolts are permitted.

(8) Angle compensating devices shall be used to compensate for the angle when tensioned roof bolts are installed at angles greater than 5 degrees from the perpendicular to the bearing plate.

(g) *Non-tensioned grouted roof bolts.* The first non-tensioned grouted roof bolt installed during each roof bolting cycle shall be tested during or immediately after the first row of bolts has been installed. If the bolt tested does not withstand at least 150 foot-pounds of torque without rotating in the hole, corrective action shall be taken.

30 CFR § 75.205

Installation of roof support using mining machines with integral roof bolters.

When roof bolts are installed by a continuous mining machine with intregal roof bolting equipment:

(a) The distance between roof bolts shall not exceed 10 feet crosswise.

(b) Roof bolts to be installed 9 feet or more apart shall be installed with a wooden crossbar at least 3 inches thick and 8 inches wide, or material which provides equivalent support.

(c) Roof bolts to be installed more than 8 feet but less than 9 feet apart shall be installed with a wooden plank at least 2 inches thick and 8 inches wide, or material which provides equivalent support.

30 CFR § 75.206

Conventional roof support.

(a) Except in anthracite mines using non-mechanized mining systems, when conventional roof support materials are used as the only means of support--

(1) The width of any opening shall not exceed 20 feet;

(2) The spacing of roadway roof support shall not exceed 5 feet;

(3)(i) Supports shall be installed to within 5 feet of the uncut face;

(a)(3)(ii) When supports nearest the face must be removed to facilitate the operation of face equipment, equivalent temporary support shall be installed prior to removing the supports;

(4) Straight roadways shall not exceed 16 feet wide where full overhead support is used and 14 feet wide where only posts are used;

(5) Curved roadways shall not exceed 16 feet wide; and

(6) The roof at the entrance of all openings along travelways which are no longer needed for storing supplies or for travel of equipment shall be supported by extending the line of support across the opening.

(b) Conventional roof support materials shall meet the following specifications:

(1) The minimum diameter of cross-sectional area of wooden posts shall be as follows:

Post length (in inches)	Diameter of round posts (in inches)	Cross-sectional area of split posts (in square inches)
60 or less...........	4	13
Over 60 to 84.........	5	20
Over 84 to 108........	6	28
Over 108 to 132.......	7	39
Over 132 to 156.......	8	50
Over 156 to 180.......	9	64
Over 180 to 204.......	10	79
Over 204 to 228.......	11	95
Over 228..............	12	113

(**2**) Wooden materials used for support shall have the following dimensions:

(b)(2)(i) Cap blocks and footings shall have flat sides and be at least 2 inches thick, 4 inches wide and 12 inches long.

(b)(2)(ii) Crossbars shall have a minimum cross-sectional area of 24 square inches and be at least 3 inches thick.

(b)(2)(iii) Planks shall be at least 6 inches wide and 1 inch thick.

(3) Cribbing materials shall have at least two parallel flat sides.

(c) A cluster of two or more posts that provide equivalent strength may be used to meet the requirements of paragraph (b)(1) of this section, except that no post shall have a diameter less than 4 inches or have a cross-sectional area less than 13 square inches.

(d) Materials other than wood used for support shall have support strength at least equivalent to wooden material meeting the applicable provisions of this section.

(e) Posts and jacks shall be tightly installed on solid footing.

(f) When posts are installed under roof susceptible to sloughing a cap block, plank, crossbar or materials that are equally effective shall be placed between the post and the roof.

(g) Blocks used for lagging between the roof and crossbars shall be spaced to distribute the load.

(h) Jacks used for roof support shall be used with at least 36 square inches of roof bearing surface.

30 CFR § 75.207

Pillar recovery.

Pillar recovery shall be conducted in the following manner, unless otherwise specified in the roof control plan:

(a) Full and partial pillar recovery shall not be conducted on the same pillar line, except where physical conditions such as unstable floor or roof, falls of roof, oil and gas well barriers or surface subsidence require that pillars be left in place.

(b) Before mining is started in a pillar split or lift--

(1) At least two rows of breaker posts or equivalent support shall be installed--

(b)(1)(i) As close to the initial intended breakline as practicable; and

(b)(1)(ii) Across each opening leading into an area where full or partial pillar extraction has been completed.

(2) A row of roadside-radius (turn) posts or equivalent support shall be installed leading into the split or lift.

(c) Before mining is started on a final stump--

(1) At least 2 rows of posts or equivalent support shall be installed on not more than 4 ft centers on each side of the roadway; and

(2) Only one open roadway, which shall not exceed 16 feet wide, shall lead from solid pillars to the final stump of a pillar. Where posts are used as the sole means of roof support, the width of the roadway shall not exceed 14 feet.

(d) During open-end pillar extraction, at least 2 rows of breaker posts or equivalent support shall be installed on not more than 4 ft centers. These supports shall be installed between the lift to be started and the area where pillars have been extracted. These supports shall be maintained to within 7 feet of the face and the width of the roadway shall not exceed 16 feet. Where posts are used as the sole means of roof support, the width of the roadway shall not exceed 14 feet.

30 CFR § 75.208

Warning devices.

Except during the installation of roof supports, the end of permanent roof support shall be posted with a readily visible warning, or a physical barrier shall be installed to impede travel beyond permanent support.

30 CFR § 75.209

Automated Temporary Roof Support (ATRS) systems.

(a) Except in anthracite mines and as specified in paragraphs (b) and (c) of this section, an ATRS system shall be used with roof bolting machines and continuous-mining machines with integral roof bolters operated in a working section. The requirements of this paragraph shall be met according to the following schedule:

(1) All new machines ordered after March 28, 1988.

(2) All existing machines operated in mining heights of 36 inches or more after March 28, 1989; and

(3) All existing machines operated in mining heights of 30 inches or more but less than 36 inches after March 28, 1990.

(b) After March 28, 1990 the use of ATRS systems with existing roof bolting machines and continuous-mining machines with integral roof bolters operated in a working section where the mining height is less than 30 inches shall be addressed in the roof control plan.

(c) Alternative means of temporary support shall be used, as specified in the roof control plan, when--

(1) Mining conditions or circumstances prevent the use of an ATRS system; or

(2) Temporary supports are installed in conjunction with an ATRS system.

(d) Persons shall work or travel between the support device of the ATRS system and another support, and the distance between the support device of the ATRS system and support to the left, right or beyond the ATRS system, shall not exceed 5 feet.

(e) Each ATRS system shall meet each of the following:

(1) The ATRS system shall elastically support a deadweight load measured in pounds of at least 450 times each square foot of roof intended to be supported, but in no case less than 11,250 pounds.

(2) The controls that position and set the ATRS system shall be--

(e)(2)(i) Operable from under permanently supported roof; or

(e)(2)(ii) Located in a compartment, which includes a deck, that provides the equipment operator with overhead and lateral protection, and has the structural capacity to elastically support a deadweight load of at least 18,000 pounds.

(3) All jacks affecting the capacity of the ATRS system and compartment shall have check valves or equivalent devices that will prevent rapid collapse in the event of a system failure.

(4) Except for the main tram controls, tram controls for positioning the equipment to set the ATRS system shall limit the speed of the equipment to a maximum of 80 feet-per-minute.

(f) The support capacity of each ATRS system and the structural capacity of each compartment shall be certified by a registered engineer as meeting the applicable requirements of paragraphs (e)(1) and (e)(2) of this section. The certifications shall be made available to an authorized representative of the Secretary and representative of the miners.

30 CFR § 75.210

Manual installation of temporary support.

(a) When manually installing temporary support, only persons engaged in installing the support shall proceed beyond permanent support.

(b) When manually installing temporary supports, the first temporary support shall be set no more than 5 feet from a permanent roof support and the rib. All temporary supports shall be set so that the person installing the supports remains between the temporary support being set and two other supports which shall be no more than 5 feet from the support being installed. Each temporary support shall be completely installed prior to installing the next temporary support.

(c) All temporary supports shall be placed on no more than 5-foot centers.

(d) Once temporary supports have been installed, work or travel beyond permanent roof support shall be done between temporary supports and the nearest permanent support or between other temporary supports.

30 CFR § 75.211

Roof testing and scaling.

(a) A visual examination of the roof, face and ribs shall be made immediately before any work is started in an area and thereafter as conditions warrant.

(b) Where the mining height permits and the visual examination does not disclose a hazardous condition, sound and vibration roof tests, or other equivalent tests, shall be made where supports are to be installed. When sound and vibration tests are made, they shall be conducted--

(1) After the ATRS system is set against the roof and before other support is installed; or

(2) Prior to manually installing a roof support. This test shall begin under supported roof and progress no further than the location where the next support is to be installed.

(c) When a hazardous roof, face, or rib condition is detected, the condition shall be corrected before there is any other work or travel in the affected area. If the affected area is left unattended, each entrance to the area shall be posted with a readily visible warning, or a physical barrier shall be installed to impede travel into the area.

(d) A bar for taking down loose material shall be available in the working place or on all face equipment except haulage equipment. Bars provided for taking down loose material shall be of a length and design that will allow the removal of loose material from a position that will not expose the person performing this work to injury from falling material.

30 CFR § 75.212

Rehabilitation of areas with unsupported roof.

(a) Before rehabilitating each area where a roof fall has occurred or the roof has been removed by mining machines or by blasting--

(1) The mine operator shall establish the clean up and support procedures that will be followed;

(2) All persons assigned to perform rehabilitation work shall be instructed in the clean-up and support procedures; and

(3) Ineffective, damaged or missing roof support at the edge of the area to be rehabilitated shall be replaced or other equivalent support installed.

(b) All persons who perform rehabilitation work shall be experienced in this work or they shall be supervised by a person experienced in rehabilitation work who is designated by the mine operator.

(c) Where work is not being performed to rehabilitate an area in active workings where a roof fall has occurred or the roof has been removed by mining machines or by blasting, each entrance to the area shall be supported by at least one row of posts on not more than 5-foot centers, or equally effective support.

30 CFR § 75.213

Roof support removal.

(a)(1) All persons who perform the work of removing permanent roof supports shall be supervised by a management person experienced in removing roof supports.

(2) Only persons with at least one year of underground mining experience shall perform permanent roof support removal work.

(b) Prior to the removal of permanent roof supports, the person supervising roof support removal in accordance with paragraph (a)(1) of this section shall examine the roof conditions in the area where the supports are to be removed and designate each support to be removed.

(c)(1) Except as provided in paragraph (g) of this section, prior to the removal of permanent supports, a row of temporary supports on no more than 5-foot centers or equivalent support shall be installed across the opening within 4 feet of the supports being removed. Additional supports shall be installed where necessary to assure safe removal.

(2) Prior to the removal of roof bolts, temporary support shall be installed as close as practicable to each roof bolt being removed.

(d) Temporary supports installed in accordance with this section shall not be removed unless--

(1) Removal is done by persons who are in a remote location under supported roof; and

(2) At least two rows of temporary supports, set across the opening on no more than 5-foot centers, are maintained between the miners and the unsupported area.

(e) Each entrance to an area where supports have been removed shall be posted with a readily visible warning or a physical barrier shall be installed to impede travel into the area.

(f) Except as provided in paragraph (g) of this section, permanent support shall not be removed where--

(1) Roof bolt torque or tension measurements or the condition of conventional support indicate excessive loading;

(2) Roof fractures are present;

(3) There is any other indication that the roof is structurally weak; or

(4) Pillar recovery has been conducted.

(g) Permanent supports may be removed provided that:

(1) Removal is done by persons who are in a remote location under supported roof; and

(2) At least two rows of temporary supports, set across the opening on no more than 5-foot centers, are maintained between the miners and the unsupported area.

(h) The provisions of this section do not apply to removal of conventional supports for starting crosscuts and pillar splits or lifts except that prior to the removal of these supports an examination of the roof conditions shall be made.

30 CFR § 75.214

Supplemental support materials, equipment and tools.

(a) A supply of supplementary roof support materials and the tools and equipment necessary to install the materials shall be available at a readily accessible location on each working section or within four crosscuts of each working section.

(b) The quantity of support materials and tools and equipment maintained available in accordance with this section shall be sufficient to support the roof if adverse roof conditions are encountered, or in the event of an accident involving a fall.

30 CFR § 75.215

Longwall mining systems.

For each longwall mining section, the roof control plan shall specify--

(a) The methods that will be used to maintain a safe travelway out of the section through the tailgate side of the longwall; and

(b) The procedures that will be followed if a ground failure prevents travel out of the section through the tailgate side of the longwall.

30 CFR § 75.220

Roof control plan.

(a)(1) Each mine operator shall develop and follow a roof control plan, approved by the District Manager, that is suitable to the prevailing geological conditions, and the mining system to be used at the mine. Additional measures shall be taken to protect persons if unusual hazards are encountered.

(2) The proposed roof control plan and any revisions to the plan shall be submitted, in writing, to the District Manager. When revisions to a roof control plan are proposed, only the revised pages need to be submitted unless otherwise specified by the District Manager.

(b)(1) The mine operator will be notified in writing of the approval or denial of approval of a proposed roof control plan or proposed revision.

(2) When approval of a proposed plan or revision is denied, the deficiencies of the plan or revision and recommended changes will be specified and the mine operator will be afforded an opportunity to discuss the deficiencies and changes with the District Manager.

(3) Before new support materials, devices or systems other than roof bolts and accessories, are used as the only means of roof support, the District Manager may require that their effectiveness be demonstrated by experimental installations.

(c) No proposed roof control plan or revision to a roof control plan shall be implemented before it is approved.

(d) Before implementing an approved revision to a roof control plan, all persons who are affected by the revision shall be instructed in its provisions.

(e) The approved roof control plan and any revisions shall be available to the miners and representative of miners at the mine.

75.221 Roof control plan information.

30 CFR § 75.221

Roof control plan information.

(a) The following information shall be included in each roof control plan:

(1) The name and address of the company.

(2) The name, address, mine identification number and location of the mine.

(3) The name and title of the company official responsible for the plan.

(4) A typical columnar section of the mine strata which shall--

(a)(4)(i) Show the name and the thickness of the coalbed to be mined and any persistent partings;

(a)(4)(ii) Identify the type and show the thickness of each stratum up to and including the main roof above the coalbed and for distance of at least 10 feet below the coalbed; and

(a)(4)(iii) Indicate the maximum cover over the area to be mined.

(5) A description and drawings of the sequence of installation and spacing of supports for each method of mining used.

(6) When an ATRS system is used, the maximum distance that an ATRS system is to be set beyond the last row of permanent support.

(7) When tunnel liners or arches are to be used for roof support, specifications and installation procedures for the liners or arches.

(8) Drawings indicating the planned width of openings, size of pillars, method of pillar recovery, and the sequence of mining pillars.

(9) A list of all support materials required to be used in the roof, face and rib control system, including, if roof bolts are to be installed--

(a)(9)(i) The length, diameter, grade and type of anchorage unit to be used;

(a)(9)(ii) The drill hole size to be used; and

(a)(9)(iii) The installed torque or tension range for tensioned roof bolts.

(10) When mechanically anchored tensioned roof bolts are used, the intervals at which test holes will be drilled.

(11) A description of the method of protecting persons--

(a)(11)(i) From falling material at drift openings; and

(a)(11)(ii) When mining approaches within 150 feet of an outcrop.

(b) Each drawing submitted with a roof control plan shall contain a legend explaining all symbols used and shall specify the scale of the drawing which shall not be less than 5 feet to the inch or more than 20 feet to the inch.

(c) All roof control plan information, including drawings, shall be submitted on 8 1/2 by 11 inch paper, or paper folded to this size.

[60 FR 33719, June 29, 1995]

75.222 Roof control plan approval criteria.

30 CFR § 75.222

Roof control plan-approval criteria.

(a) This section sets forth the criteria that shall be considered on a mine-by-mine basis in the formulation and approval of roof control plans and revisions. Additional measures may be required in plans by the District Manager. Roof control plans that do not conform to the applicable criteria in this section may be approved by the District Manager, provided that effective control of the roof, face and ribs can be maintained.

(b) *Roof Bolting.* (1) Roof bolts should be installed on centers not exceeding 5 feet lengthwise and crosswise, except as specified in §75.205.

(2) When tensioned roof bolts are used as a means of roof support, the torque or tension range should be capable of supporting roof bolt loads of at least 50 percent of either the yield point of the bolt or anchorage capacity of the strata, whichever is less.

(3) Any opening that is more than 20 feet wide should be supported by a combination of roof bolts and conventional supports.

(4) In any opening more than 20 feet wide--

(b)(4)(i) Posts should be installed to limit each roadway to 16 feet wide where straight and 18 feet wide where curved; and

(b)(4)(ii) A row of posts should be set for each 5 feet of space between the roadway posts and the ribs.

(5) Openings should not be more than 30 feet wide.

(c) *Installation of roof support using mining machines with integral roof bolters.* (1) Before an intersection or pillar split is started, roof bolts should be installed on at least 5-foot centers where the work is performed.

(2) Where the roof is supported by only two roof bolts crosswise, openings should not be more than 16 feet wide.

(d) *Pillar recovery*. (1) During development, any dimension of a pillar should be at least 20 feet.

(2) Pillar splits and lifts should not be more than 20 feet wide.

(3) Breaker posts should be installed on not more than 4-foot centers.

(4) Roadside-radius (turn) posts, or equivalent support, should be installed on not more than 4-foot centers leading into each pillar split or lift.

(5) Before full pillar recovery is started in areas where roof bolts are used as the only means of roof support and openings are more than 16 feet wide, at least one row of posts should be installed to limit the roadway width to 16 feet. These posts should be--

(d)(5)(i) Extended from the entrance to the split through the intersection outby the pillar in which the split or lift is being made; and

(d)(5)(ii) Spaced on not more than 5-foot centers.

(e) *Unsupported openings at intersections.* Openings that create an intersection should be permanently supported or at least one row of temporary supports should be installed on not more than 5-foot centers across the opening before any other work or travel in the intersection.

(f) *ATRS systems in working sections where the mining height is below 30 inches.* In working sections where the mining height is below 30 inches, an ATRS system should be used to the extent practicable during the installation of roof bolts with roof bolting machines and continuous-mining machines with integral roof bolters.

(g) *Longwall mining systems.* (1) Systematic supplemental support should be installed throughout--

(g)(1)(i) The tailgate entry of the first longwall panel prior to any mining; and

(g)(1)(ii) In the proposed tailgate entry of each subsequent panel in advance of the frontal abutment stresses of the panel being mined.

(2) When a ground failure prevents travel out of the section through the tailgate side of the longwall section, the roof control plan should address--

(g)(2)(i) Notification of miners that the travelway is blocked;

(g)(2)(ii) Re-instruction of miners regarding escapeways and escape procedures in the event of an emergency;

(g)(2)(iii) Re-instruction of miners on the availability and use of self-contained self-rescue devices;

(g)(2)(iv) Monitoring and evaluation of the air entering the longwall section;

(g)(2)(v) Location and effectiveness of the two-way communication systems; and

(g)(2)(vi) A means of transportation from the section to the main line.

(3) The plan provisions addressed by paragraph (g)(2) of this section should remain in effect until a travelway is reestablished on the tailgate side of a longwall section.

75.223 Evaluation and revision of roof control plan.

30 CFR § 75.223

Evaluation and revision of roof control plan.

(a) Revisions of the roof control plan shall be proposed by the operator--

(1) When conditions indicate that the plan is not suitable for controlling the roof, face, ribs, or coal or rock bursts; or

(2) When accident and injury experience at the mine indicates the plan is inadequate. The accident and injury experience at each mine shall be reviewed at least every six months.

(b) Each unplanned roof fall and rib fall and coal or rock burst that occurs in the active workings shall be plotted on a mine map if it--

(1) Is above the anchorage zone where roof bolts are used;

(2) Impairs ventilation;

(3) Impedes passage of persons;

(4) Causes miners to be withdrawn from the area affected; or

(5) Disrupts regular mining activities for more than one hour.

(c) The mine map on which roof falls are plotted shall be available at the mine site for inspection by authorized representatives of the Secretary and representatives of miners at the mine.

(d) The roof control plan for each mine shall be reviewed every six months by an authorized representative of the Secretary. This review shall take into consideration any falls of the roof, face and ribs and the adequacy of the support systems used at the time.