ITEM XII-6
BLACKHAWK ENGINEERING STUDY

COAL PILLAR SIZING

GENWAL MINE

Emery County, Utah

Prepared By:

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Coal Pillar Sizing - Genwal Mine

Scope: This report is presented at the request of Mr. Bill Wolen of Genwal Coal Co.. Specifically, Blackhawk Engineering was asked to evaluate the feasibility of using 60'x60' centers on the entries and rooms projected for future mining in the Genwal Mine, and to compare extraction ratios and pillar strengths with the present 80'x 80' center projections.

Procedure: Various pillar sizes were evaluated at cover depths of 700' and 1000'. A factor of safety was then calculated for each of the pillar sizes, and this safety factor was related to the relative importance and longevity of the projected mining areas (i.e.-Mains vs. Rooms).

Criteria: The following criteria were used in the evaluation:

(1) Compressive strength of the coal - 1400 psi.

Note: Compressive strengths of coals in this area are highly variable and may run from 1000 to 2000 psi; however, a conservative figure of 1400 psi has been assumed due to unavailable test data for this mine.

(2) Mining Height - 6'.

(3) Entry Width - 20'.

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(4) Minimum acceptable safety factor for Main entries - 1.5.

(5) Minimum acceptable safety factor for Rooms - 1.5.

(6) Main Entries are assumed to have to remain in place greater than 2 years. (Long Term).

(7) Rooms will be driven and left or pillared shortly after development (Short Term).

(8) Overburden Density = 145 lbs./ft.^{3} or 1.0 psi per foot of overburden.

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Equations for Pillar Size
and
Safety Factors for Genwal Mine

Coal Strength - 1400 psi. = C

Pillar Strength - $C_p = C\left(.778 + .222\left(\frac{W}{H}\right)\right)$

C_p = Pillar Compressive Strength
W = Width of Pillar
H = Height of Pillar

Recovery Factor - $R = \frac{A_o}{A_t}$

A_o = Area of Entry
R = Recovery Factor
A_t = Total Area

Safety Factor - $F.S. = C_p\,(1-R) / S_v$

C_p = Compressive Strength of Pillar
R = Recovery Factor
S_v = Vertical Stress = Overburden Thickness x Density
F.S. = Factor of Safety

"Rock Mechanics and the Design of Structures in Rock", by Obert and Duvall, (pp. 540-543).

"Mining Engineering Handbook", Volume I, (pp. 7-48 to 7-49).

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Calculations

40'x 40' Pillars (60' Centers)

C=1400psi; W = 40'; L = 40'; W_o = 20'; H = 6'.

C_p = 1400 (.778 + .222(40/6)) = 3161 psi

R = 20 x (60 + 40) / 60 x 60 = .56

@ S_v = 700 psi (700' Cover), F.S. = 3161 (1-.56)/700 = 1.99

@ S_v = 1000 psi (1000' Cover) F.S.= 3161 (1-.56)/1000= 1.39

40'x 100' Pillars (60'x 120' Centers)

C = 1400 psi; W =40'; L = 100'; W_o = 20'; H = 6'.

C_p = 1400 (.778 + .222 (40/6)) = 3161 psi

R = 20 x (60 + 100) / 60 x 120 = .44

@ S_v = 700 psi (700' Cover), F.S. = 3161 (1-.44)/700 = 2.53

@ S_v = 1000 psi (1000' Cover),F.S. = 3161 (1-.44)/1000 = 1.77

60'x 60' Pillars (80' Centers)

C = 1400 psi; W = 60'; L = 60'; W_o = 20'; H = 6'.

C_p = 1400 (.778 + .222(60/6)) = 4197 psi

R = 20 x (80 + 60) / 80 x 80 = .44

@ S_v = 700 psi (700' Cover), F.S. = 4197 (1-.44)/ 700 = 3.36

@ Sv = 1000 psi (1000' Cover), F.S. = 4197 (1-.44)/1000 = 2.35

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Conclusions: Based on the calculations, room pillars driven on 60' centers (40'x 40' pillars) will have a safety factor of 1.39 or greater with less than 1000' of cover. This is acceptable for short-term entries. Main Entries will have to remain open until room development and pillaring are completed. Since the Mains are under the heavier cover (700' - 1000'), they should not be driven on 60' centers. To well ensure longevity, mains should be driven on 60' x 120' centers or 60'x 60' centers. The safety factors for 60' centers are greater than 2; therefore, these centers are acceptable for either rooms or mains.

Recommendations: Rooms can be driven on either 60' or 60' centers with a reasonable factor of safety. If rooms are driven on 60' centers, it is recommended that the main entries be driven initially on 60'x 120' centers. This will provide a greater factor of safety. The main pillars could then be split on retreat as the rooms are developed, to optimize recovery. If 60' centers are used for both rooms and mains, a reasonable factor of safety can be expected, providing that the mains are developed to the limit before room development or pillaring begins.

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Summary:

(1) 40'x 40' Pillars (60' Centers)

Safety Factor @ 700' Cover = 1.99

Safety Factor @ 1000' Cover= 1.39

Recovery Factor = 56%

(2) 40'x 100' Pillars (60'x 120' Centers)

Safety Factor @ 700' Cover = 2.53

Safety Factor @ 1000' Cover = 1.77

Recovery Factor = 44%

(3) 60'x 60' Pillars (80' Centers)

Safety Factor @ 700' Cover = 3.36

Safety Factor @ 1000' Cover = 2.35

Recovery Factor = 44%