PEM 2022

CASE STUDY: BLASTING WITH AIR DECKS TO MAINTAIN PERFORMANCE WHILE SAVING COSTS

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PROJECT SUMMARY

POWDER RIVER BASIN / WYOMING

- RESPEC's explosives engineering group was contracted by the MTi Group to conduct a third-party study and evaluation of the performance of MITi's SOLO Blastbag in overburden shots at a surface coal operation

- SOLO Blastbag Test Blast Summary
  - Initial on-site review of the drill and blast operations
  - Examined and evaluated various air-deck designs as a proof of concept for implementing SOLO Blastbags
  - Focus on maintaining production while reducing costs associated with blasting
  - Performed 4 test blasts with 3 different designs
- Post-blast review and on-site support throughout the test blasting campaign

TEST BLAST 1

POWDER RIVER BASIN / WYOMING

- Partial test blast
- Original Design
  - First 9 rows of the shot
  - Explosives Column heigh based on a powder factor of 0.7 lb/cyd
- Air-Deck Design 1
  - Last 3 rows of the shot
  - Reduced explosive column by 3 ft from Original Design
  - Maintain a stemming height of 48 ft
  - Air-deck of 8 ft
  - Reduced to a powder factor of 0.67 lb/cyd in first 9 rows
- Verified burden and spacing
  - Acceptable variance of 1.0%
- All blast design actuals verified throughout the loading process
- Post blast review did not indicate a variance in the blast performance between the Original Design and Air-Deck Design 1

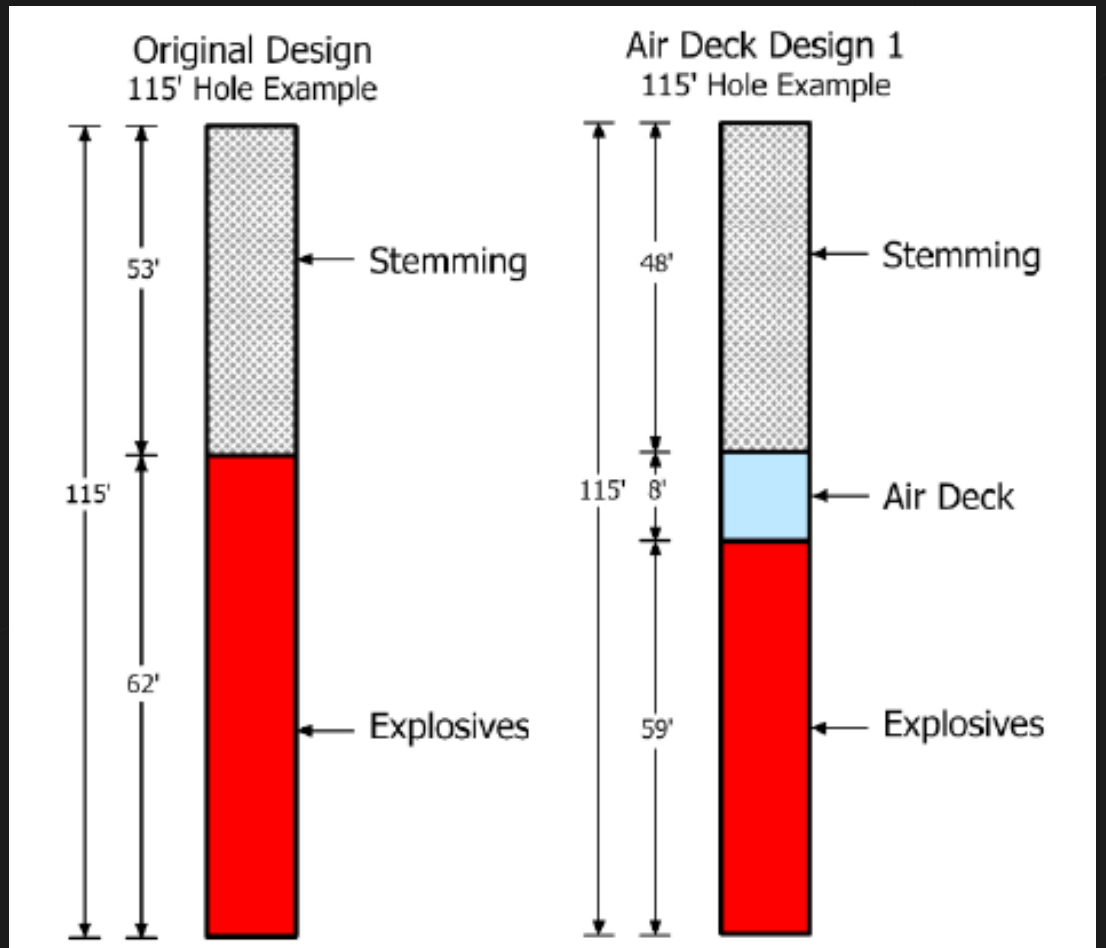


Figure 3-1. SOLO BlastBags™ Configuration for Test Blast 1.

TEST BLAST 1

POWDER RIVER BASIN / WYOMING

TEST BLAST 2

POWDER RIVER BASIN / WYOMING

- Tested two air-deck designs
  - Reduced to a powder factor of 0.67 lb/cyd on both designs
  - Reduced explosives column by 3 ft from Original Design
  - Reduced to a powder factor of 0.67 lb/cyd
- Air-Deck Design 1
  - First 6 rows of the shot
  - Maintain a stemming height of 48 ft
  - Air-deck of 8 ft
- Air-Deck Design 2
  - Last 6 rows of the shot
  - Maintain a stemming height of 40 ft
  - Air-deck of 16 ft
- Verified burden and spacing
  - Acceptable variance of 0.7%
- All blast design actuals verified throughout the loading process

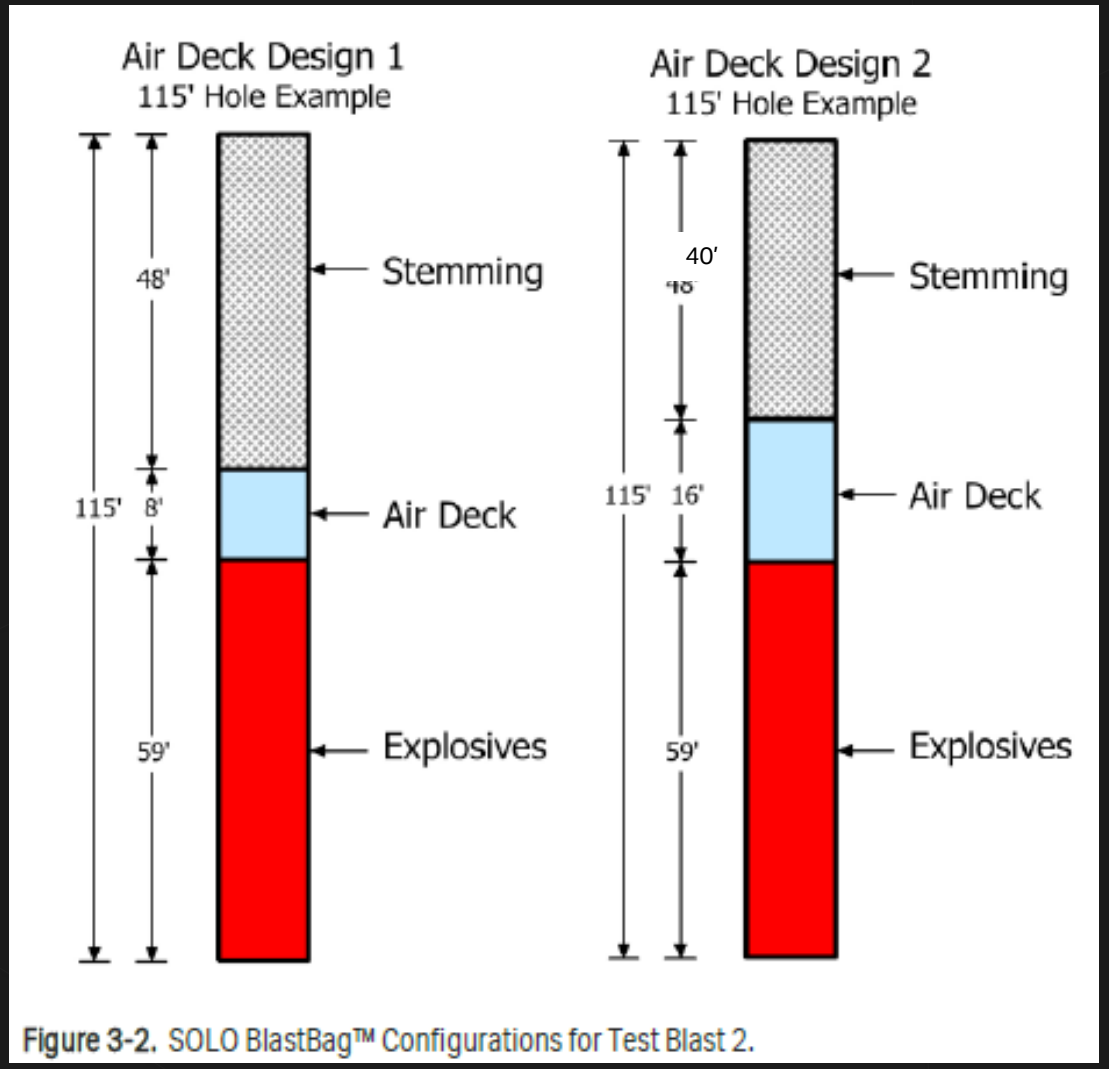


Figure 3-2. SOLO BlastBag™ Configurations for Test Blast 2.

TEST BLAST 2

POWDER RIVER BASIN / WYOMING

TEST BLAST 2 CONT.

POWDER RIVER BASIN / WYOMING

- Post blast review indicated a variance in the blast performance between the Original Design and Air-Deck Design 1 & 2
- Significant overbreak past crest line stakes
  - 15 ft of overbreak in the middle of Air-Deck Design 1
  - 35 ft of overbreak in the last third of Air-Deck Design 1
  - 35 to 40 ft of overbreak in all of Air-Deck Design 2
- Increased material movement
  - Reduced confinement
  - More relief on a hole-to-hole basis
  - Increased vertical distribution of the explosive energy along the length of the air-deck
    - Indicated by VOD readings

TEST BLAST 3

POWDER RIVER BASIN / WYOMING

- New air-deck design based on the post blast review from Test Blast 2 and after conferring with MTi and the mine site.
- Tested sing air-deck design on the entire shot
- Air-Deck Design 3
  - Maintain a stemming height from Original Design
  - Reduce explosives column by 5 ft
  - Reduced to a powder factor of 0.65 lb/cyd
- Verified burden and spacing
  - Acceptable variance of 1.9%
- All blast design actuals verified throughout the loading process
- Post blast review did not indicate variance in the blast performance between the Original Design and Air-Deck Design 3
  - Backbreak did not reach or surpass the crest line stakes

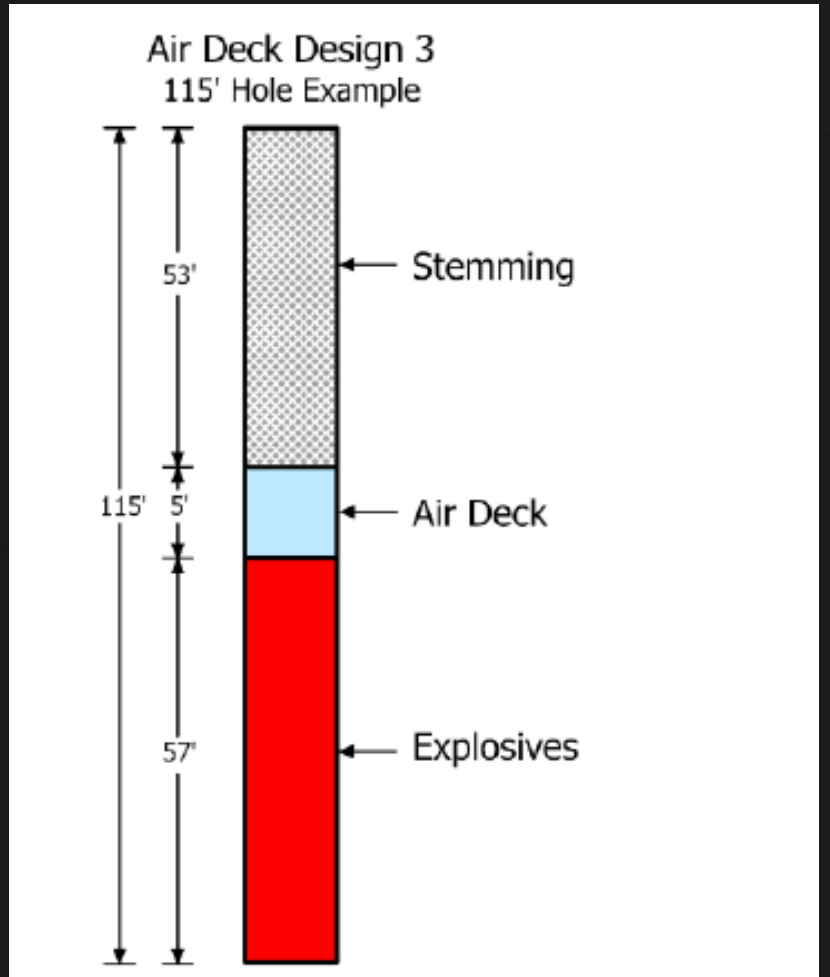


Figure 3-3. SOLO BlastBag™ Configurations for Test Blast 3 and 4.

TEST BLAST 3

POWDER RIVER BASIN / WYOMING

TEST BLAST 3

POWDER RIVER BASIN / WYOMING

TEST BLAST 4

POWDER RIVER BASIN / WYOMING

- Verifying the results from Test Blast 3
- Tested sing air-deck design on the entire shot
- Air-Deck Design 3
  - Maintain a stemming height from Original Design
  - Reduce explosives column by 5 ft
  - Reduced to a powder factor of 0.65 lb/cyd
- Verified burden and spacing
  - Acceptable variance of 1.9%
- All blast design actuals verified throughout the loading process
- Post blast review did not indicate variance in the blast performance between the Original Design and Air-Deck Design 3
  - Backbreak went up to the crest line stakes
    - Most likely due to deeper holes, increased confinement, and increased explosive weight per hole
    - Soft material and geology may be a potential effect based on reported field observations

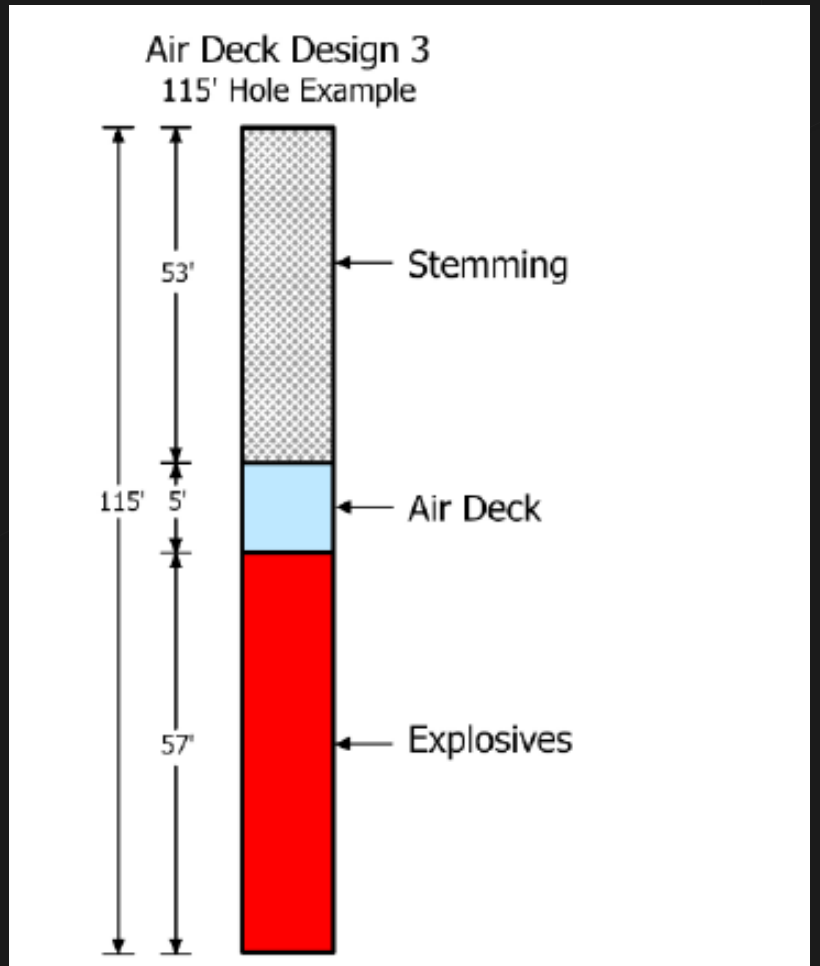


Figure 3-3. SOLO BlastBag™ Configurations for Test Blast 3 and 4.

TEST BLAST 4

POWDER RIVER BASIN / WYOMING

BLASTBAG DEPLOYMENT TIMING

POWDER RIVER BASIN / WYOMING

- Air-decked holes were left for approximately 20 to 30 minutes prior to stemming
  - Allowed blastbags to fully inflate and lock into place
- Blastbag deployment timed from initiation until downline was removed
  - Timed for Test Blast 1, 2, & 3
  - Average deployment time of 1.1 min per blastbag
- Blastbag deployment analysis
  - Inflation time can vary depending on the release (slow vs. fast) and temperature
  - Timing tested over a wide range of temperatures during test blasting
- Blastbag inflation speed performed consistently and reliably throughout test blasting
- Time added to loading process from the addition of blastbags was determined to be negligible
  - Availability to load during night shift
  - Current blast crew downtime and availability while loading behind drills

BLASTBAG DOWNHOLE MOVEMENT

POWDER RIVER BASIN / WYOMING

- Blastbags were tested for movement during the stemming process
  - Tests performed on Test Blast 2, 3, & 4
  - Ensure blastbags were not dislodged during stemming
  - Strings tied to blastbags downhole and stakes on the surface (see image to left)
  - Strings and stakes checked for movement 1 to 3 hours after stemming
- All tests showed no movement from blastbags and indicated blastbags stayed in place

DIGABILITY ANALYSIS AND REVIEW

POWDER RIVER BASIN / WYOMING

- Digability data for the shovels was collected by the mine site
- Variances between the original blast design and test blasts were analyzed
- Excavation performance data had minimal changes from the baseline data received and reviewed
- The surface coal mine does not usually consider a change to be significant unless greater than a 5 to 10 percent variance

Parameter	Baseline Area	Test Blast Area	Variance	
Digability	160.96	163.86	2.90	1.80%
Payload (ton/bucket)	106.57	109.15	2.57	2.41%
Cycle Time (sec)	43.70	44.07	0.37	0.84%

COST SAVINGS

POWDER RIVER BASIN / WYOMING

- It was determined that air decking could be implemented at the mining operation without significantly impacting the site's previous blast performance
- Bulk explosive cost, hole blasted per month, and blastbag cost have been changed to protect the privacy of the clients
- Potential reduction of 11 million lbs of bulk explosives per year
  - Assumes a reduction of 5 ft in the explosive column
- Annual cost savings of approximately $1,500,000 US
  - Assumes a bulk explosive cost of $0.20 per pound

Cost Item	Cost per unit	
	Value	Units
Holes blasted per month	2,250	hole/month
Hole Diameter	12.25	inch
Explosive Column Reduction	5.00	ft
Newly Planned Powder Factor	0.64	lbs/CYD
Bulk Explosives Density	1.26	g/cc
Explosive Weight Reduction	64.35	lbs/ft
	321.75	lbs/hole
	723,947.75	lbs/month
	8,687,373.02	lbs/year

Cost Item	Cost per unit	
	Cost	Units
Bulk Explosives Cost	$0.22	per lb
Bulk Explosives Savings*	$70.79	per hole
	$159,268.51	per month
	$1,911,222.07	per year
SOLO Blastbag Cost ($15 Each)*	$405,000.00	per year
Total Estimated Savings	**$1,506,222.07**	**per year**

FUTURE BLASTBAG TESTING RECOMMENDATIONS

POWDER RIVER BASIN / WYOMING

- Continued testing of Air-Deck Design 3 for three months to verify results of Test Blast 3 and 4
- Continued testing of Air-Deck Design 3 for three months to verify results of Test Blast 3 and 4 to establish long-term viability of using blastbags
- Incrementally increase the air-deck of future test blasts by decreasing the explosive column to maximize the potential cost savings
  - Test small incremental changes of no more than 1 ft
  - Smaller changes are easier to assess the results and ensure a small effected area if the targeted results are not achieved
  - Analyze the blast performance post blast for each new test blast
- Potential cost savings of $14.14 per foot of bulk explosives reduced per hole (see table below)

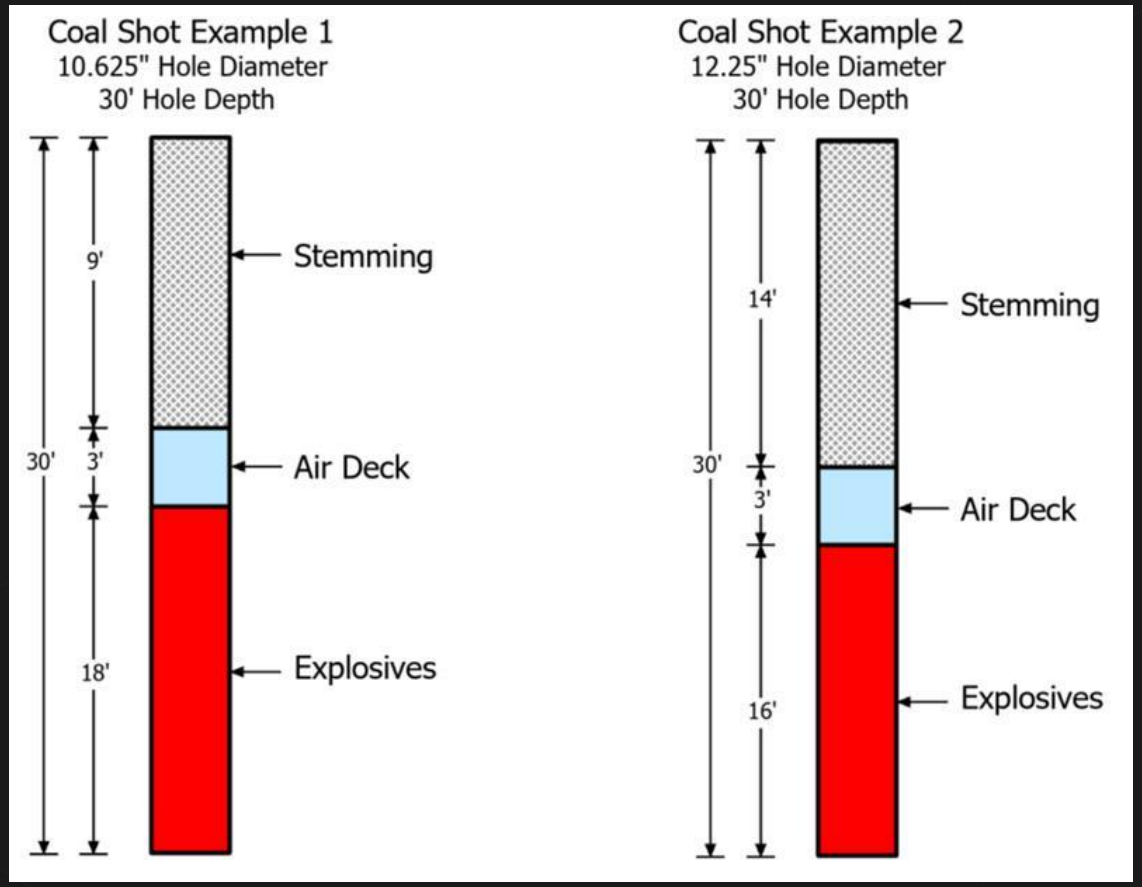
Product	Cost per pound	Pounds in 1 foot 12.25"	Savings per Foot
Emulsion 50/50 Blend	$0.22	64.29	$14.14

FUTURE BLASTBAG TESTING RECOMMENDATIONS CONT.

POWDER RIVER BASIN / WYOMING

- Trial blastbag test blasting in coal shots
  - Reduce 3 ft of bulk explosives
  - Increase test in 1 ft increments
- Cost savings at $0.22 per point of 50/50 bulk explosive reduced

Product	BH Dia.	Lb/Ft	Cost 1 ft	Cost 3 ft
50/50	10.625	48.41	$8.71	$26.14
50/50	12.25	64.35	$14.14	$34.75



THANK YOU

QUESTIONS?