POCKET BLAST GUIDE

JUNE 2021

AUSTRALIA PACIFIC AND ASIA

ORICA

Take 5

1 **Stop. Describe the task.**
2 **Think. List the hazards.**
3 **Identify. Assess the risk.**
4 **Plan. List the controls.**
5 **Proceed. Decide what is next.**

Risk Matrix

		CONSEQUENCES		
		Minimal e.g. • First Aid • Small spill of product • Minor plant damage	**Significant** e.g. • Recordable accident • Medical treatment • Plant damage • Loss of containment	**Catastrophic** e.g. • Severe injury or death • Severe plant damage • Major loss of containment
LIKELIHOOD	Very Likely	B	A	A
	Possible	C	B	A
	Very Unlikely	C	C	B

Decision

A Stop, Get Supervisor, JSERA **B** Stop, JSERA **C** Continue

Contents

Blasthole Charge Weights

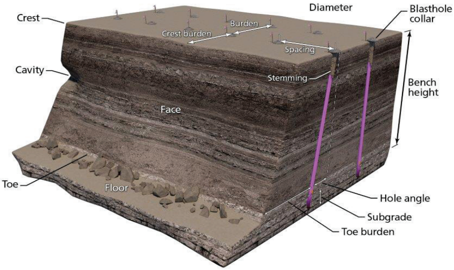
Values in table are kilograms of bulk explosive per metre of blasthole

Diameter		Bulk explosive average in hole density (g/cm³)						
(mm)	(in)	0.30	0.45	0.60	0.80	0.85	0.90	0.95
32	1¼	0.24	0.36	0.48	0.64	0.68	0.72	0.76
38	1½	0.34	0.51	0.68	0.91	0.96	1.02	1.08
45	1¾	0.48	0.72	0.95	1.27	1.35	1.43	1.51
51	2	0.61	0.92	1.23	1.63	1.74	1.84	1.94
57	2¼	0.77	1.15	1.53	2.04	2.17	2.30	2.42
64	2½	0.97	1.45	1.93	2.57	2.73	2.90	3.06
76	3	1.36	2.04	2.72	3.63	3.86	4.08	4.31
89	3½	1.87	2.80	3.73	4.98	5.29	5.60	5.91
102	4	2.45	3.68	4.90	6.54	6.95	7.35	7.76
114	4½	3.06	4.59	6.12	8.17	8.68	9.19	9.70
127	5	3.80	5.70	7.60	10.13	10.77	11.40	12.03
130	5⅛	3.98	5.97	7.96	10.62	11.28	11.95	12.61
152	6	5.44	8.17	10.89	14.52	15.42	16.33	17.24
165	6 ½	6.41	9.62	12.83	17.11	18.18	19.24	20.31
200	7 ⅞	9.42	14.14	18.85	25.13	26.70	28.27	29.85
229	9	12.36	18.53	24.71	32.95	35.01	37.07	39.13
251	9⅞	14.84	22.27	29.69	39.58	42.06	44.53	47.01
270	10⅝	17.18	25.76	34.35	45.80	48.67	51.53	54.39
311	12¼	22.79	34.18	45.58	60.77	64.57	68.37	72.17
381	15	34.20	51.30	68.41	91.21	96.91	102.61	108.31

Table continued below

Diameter		Bulk explosive average in hole density (g/cm³)					
(mm)	(in)	1.00	1.10	1.15	1.20	1.25	1.30
32	1¼	0.80	0.88	0.92	0.97	1.01	1.05
38	1½	1.13	1.25	1.30	1.36	1.42	1.47
45	1¾	1.59	1.75	1.83	1.91	1.99	2.07
51	2	2.04	2.25	2.35	2.45	2.55	2.66
57	2¼	2.55	2.81	2.93	3.06	3.19	3.32
64	2½	3.22	3.54	3.70	3.86	4.02	4.18
76	3	4.54	4.99	5.22	5.44	5.67	5.90
89	3½	6.22	6.84	7.15	7.47	7.78	8.09
102	4	8.17	8.99	9.40	9.81	10.21	10.62
114	4½	10.21	11.23	11.74	12.25	12.76	13.27
127	5	12.67	13.93	14.57	15.20	15.83	16.47
130	5⅛	13.27	14.60	15.26	15.93	16.59	17.26
152	6	18.15	19.96	20.87	21.78	22.68	23.59
165	6½	21.38	23.52	24.59	25.66	26.73	27.80
200	7⅞	31.42	34.56	36.13	37.70	39.27	40.84
229	9	41.19	45.31	47.37	49.42	51.48	53.54
251	9⅞	49.48	54.43	56.90	59.38	61.85	64.33
270	10⅝	57.26	62.98	65.84	68.71	71.57	74.43
311	12¼	75.96	83.56	87.36	91.16	94.96	98.75
381	15	114.01	125.41	131.11	136.81	142.51	148.21

Blast Calculations



Hole length, L (m)	=	$(BH/\cos\beta) + Su$
Charge length, C (m)	=	$L - St$
Volume of charge per hole, V_c (litres)	=	$\pi \times D^2/4000 \times C$ (D in mm)
Mass of charge per hole, M_c (kg)	=	$V_c \times \rho_{expl}$
Volume of rock per hole, V_r (m^3)	=	$B \times S \times BH$
Total Blast volume, V (m^3)	=	$V_r \times N$
Total Blast Mass, M (t)	=	$V \times \rho_{rock}$
Powder Factor, PF (kg/m^3)	=	M_c / V_r
N	=	Number of holes in blast
ρ_{expl}	=	Average inhole Explosive Density (g/cm^3)
ρ_{rock}	=	Rock density (t/m^3)
L	=	Hole Length (m)
Su	=	Subgrade (m)
St	=	Stemming (m)
BH	=	Bench Height (m)
β	=	Blasthole angle measured from vertical

Rules of Thumb

This table describes the most common ratios between blast design parameters for production blasting in rock. Special requirements may require a design outside these rules.

Hole Diameter	=	D
Burden	=	(20 to 40) × D
Spacing	=	(1.1 to 1.4) × B (1.15 for even hole distribution in a staggered pattern)
Subgrade	=	(8 to 12) × D
Stemming length	=	(20 to 30) × D
Stemming particle size	=	0.1D

Initiation Timing Rules of Thumb

Timing between holes for fragmentation, 3 to 8 ms per metre of hole spacing.

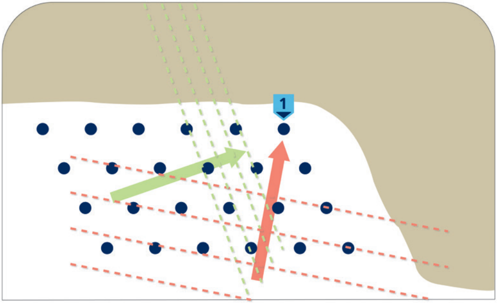
Timing between rows for heave, 15 to 30 ms per metre of hole burden.

The overall burden relief rate for surface production blasting is usually in the range of 10 to 20ms/m, measured perpendicular to the angle of initiation.

Golden Rules for Non-Electric Surface Delays

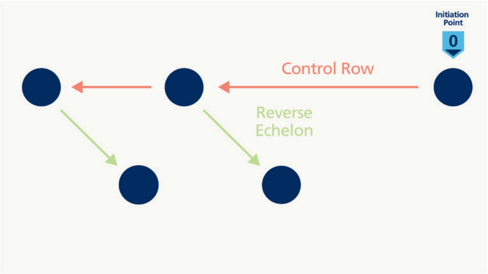
Movement is always towards the initiation point

When using non-electric systems, the rock will always move towards the initiation point. If the rock must go in a particular direction, select the initiation point to suit.

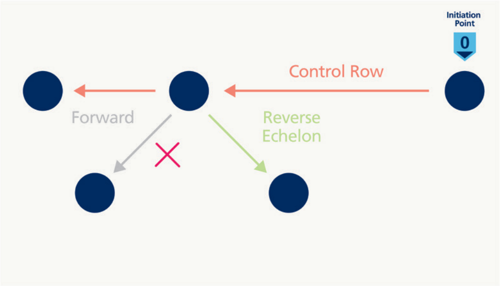


Always Use Reverse Echelons

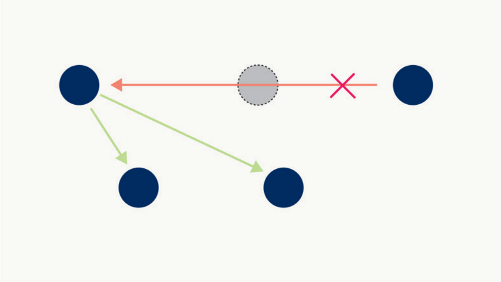
Always connect surface delays on the reverse echelon.



Never use forward echelons
Connecting surface delays on the forward echelon may cause an out-of-sequence initiation.

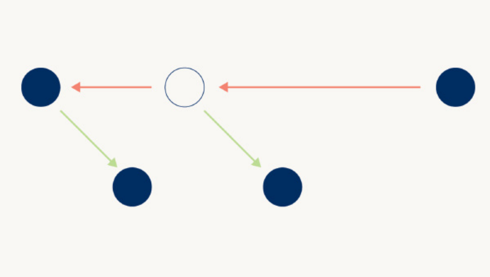


Don't skip missing holes
This can cause an out-of-sequence initiation

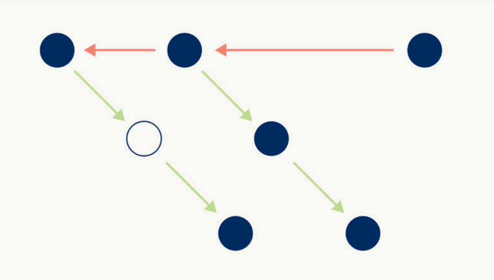


Golden Rules for Non-Electric Surface Delays Continued.

Use dummy holes
Connect missing holes as if they were there. This will keep the planned sequence.

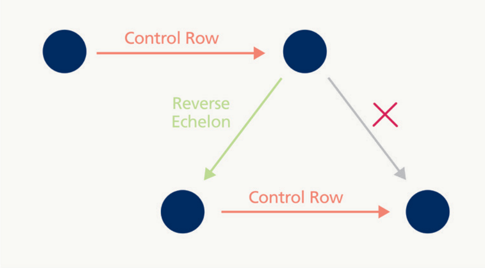


Use dummy holes
Always pretend the missing hole is actually there when designing and tying up.



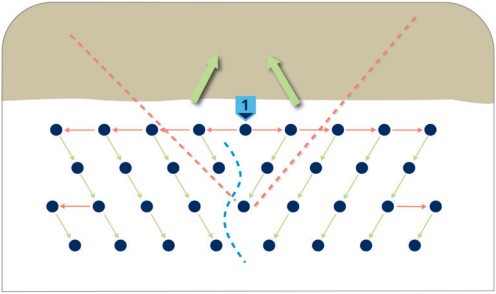
If the control row ends, drop back and continue

Try to keep the control row connections parallel.



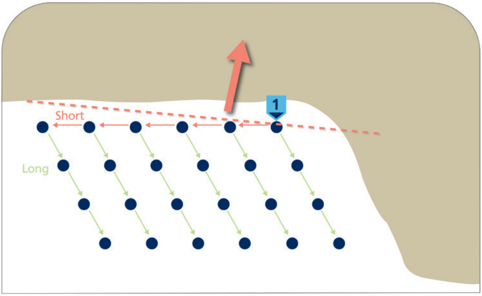
Classic "V"

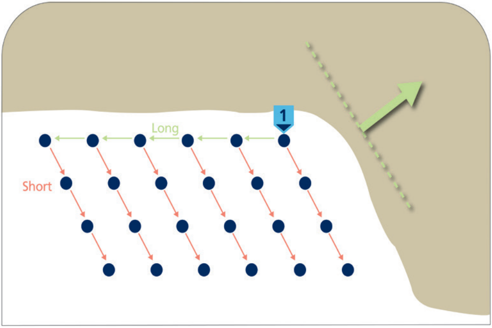
Keep the sequence symmetrical around an imaginary line drawn back from the initiation point.



Using Timing for Shaping

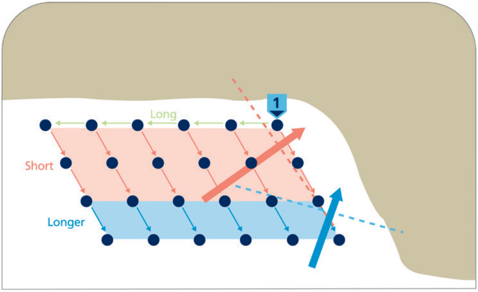
Select control row delays and echelon delays to change the direction of movement. Shorter control row delays promote forward movement, while shorter echelon delays stand the blast up.





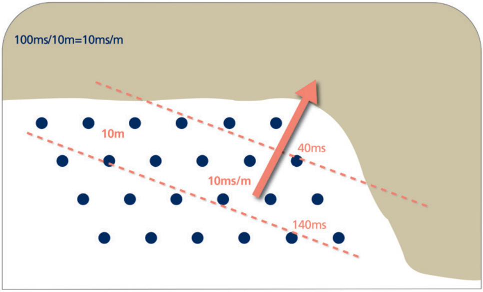
Variations - Slow Down Back Row

It is common practice to add more time into the back row to provide greater relief and achieve better walls with less backbreak. This is a free and easy design choice.



Burden Relief Rate

The Burden Relief Rate is an absolute measure of the timing of the blast.



Typical Rock Properties

Material	Rock Density (t/m^3)	Unconfined Compressive Strength (MPa)	Young's Modulus (GPa)	Poisson's Ratio
Basalt	3.0	78 – 412	20 – 100	0.14 – 0.25
Bauxite	2.1			
Clay – dense, wet	1.7			
Coal, Anthracite	1.6	8 – 50		
Coal, Bituminous	1.4			
Diabase	2.8	150 – 330	10 – 100	0.1 – 0.25
Diorite	3.0	115 – 340	25 – 30	0.1 – 0.8
Dolerite	2.8	290 – 500		
Dolomite	3.0	15 – 118	20 – 84	0.1 – 0.2
Earth, moist	1.8			
Gneiss	2.9	78 – 240	25 – 60	0.1 – 0.19
Granite	2.7	100 – 275	25 – 70	0.15 – 0.34
Gypsum	2.8			
Haematite	4.8			
Iron Ore	4.9			
Limestone	2.6	10 – 245	10 – 80	0.1 – 0.23
Limonite	3.8			
Magnesite	3.2			
Magnetite	5.1			
Marble	2.5	50 – 200	60 – 90	0.2 – 0.35

Table continues below

Material	Rock Density (t/m³)	Unconfined Compressive Strength (MPa)	Young's Modulus (GPa)	Poisson's Ratio
Mica-Schist	2.7			
Porphyry	2.5			
Quartzite	2.5	85 – 350	26 – 100	0.15 – 0.2
Sandstone	2.4	50 – 160	5 – 86	0.1 – 0.3
Shale	2.6	20 – 150	8 – 30	0.1 – 0.3
Silica Sand	2.6			
Siltstone	2.2			
Slate	2.8	98 – 196	30 – 90	0.1 – 0.44
Talc	2.6			

Typical Powder Factors used in Production Blasts

Typical powder factors used in bench blasts		Typical powder factors used in presplit and smooth blasting	
Rock type	**PF (kg/m^3)**	**Rock type**	**PF (kg/m^2)**
Strong	0.8 – 1.2	Strong	0.6 – 0.9
Medium	0.6 – 0.8	Medium	0.4 – 0.5
Soft	0.4 – 0.6	Soft	0.2 – 0.3
Very Soft	< 0.4		

Survey Offset Chart

When using the clinometer on drill holes, remember that it has 90º as vertical so for a hole drilled at 20º, the clinometer should read 70º.

Degrees from vertical	5		7.5		10	
Vertical Depth	o/s	Hole Length	o/s	Hole Length	o/s	Hole Length
1.0	0.09	1.0	0.13	1.0	0.18	1.0
2.0	0.17	2.0	0.26	2.0	0.35	2.0
3.0	0.26	3.0	0.39	3.0	0.53	3.05
4.0	0.3	4.0	0.5	4.0	0.7	4.1
5.0	0.4	5.0	0.7	5.0	0.9	5.1
6.0	0.5	6.0	0.8	6.1	1.1	6.1
7.0	0.6	7.0	0.9	7.1	1.2	7.1
8.0	0.7	8.0	1.1	8.1	1.4	8.1
9.0	0.8	9.0	1.2	9.1	1.6	9.1
10.0	0.9	10.0	1.3	10.1	1.8	10.2
11.0	1.0	11.0	1.4	11.1	1.9	11.2
12.0	1.0	12.0	1.6	12.1	2.1	12.2
13.0	1.1	13.0	1.7	13.1	2.3	13.2
14.0	1.2	14.1	1.8	14.1	2.5	14.2
15.0	1.3	15.1	2.0	15.1	2.6	15.2
16.0	1.4	16.1	2.1	16.1	2.8	16.2
17.0	1.5	17.1	2.2	17.1	3.0	17.3
18.0	1.6	18.1	2.4	18.2	3.2	18.3
19.0	1.7	19.1	2.5	19.2	3.4	19.3
20.0	1.7	20.1	2.6	20.2	3.5	20.3
22.2	1.9	22.3	2.9	22.4	3.9	22.5
21.0	1.8	21.1	2.8	21.2	3.7	21.3

Degrees from vertical	12.5		15		17.5	
Vertical Depth	o/s	Hole Length	o/s	Hole Length	o/s	Hole Length
1.0	0.22	1.0	0.27	1.0	0.32	1.05
2.0	0.44	2.05	0.54	2.07	0.63	2.10
3.0	0.67	3.07	0.80	3.11	0.95	3.15
4.0	0.9	4.1	1.1	4.1	1.3	4.2
5.0	1.1	5.1	1.3	5.2	1.6	5.2
6.0	1.3	6.1	1.6	6.2	1.9	6.3
7.0	1.6	7.2	1.9	7.2	2.2	7.3
8.0	1.8	8.2	2.1	8.3	2.5	8.4
9.0	2.0	9.2	2.4	9.3	2.8	9.4
10.0	2.2	10.2	2.7	10.4	3.2	10.5
11.0	2.4	11.3	2.9	11.4	3.5	11.5
12.0	2.7	12.3	3.2	12.4	3.8	12.6
13.0	2.9	13.3	3.5	13.5	4.1	13.6
14.0	3.1	14.3	3.8	14.5	4.4	14.7
15.0	3.3	15.4	4.0	15.5	4.7	15.7
16.0	3.5	16.4	4.3	16.6	5.0	16.8
17.0	3.8	17.4	4.6	17.6	5.4	17.8
18.0	4.0	18.4	4.8	18.6	5.7	18.9
19.0	4.2	19.5	5.1	19.7	6.0	19.9
20.0	4.4	20.5	5.4	20.7	6.3	21.0
22.2	4.9	22.7	5.9	23.0	7.0	23.3
21.0	4.7	21.5	5.6	21.7	6.6	22.0

Survey Offset Chart continued

Degrees from vertical	20		22.5		25	
Vertical Depth	o/s	Hole Length	o/s	Hole Length	o/s	Hole Length
1.0	0.36	1.06	0.41	1.08	0.47	1.10
2.0	0.73	2.13	0.83	2.16	0.93	2.21
3.0	1.09	3.19	1.24	3.25	1.40	3.31
4.0	1.5	4.3	1.7	4.3	1.9	4.4
5.0	1.8	5.3	2.1	5.4	2.3	5.5
6.0	2.2	6.4	2.5	6.5	2.8	6.6
7.0	2.5	7.4	2.9	7.6	3.3	7.7
8.0	2.9	8.5	3.3	8.7	3.7	8.8
9.0	3.3	9.6	3.7	9.7	4.2	9.9
10.0	3.6	10.6	4.1	10.8	4.7	11.0
11.0	4.0	11.7	4.6	11.9	5.1	12.1
12.0	4.4	12.8	5.0	13.0	5.6	13.2
13.0	4.7	13.8	5.4	14.1	6.1	14.3
14.0	5.1	14.9	5.8	15.2	6.5	15.4
15.0	5.5	16.0	6.2	16.2	7.0	16.6
16.0	5.8	17.0	6.6	17.3	7.5	17.7
17.0	6.2	18.1	7.0	18.4	7.9	18.8
18.0	6.6	19.2	7.5	19.5	8.4	19.9
19.0	6.9	20.2	7.9	20.6	8.9	21.0
20.0	7.3	21.3	8.3	21.6	9.3	22.1
22.2	8.1	23.6	9.2	24.0	10.4	24.5

Secondary Blasting

Secondary blasting can produce flyrock and noise if not carefully controlled.

Popping

- Breaking boulders by placing an explosive charge in a blasthole drilled to the approximate centre of the boulder.
- Use only sufficient explosive to break the boulder into manageable rock.

Plaster Shooting

- Explosive is placed in firm contact with the surface of a boulder.
- Handy when time or drilling constraints apply.
- Boulders of 1.5 m thickness are the limit for plaster shooting.
- Explosive should be laid on top of, and in intimate contact with the boulder and covered with stiff mud or clay.

Charge mass for secondary blasting

Typical powder factors for boulder are in the range of 0.05 - 0.15kg/m³.
Larger boulders typically need a higher Powder Factor.
The powder factor also depends on the fragmentation required, number of blasthole and placement of the charge.

Blasting Nuisances

Airblast

Blasting generates overpressure, also called airblast. Airblast includes audible and inaudible components.

Regulatory authorities in Australia enforce limits that are are relevant to local conditions and state law. Typical limits for airblast are 115dB(L) to 120 dB(L) for human comfort. Damage is extremely unlikely below 130 dB(L). Broken windows are the most common form of damage from overpressure.

Appropriate Actions to Reduce Overpressure

(a) Reduce the maximum instantaneous charge (MIC) or charge mass per delay to the lowest possible level.

(b) Measure deviation of front row holes and adapt front row loading designs to match actual face burdens.

(c) Ensure the design stemming length is achieved. Use good quality stemming. Use video to check stemming effectiveness.

(d) Eliminate exposed detonating cord. Investigate alternative initiation methods.

(e) Eliminate secondary blasting (instead of popping, use rock breaker or drop hammer).

(f) Make extra efforts to eliminate the need for toe shots (e.g better preparation of the drill bench, redrill lost holes, use good loading technique).

(g) Defer blasting if the forecast wind direction is towards the receiver, or a temperature inversion is forecast.

(h) If possible, orient free faces away from receivers.

(i) If the face is oriented towards receivers, design to reduce the face acceleration and velocity.

(j) Exercise strict control of drilling and loading, especially front row holes.

(k) Take extra care when the ground is broken, faulted, layered or if there are cavities. Consider decking.

(l) Always use a wind-screen on the microphone and place the microphone close to the ground and away from sources of noise and turbulence.

Ground Vibration

$$V=K\left(\frac{R}{\sqrt{Q}}\right)^{B}$$

Where:

V is the peak particle velocity of the ground vibration in mm/s,

R is the distance between the blast and monitoring point in metres,

Q is the charge in kg, and

K and **B** are constants related to site and rock properties.

K can vary from 500 to more than 5000 depending on geology.

For regular production blasting in quarries default values used in the absence of measured values are:

K = 1140

B = -1.6

Methods of controlling ground vibration

(a) Reduce the charge mass per blasthole by reducing the blasthole diamater, charge length, explosive density, or by decking.

(b) Reduce the charge mass per delay by changing the initiation sequence.

(c) Fire when blasting is likely to have the least impact on neighbours. Ensure neighbours are aware of blasting times, and stick to those times.

(d) Initiate blasts from the end closest to the receiver to reduce the risk of reinforcement.

(e) Ensure vibration monitors are firmly coupled to the natural ground surface, away from structures.

Common ground vibration limits

- Occupied sensitive sites subject to regular or repeated blasting (e.g. houses near quarries): 5 mm/s – 10 mm/s.
- Less sensitive occupied sites such as factories and industrial buildings: 25 mm/s.
- To reduce the risk of cosmetic damage to houses and buildings: 25 mm/s – 50 mm/s.

Refer to AS2187.2-2006 Appendix J for more details.

Perimeter Blasting – Opencut

Principles of Perimeter Control

There are three main principles in wall control blasting on the surface.

1. Reduce the explosive energy in holes adjacent to the final wall
2. Reduce vibration
3. Provide relief to the back row

Energy

Lowering the explosive energy in blastholes can be achieved by:

- Drilling smaller diameter holes on a smaller pattern
- Using lower energy explosive
- Air decking in the blasthole
- Specialty perimeter explosives e.g. Senatel™ Powersplit™
- Using lower density or decoupled explosives.

Relief

Conventional blasting theory says that providing relief reduces damages to final walls. This is usually achieved by using longer delays in the back rows.

Special Blasting Applications

Presplitting

- Most effective in brittle, massive rock.
- Measure presplit powder factor in terms of explosive mass per square metre.
- The charge diameter should be 20 to 40% of the blasthole diameter when using packaged presplit explosive.
- In large diameter holes, deck charges of bulk explosive can be used but are less effective.

Mid-splitting

- Like a presplit, but fired at the same time as the accompanying production or trim blast.
- Reduces the number of blasts in the mining schedule.
- Usually more risky and less effective than presplitting.

Cushion Blasting

- Blastholes on a reduced burden and spacing, along the back row of the blast, charged with reduced explosive per hole.
- Powder factor may be the same as or lower than, that of a standard production blast.
- Airdecks can be used within blastholes to improve explosive distribution.

Trim Blasting

- A separate blast of only 2-3 rows fired against a final wall
- Sometimes with a reduced pattern and hole diameter
- Usually fired with a free face for relief

Post Splitting

- Used to break out a single row of blastholes along the final limit or remove a small section of rock that has been damaged by backbreak from previous production blasts.
- Single row of closely spaced blastholes drilled along the final pit limit.
- Fired instantaneously or in groups of simultaneous blastholes so that the blastholes work together and create a splitting effect between the holes.
- Rarely as effective as presplitting.

Line Drilling

- Parallel very closey spaced uncharged holes drilled on the design perimeter
- The spacing is usually less than 3 hole diameters.

Perimeter Blasting – Underground

Energy

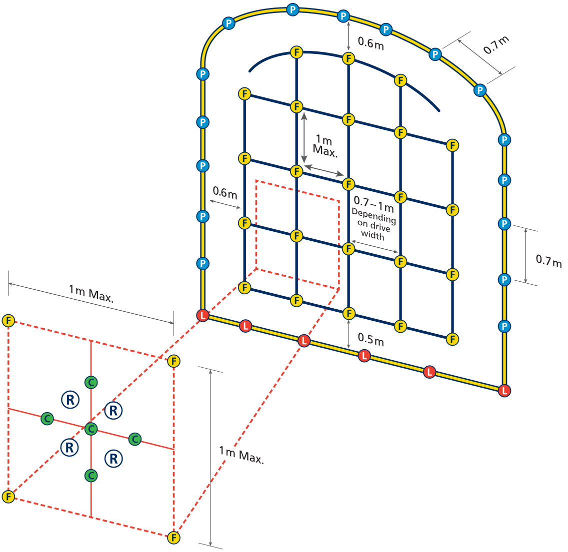
Reduce the energy in perimeter holes by:

- Low density ANFO (Impact range)
- Low density emulsion (Subtek Control)
- Heavy detonating cord (more than 70g/m)
- Smaller diameter decoupled explosive (packaged or string loaded emulsion)
- Speciality packaged emulsion presplit product
- Smaller diameter, closely spaced blastholes

Relief

In stopes, the last blasthole in each row should have an additional delay of 15 ms to 40 ms, depending on the initiation sequence for the rest of the blast. In development, the last hole in each row should have the next delay available.

Underground Tunnelling and Development



P = Perimeter Blasthole

Require lower energy and preferably decoupled charges to reduce damage and overbreak.

Use:

Impact™ 50 – Higher Energy

Impact™ 30 – Low Energy

Subtek™ Control – Variable Energy

F = Face Blastholes

Blow loaded ANFO is still commonly used but pumpable bulk emulsion is gaining in popularity due to its better reliability in wet conditions.

Use: Typically 45 mm or 51 mm diameter – when drilled with a Jumbo or 32mm when drilled by hand.

Subtek™ Bulk emulsion (wet blast holes).

Senatel™ Magnum™ (wet blast holes).

AMEX™ (dry blast holes).

Subtek™ range for all blasting conditions primed with Pentex™ D booster.

Uncharged collar approximately half the burden.

Initiation for Tunneling and Development

Non-electric long period (LP) delays initiated with a loop of detonating cord are most commonly used in development mining. Electronic detonators are used in larger faces and for vibration control. Packaged emulsion primers are commonly used in holes charged with ANFO. Cast boosters such as Pentex™ D are recommended for holes charged with bulk emulsion.

L = Lifter Blastholes

Initiated last in the sequence and usually on simultaneous delays to lift and loosen the muckpile.

Use: Senatel™ Magnum™ 32 × 700 (45 mm blastholes).

Senatel™ Powerfrag™ 32 × 700 (45 mm blastholes).

Senatel™ Magnum™ 25 × 700 (32 mm blastholes).

Subtek™ Bulk Emulsion (fully coupled holes) primed with Pentex™ D booster.

Uncharged collar approximately 3 to 5 hole diameters.

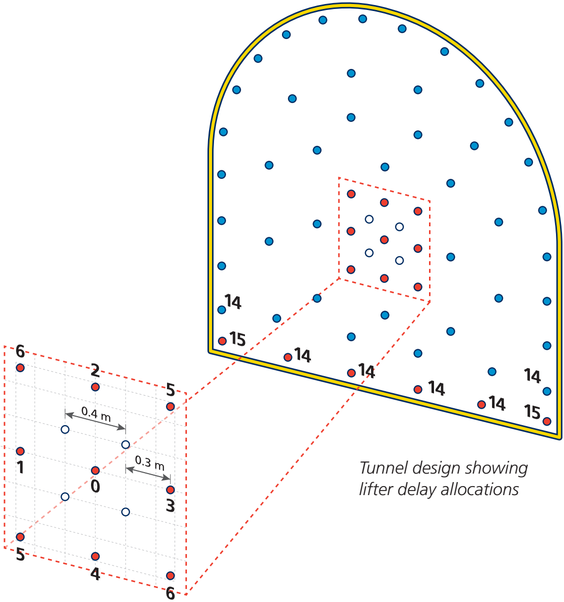
C = Cut Blastholes

Initiated first in the sequence, usually with each hole on a different delay.
Typically 45 mm diameter – Jumbo.

32 mm diameter – Hand held machine.

R = Reamer Holes

Typically 102 mm or 127 mm diameter – uncharged holes to provide relief.



Tunnel design showing lifter delay allocations

A basic burn cut design and LP detonator initiation sequence (by numbers)

Underground Blasting Rules of Thumb

Production Blast Parameters

Drill diameter (D)	=	16 × √ Maximum hole length (m)
Ring burden (B)	=	16 – 26 × D
Hole toe spacing (parallel hole rings)	=	1 – 1.4 × B
Hole toe spacing (radial hole rings)	=	1.4 – 2.0 × B
Stemming length	=	15 – 25 × D
Stemming rock size	=	10% × D
Void ratio calculation	=	Void Vol / Vol of rock x 100 (%)
Void ratio required for rock swell	=	30 – 50%
Max distance from blast hole to void hole in cut	=	2.5 x Void hole diameter (≤ 0.5 m)

Diameter and number of relief holes for increasing blind raise length to increase probability of success:

Hole Diameter (mm)	Raise Length (m)			
	5	10	15	20
165	4	5	6	8
200	3	4	5	6

Blast Timing

Delay between holes in cut (Note: for blind long hole raise use upper limit)	=	15 – 40 ms per m of hole length
Delay between rings – Best throw	=	30 – 50 ms per m of burden
Delay between holes – Best fragmentation	=	2 – 6 ms per m of spacing

Underground Troubleshooting

Excess butts in the cut area – poor tunnel advance

- Review cut drilling to ensure holes are correct length and parallel.
- Review charging quality to ensure primers are located at the toe of the blast hole.
- Increase number or size of Void Holes in the Cut Area.
- Skip delay numbers to slow the cut initiation sequence.
- Reduce dimensions of the cut spacings < 2.5 × Void Diameter.
- Use lower density bulk explosive in the cut for better sensitivity.

Excess butts in perimeter area (dishing) – poor tunnel advance

- Review drilling quality to ensure holes are parallel.
- Review charging quality to ensure primers are located at the toe of the blast hole.
- Review initiation sequence to ensure adequate relief (no tight corners).
- Use next delay in corners of the blast to allow for delay scatter.
- Reduce drill burdens/spacings to increase energy at the toe.

Excess dishing of face – few butts evident / dogboxing of cut

- Reduce drill burden/spacings from outer box.
- Review geology – reduce depth of burn.
- Reduce energy in Cut – low density products.

Excess collar bridging, toe or lumpy floor

- Reduce uncharged collars in perimeter holes and/or the next row in.
- Review initiation timing to ensure adequate relief (no tight corners).
- Use next delay in corners of the blast to allow for delay scatter.
- Review number of lifters or explosives type for greater energy.
- Review product use for lifters i.e. incorrect product.
- Review charging practices.

Excess damage in perimeter – overbreak

- Review initiation sequence to ensure adequate relief (no tight corners).
- Review drilling pattern to reduce burden of the perimeter row.
- Reduce the perimeter (and/or next row) explosives energy per metre.
- Use low energy ANFO based products (Impact™ range).
- Use tailored energy bulk emulsion products (Subtek™ Control/low density).
- In stopes, allow extra delay of 15–40 ms for the last blasthole in each row.

Leaving blast material behind – underbreak

- Review drill design for adequate breakout angle at toe (> 100°) or sub drill.
- Review drill and blast design for adequate energy.
- Review initiation design for adequate relief to minimise confinement.
- Review primer positions and charging quality.

Very large boulders in blasted material

- Review drill pattern for excessive burdens and spacings from deviation.
- Review boulders for blastholes, indicating cut-off explosive columns.
- Review initiation design for slow timing.
- Review boulders for source outside blast area – overbreak (see above).

Conversion Factors

This unit →	Multiplied by →	Converts to
	Length	
metres (m)	3.280	feet (ft)
	39.370	inches (in)
kilometres (km)	0.621	miles (mi)
inches (in)	25.4	millimetres (mm)
	Mass	
kilogram (kg)	2.20	pound (lb)
metric tonne (t)	1.10	short tons
ounce (oz)	28.35	grams (g)
ounce (troy)	31.10	grams (g)
grains per ft	0.2126	grams per metre
	Energy	
joule (J)	0.24	calorie
	0.74	ft-lb
calorie	3.09	ft-lb
kilowatt (kW)	1.34	horsepower (hp)
	Volume	
cub. centimetres (cm^3 or cc)	0.06	cubic inches (in^3)
cub. metres (m^3)	1.31	cubic yards (yd^3)
cubic feet (ft^3)	0.03	cubic metres (m^3)
US gallon	3.79	litres (l)
Ounce (US fluid)	29.57	cubic cm (cm^3)
Converts to ←	Divided by ←	This unit

This unit →	Multiplied by →	Converts to
Density		
lbs/ft³	16.02	kg/m³
g/cm³	62.43	lbs/ft³
Powder Factor		
kg/m³	1.69	lb/yd³
Speed		
m/sec	3.28	ft/sec
in/sec	25.4	mm/sec
km/hour	0.62	miles/hour
Pressure		
psi	6.89	kPa
atm	14.70	psi
bar	14.50	psi
	100	kPa
Temperature		
Fahrenheit –32	0.56	Celsius (°C)
Celsius +17.78	1.8	Fahrenheit (°F)
Area		
cm²	0.16	in²
m²	1550.00	in²
ft²	0.09	m²
Converts to ←	Divided by ←	This unit

Properties of Senatel™ Special Use Explosives

Application	Explosives	Cartridge diam × length (mm)	Density (g/cm^3)	Minimum VOD (km/sec)	Cartridge count	Case weight (kg)
UG Coal	Senatel™ Permitted 1000	32 × 400	1.16	4.5	66	25
Surface	Senatel™ Powersplit™	26 × 25.2 m 32 × 20.1 m 32 × 25.2 m	1.18	6.5	1	15.3 17 21.3
Hot & Reactive*	Senatel™ Pyrosplit™	32 × 25.2 m	1.18	6.5	1	21
Hot & Reactive*	Senatel™ Pyromex™	32 x 200 32 x 700 50 x 220	1.16	4.7	135 38 50	25

* *The degree of heat and reactivity is determined by Orica standard temperature and reactive ore tests.*

Senatel™ Permitted 1000

Senatel™ Powersplit™

Senatel™ Pyrosplit™

Senatel™ Pyromex™

Packaged Emulsion Explosives Properties

Explosives	Nominal Density (g/cc)	REE Bulk Strength (% ANFO at 0.8 g/cc)	REE Bulk Strength (% ANFO at 0.95 g/cc)	Minimum VOD (km/s)	Nominal Cartridge Diam/ Length (mm)	Cartridge count	Case weight (kg)
Senatel™ Powerfrag™	1.21	183	139	3.4	32 × 200	135	25
					32 × 700	38	25
					45 × 400	33	25
					55 × 300	30	25
					65 × 300	21	25
					80 × 400	11	25
Senatel™ Magnum™	1.23	201	153	3.4	25 × 200	215	25
					25 × 700	60	25
					32 × 200	135	25
					32 × 700	38	25

Note

1 *Only fragmentation energy is quoted for packaged explosives because the current detonation codes cannot accurately model the effects of air decoupling on heave energy.*

2 *Fragmentation energy and heave energy are quoted for bulk explosives in the previous tables.*

Senatel™ Powerfrag™

Senatel™ Magnum™

Exel™ Non-Electric Initiation

Exel™ Non-Electric Detonators

LP Series			
Delay No.	J Hook Colour	Firing times (ms)	Delay Interval
0		25	175
1		200	200
2		400	200
3		600	400
4		1000	400
5		1400	400
6		1800	600
7		2400	600
8		3000	800
9		3500	800
10		4500	900
11		5500	900
12		6500	1000
13		7500	1100
14		8500	1100
15		9500	

MS Series		
Delay No.	Firing times (ms)	Delay Interval
		25
1	25	25
2	50	25
3	75	25
4	100	25
5	125	25
6	150	25
7	175	25
8	200	50
9	250	50
10	300	50
11	350	50
12	400	50
13	450	50
14	500	100
15	600	

Exel™ Enduradet™ Extended Millisecond Range Non-Electric Detonators

Delay No.	Firing times (ms)	Delay Interval
1	25	25
2	50	25
3	75	25
4	100	25
5	125	25
6	150	25
7	175	25
8	200	50
9	250	50
10	300	50
11	350	50
12	400	50
13	450	50
14	500	100
15	600	100
16	700	100
17	800	100
18	900	

Delay No.	Firing times (ms)	Delay Interval
		125
19	1000	100
20	1100	100
21	1200	175
22	1400	275
23	1600	275
24	1800	325
25	2000	375
26	2400	400
27	3000	400
28	3500	450
29	4000	450
30	4500	500
31	5000	500
32	5500	550
33	6000	650
34	6500	700
35	7500	800
36	8500	

Properties of Exel™ Detonators

Product	Detonator PETN Mass (g)	Delay Range	Tube Colour	Lead Lengths (m)
Exel™ Millisecond (MS)	PETN 790	9 – 600 ms	Orange	3.6, 6, 7.2, 9, 12, 15,18, 24
Exel™ Long Period (LP)	PETN 790	25 – 9600 ms	Yellow	3.6, 4.9, 6.1, 24
Exel™ Enduradet™	PETN 790	25 – 8050 ms	Red	9, 12, 15, 18, 24, 30, 36, 45,
Exel™ Bunchdet™	PETN 480	600 ms	Pink	1, 6
Exel™ Handidet	PETN 790	25 ms (surface)/ 400 ms in	Yellow	3.6, 6.1, 9,12,18, 24

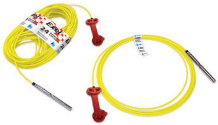
Not all lengths are part of the standard offering

Exel™ Millisecond Detonators

Exel™ Long Period Detonators

Exel™ Enduradet™ Detonators

Exel™ Bunchdet



Exel™ Handidet™ Detonators

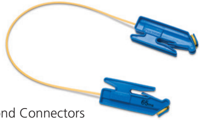
Exel™ Surface Initiation Connectors

<table>
<tr><th>Nominal Time (ms)</th><th>Block Colour</th><th>Tube Colour</th></tr>
<tr><td>9</td><td>Green</td><td rowspan="9">Pink</td></tr>
<tr><td>17</td><td>Yellow</td></tr>
<tr><td>25</td><td>Red</td></tr>
<tr><td>42</td><td>White</td></tr>
<tr><td>65</td><td>Blue</td></tr>
<tr><td>100</td><td>Orange</td></tr>
<tr><td>125</td><td>Cream</td></tr>
<tr><td>150</td><td>Mustard</td></tr>
<tr><td>175</td><td>Lime Green</td></tr>
</table>

Exel™ signal tube (3 mm OD)
Standard length – 3.6, 4.8, 6.0, 9, 12, 15, 18

Exel™ Connectadet™ Detonators

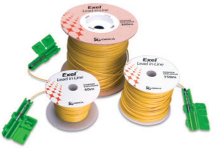
Exel™ Surface Intiation Connectors



Exel™ Millisecond Connectors

Nominal Delay Time (ms)	Cleat Colour
9	Green
17	Yellow
25	Red
35	Pink
42	White
65	Blue
Yellow Exel™ signal tube (3 mm OD) Total length 80 cm	

Type	Standard Length (m)	Detonator PETN charge (g)
Exel™ Lead in Line	60, 300	0.45 (#8 Strength)
Exel™ Connectaline™	700	N/A



Exel™ Lead in Line

Exel™ Connectaline™

Properties of Pentex™ Boosters

Booster Type	Nominal Density (g/cm³)	VOD (km/s)	Nominal Diameter (mm)	Nominal Mass (g)	Shell Colour
Pentex™ D	1.5 – 1.65	6.5	21	25	Orange
Pentex™ G	1.7	7.2	31	110	Pink
Pentex™ H	1.7	7.2	34	150	Green
Pentex™ ProTECT-e	1.7	7.2	51	420	Yellow
Pentex™ PPP	1.7	7.2	55	400	Orange
Pentex™ PowerPlus™ 900	1.7	7.2	80	900	Red
Pentex™ Stopeprime™	1.7	7.2	41	250	Yellow
Pentex™ G L	1.6	7.2	53	432	Yellow / Green Cap

From left:
Pentex™ H, Pentex™ D, Pentex™ G, Pentex™ Stopeprime™, Pentex™ G L, Pentex™ PP900, Pentex™ PPP

Pentex™ Boosters Recommended for Hole Diameter/ Explosive Combinations

<table>
<tr><th></th><th colspan="10">Hole Diameter (mm)</th></tr>
<tr><th>Product</th><th>38</th><th>45</th><th>64</th><th>76</th><th>89</th><th>102</th><th>115</th><th>160</th><th>200</th><th>300</th></tr>
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<tr><td rowspan="4">Fortis™</td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Pentex™ G L / PPP</td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Pentex™ PP900</td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Pentex™ PP900</td></tr>
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Cord Type	Nominal Coreload (g/m)	Length (m)	VOD (km/s)	Nominal Diameter (mm)	Maximum Hole Temp	Colour
Cordtex™ 4.3W	4.3	250 500	6.5 – 7.0	4.0	80°C	Orange two black stripes
Cordtex™ XTL NC	10	300	5.5 – 6.0	4.6	80°C	Yellow
Cordtex™ Pyrocord™	10	350	6.5 – 7.0	4.6	100°C	Orange

Cordtex™ 4.3W

Cordtex™ XTL NC

Cordtex™ Pyrocord

Combinations of Detonators, Detonating Cords and Boosters

Donor \ Receptor	Lead in Line	MS & LP Detonator	Enduradet™	MSC	Connectadet™	Handidet™	Bunchdet (Surface)	Cordtex™ 4.3W	Cordtex™ XTL NC	Pentex™ D	Pentex™ G	Pentex™ H	Pentex™ G L / PPP	Pentex™ PP900	Pentex™ proTECT-e	Pentex™ Stopeprime™
Detonator																
Electric Instantaneous II	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y
Electronic Detonator																
eDev™ II	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y
i-kon™ III	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
uni tronic™ 600	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Exel™																
Lead in Line	Y	Y	Y	**N**	Y	Y	Y	Y	Y	**N**	**N**	**N**	**N**	**N**	**N**	**N**
MS & LP Detonator	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y
Enduradet™	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y
Millisecond Connector (MSC)	**N**	**N**	**N**	**N**	**N**	**N**	**N**	Y	Y	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Connectadet™	Y	Y	Y	**N**	Y	Y	Y	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Handidet™	Note: Handidet™ should be considered as Connectadet™ or MS detonator, depending on the donor/receptor combination being applied.															
Bunchdet (Surface)	Y	Y	Y	**N**	Y	Y	Y	Y	Y	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Detonating Cord																
Cordtex™ 4.3W	Y	Y	Y	Y	Y	**N**	Y	Y	Y	**N**	**N**	**N**	Y	Y	**N**	**N**
Cordtex™ XTL NC	**N**	**N**	**N**	Y	**N**	**N**	**N**	Y	Y	**N**	Y	Y	Y	Y	**N**	Y

Compatibility tables should be read in conjunction with all relevant Technical Data Sheets. Disclaimers contained within these Technical Data Sheets will apply.

uni tronic™ 600

uni tronic 600
Electronic Blasting System

Application

Application	Key Benefits
Small surface mines and quarries	• Quick on-bench diagnostics via on-bench testability. • Quick hook-up on blast day via new connector and duplex wire. • Improved resistance to leakage via new Application Specific Integrated Circuit (ASIC) and Printed Circuit Board (PCB). • Improved precision. • Improved reliability via 6 Sigma target. • More robust communications. • New safety features in electronics. • Improved packaging. • Help for blaster via length encoded ID number.

Technical Properties

Type	Delay times	Wire length (m)	Downline wire
uni tronic™ 600	Fully programmable from 0 ms to 10,000 ms in 1 ms increments	9 15 20 25 30	Copper clad steel

Remote firing available for open cut applications.

Blast Box 310/310R

The Blast Box provides the voltage and command to fire the detonators in programmed sequence. The 310R (pictured) offers remote firing capability.

Scanner 200

The Scanner 200 scans unique ID numbers on the detonators and allows the functionality of each detonator in the pattern to be tested before the bench is cleared.

SHOTPlus™ Blast Design Software

Orica's SHOTPlus™ Blast Design Software gives printed blast plans, useful on the bench with the uni tronic™ 600 system.

uni tronic™ 600 Detonator

Accurate and fully programmable electronic detonator.

uni tronic™ 600 Connector

Designed for on-bench efficiency, the connector carries signals between the detonator and the harness wire.

Duplex Harness Wire

Faster and easier to use, the duplex wire connects detonators with the Blast Box.

i-kon™ III

i-kon™ III
Electronic Blasting System

CONNECT

The premium i-kon™ III system includes new features and equipment that enhances productivity with faster deployment and blast set-up for both small and large scale blasting:

- Connector 6 with redesigned hinge, clip and dual plastic design locks out water, dirt and snow for faster tie-in and less leakage.
- Blaster 3000 with remote firing of up to 6 benches completes more blasts within the firing window with minimal set-up and equipment.

PROTECT

Reliable even in harsh mining environmental and blasting conditions, the i-kon™ III system reduces blasts delays with:

- Improved dynamic shock resistance by approximately 30%, over existing copper alloy shell, reducing risk of misfire due to dynamic shock in challenging ground conditions.
- Bi-metallic shells protects the detonator for up to 60 days in highly corrosive conditions.
- The correct wire for the conditions including Extreme wire which performs in metal mines where hard, sharp and abrasive rock is prevalent.

PERFORM

Unlock possibilities and cutting edge blasting techniques with greater precision through the premium i-kon™ III system:

- Blaster 3000 with remote firing of up to 6 benches completes more blasts within the firing window with minimal set-up and equipment.
- Achieve greater wall stability, increased fragmentation and reduced vibration.

i-kon™ III RX

Stronger and more impact resistant wire is suitable for most metal mines or large mines.

i-kon™ III Extreme

Strongest and most impact resistant wire. Suitable for metal mines with very harsh conditions.

Technical Properties

Type	Delay times	Wire length (m)	Wire tensile strength
i-kon™ III	Programmability 1ms steps maximum delay 30 secs	6, 10, 15, 20, 30, 40, 60, 80	25 kgf/ 250N load
i-kon™ III Starter	Programmability 1ms steps maximum delay 30 secs	2	20kg
i-kon™ III Extreme	Programmability 1ms steps maximum delay 30 sec	10, 15, 20, 30, 40, 60, 80	50kg

i-kon™ III Detonator

Accurate and fully programmable electronic detonator.

i-kon™ III Extreme Detonator

Accurate and fully programmable electronic detonator for harsh mining conditions.

i-kon™ III Starter Detonator

Accurate and fully programmable electronic detonator. For remote initiation of development and production blasting from a safe and controlled location underground or on the surface

14. Electronic Blasting Systems

Blaster 400 and Blaster 3000

The Blaster provides the voltage and command to fire the detonators in programmed sequence. Blaster 3000 features advanced functionality for safe, precise and reliable blasting.

Duplex Harness Wire

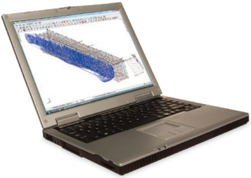
The duplex wire connects detonators with the Logger.

i-kon™ III Connector 6

Designed for on-bench efficiency, the connector carries signals between the detonator and the harness wire.

i-kon™ Logger II

Rugged and field proven.



SHOTPlus™ Blast Design Software

Orica's SHOTPlus™ Blast Design Software downloads blast plans to the i-kon™ III Loggers.

eDev™ II Electronic Tunnel Blasting System

eDev II
Electronic Tunnel Blasting System

Application

Application	Key Benefits
Civil tunnels and vibration constrained underground development	• Better perimeter control. • Improved advancement rate. • Less time at face. • Easier hook up. • Specialty blast design software. • eDev™ II detonators are delivered as a single item per wire length. • Faster blast programming time and faster hookup. • Improved packaging. • Increased maximum delay time. • Fully programmable in one millisecond steps. • Greater precision of delay (0.01% coefficient variation). • Glove-friendly connectors. • Software upgrades ensure current hardware isn't obsolete. • Improved vibration control. • Operational efficiency. • Multiple Heading blasting. • Uniform fragmentation for easier and efficient muck removal. • Versatility for changing geology. • Improved perimeters, over-break, side walls and hanging walls.

Technical Properties

Type	Delay times	Wire length (m)
eDev™ II	0 ms to 20,000 ms	2 3 4 5 6 8

14. Electronic Blasting Systems

Blast Box 610 is a standalone box for firing eDev™ blasts via a wired connection to the detonators. Blast Box 610C does not function as a standalone box. It must be integrated into an i-kon™ CEBS system (for centralised blasting in underground mines) and can only be used with eDev™ II detonators.

Blast Box 610/610C

The Blast Box 610 provides the voltage and command to fire the detonators in programmed sequence.

Blaster 3000

The Blaster 3000 provides the voltage and command to fire the detonators in programmed sequence and features advanced functionality for safe, precise and reliable blasting.

Scanner 260

The Scanner 260 scans unique ID numbers on the detonators and allows the functionality of each detonator in the pattern to be tested before the bench is cleared.

SHOTPlus™ Blast Design Software

Orica's SHOTPlus™ Blast Design Software produces printed blast plans, useful at the face with the eDev™ II system.

eDev™ II Detonator

Accurate and fully programmable electronic detonator.

eDev™ II Connector

Designed for at-face efficiency, the connector carries signals between the detonator and the harness wire.

Duplex Harness Wire

Faster and easier to use, the duplex wire connects detonators with the Blast Box.

Bulk Systems Products

Product		Density (/cc)	RBS%*	VOD (km/s)	Rec. Min. Blasthole Diam(mm)	Rec. Max. Blasthole Depth (m)
ANFO		0.80	100	2.5–4.8	76	80
Coal						
Fortan™ Coal	9 10 11 12 13	0.90 1.00 1.10 1.20 1.28	119 134 154 175 189	2.5- 5.8 2.5–5.8 2.5–5.8 2.8–6.1 3.1–6.3	89 89 89 102 150	80
Aquacharge™ Coal		1.20–1.25	166–173	4.0–6.3	120	80
Fortis™	Coal Coal S Coal H	1.15–1.25	144–166 139–161 148–172	3.7–6.5	115	50
Flexigel™ Coal	50 60 70 80 90 100	+Nominal density refer to TDS	29 40 75 92 109 128	2.5–4.1	200 200 200 100 150 150	60
Fortis™	Deep	1.25	178	4.5–6.5	250	70
Hard Rock						
Fortan™ Advantage	9 10 11 12 13	0.90 1.00 1.10 1.20 1.28	119 134 154 175 189	2.5- 5.8 2.5–5.8 2.5–5.8 2.8–6.1 3.1–6.3	89 89 89 102 150	30
Aquacharge™ Advantage		1.20–1.25	162–176	4.0–6.3	120	30
Fortis™	Advantage Advantage S Advantage H	1.10–1.25	137–172 133–167 142–177	3.7–6.5	89	20
Flexigel™ Advantage	50 60 70 80 90 100	+Nominal density refer to TDS	29 40 75 92 109 128	2.5–4.1	200 200 200 100 150 150	60

Table continues below

Hot and Reactive Ground						
Fortan™ Eclipse	10 11 12 13	1.00 1.10 1.20 1.30	134 154 175 194	2.8–5.6 3.6–6.0 3.5–6.0 4.0–6.8	89 89 102 150	80
Aquacharge™ Eclipse		1.20–1.25	168–180	4.0–6.7	120	80
Fortis™	Eclipse Eclipse S Eclipse H	1.10–1.25	140–175 135–169 144–181	3.7–6.6 3.7–6.5 4.1–6.7	90	45
Flexigel™ Eclipse	70 80 90 100	+ Nominal density refer to TDS	74 92 108 129	2.5–4.1	200 100 150 150	60
Fortan™ Eclipse Plus	10 11 12 13	1.00 1.10 1.20 1.30	135 155 177 198	2.8–5.6 3.2–6.1 3.5–6.5 3.8–6.9	89 89 102 150	80
Aquacharge™ Eclipse Plus		1.20 1.25	171 183	4.0–6.5 4.0–6.7	120	80
Fortis™	Eclipse Plus Eclipse Plus H	1.10–1.25	135–169 137–172	3.7–6.5 4.1–6.5	90	30
Fortis™	Vulcan H	1.10–1.25 1.10–1.25	140–175 144–181	3.7–6.6 4.1–6.7	89	50
Fortan™ Xtreme™		1.20	177	2.8–6.5	102	80
Fortis™ Xtreme™		1.20	169	4.4–6.5	76	50
Xtreme™		0.80	100	2.5–4.8	76	80
Vistan™ si		1.20–1.35	224–251	4.0–6.0	100	30
Vistis™ i		1.20–1.35	216–243	4.5–6.0	90	30
Challenging						
Aquacharge™ Clear		1.20–1.25	169–181	4.0–6.6	120	80
Aquacharge™ Clear i		1.20–1.25	169–181	4.0–6.6	120	80
Flexigel™ Clear	70 80 90 100	+ Nominal density refer to TDS	74 92 108 129	2.5–4.1	200 100 150 150	60

Table continues overleaf

Bulk Systems Products continued

Product		Density (g/cc)	RBS%*	VOD (km/s)	Rec. Min. Blasthole Diam. (mm)	Rec. Max. Blasthole Depth (m)
Flexigel™ Clear i	70 80 90 100	+Nominal density refer to TDS	74 92 108 129	2.5–4.1	200 100 150 150	60
Fortis™ Clear		1.15–1.25	147–169	3.7–6.6	115	50
Fortis™ Clear S		1.15–1.25	144–166	3.7–6.5	115	50
Fortis™ Clear i S		1.15–1.25	144–166	3.7–6.5	115	50
Fortis™ Clear i		1.15 1.20 1.25	147 158 169	3.7–6.2 3.7–6.4 3.7–6.6	115 115 115	30 45 50
Aquacharge Extra		1.20–1.25	174–186	4.0–6.5	120	80
Fortan™ Extra	9 10 11 12 13	0.90 1.00 1.10 1.20 1.30	121 137 159 183 208	2.5 - 5.2 2.5–5.6 2.5–6.0 2.8–6.5 3.8–6.8	89 89 89 102 150	80
Fortan™ Extra i	10 11 12 13	1.00 1.10 1.20 1.30	135 157 178 203	2.8–5.6 3.6-6.0 3.5-6.5 4.0-6.8	89 89 102 150	80
Fortis™	Extra Extra H	1.10–1.25	151–187 151–189	4.1–6.7 4.1–6.7	64	45
Vistan™ s		1.20–1.40	227–278	4.0–6.0	100	30
Vistis™		1.20–1.40	223–273	4.5–6.0	90	30
Underground						
Subtek™ with Subtek™ Control		0.8 1.0 1.2	75 110 151	3.0–6.2	38 38 45	—
Subtek™ Control (Decoupled Charging)		>0.55	40		45	

Table continues below

Subtek™ Eclipse with Subtek™ Control		0.8	75	3.0–6.2	38	—
		1.0	110		38	
		1.2	151		45	
Subtek™ Control (Decoupled Charging)		>0.55	40		45	
Quarry/Construction						
Centra™	Gold	1.15-1.25	168	4.5–6.4	76	25
	Gold ES	1.10	142	4.1–5.9	76	30
	Gold GT	1.15-1.25	162-187	4.4–6.7	76	25
Centra™ Extend		1.10	158	3.5–6.05	89	25
Centra™ Eclipse		1.10–1.25	140–175	3.7–6.6	90	30
Civil Tunnelling						
Civec™		0.80–1.20	72–147	4.5–6.2	38–64	—

** Relative to ANFO @ density 0.8 g/cc.*

Accessories Range

Electric Exploders

Ausdet Stinger SB10 Exploder

A capacitor discharge exploder including rechargeable battery power.

The SB10 exploder is suitable for use in all mining, quarrying, construction and general blasting applications, except in underground coal mines.

Not suitable for gassy coal mines.

Ausdet Stinger SB100 Exploder

A capacitor discharge exploder including rechargeable battery power and a built-in circuit tester.

The SB100 exploder/circuit tester is a dual-function unit enclosed in a robust glass filled Nylon case. The case is dust and splash resistant. The SB100 is a 100-shot capacitor discharge exploder, suitable for use in all mining, quarrying, construction and general blasting applications, except in underground coal mines.

Not suitable for gassy coal mines.

Schaffler 808T Exploder

Hand twist dynamo capacitor discharge exploder. Built strong with fully enclosed, sealed metal casing.

The Schaffler 808T is a 100 shot capacitor discharge exploder, enclosed in a robust metal housing. It is designed particularly to meet the requirements of blasting in gassy underground coal mines.

The Schaffler 808T exploder will initiate 1 to 100 standard electrical detonators connected in series.

Beethoven Mk7 Exploder

A 100-shot hand crank dynamo capacitor discharge exploder. Fully enclosed, sealed plastic heavy-duty casing.

The Beethoven Mk7 is designed to meet the requirements of blasting in gassy underground coal mines. The Mk7 has an integral digital ohmmeter which can be used to measure the total circuit series resistance. The d/c voltage required to initiate the detonators is supplied by a hand operated generator which charges a capacitor.

The Beethoven Mk7 exploder is approved for use in gassy underground coal mines in Queensland only.

Non-Electric Starters

Shot Shell Starter Kit

A hardened stainless steel percussion starter for signal tube initiation with shot shell primers.

Shot Shell Starter kit is supplied complete with 100-shot shells and maintenance equipment in a sturdy storage bag.

Testing Equipment

ZEB/DZ3 Digital Ohmmeter

Precision circuit tester with digital read out. Resistance reading range from 0 to 1999 ohms, with 0.1 ohms resolution.

The ZEB/DZ3 digital ohmmeter is a high quality portable instrument mounted in a dust and splash resistant case. The ohmmeter is an auto-ranging type incorporating a highly visible digital readout. Screw terminals are fitted for simple attachment of the firing circuit wires.

Schaffler Digiohm Ohmmeter

An approved digital circuit testing ohmmeter for underground coal mines.

The DIGIOHM may be used to test individual bridge wire detonators, chains of detonators, firing lines and whole firing circuits.

CT100 Digital Ohmmeter

General purpose circuit resistance tester with digital read out. Precise resistance reading range from 0 to 199 ohms, with 0.1 ohm resolution.

The CT100 circuit tester is a portable ohmmeter designed specifically for testing electrical firing circuits. The ohmmeter is a fixed range type incorporating a highly visible digital readout.

The complete unit is enclosed in a protective leather case complete with belt clip and neck strap. The CT100 circuit tester is suitable for use at mine, quarry, construction and general blasting sites. It is not suitable for use in gassy underground coal mines.

Shot Firing Cables

White Shot Firing Cable

Twin multi-stranded insulated copper conductors which lead from the exploder to the detonator wires.

Yellow Shot Firing Cable

Twin multi-stranded insulated, heavy duty, insulated, low resistance cable for blast initiation.

Twin Twist Connecting Wire

Twin Two single strands of copper wire, coated with PVC, for electric blasting circuits.

Suitable for extending detonator leads down blastholes, away from faces, or otherwise connecting lead wires to the firing line.

Not recommended for use as a main firing line.

Hoses

Lo-Stat™ Special Hose

The Lo-Stat™ Special Hose is a lightweight, robust, semi-conductive, thermoplastic loading hose used for the delivery of ANFO in underground applications.

Available in 30 m and 60 m lengths.

Underground Powerhose MK3

Used in underground bulk emulsion systems, for optimal pumping rates and loading efficiency.

Pentex™ Accessories

Pentex™ D Applicator

Applicator used with the Pentex™ D Booster. The Applicator twists into a production nozzle at the end of a static mixer or yellow Underground bulk delivery hose.

The unique design features facilitate ease of loading, retention of the unit in the hole and the secure placement of a high strength detonator.

Pentex™ D Hosetail and Hose Nozzle

The Hosetail is designed to be screwed into the Underground Powerhose MK3 and is supplied with a *protective shroud* on the exposed thread.

The hose nozzle is screwed into the internal Hosetail thread.

On removal of the *protective shroud*, the Applicator (supplied with Pentex™ D) can be fitted to facilitate the use of Pentex™ D.

Pentex™ D Hosetail and Hose Nozzle

The 3/4" nozzle and hose tail assembly is an alternative to the Pentex D nozzle for production loading rates only and is compatible with PentexTM Stopeprime booster.

The Hosetail Production is designed to be screwed into the Powerhose MK3.

The Hose Nozzle 3/4" Production is then screwed into the internal Hosetail thread.

Ballistic Disc Accessories

Ballistic Disc 260

Ballistic Discs provide a safe and effective way of remotely clearing hang ups and upstanding drill in draw points and stopes for the underground market.

Comprises 6.9 kg of explosive cast into an aluminium lining, capped with a steel disc. The unit is initiated by a detonating cord assembly made from 20 g/m detonating cord.

Laser Aimer for Ballistic Disc 260

A machined base supports a firearm Laser Sight to provide highly accurate illumination of the ballistic disc target site.

The Laser Aimer magnetically attaches to the face of a Ballistic Disc.

Borehole Spring (75 mm)

Polyethelene plug used in conjunction with stemming and for securing explosives in blast holes. Also used for marking and keeping back fill from entering hole.

Retention Devices

Borehole Plug Brush

Borehole retention device for use in upholes loaded with bulk emulsion (150 mm × 225 mm).

Auto Prime Shell

Plastic shell used to secure Pentex™ G primers in up-holes of 51 mm to 89 mm diameter.

Ideal application for use in production up-holes.

Spiders for Pentex™ Stopeprime™

Pentex™ Stopeprime™ Spider

Plastic spider used to secure Stopeprimer primers in up-holes. Ideal for use in perimeter and lifter boreholes, wet development headings, stope hanging walls and pre-split applications where floating and rifling can occur.

Detonating Cord Cutters

Detonating Cord Cutters

Heavy duty, single action cutter featuring a long stainless steel blade with synthetic anvil, avoiding hazardous shearing action.

J-Style Easy Cord Cutter

Drag knife, for slicing easily through Cordtex™ Detonating cord. No moving parts, and small enough to fit on a miner's belt.

Sold in packets of 10, safe and economical method of cutting cord.

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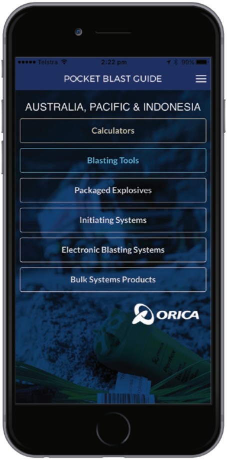

Our Pocket Blast Guide continues to provide users with reliable content and the ability to perform complex blasting calculations.

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